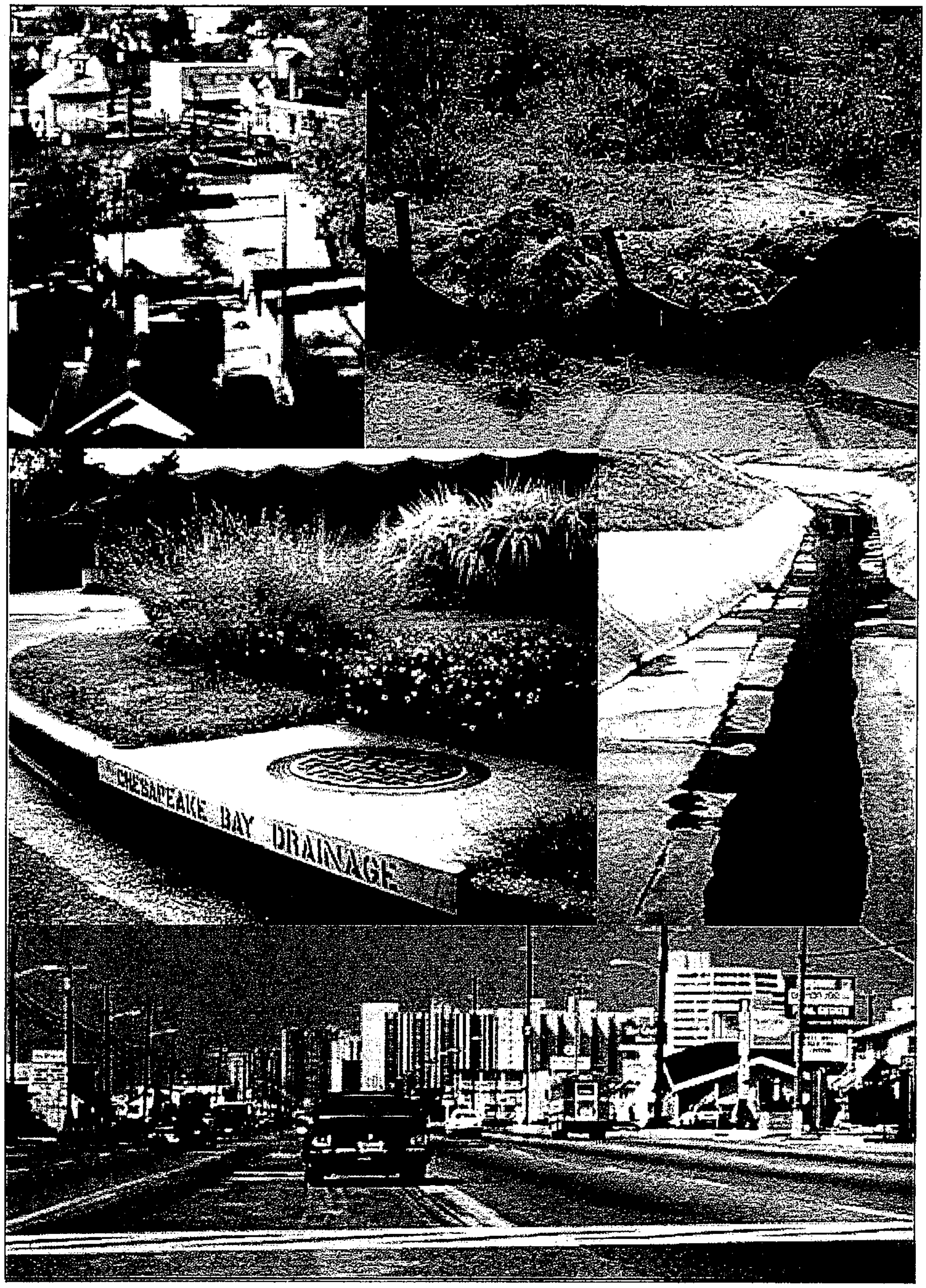
National Management Measures to Control Nonpoint Source Pollution from Urban Areas



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INTRODUCTION

The nation's aquatic resources are among its most valuable assets. Although environmental protection programs in the United States have improved water quality during the past several decades, many challenges remain. Of special concern are the problems in our urban streams, lakes, estuaries, aquifers, and other water bodies caused by runoff that is inadequately controlled or treated. These problems include changes in flow, increased sedimentation, higher water temperature, lower dissolved oxygen, degradation of aquatic habitat structure, loss of fish and other aquatic populations, and decreased water quality due to increased levels of nutrients, metals, hydrocarbons, bacteria, and other constituents.

The *National Water Quality Inventory: 2000 Report to Congress* identified urban runoff as one of the leading sources of water quality impairment in surface waters (USEPA, 2002b). Of the 11 pollution source categories listed in the report, "urban runoff/storm sewers" was ranked as the fourth leading source of impairment in rivers, third in lakes, and second in estuaries (Table 0.1).

Table 0.1: Leading sources[b] of water quality impairment related to human activities for rivers, lakes, and estuaries (USEPA, 2002b).

Rivers and Streams	Lakes, Ponds, and Reservoirs	Estuaries
Agriculture (48%)[a]	Agriculture (41%)[a]	Municipal point sources (37%)[a]
Hydrologic modifications (20%)	Hydrologic modifications (18%)	Urban runoff/storm sewers (32%)
Habitat modifications (14%)	Urban runoff/storm sewers (18%)	Industrial discharges (26%)
Urban runoff/storm sewers (13%)	Misc. nonpoint source pollution (14%)	Atmospheric deposition (24%)

[a]Values in parentheses represent the percentage of assessed river miles, lake acres, or estuary square miles that are classified as impaired. States assessed 19% of stream miles, 43% of lakes, ponds, and reservoirs, and 36% of square mileage of estuaries.
[b]Excluding unknown, natural, and "other" sources.

0.1 Purpose and Scope of the Guidance

National summaries, such as those shown in Table 0.1, are useful in providing an overview of the magnitude of the problems associated with urban runoff. Solutions, however, are usually applied at the local level. State and local elected officials and agencies, landowners, developers, environmental and conservation groups, and others play a crucial role in protecting, maintaining, and restoring water resources. Their efforts, in aggregate, form the basis for changing the status of urban runoff from a local problem to a national problem.

This document provides guidance to states, territories, authorized tribes, and the public regarding management measures that can be used to reduce nonpoint source pollution from urban activities. This document refers to statutory and regulatory provisions that contain legally binding requirements. This document does not substitute for those provisions or regulations, nor is it a regulation itself. Thus, it does not impose legally binding requirements on the U.S. Environmental Protection Agency (EPA), states, territories, authorized tribes, or the public and may not apply to a particular situation based upon the circumstances. EPA, state, territory, and authorized tribe decision-makers retain the discretion to adopt approaches that differ from this guidance on a case-by-case basis. Interested parties are free to raise questions and objections about the appropriateness of the application of the guidance to a situation, and EPA will consider whether or not the recommendations in this guidance are appropriate in that situation. EPA may change this guidance in the future.

This guidance document *is* intended to provide technical assistance to state and local program managers and other practitioners on the best available, most economically achievable means of managing urban runoff and reducing nonpoint source pollution of surface and ground waters from urban sources. It describes how to develop a comprehensive runoff management program that deals with all phases of development—from predevelopment watershed planning and site design, through the construction phase of development, to the operation and maintenance of structural controls. It also provides information for other situations such as retrofitting existing development, implementing nonstructural controls, and reevaluating the runoff management program. Figure 0.1 presents the components of a comprehensive runoff management program.

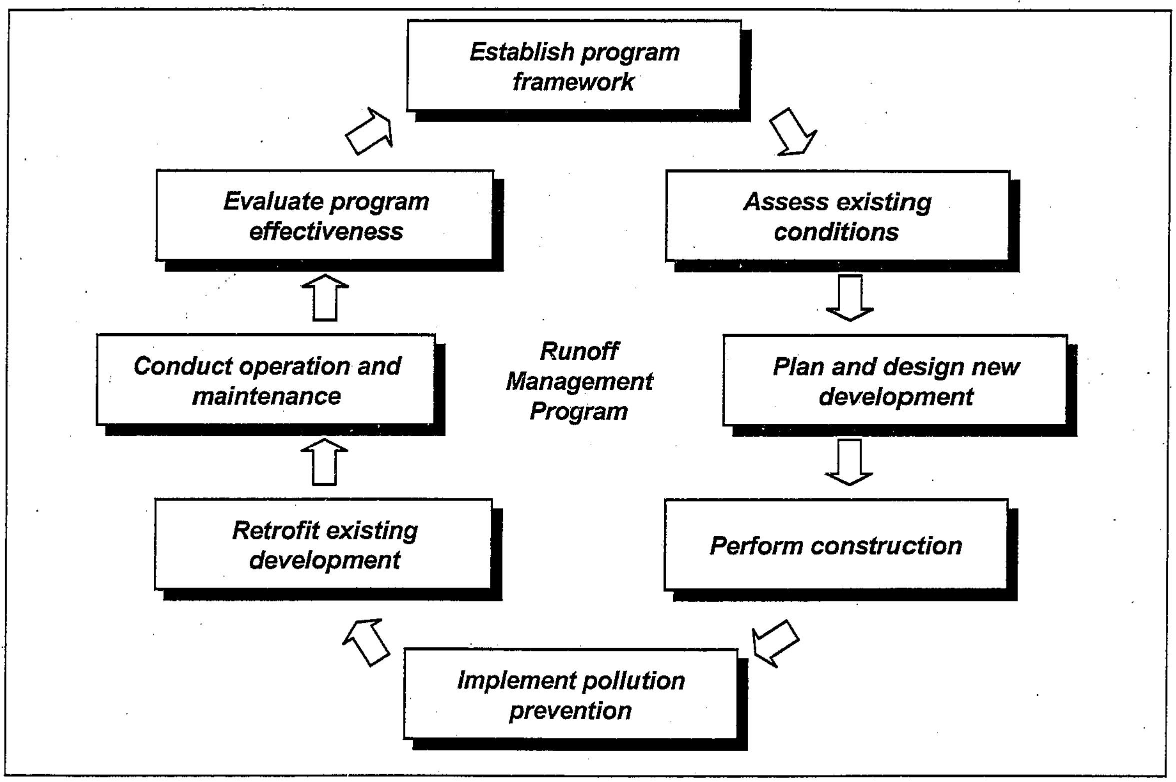

Figure 0.1: Components of a comprehensive runoff management program.

This document is intended to provide guidance for all urban areas, not just those covered by National Pollutant Discharge Elimination System (NPDES) phase II requirements. While the document can serve as a resource for meeting NPDES phase II requirements, there are still a number of smaller jurisdictions that are not regulated by the NPDES program and that can benefit from guidance in developing an urban runoff program.

0.1.1 Management Measures

Management measures can be used to guide the development of a runoff management program. They establish performance expectations and, in many cases, specify actions that can be taken to prevent or minimize nonpoint source pollution or other negative impacts associated with uncontrolled and untreated urban runoff. Twelve management measures have been included in this guidance. Figure 0.2 groups these measures within the context of the runoff management program cycle.

Each management measure listed in Figure 0.2 deals with an important aspect of the runoff management cycle. For example, Management Measure 8 focuses on construction site erosion, sediment, and chemical control. Local officials and developers should address these issues because if exposed soils are allowed to erode and move off construction sites as sediment, they can clog storm drains, streams, and other water bodies, harm habitat, and impair water quality.

This management measure has four elements:

- Prior to land disturbance, prepare and implement an approved erosion and sediment control plan or similar administrative document that contains erosion and sediment control provisions.
- Reduce erosion and, to the extent practicable, retain sediment on-site during and after construction.
- Use good housekeeping practices to prevent off-site transport of waste material and chemicals.
- Minimize application and generation of potential pollutants, including chemicals.

Note that specific actions or practices for achieving the performance expectations are not included in the management measure statement. This is by design. Local officials and other practitioners need the flexibility to choose management practices that best achieve the management measure's performance expectations given their own unique circumstances. To aid in their decision, however, this guidance presents several management practices that can potentially be used to achieve each management measure.

The components of the runoff management program shown in Figure 0.2 are organized in a cycle that can be followed stepwise if desired. The elements are meant to work together, but each can stand alone. The elements of the cycle do not have to be implemented consecutively.

The cycle begins with establishing a program framework that provides legal authority, funding, and staffing for watershed initiatives (Management Measure 1). Once this framework is established, watershed managers can commence an assessment of existing conditions (Management Measure 2) to identify areas in need of protection or restoration. This assessment also provides stream channel and water quality baselines (i.e., environmental indicators) against which the success of watershed initiatives can be compared (Management Measure 12: Evaluate Program Effectiveness).

Management Measures 3 through 7 address issues associated with new development. The watershed protection management measure (3) focuses on siting development and establishing

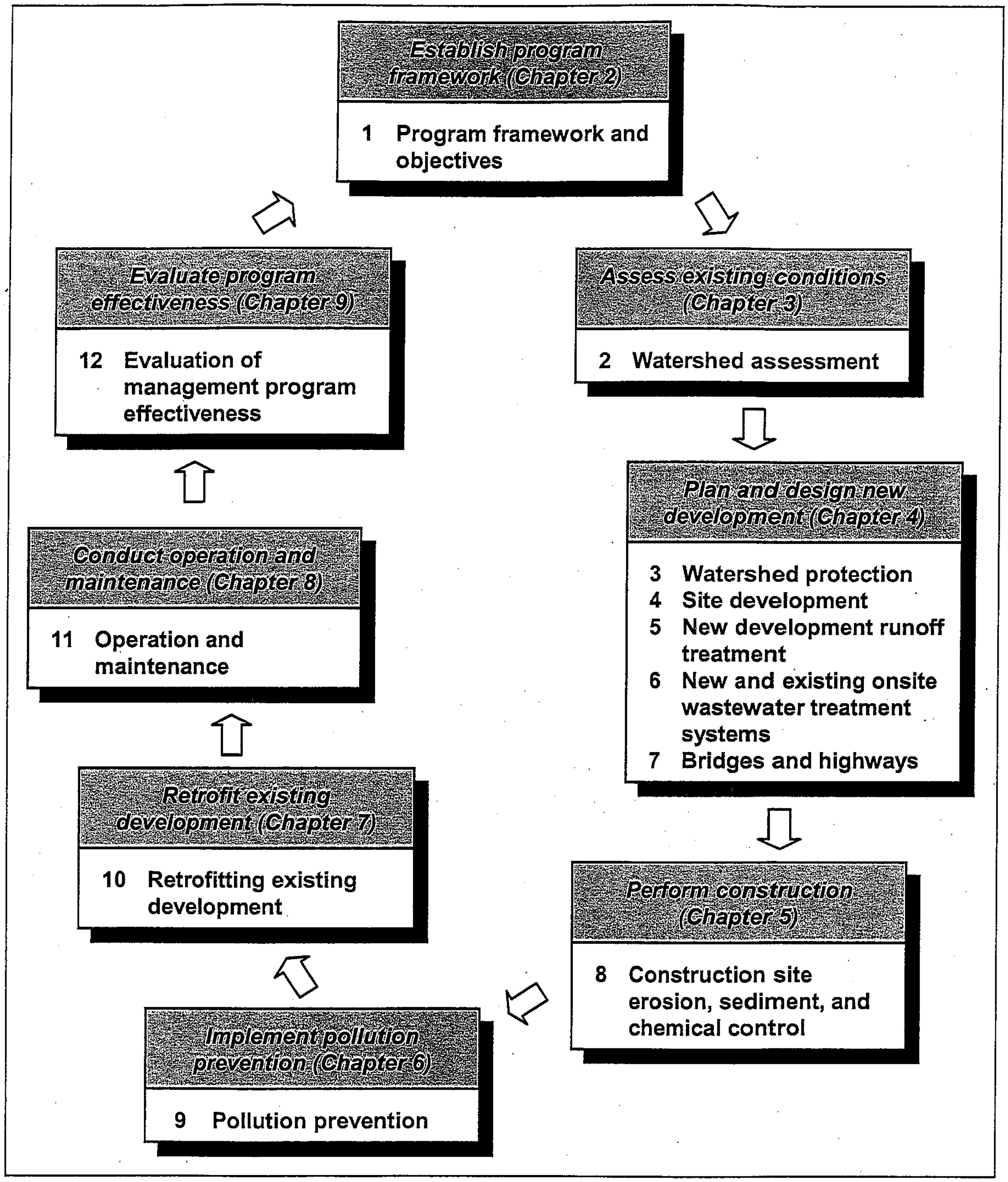

Figure 0.2: Twelve management measures associated with the runoff management program cycle.

actions to protect areas identified as sensitive or ecologically valuable. The Site Development Management Measure (4) provides guidance for planning development on the site scale with alternative, low-impact site layouts and infrastructure options that protect sensitive areas and reduce the quantity of runoff leaving the site. The New Development Runoff Treatment Management Measure (5) details practices that can be identified to prevent pollutants in runoff generated from newly developed areas. The onsite wastewater treatment systems management measure (6) provides guidance on how to reduce pollutant loadings from both new and existing on-site systems. Finally, the Highways and Bridges Management Measure (7) addresses pollutants generated from activities related to new and existing transportation infrastructure.

Once development plans have been made, watershed managers can refer to Management Measure 8: Construction Site Erosion, Sediment, and Chemical Control. This measure presents practices that reduce pollutant loadings from land-disturbing activities.

Throughout the runoff management program cycle, watershed managers can use the Pollution Prevention Management Measure (9) to target municipalities, businesses, and individual citizens with education and awareness programs to reduce pollutants generated from day-to-day activities. Managers also can use the practices presented in the Existing Development Management Measure (10) to address areas in need of restoration or retrofitting of existing management practices. Additionally, the Operation and Maintenance Management Measure (11) describes activities needed to maintain and extend the life of new and existing management practices.

Once programs have been established and management practices implemented, managers can evaluate their effectiveness using program and administrative indicators (Management Measure 12). This evaluation involves reassessing conditions in the watershed to determine whether the implemented practices effectively reduced nonpoint source pollution. This evaluation also identifies areas where additional restoration or preservation activities are needed, guiding future watershed initiatives and thereby restarting the management cycle.

North Branch of the Chicago River Demonstration Project

Through the North Branch of the Chicago River Demonstration Project, the Friends of the Chicago River, and the Lake County Storm Water Management Commission joined to develop a plan to address NPS pollution and flooding while educating and involving citizens and community leaders in the process (USEPA, 2000a). The result was an urban watershed planning model, similar to the one presented in this guidance, that any city can use to protect its water resources.

This 96-square-mile watershed was affected by storm water runoff from two counties and 24 towns. The partners in the North Branch of the Chicago River Demonstration Project divided the project into four tasks—developing a watershed plan, conducting an information and education campaign, developing a handbook to guide them through the process, and conducting a series of demonstration projects. For more information, contact Friends of the Chicago River (http://www.chicagoriver.org).

0.1.2 Document Organization

Chapters 2 through 9 of this document consecutively focus on the eight components of the runoff management program cycle (Figure 0.2). Each chapter describes a component, introduces one or more management measures that define the performance expectation(s) for that component, and presents a range of management practices that potentially can be implemented to achieve the management measure(s). When available, information concerning effectiveness and costs of practices is included in the discussion, as are case studies that illustrate how select management practices have been implemented within communities.

0.2 Origin and Regulatory Context

0.2.1 Origin of This Guidance

This document is an update of the urban management measures and practices provided in Chapter 4 of an EPA manual entitled *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters* (USEPA, 1993). That document, referred to hereafter as the Coastal Management Measures Guidance, was published in January 1993 for the specific purpose of providing state and territorial officials with management measures to incorporate into their coastal nonpoint source (NPS) pollution control programs.

Through the Coastal Zone Act Reauthorization Amendments of 1990 (CZARA), Congress mandated that EPA develop the Coastal Management Measures Guidance, and that every state and territory with an approved coastal zone management program develop an NPS pollution control program, including enforceable policies and mechanisms to implement all of the specified management measures. The programs were submitted to EPA and the National Oceanic and Atmospheric Administration (NOAA) for approval. All were subsequently approved, some with conditions. The Coastal Management Measures Guidance functions as a blueprint for the coastal states and territories in their efforts to put together their NPS control programs.

The Coastal Management Measures Guidance included management measures for urban areas (Chapter 4), agriculture (Chapter 2), silviculture (Chapter 3), marinas (Chapter 5), and hydromodification (Chapter 6). It also addressed protection of wetlands and riparian areas from NPS pollution impacts and the use of vegetative treatment systems, such as constructed wetlands, as management practices to control runoff (Chapter 7).

Of all the NPS pollution sources identified in the Coastal Management Measures Guidance, none has experienced the rapid technical advancement that has occurred in the areas of urban NPS pollution control. Many communities have set their sights beyond simple NPS pollutant reduction targets and are now seeking ways to achieve balance and integration of many quality-of-life factors, including economic growth, community livability, and environmental protection.

Based on these changes, EPA perceived a need to update and expand the information in Chapter 4 of the Coastal Management Measures Guidance to help local urban officials in both coastal and inland areas remain current with state-of-the-art management measures and practices. Readers should note, however, that this guidance does *not* supplement or replace the 1993 *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters* for the purpose of implementing programs under CZARA. It simply serves as an additional resource guide for local officials seeking to develop or improve their urban runoff management programs.

Fundamental differences between this guidance and the Coastal Management Measures Guidance are presented in Table 0.2.

Table 0.2: Key differences between the *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters* (USEPA, 1993) and *National Management Measures to Control Nonpoint Source Pollution from Urban Areas*.

	Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters	National Management Measures to Control Nonpoint Source Pollution from Urban Areas
Date	1993	2005
Target audience	*Primary:* state and territory officials *Secondary:* all others interested in NPS pollution	All persons interested in urban NPS pollution and control practices
Focus	NPS management measures and control practices in coastal areas	NPS management measures and control practices in coastal and inland areas
Use	Required under CZARA	Voluntary
Organization	Management measures and practices presented by source category	Management measures and practices presented in the context of a comprehensive watershed program

0.2.2 Regulatory Context

During the first 15 years (1972–1987) of the national program to abate and control water pollution, EPA and the states focused most of their activities on traditional point sources. These point sources have been regulated by EPA and the states through the NPDES permit program established by Section 402 of the Clean Water Act. The NPDES program functions as the primary regulatory tool for ensuring compliance with water quality standards. NPDES permits, issued by either EPA or an authorized state, contain discharge limits designed to meet water quality standards and national technology-based effluent regulations.

In 1987, in view of the progress achieved in controlling point sources and growing national awareness of the increasingly dominant influence of NPS pollution on water quality, Congress amended the Clean Water Act to focus greater national efforts on nonpoint sources. Under this amended version, referred to as the 1987 Water Quality Act, Congress revised Section 101, "Declaration of Goals and Policy," to add the following fundamental principle:

> It is the national policy that programs for the control of nonpoint sources of pollution be developed and implemented in an expeditious manner so as to enable the goals of this Act to be met through the control of both point and nonpoint sources of pollution.

The Water Quality Act of 1987 also included language that required comprehensive storm water regulation using a two-phased approach. (Detailed information on both phases of the NPDES Storm Water Program is available at http://www.epa.gov/npdes/stormwater.) Phase I, in place since 1990, required operators of medium and large municipal separate storm sewer systems (MS4s) located in incorporated areas and counties with populations of more than 100,000, certain industrial activities, and construction activities disturbing 5 acres or more to obtain an NPDES permit to discharge storm water runoff. In October 1999 EPA expanded the federal storm water program with the promulgation of the Phase II rule.

Phase II requires operators of small MS4s (non-Phase I regulated MS4s) in "urbanized areas" (as defined by the Bureau of the Census) and small construction activities disturbing between 1 and

5 acres of land to obtain an NPDES permit. Further, the NPDES permitting authority may require operators of small MS4s not in urbanized areas and small construction activities disturbing less than 1 acre to obtain an NPDES permit based on the potential for contribution to a violation of a water quality standard. NPDES permitting authorities are required under the rule to assess for potential designation all small MS4s located outside an urbanized area that are in areas with a population of at least 10,000 and a population density of 1,000 per square mile. The Phase II rule also includes a revised conditional no-exposure provision for industrial facilities, which provides for a waiver from the permit program if the storm water pollutant sources at a facility can be demonstrated to be isolated from precipitation and runoff.

For small MS4 permits, Phase II prescribes a set of six minimum control measures, as well as requirements for evaluation and assessment efforts. The minimum measures are: (1) public education and outreach on storm water impacts; (2) public involvement/participation; (3) illicit discharge detection and elimination; (4) construction site runoff control; (5) postconstruction storm water management in new development and redevelopment; and (6) pollution prevention/good housekeeping for municipal operations. The regulated operators must choose and implement appropriate best management practices (BMPs) and define measurable goals for each measure. The operators must also periodically evaluate and assess program compliance, the appropriateness and effectiveness of their chosen BMPs, and progress toward achieving their identified measurable goals. This guidance is expected to be consistent with any guidance issued for regulated small MS4 operators to meet the requirements of Phase II NPDES storm water discharge permits. Therefore, the management measures and practices herein can serve as a resource in developing a community's storm water management program. It is important to note, however, that additional requirements not addressed in this guidance may be imposed under an NPDES storm water permit. Table 0.3 specifies how the management measures relate to each of the six minimum control measures.

Table 0.3: Comparison of management measures to the six minimum control measures of NPDES Phase II.

	Public Education	Public Involvement	Illicit Discharge	Construction Site ESC	Post Construction	Pollution Prevention
Program Framework and Objectives						
Establish Legal Authority			✓	✓	✓	✓
Develop an Institutional Structure						
Provide Adequate Funding and Staffing						
Foster Input From Technical Experts, Citizens, and Stakeholders		✓				
Establish Intergovernmental Coordination		✓				
Develop Training and Education Programs and Materials	✓	✓				
Watershed Assessment						
Characterize Watershed Conditions						
Assess Cumulative Effects						
Estimate the Effectiveness of Treatment Programs						
Establish a Set of Watershed Indicators						
Establish Water Quality Indicators	Measurable Goals					
Establish Physical and Hydrological Indicators						
Establish Biological Indicators						
Establish Programmatic Indicators						
Develop a Suite of Social Indicators						
Watershed Protection						
Resource Inventory and Information Analysis					✓	
Development of Watershed Management Plan					✓	
Implement the Plan					✓	
Land or Development Rights Acquisition Practices					✓	
Site Development						
Site Planning Practices					✓	
On-Lot Impervious Surfaces					✓	
Residential Street and Right-of-Way Impervious Surfaces					✓	
Parking Lot Impervious Surfaces					✓	
Xeriscaping Techniques					✓	
New Development Runoff Treatment						
Infiltration Practices					✓	
Vegetated Open Channel Practices					✓	
Filtering Practices					✓	
Detention and Retention Practices					✓	
Other Practices					✓	
New and Existing Onsite Wastewater Treatment Systems						
Permitting and Installation Programs			✓			✓
Operation and Maintenance Programs			✓			✓

Table 0.3 (continued).

	Public Education	Public Involvement	Illicit Discharge	Construction Site ESC	Post Construction	Pollution Prevention
Bridges and Highways						
Site Planning and Design Practices					✓	
Soil Bioengineering and Other Runoff Controls for Highways					✓	
Structural Runoff Controls for Bridges					✓	
Bridge Operation and Maintenance Controls						✓
Nonstructural Runoff Control Practices						✓
Construction Site Erosion, Sediment, and Chemical Control						
Erosion and Sediment Control Programs				✓		
Erosion Control Practices				✓		
Sediment Control Practices				✓		
Develop and Implement Programs to Control Chemicals and Other Construction Materials				✓		
Pollution Prevention						
Household Chemicals	✓	✓				✓
Lawn, Garden, and Landscape Activities	✓	✓				✓
Commercial Activities	✓	✓	✓			✓
Trash	✓	✓				✓
Nonpoint Source Pollution Education for Citizens	✓	✓				
Existing Development						
Identify, Prioritize, and Schedule Retrofit Opportunities					✓	
Implement Retrofit Projects as Scheduled					✓	
Restore and Limit the Destruction of Natural Runoff Conveyance Systems					✓	
Restore Natural Streams					✓	
Preserve, Enhance, or Establish Buffers					✓	
Redevelop Urban Areas to Decrease Runoff-Related Impacts					✓	
Operation and Maintenance						
Establishing an Operation and Maintenance Program					✓	✓
Source Control Operation and Maintenance					✓	✓
Treatment Control Operation and Maintenance					✓	✓
Evaluate Program Effectiveness						
Assess the Runoff Management Program Framework	Measurable Goals					
Track Management Practice Implementation						
Gauge Improvements in Water Quality Resulting from Management Practice Implementation						
Develop and Implement a Schedule to Improve the Management Program Framework						

The Clean Water Act establishes several reporting, funding, and regulatory programs that address pollutants carried in runoff that is not subject to confinement or treatment. These programs relate to watershed management and urban NPS control. Readers are encouraged to use the information contained in this guidance to develop nonpoint source management programs/plans that comprehensively address the following EPA reports and programs:

- *Section 303(d) Lists and TMDLs*. Under section 303(d) of the Clean Water Act, states are required to compile a list of impaired waters that fail to meet any of their applicable water quality standards or cannot support their designated or existing uses. This list, called a "303(d) list," is submitted to Congress every two years, and states are required to develop a Total Maximum Daily Load (TMDL) for each pollutant causing impairment for water bodies on the list. More information on the TMDL program and 303(d) lists is provided at http://www.epa.gov/owow/tmdl.
- *Section 305(b) and the National Water Quality Inventory: Report to Congress*. Every two years, states are required to submit a report to Congress detailing the health of their waters. These periodic reports allow Congress to gauge progress toward meeting the goals of the Clean Water Act and to help identify priorities for future pollution control funding and activities. More information on the 305(b) program and the National Water Quality Inventory is provided at http://www.epa.gov/owow/305b.
- *Section 319 Grant Program*. Under Section 319 of the Clean Water Act, EPA awards funds to states and eligible tribes to implement NPS management programs. These funds can be used for projects that address urban sources of pollution. More information about the Section 319 program is provided at http://www.epa.gov/owow/nps/cwact.html.
- *Section 404 Discharge of Dredged and Fill Material*. Under Section 404 of the Clean Water Act, persons planning to discharge dredged or fill material to wetlands or other waters of the United States generally must obtain authorization for the discharge from the U.S. Army Corps of Engineers (Corps), or a state approved to administer the Section 404 program. Such authorization can be through issuance of an individual permit, or may be subject to a general permit, which applies to certain categories of activities having minimal adverse environmental effects. Implementation of Section 404 is shared between the Corps and EPA. The Corps is responsible for reviewing permit applications and deciding whether to issue or deny permits. EPA, in consultation with the Corps, develops the Section 404(b)(1) Guidelines, which are the environmental criteria that the Corps applies when deciding whether to issue permits. EPA also has authority under Section 404(c) to "veto" Corps issuance of a permit in certain cases. More information about the 404 program is provided at http://www.epa.gov/owow/wetlands.
- *Clean Water State Revolving Fund*. EPA established the Clean Water State Revolving Fund (CWSRF) to provide states with low- or no-interest loans for projects that improve water resources. These funds can be used to support urban NPS pollution programs and projects. To receive CWSRF loans from EPA for water quality projects, states must develop annual Intended Use Plans that outline the expected use of these funds. More information on the CWSRF program is provided at http://www.epa.gov/OWM/finan.htm.
- *National Estuary Program*. Under the National Estuary Program, states work together to evaluate water quality problems and their sources, collect and compile water quality data,

and integrate management efforts to improve conditions in estuaries. So far 28 estuaries have been accepted into the program. Estuary programs can be an excellent source of water quality data and can provide information on management practices. More information on the National Estuary Program is provided at http://www.epa.gov/owow/estuaries/nep.html.

Two excellent resources for learning more about the Clean Water Act and the many programs established under it are *The Clean Water Act: An Owner's Manual* (Elder et al., 1999) and *The Clean Water Act Desk Reference* (WEF, 1997).

Safe Drinking Water Act. Many urban areas, especially urban fringe areas, need to maintain or improve the quality of surface and ground waters that are used as drinking water sources. This act requires states, among other things, to develop Source Water Assessment Reports and implement Source Water Protection Programs. Low- or no-interest loans are available under the Drinking Water State Revolving Fund Program. More information about the Safe Drinking Water Act and Source Water Protection Programs can be found at http://www.epa.gov/safewater/protect.html.

0.3 Key Concepts

0.3.1 Watershed Approach

Since 1991, EPA has promoted the watershed approach as the key framework for dealing with problems caused by urban runoff and other sources that impair surface and ground waters (USEPA, 1998). Five principles guide the watershed approach:

- *Place-based focus*. Activities are directed within specific geographic areas known as management units. When surface runoff is the primary issue, these management units are defined by watershed boundaries. Other types of boundaries can also be used to define management units in special circumstances. If ground water is an issue, for example, ground water recharge areas might be a logical designation.

- *Stakeholder involvement and partnerships*. The people most affected by management decisions are involved throughout the process. Stakeholder participation helps to ensure that local quality of life, economic stability, and other important community issues are incorporated into planning and implementation activities. Partnerships among public agencies and private groups at all levels are also crucial for long-term success.

- *Environmental goals and objectives*. The success of watershed initiatives is measured by improvements of the water resource rather than by programmatic objectives. For example, reestablishing the pool and riffle structure in a stream channel to increase aquatic insect and fish populations might be an objective. Local goals and objectives need to be consistent with all applicable state, tribal, and federal statutes and regulations, including water quality standards.

- *Problem identification and prioritization*. Sound scientific data and methods are used to identify and prioritize threats to human and ecosystem health. This process usually begins with the assessment and characterization of current natural resource and community conditions within the management unit(s). Problems, including their causes and sources, are also documented. Stakeholders and partners then work jointly to set priorities among the various water resource concerns, taking into account priorities already established at scales above and below the management unit.

– *Integration of actions*. Stakeholders and partners take actions in a comprehensive and integrated manner. Results are then evaluated and actions are adjusted as needed.

A key attribute of the watershed approach is that it can be applied with equal success to large- and small-scale watersheds. Federal agencies, states, interstate commissions, and tribes usually apply the approach on watersheds of approximately 100 square miles. Local agencies and urban communities, however, can apply the approach to watersheds as small as 1 square mile. Although specific objectives, priorities, actions, timing, and resources might vary from large scale to small scale, the basic goals of the watershed approach remain the same—protecting, maintaining, and restoring water resources.

Local runoff management program officials must be especially conscious of watershed scale when planning and implementing specific management practices. Nonstructural practices, such as stream protection ordinances and public education campaigns, are usually applied community-wide. Consequently, the results benefit many small watersheds. In contrast, structural practices, such as infiltration basins and sand filters, usually provide direct benefits to a single stream. Regional structural management practices such as retention ponds for larger watersheds can be used, but they do not protect smaller contributing streams. Given limited resources, runoff program officials must often analyze costs and benefits and choose between large- and small-scale practices. Often, a combination of nonstructural and structural practices is the most cost-effective approach.

British Columbia's Watershed Approach

The Province of British Columbia has taken a watershed approach in planning for water quality protection through runoff volume management. Program officials have recognized the link between surface water volume and watershed health, and are incorporating land use planning into urban runoff management efforts. The Water Balance Model is a decision support tool developed to assist in the integration of land use planning and urban runoff management by simulating the effects of source controls within the watershed. This tool allows the province to establish priorities and efficiently evaluate the potential effectiveness of management efforts (Stephens et al., 2003).

0.3.2 Stream Network

The size of a watershed is closely related to the network of streams contained within its borders. Streams with no upstream tributaries are designated as first-order streams down to their first confluence. A second-order stream is formed when two first-order streams meet. A third-order stream is created by the confluence of two second-order streams, and so on.

Headwater streams are defined as first- and second-order streams. What they lack in individual size and length, they make up through sheer numbers. Headwater streams dominate the landscape, accounting for roughly 75 percent of the total stream and river mileage in the United

States (Table 0.4). Because they are the dominant drainage feature, headwater streams also directly receive the bulk of runoff from construction sites, developments, parking lots, highways, and other features of the urban landscape. In most communities, runoff is collected by a storm sewer system and discharged with no treatment. Increases in the volume and rate of storm water runoff have historically resulted in construction of concrete channels and drainage pipes, eliminating many headwater streams.

Table 0.4: National stream order statistics (Leopold et al., 1964).

Stream Order	Number of Streams	Total Length of Stream Miles	Mean Drainage Area (square miles)
1	1,570,000	1,570,000	1
2	350,000	810,000	4.7
3	80,000	420,000	23
4	18,000	220,000	109
5	4,200	116,000	518
6	950	61,000	2,460
7	200	30,000	11,700
8	41	14,000	55,600
9	8	6,200	264,000
10	1	1,800	1,250,000

0.3.2.1 Watershed scales

Any number of watersheds can be defined by the streams within the network. Larger watersheds encompass progressively smaller watersheds in a hierarchical manner. Larger watershed scales, or national scales, are classified using the Hydrologic Unit Code (HUC), a system of hierarchical codes used by federal agencies, states, interstate commissions, tribes, and others to identify watersheds at the national level. Smaller local watersheds, existing at scales below the smallest HUC scale, are identified more informally.

The U.S. Geological Survey (USGS) has developed the National Hydrography Dataset (NHD), which is a comprehensive set of digital spatial data derived from USGS digital line graphs and EPA's reach file 3 that contains information about surface water features such as lakes, ponds, streams, rivers, springs, and wells. Within the NHD, surface water features are combined to form "reaches," which provide the framework for linking water-related data to the NHD surface water drainage network. These linkages enable the analysis and display of these water-related data in upstream and downstream order. More information about the NHD is provided at http://nhd.usgs.gov.

0.3.2.2 National-level scales

USGS developed the HUC system for the purpose of inventorying all "national scale" watersheds in the United States. To accomplish this objective the agency first divided the country into 21 regions that account for the watersheds of 21 major river basins. Within those major river basins the agency identified a total of 222 watershed subregions. The subregions, in turn, were classified as 352 accounting units. The accounting units were further broken down into 2,262 smaller watersheds called cataloging units.

Each level, or scale, in the watershed hierarchy is identified by a numerical code. The cataloging unit, the smallest scale in the hierarchy, has an eight-digit code that uniquely identifies its location. The region where the cataloging unit resides is designated by the first two digits of the code, the subregion by the second two digits, and so on until the four scales are identified. For example, the watershed of the Upper Mississippi River at Hasting, Minnesota, has a HUC code of 07010206. This code breaks down as follows:

Major River Basin ID	07
Subbasin ID	0701
Accounting Unit ID	070102
Catalog Unit ID	07010206

0.3.2.3 Local-level scales

The hierarchy established by the HUC system identifies scales useful for watershed planning and management by national, regional, state, and multi-state jurisdictions. In many instances, a municipality or urban community is part of a larger team and undertakes activities in a large-scale context. However, because even the smallest scale, the cataloging unit, usually describes watersheds of 100 to 1,000 square miles, local practitioners of runoff management typically find the HUC-designated scales simply too large to be of practical use. This is especially true when designing and implementing runoff control practices for individual developments and sites. Consequently, the watershed hierarchy must be extended to include smaller-scale management units. A national effort is under way to designate 14-digit HUCs.

The Center for Watershed Protection (Caraco et al., 1998) proposed three progressively smaller scales in the watershed hierarchy below the subbasin cataloging unit (Figure 0.3):

- *Watershed.* The scale encompassed by the cataloging unit. Generally, this is the largest management unit that falls within the local land use planning authority. A community might have one or more watersheds within its borders, depending on its size.

- *Subwatershed.* The scale encompassed by the watershed. Its boundaries include all the land area draining to the point where two second-order streams come together to form a third-order stream. In most regions, subwatersheds are a few square miles in area and are drained by a stream several feet in width.

- *Catchment.* The smallest scale in the hierarchy. The Center for Watershed Protection defines it as the area that drains an individual development site to its first intersection with a stream. In some cases this intersection is in the form of a pipe outfall. Depending on the size of the development site, the catchment might also include some off-site drainage.

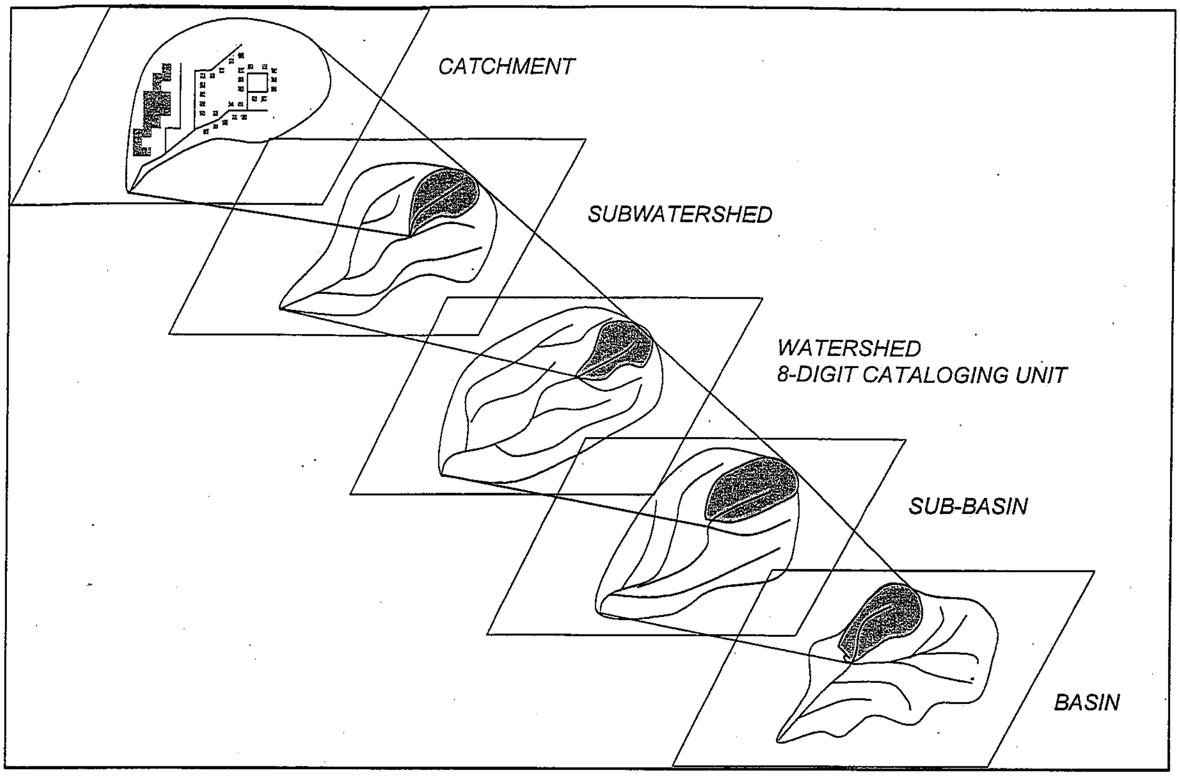

Figure 0.3: Scales of watershed management units (Schueler, 1995).

0.3.3 Impervious and Pervious Surfaces in the Urban Landscape

The term impervious surface refers to land cover, both natural and human-made, that cannot be penetrated by water. Consequently, precipitation that falls on impervious surfaces does not infiltrate into the soil. Instead, it runs off to a pervious area where all or a portion infiltrates into the soil, or it continues to travel down-slope on impervious surfaces including saturated soils until it is eventually conveyed to a ditch, a storm drain network, a stream, a lake, a wetland, an estuary, or some other type of surface receiving water. For additional discussion on the water quality impacts of imperviousness, see Section 1.3.5, Changes in the Watershed Due to Increased Imperviousness.

Most of the impervious cover in an urban watershed or subwatershed can be organized into three main categories:

- *Rooftops*. Impervious cover created by buildings, homes, garages, stores, warehouses, and other structures with roofs.
- *Transport systems*. Impervious cover created by structures such as roads, sidewalks, driveways, and parking lots. Most of these structures are associated with transportation of people or materials, hence the name transport systems.

- *Recreational facilities*. Impervious cover created by tennis and basketball courts, playgrounds, decks, and swimming pools.

In most areas the transport systems component covers a larger percentage of land than the rooftops component. A study in the city of Olympia, Washington, for example, revealed that transport system imperviousness constituted 63 to 70 percent of the total impervious cover at 11 sites of varying land use, including residential, multifamily, and commercial areas (City of Olympia, 1995).

0.3.3.1 Total and effective impervious surface

The amount of impervious cover in a watershed or subwatershed is reported in two basic ways:

- *Total (or mapped) impervious area*. Includes all impervious cover in a watershed or subwatershed—rooftops, transport systems, and recreational facilities. It is usually expressed as a percentage of the total watershed or subwatershed area. It can be calculated by direct measurement or by percentage estimation based on land use, road density, population density, or another indicator.

- *Effective impervious area (EIA)*. The portion of total impervious cover that is directly connected to the storm drain network (Sutherland, 1995). These surfaces usually include street surfaces and paved driveways and sidewalks connected to or immediately adjacent to them, parking lots, and rooftops that are hydraulically connected to the drainage network (e.g., downspouts running directly to gutters or driveways). EIA also is usually expressed as a percentage of the total watershed or subwatershed area. It is the preferred statistic for use when estimating runoff volumes because it is the portion of the impervious cover that generates direct runoff.

Subtracting EIA from the total impervious area yields the amount of impervious area that is not directly connected to the storm drain network, or the ineffective impervious area. Residential rooftops are an example of possible ineffective impervious areas because downspouts can direct runoff to yards and other pervious landscaping areas, where a portion of the water can infiltrate the ground. Rooftops in some residential and most commercial areas, however, will likely be classified as effective impervious areas because their downspouts typically will be tied directly to the storm drain network. Filtration, infiltration, evaporation, and biological uptake of pollutants can substantially reduce runoff volume and improve water quality when runoff is directed over vegetated areas. For further discussion on downspout disconnection, see Management Measure 4: Site Development and Management Measure 10: Existing Development.

Both the amount of impervious area and the relationship between total and effective impervious areas varies according to land use (Caraco et al., 1998). For example, work in the Puget Sound area revealed that total impervious area in low-density residential sites averaged approximately 10 percent, with an effective impervious area of only 4 percent. In commercial and industrial areas, however, total impervious area averaged about 90 percent. Almost all of the total impervious area is also effective impervious area because of the lack of pervious areas to break up direct connections.

0.3.3.2 Pervious surfaces

The urban and suburban landscape has a variety of pervious surfaces, including

- Forests and wetlands
- Lawns and other private turf
- Public turf
- Intensively landscaped areas
- Vacant lands
- Runoff treatment areas

Although most of these areas are green, it would be a mistake to think of them as hydrologically equivalent to an undisturbed meadow, forest, or other natural pervious area, especially in terms of their ability to allow runoff to infiltrate. Soils in urban landscapes are usually highly disturbed and compacted, poor in structure, and low in permeability. In addition, they often receive runoff from adjacent impervious areas, resulting in water inputs many times greater than normal. These factors and others tend to decrease the ability of pervious urban areas to infiltrate runoff, which means an increased fraction of water moves off these areas to impervious areas and storm drainage networks. In extreme cases, the amount of runoff generated is close in volume to that generated from impervious surfaces. Consequently, some "pervious" areas function as impervious areas and cause analysts to underestimate peak flow, runoff volumes, and time of concentration. Refer to Management Measure 9: Pollution Prevention, for more information on runoff from lawns.

0.3.4 Impervious Cover Model

A simple tool, the *Impervious Cover Model*, can be used to project the current and future quality of streams and other water resources at the subwatershed scale based on impervious cover (Caraco et al., 1998). The objective of this model is to assist local officials and other watershed practitioners in devising realistic goals and objectives given present and future levels of development. The impervious cover model is a simple urban stream classification system that contains three stream categories based on the percentage of impervious cover present in the subwatershed. It is intended to help managers decide how to adapt and refine management measures given the intensity of urban development in their watersheds. The impervious cover model has some limitations. These are (Caraco et al., 1998):

- *Reference condition*. The model predicts potential, not actual, stream quality, so in some cases stream reaches might depart from the model's predictions.

- *Scale effect*. The model should be applied only to small, first- to third-order streams because the influence of impervious cover is strongest at these spatial scales.

- *Statistical variability*. There is a moderate degree of scatter exhibited in individual impervious cover/stream quality indicator relationships, although the indicators show a general downward trend as imperviousness increases. The model predicts the average behavior of multiple indicators over a range of imperviousness, and the impervious cover thresholds are not sharp breakpoints but transitions.

- *Measuring and projecting impervious cover.* Accurately quantifying actual and projected impervious cover is important for the model. However, there is no standardized method for measuring total or effective imperviousness.

- *Regional adaptability.* The model has been tested mostly in the mid-Atlantic and Puget Sound ecoregions but little research has been conducted to determine the applicability of the model in western, midwestern, and mountain streams.

- *Defining thresholds for nonsupporting streams.* More sampling and study are needed to more firmly establish the threshold for the transition between impacted streams and nonsupporting streams, projected to occur at 25 percent impervious cover for small urban streams.

- *Influence of management practices in extending thresholds.* The changes in hydraulic and pollutant loadings, and their effects on receiving streams, should be carefully considered when practices are used to extend the threshold of imperviousness.

- *Influence of riparian cover in extending thresholds.* Conservation or restoration of a riparian zone has been shown to extend the impervious cover threshold.

- *Pervious area.* Urban landscapes contain pervious areas, but many of them are highly disturbed and do not resemble pervious areas in non-urban landscapes. However, planners can integrate pervious and impervious areas to greatly reduce effective impervious area and reduce the impact of imperviousness on stream quality.

0.3.4.1 Subwatersheds as the primary management unit

The impervious cover model relies on the subwatershed as the primary management unit. Table 0.5 displays the influence of impervious cover in the context of a hierarchy of watershed-based management units. The subwatershed scale is ideal for planning purposes at the local level for many reasons, including:

- The influence of impervious cover on hydrology, channel stability, water quality, and biodiversity is most evident at the subwatershed scale because the receiving water body is typically a headwater stream.

- The smaller scale helps local officials more easily identify impacts of individual development projects and sources of pollutants.

- Subwatersheds are typically small enough to be within the borders of one or two jurisdictions. This eases the burden of establishing regulatory authority as well as keeping the number of stakeholders to a manageable number.

- Assessments and evaluations can be conducted more easily because most subwatersheds can be mapped on a standard 24-inch by 36-inch sheet with sufficient detail to provide useful management information. The smaller scale also allows assessments and evaluations to be completed more rapidly than similar efforts at larger scales. This creates the opportunity for phasing the development of subwatershed plans (or focusing on areas needing priority attention), making the best use of limited resources. Officials and local citizens can more easily recognize progress as plans are completed and implemented over a coordinated cycle.

Table 0.5: Idealized characteristics of five watershed management units with respect to size and the influence of impervious cover (adapted from Caraco et al., 1998).

Watershed Management Unit	Typical Area (square miles)	Influence of Impervious Cover
Catchment	0.05–0.50	Very strong
Subwatershed	1–10	Strong
Watershed	10–100	Moderate
Subbasin	100–1,000	Weak
Basin	1,000–10,000	Very weak

0.3.4.2 Classification levels

The impervious cover model designates three levels of classification based on impervious cover:

– *Sensitive subwatersheds*, which have less than 10 percent impervious cover. Streams found in sensitive subwatersheds are at, or close to, predevelopment conditions. Urban runoff management strategies, therefore, should focus on maintaining these conditions. New development and redevelopment should be discouraged or designed to have no impact to prevent any increase of impervious cover in subwatersheds of this type.

– *Degrading subwatersheds*, which have 11 to 25 percent impervious cover. Degrading subwatersheds have crossed the 10 percent imperviousness threshold, and have experienced degradation of key stream attributes or can be expected to experience such degradation over time. Some of the more sensitive organisms probably have disappeared or will disappear. Resource objectives consequently should focus more on maintaining or restoring key conditions than on resource protection as a whole. Structural and nonstructural practices that deal with, or counteract, increased urban runoff are recommended.

– *Nonsupporting subwatersheds*, which have more than 25 percent impervious cover. Streams in nonsupporting subwatersheds are well beyond the impervious cover thresholds and may never recover predevelopment conditions no matter how many management practices are implemented. Resource objectives are primarily aimed at reducing peak flows and preventing and removing urban pollutants so they will not be carried downstream. Limited restoration of some attributes such as increased biodiversity can sometimes be achieved given the right circumstances. Pollution prevention and retrofitting in existing urban areas are the most frequently used practices.

Table 0.6 describes channel stability, water quality, and biodiversity attributes, as well as general resource and water quality objectives associated with each category.

Table 0.6: Characteristics of aquatic integrity in urban watersheds.

Integrity Rating	Low	Moderate	High
Riparian Habitat Characteristics	– Riparian zone greatly reduced – Increased sediment deposition – Completely bare/exposed banks – Deeply incised and widened channel cross-section 	– Riparian zone partly cleared – Moderate sediment deposition, sand bar formation – Banks slightly exposed – Steep banks and widened channel cross-section 	– Mature riparian zone – Decreased sediment deposition, mostly rocky substrates – Bank well-vegetated and forested – Floodplain terrace channel cross-section 
Macroinvertebrate Community Characteristics	– Pollution-tolerant species – Tolerant of low dissolved oxygen (DO) levels – Reduced feeding and life history requirements – Decreased diversity and number of species	– Moderately pollution-tolerant species – Tolerant of moderate DO levels – Some general reduction in life history and feeding requirements	– Pollution-intolerant species – Intolerant of low DO levels – Unaltered life history and feeding requirements – Increased number and diversity of species
Fish Assemblage Characteristics	– Pollution-tolerant species – Exotic/introduced species – Reduced feeding and life history requirements – Decreased diversity and number of species	– Moderately pollution-tolerant species – Intermediate number of individuals and species – Some general reduction in life history and feeding requirements	– Pollution-intolerant species – Unaltered life history and feeding requirements – Increased number and diversity of species
Rehabilitation Process	Degraded		Improved

0.3.5 Changes in the Watershed Due to Increased Imperviousness

Watershed imperviousness plays an important role in determining the conditions in streams and other bodies of water. Impervious cover, however, is an inescapable attribute of development and a permanent part of the urban/suburban landscape. Figure 0.4 illustrates how four important components in the water cycle are affected by increasing levels of imperviousness (FISRWG, 1998). In natural landscapes, there is usually very little or no surface runoff. Water either percolates into the ground or is returned to the atmosphere by evaporation and transpiration. As imperviousness increases:

— Runoff increases because the surface area of rooftops and transportation systems is increased.

— Soil percolation decreases because pervious areas are reduced.

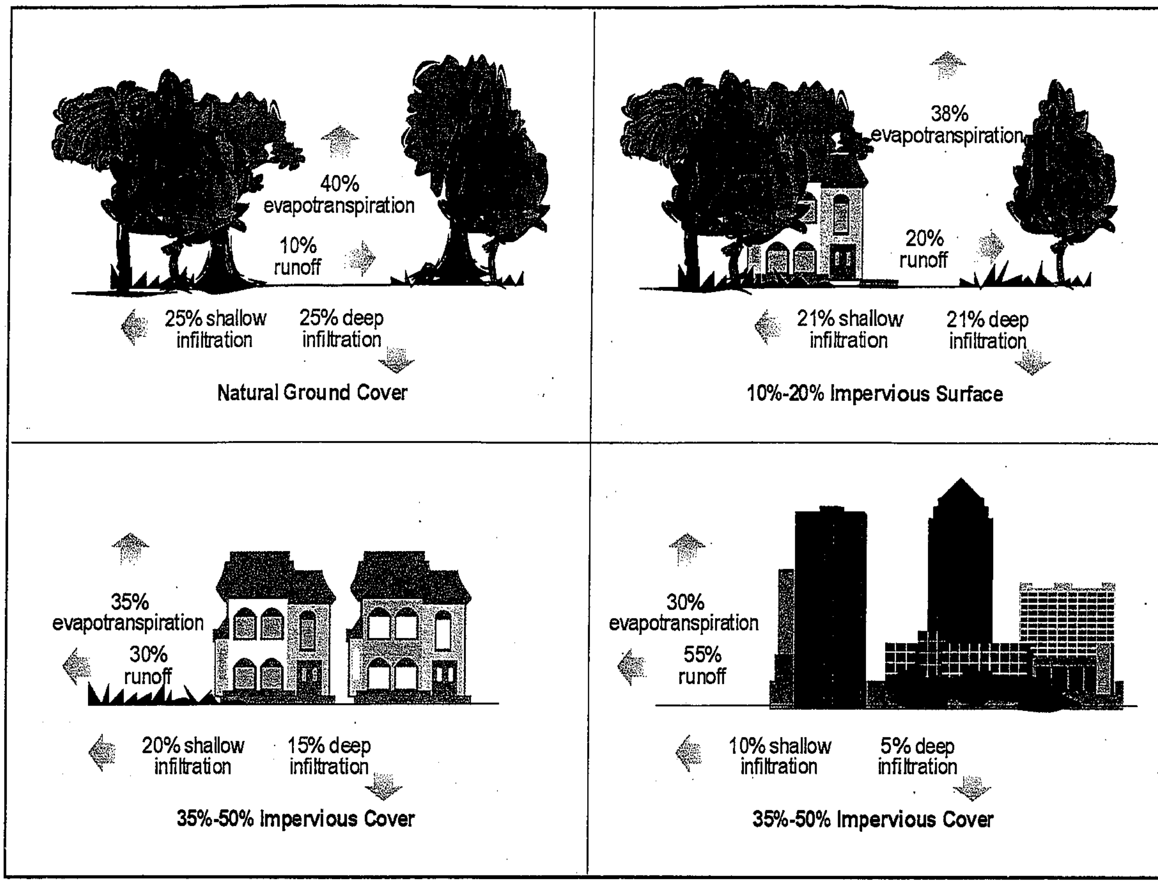

Figure 0.4: Impacts of urbanization on the water cycle (Adapted from FIRSWG, 1998).

- Evaporation decreases because there is less time for it to occur when runoff moves quickly off impervious surfaces.

- Transpiration decreases because vegetation has been removed.

As might be expected, there is a linear relationship between the amount of impervious surfaces in a given area and the amount of runoff generated. What is unexpected is what this means in terms of both the volume of water generated and the rate at which it exits the surface. Depending on the degree of impervious cover, the annual volume of storm water runoff can increase to anywhere from 2 to 16 times the predevelopment amount (Schueler, 1994). Impervious surface coverage as low as 10 percent can destabilize a stream channel, raise water temperature, and reduce water quality and biodiversity (Schueler, 1995). One recent study found that connected imperviousness levels between 8 and 12 percent represented a threshold region where minor changes in urbanization could result in major changes in stream condition (Wang et al., 2001).

Figure 0.5 shows a hydrograph comparing stream flow rates before, during, and after a storm under pre- and postdevelopment conditions (Schueler, 1987). As indicated, streams with developed watersheds have substantially higher peak flows, and these peak flows occur more quickly than under predevelopment conditions. This is reflective of typical urban conditions, where runoff moves quickly over impervious surfaces and drains into a channel.

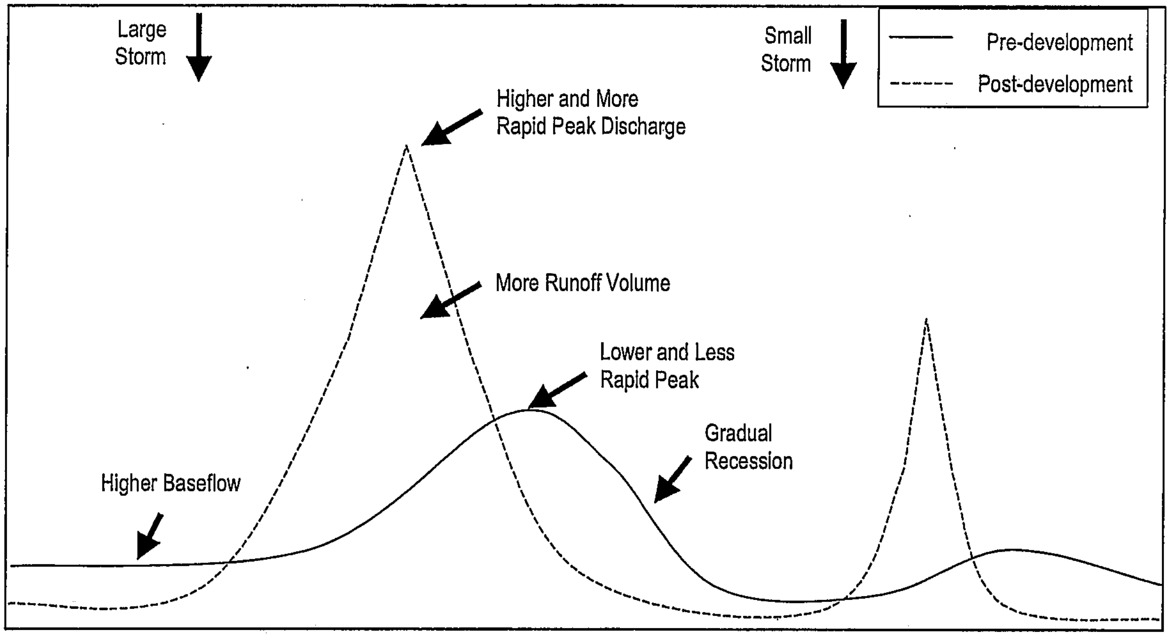

Figure 0.5: Changes in stream flow hydrograph as a result of urbanization (Schueler, 1987).

Development and increased impervious cover also lead to erosion and undercutting of streambanks, widening of channels, and depositing of in-channel sediment. In addition, decreased base flow occurs in dry weather because a greater portion of runoff flows off the

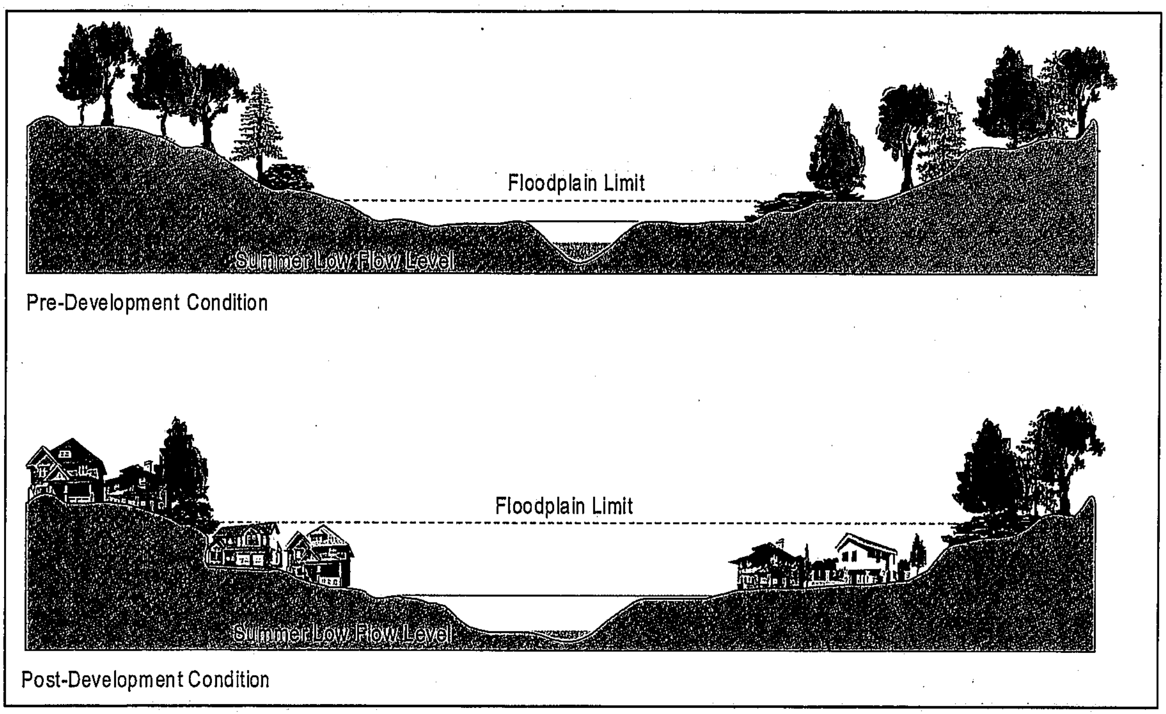

Figure 0.6: Response of stream geometry to urbanization (Schueler, 1987).

surface, resulting in less infiltration to ground water reserves that normally provide base flow to streams. Figure 0.6 shows changes to stream geometry in response to urbanization (Schueler, 1987).

EPA (1997) reviewed the literature for case studies that quantitatively examined the relationship between increased impervious surfaces and stream impacts. Table 0.7 lists these relationships, and Table 0.8 summarizes the case studies used to derive the relationships.

Table 0.7: Impacts from increases in impervious surfaces (USEPA, 1997).

Increased Imperviousness Leads to:	Resulting Impacts				
	Flooding	**Habitat Loss**	**Erosion**	**Channel Widening**	**Streambed Alteration**
Increased Volume	✓	✓	✓	✓	✓
Increased Peak Flow	✓	✓	✓	✓	✓
Increased Peak Duration	✓	✓	✓	✓	✓
Increased Stream Temperature		✓			
Decreased Base Flow		✓			
Sediment Loading Changes	✓	✓	✓	✓	✓

Table 0.8: Summary of case studies linking urbanization to hydrological impacts on streams (USEPA, 1997).

Case Study	Location	Documented Impacts	Inferred Impacts
East Meadow Brook	Nassau County, NY	– Increased peak flows	Flooding, habitat loss, erosion, channel widening, streambed alteration
Holmes Run Watershed	Fairfax, VA	– Frequent flooding – Severe streambank erosion – Sedimentation	Flooding, habitat loss, erosion, channel widening, streambed alteration
Kelsey Creek	Bellvue, WA	– Degradation of designated uses – Decreased base flow – Loss of fish populations	Habitat loss, channel widening
Patuxent River System	Maryland	– Increased instream sediment load – Changes in morphology of urban channels	Habitat loss, erosion, channel widening
Peachtree Creek	Atlanta, GA	– Increased bankfull events – Decreased base flow	Flooding, habitat loss, erosion, channel widening, streambed alteration
Pheasant Branch Basin	Middleton, WI	– Stream incision – Increase in bankfull events – Sedimentation	Flooding, habitat loss, erosion, channel widening, streambed alteration
Pipers Creek	Seattle, WA	– Increased peak flows – Loss of fish populations – Aesthetic degradation	Flooding, habitat loss, erosion, channel widening, streambed alteration
Several creeks	Dekalb County, GA	– Stream enlargement – Stream incision – Increased sediment transport	Habitat loss, erosion, channel widening, streambed alteration
Valley Stream, Pines Brook, Bellmore Creek, and Massapequa Creek	Nassau County, NY	– Decreased base flow	Habitat loss

Recent research has shown that streams in urban watersheds have a fundamentally different character from that of streams in forested, rural, or even agricultural watersheds. The amount of impervious cover in the watershed can be used as an indicator to predict how severe these differences might be. In many regions of the country, as little as 10 percent watershed impervious cover has been linked to stream degradation, with the degradation becoming more severe as impervious cover increases (Schueler, 1995).

Some key changes in urban streams that merit special attention are detailed below:

– *Bankfull and subbankfull floods increase in magnitude and frequency.* The peak discharge associated with the bankfull flow (the 1.5- to 2-year return storm) increases sharply in magnitude in urban streams. In addition, channels experience more bankfull and subbankfull flood events each year and are exposed to critical erosive velocities for longer intervals (Booth et al., 1996; Hollis, 1975; and MaCrae, 1996).

– *Dimensions of the stream channel are no longer in equilibrium with its hydrologic regime.* The hydrologic regime that defined the geometry of the predevelopment stream channel irreversibly changes, and the stream experiences higher flow rates on a more frequent basis. The higher-flow events of the urban stream are capable of moving more sediment than before.

– *Channels enlarge.* The customary response of an urban stream is to increase its cross-sectional area to accommodate the higher flows. This is done by streambed downcutting, channel widening, or a combination of both. Urban stream channels often enlarge their cross-sectional area by a factor of 2 to 5 depending on the degree of impervious cover in the upland watershed and the age of development (Arnold et al., 1982; Gregory et al., 1992; and Macrae, 1996).

– *Stream channels are highly modified by human activity.* Urban stream channels are extensively modified in an effort to protect adjacent property from streambank erosion or flooding. Headwater streams are frequently enclosed within storm drains, while other streams are channelized, lined, and/or "armored" by heavy stone. Another modification unique to many urban streams is the installation of sanitary sewers underneath or parallel to the stream channel.

– *Upstream channel erosion contributes greater sediment load to the stream.* The prodigious rate of channel erosion coupled with sediment erosion from active construction sites increases sediment discharge to urban streams. Researchers have documented that channel erosion constitutes as much as 75 percent of the total sediment budget of urban streams (Crawford and Lenat, 1989; Trimble, 1997). Urban streams also tend to have a higher sediment discharge than non-urban streams, at least during the initial period of active channel enlargement.

– *Dry weather flow in the stream declines.* Because impervious cover prevents rainfall from infiltrating the soil, less flow is available to recharge ground water. Consequently, during extended periods without rainfall, baseflow levels are often reduced (Simmons and Reynolds, 1982).

- *Wetted perimeter of the stream declines.* The wetted perimeter of a stream is the proportion of the total cross-sectional area of the channel that is covered by flowing water during dry weather, and it is an important indicator of habitat degradation in urban streams. Given that urban streams develop a larger channel cross-section at the same time that their base flow rates decline, it follows that the wetted perimeter will become smaller. Thus, for many urban streams, this results in a very shallow, low-flow channel that "wanders" across a very wide streambed, often changing its lateral position in response to storms.

- *Instream habitat structure degrades.* Urban streams are routinely scored as having poor instream habitat quality, regardless of the specific metric or method employed. Habitat degradation is often exemplified by loss of pool and riffle structure, embedding of streambed sediments, shallow depths of flow, eroding and unstable banks, and frequent streambed turnover.

- *Large woody debris (LWD) is reduced.* LWD is an important structural component of many low-order stream systems because it creates complex habitat structure and generally makes the stream carry more water. In urban streams, the quantity of LWD found in stream channels declines sharply because of the loss of riparian forest cover, storm washout, and channel maintenance practices (Booth et al. 1996; May et al., 1997).

- *Stream crossings and potential fish barriers increase.* Many forms of urban development are linear in nature (e.g., roads, sewers, and pipelines) and cross stream channels. The number of stream crossings increases in direct proportion to impervious cover (May et al., 1997), and many crossings can become partial or total barriers to upstream fish migration, particularly if the streambed erodes below the fixed elevation of a culvert or pipeline.

- *Riparian forests become fragmented, narrower, and less diverse.* The important role that riparian forests play in stream ecology is often diminished in urban watersheds as tree cover is often partially or totally removed along the stream as a consequence of development (May et al., 1997). Even when stream buffers are preserved, encroachment often reduces their effective width and native species are supplanted by exotic trees, vines, and ground covers.

- *Water quality declines.* The water quality of urban streams during storms is consistently poor. Urban storm water runoff contains moderate to high concentrations of sediment, carbon, nutrients, trace metals, hydrocarbons, chlorides, and bacteria (Schueler, 1987). Although considerable debate exists as to whether storm water pollutant concentrations are actually toxic to aquatic organisms, researchers agree that pollutants deposited in the streambed exert an undesirable impact on the stream community.

- *Summer stream temperatures increase.* The impervious surfaces, ponds, and poor riparian cover in urban watersheds can increase mean summer stream temperatures by 2 °F to 10 °F (Galli, 1991). Because temperature plays a central role in the rate and timing of instream biotic and abiotic reactions, such increases have an adverse impact on streams. In some regions, summer stream warming can irreversibly shift a cold-water stream to a cool-water or even warm-water stream, resulting in deleterious effects on salmonids and other temperature-sensitive organisms.

– *Reduced aquatic diversity.* Urban streams are typified by fair to poor fish and macroinvertebrate diversity, even at relatively low levels of watershed impervious cover or population density (Couch, 1997; Crawford and Lenat, 1989; May et al., 1997; Miltner, 2003; Schueler, 1995; Shaver et al., 1994). Declines in sensitive species have been observed at levels of impervious cover as low as 4 percent. Impervious cover in highly urbanized areas comprising greater than 25 percent of a watershed may even preclude the Clean Water Act goal of "fishable" waters (Miltner, 2003). The ability to restore predevelopment fish assemblages or aquatic diversity is constrained by a host of factors, including irreversible changes in carbon supply, temperature, hydrology, lack of instream habitat structure, and barriers that limit natural recolonization.

Figure 0.7 shows the relationship between impervious cover and aquatic insect diversity; Figure 0.8 shows the relationship between imperviousness and fish diversity. Both studies were conducted in Maryland streams (Schueler and Galli, 1992, as cited in Schueler, 1995).

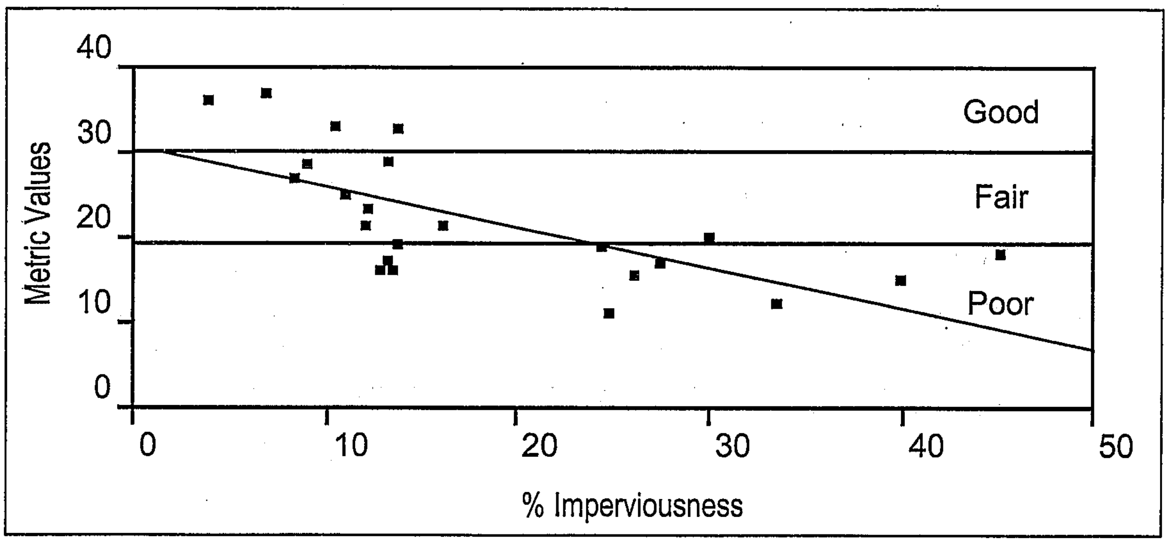

Figure 0.7: Relationship between impervious cover and aquatic insect diversity in Anacostia River subwatersheds (Schueler and Galli, 1992, as cited in Schueler, 1995).

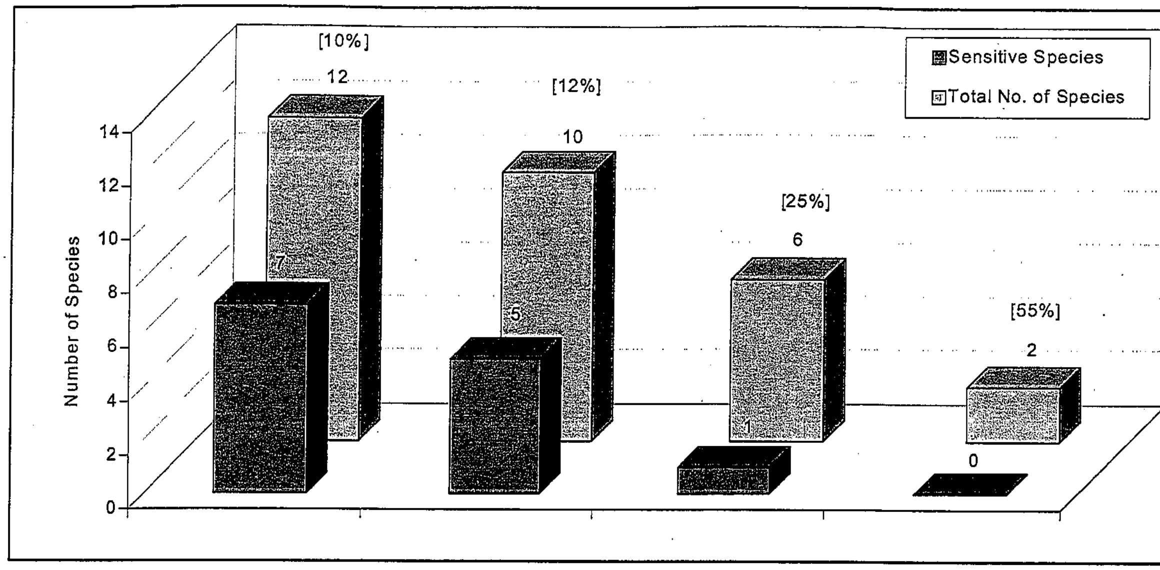

Figure 0.8: Fish diversity in four subwatersheds of different impervious cover in the Maryland Piedmont (Schueler and Galli, 1992, as cited in Schueler, 1995).

0.3.6 Nonpoint Source Pollutants and Their Impacts

Urban areas are a source for many different types of pollutants. Table 0.9 shows typical pollutant concentrations found in storm water. The following discussion identifies the principal types of pollutants found in urban runoff and describes their potential adverse effects:

0.3.6.1 Sediment

Excessive erosion, transport, and deposition of sediment in surface waters are significant sources of pollution in the United States, resulting in major water quality problems. Sediment imbalances impair waters' designated uses. Excessive sediment can impair aquatic life by filling interstitial spaces of spawning gravels, impairing sources of fish food, filling rearing pools, and reducing beneficial habitat structure in stream channels. In addition, excessive sediment can cause taste and odor problems in drinking water supplies and block water intake structures.

According to the *National Water Quality Inventory: 2000 Report to Congress* (required under section 305(b) of the Clean Water Act), states, tribes, and other jurisdictions surveyed water quality conditions in 19 percent of the nation's 3.6 million miles of rivers and streams (USEPA, 2002b). Some 39 percent of these surveyed waters were impaired by various pollution sources. Sediment was the second-leading cause of impairment, accounting for 31 percent of the impaired waters. Furthermore, sediment, especially its fine fractions, is the primary carrier of other pollutants such as organic components, metals, ammonium ions, phosphates, and toxic organic compounds.

Table 0.9: Typical pollutant concentrations found in urban storm water (adapted from MDE, 1999, and Terrene Institute, 1994).

Typical Pollutants Found in Storm Water Runoff	Units	Residential[a]	Mixed[a]	Commercial[a]	General Urban[b]
Total suspended solids	mg/L	101	67	69	80[c]
Total phosphorus	mg/L	383	263	201	0.30[c]
Total nitrogen	mg/L	–	–	–	2.0[c]
Total Kjeldahl nitrogen	mg/L	1.9	1.3	1.2	–
Nitrate + Nitrite	µg/L	736	558	572	–
Total organic carbon	mg/L	–	–	–	12.7[c]
Biological oxygen demand	mg/L	10	7.8	9.3	–
Chemical oxygen demand	mg/L	73	65	57	–
Fecal coliform bacteria	MPN/100 mL	–	–	–	3,600[c]
E. coli bacteria	MPN/100 mL	–	–	–	1,450[c]
Petroleum hydrocarbons	mg/L	–	–	–	3.5[c]
Oil and grease	mg/L	–	–	–	2 to 10[d]
Cadmium	µg/L	–	–	–	2[c]
Copper	µg/L	33	27	29	10[c]
Lead	µg/L	144	114	104	18[c]
Zinc	µg/L	135	154	226	140[c]
Chlorides (winter only)	mg/L	–	–	–	230[c]
Insecticides	µg/L	–	–	–	0.1 to 2.0[c]
Herbicides	µg/L	–	–	–	1 to 5.0[c]

[a] Source: USEPA, 1983.
[b] These concentrations represent mean or median storm concentrations measured at typical sites and may be greater during individual storms. Also note that mean or median runoff concentrations from storm water "hotspots" are 2 to 10 times higher than those shown here. Units: mg/L = milligrams/liter, µg/L = micrograms/l, MPN = most probable number.
[c] Source: MDE, 1999.
[d] Source: Terrene Institute, 1994.

A recent study of the economic impact of excessive erosion and transport of sediment in surface water systems estimates the annual cost of damage due to sediment pollution in North America at approximately $16 billion (Osterkamp et al., 1998). Sediment pollution costs can be measured in physical damages, chemical damages, and biological damages. Physical damages include harm to water conveyance, treatment, and storage facilities, and interference with recreational and navigational use. Chemical damages include deposition and storage of nutrients, metals, and pesticides associated with eroded sediments. Biological damages include harm to aquatic habitat from the movement and storage of sediment.

Potential sources of sediment pollution include agricultural erosion, deforestation, overgrazing, silvicultural erosion, urban runoff, construction activities, and mining activities. Sediments can also be dislodged and transported directly from the water body's shoreline, bank, or bottom. Atmospheric sources might also be a factor. In an informal study of atmospheric deposition of dust, Urbonas and Doerfer (2004) found that each 100 ft^2 of impervious surface can yield up to 1 to 1.2 pounds of solids in runoff on an average annual basis. Assuming that all of this dust enters storm water and that 30 percent of impervious surfaces are directly connected to the storm drain system, the authors estimate that 1 square mile of mixed-use urban development could yield 40 to 50 tons of total suspended solids in storm water each year.

The following is a summary of impacts of suspended and deposited sediments on the aquatic environment (adapted from Schueler, 1997):

Suspended sediments

- Abrasion of and damage to fish gills, increasing risk of infection and disease
- Scouring of periphyton from stream
- Loss of sensitive or threatened fish species when turbidity exceeds 25 nephelometric turbidity units (NTU)
- Shifts in fish community toward less-diverse, more sediment-tolerant species
- Decline in sunfish, bass, chum, and catfish when average monthly turbidity exceeds 100 NTU
- Reduction in sight distance for trout, with reduction in feeding efficiency
- Reduction in light penetration, resulting in a reduction in plankton and aquatic plant growth
- Reduction in filtering efficiency of zooplankton in lakes and estuaries
- Adverse impacts on aquatic insects, which are the base of the food chain
- Slight increases in stream temperature in summer
- Particles are a major vector for transport of nutrients and metals
- Turbidity, which increases probability of boating, swimming, and diving accidents
- Increased water treatment costs to meet drinking water standards of 5 NTU
- Increased wear and tear on hydroelectric and water intake equipment
- Reduction of anglers' chances of catching fish
- Diminishing quality of direct and indirect recreational experience of receiving waters
- Decreased submerged aquatic vegetation (SAV) populations

Deposited sediments

- Physical smothering of benthic aquatic insect community
- Reduced survival rates for fish eggs
- Destruction of fish spawning areas and redds

- Imbedding of stream bottom, which reduces fish and macroinvertebrate habitat value
- Loss of trout habitat when fine sediments are deposited in spawning habitat or riffle-runs
- Potential for elimination of sensitive or threatened darters and dace from fish community
- Increase in sediment oxygen demand, which can deplete dissolved oxygen in lakes or streams
- Significant contributing factor in the rapid decline of freshwater mussels
- Reduced channel capacity, exacerbating downstream bank erosion and flooding
- Reduced flood transport capacity under bridges and through culverts
- Loss of storage and lower design life for reservoirs, impoundments, and ponds
- Dredging costs to maintain navigable channels and reservoir capacity
- Spoiling of sand beaches
- Changes in the composition of bottom substrate
- Coral reef degradation in tropical and subtropical coastal areas
- Deposits that diminish the scenic and recreational value of waterways

Additional chronic effects may occur where sediments rich in organic matter or clay are present. These enriched depositional sediments may present a continued risk to aquatic and benthic life, especially where the sediments are disturbed and resuspended.

Although most concerns are due to excessive sedimentation, some ecological problems can result from insufficient sediment in a water body caused by hydrological modifications. Too little sediment can lead to channel scour and destruction of habitat dependent on an optimum level of sediment. In lakes, reservoirs, and estuaries, insufficient total suspended sediments can lead to increased light levels, resulting in the growth of nuisance algae.

The term *sediment* is broadly used to describe a problem associated with suspended solids, siltation, erosion, weathering, sedimentation, and other factors. Erosion, sediment transport, and deposition are natural processes caused by stresses placed on the earth's surface. Sediment movement is the result of water and air moving against the sediment (gravitation stresses) and natural weathering (molecular and chemical stresses). Because erosion is a natural process and significant quantities of sediments are being moved as a result of natural denudation, it would be unrealistic to expect complete control or elimination of sediment loads to receiving waters. However, it is feasible to control or manage excessive sediment loadings that have resulted from various land use activities and would be detrimental to the quality of the receiving bodies of water and to the aquatic and terrestrial habitat.

0.3.6.2 Nutrients

Nutrient overenrichment is especially prevalent in agricultural areas where manure and fertilizer inputs to crops significantly contribute to nitrogen and phosphorus levels in streams and other receiving waters. Urban streams have been shown to have the second-highest nitrate and total phosphorus levels, second only to agricultural streams (Barth, 1995). There are several nonpoint sources of nutrients in urban areas, mainly fertilizers in runoff from lawns, pet wastes, failing septic systems, and atmospheric deposition from industry and automobile emissions. Deposition of airborne pollutants is beyond the scope of this guidance. More information can be found at North Carolina State University's Web site, http://h2osparc.wq.ncsu.edu/wetland/aqlife/atmosdep.html.

Excessive nutrient levels in receiving waters can lead to exceedance of drinking water criteria (10 mg/L for nitrate-nitrogen), although monitoring data suggest that urban sources of nitrate are not high enough to pose a human health risk. However, moderately high concentrations of nutrients can result in eutrophication of sensitive receiving waters. These sensitive waters include oligotrophic or mesotrophic lakes where phosphorus is a limiting nutrient, or coastal or estuarine areas where nitrogen is limiting. Eutrophication can lead to changes in periphyton, benthic, and fish communities; extreme eutrophication can cause hypoxia or anoxia, resulting in fish kills. Surface algal scum, water discoloration, and the release of toxins from sediment can also occur.

0.3.6.3 Oxygen-demanding substances

Proper levels of dissolved oxygen (DO) are critical to maintaining water quality and aquatic life. Decomposition of organic matter by microorganisms may deplete DO and result in the impairment of the water body. Data have shown that urban runoff with high concentrations of decaying organic matter can severely depress DO levels after storms. The Nationwide Urban Runoff Program (NURP) study (USEPA, 1983) found that oxygen-demanding substances can be present in urban runoff at concentrations similar to those in secondary wastewater treatment discharges.

0.3.6.4 Pathogens

Urban runoff typically contains elevated levels of pathogenic organisms, including bacteria, viruses, and protozoa. The bacteria standard is one of the most commonly violated water quality standards in terms of both the number of water bodies and stream miles impaired. Approximately 50 percent of stream miles in Virginia are impaired due to bacteria contamination (Waye, 2002).

The presence of pathogens in runoff may result in water body impairments such as closed beaches and shellfish beds, and contaminated drinking water sources. Pathogen contamination related to onsite wastewater treatment systems (OWTSs) has been implicated in a number of shellfish bed closings. This problem may be especially prevalent in areas with porous or sandy soils and/or shoreline areas with a high concentration of OWTSs. Epidemiological studies have shown that pathogens can have significant effects on human health in contaminated marine swimming areas (Haile et al., 1999). While the most common effects of bathing in contaminated water are gastrointestinal illnesses, other conditions affecting the upper respiratory tract, ear, eye, and skin may also be contracted (USEPA, 2002a).

Indicator organisms have long been used to determine the level of risk for contracting illnesses from recreational activities in surface waters contaminated by fecal pollution. These organisms often do not cause illness directly, but have demonstrated characteristics that make them good indicators of harmful pathogens in water bodies. Until 1986, EPA recommended the use of fecal coliforms as an indicator for bacteria. However, after conducting epidemiological studies, EPA published *Ambient Water Quality Criteria for Bacteria*, which recommends that states use *Escherichia coli* (*E. coli*) for fresh recreational waters and enterococci for fresh and marine recreational waters because they are better predictors of acute gastrointestinal illness than fecal coliforms (USEPA, 1986). Some states and tribes have replaced their fecal coliform criteria with water quality criteria for *E. coli* or enterococci, but many other states and tribes have not yet made this transition (USEPA, 2002a).

Two protozoa of major concern as waterborne pathogens are *Giardia lamblia* and *Cryptosporidium parvum*. *Cryptosporidium* has become an increasingly serious pathogen problem in urban areas since the 1993 outbreak in Milwaukee, Wisconsin, when pathogens passed through a water treatment plant and left 400,000 people ill and almost 100 dead. Three major sources of pathogens in urban areas are human waste, pet waste, and anthropogenic wildlife. Anthropogenic wildlife includes raccoons, geese, pigeons, seagulls, and rats (Waye, 2002). Human waste can contaminate urban runoff through illicit connections of sanitary sewers with storm water systems, resulting in high bacterial counts and human health risks. These non-storm water sources are often a major contributor of pathogens to discharges from storm drain systems (Pitt et al., 2001).

While some types of waste can be treated before entering water bodies, others, such as feces from pets, should be disposed of properly. When pet waste is not properly disposed of, it can wash into nearby water bodies or be carried by runoff into storm drains. Since most urban storm drains do not connect to treatment facilities, but rather drain directly into lakes and streams, untreated animal feces can become a significant source of pathogens in surface waters.

As pet waste decays in a water body, it uses up oxygen, sometimes releasing ammonia. Low oxygen levels and ammonia combined with warm temperatures can be detrimental to fish and aquatic life. Pet waste also contains nutrients that promote weed and algae growth, which can cause eutrophication. Perhaps most importantly, pet waste carries bacteria, viruses, and other parasites that can pose health risks to humans and wildlife. For more information, refer to the discussion of microbial contamination in Management Measure 2: Watershed Assessment, and the discussion of pet waste in Management Measure 9: Pollution Prevention.

0.3.6.5 Road salts

According to a study by the Department of the Interior and USGS (1996), road salt has become a problem for both surface water and ground water quality, especially in the Northeast and Midwest. Nationally, an estimated $10 million are spent annually by state and local governments to remedy road salt contamination. The Northeastern Illinois Planning Commission (undated) estimates that 18 million tons of deicing salt, primarily sodium and calcium chlorides, are used each year in the United States. When the dissolved salts in runoff from highways and bridges enter soils, ground water, and surface waters, salinity levels increase and can become toxic to plants, fish, and other aquatic organisms. These impacts are especially pronounced in smaller water bodies adjacent to salted areas. Additionally, salt is corrosive and may cause damage to roadways, bridges, and vehicles. Deicing is very important for pedestrian and driver safety, and there are a number of new technologies available for reducing the threat to water quality from this activity. For a discussion of management practices to minimize the environmental impact of road salt application, see Management Measure 7: Bridges and Highways.

0.3.6.6 Hydrocarbons

The sources of oil, grease, and other petroleum hydrocarbons in urban areas include spillage and seepage of fossil fuels, discharge of domestic and industrial wastes, atmospheric deposition, and runoff. Atmospheric deposition is beyond the scope of this guidance (see North Carolina State University's Web site, http://h2osparc.wq.ncsu.edu/wetland/aqlife/atmosdep.html).

Runoff can be contaminated by leachate from asphalt roads, wearing of tires, deposition from automobile exhaust, and oiling of roadsides and unpaved roadways with crankcase oil (USEPA, 2000b). Also, many do-it-yourself auto mechanics dump used oil and other automobile-related fluids directly into storm drains (Klein, 1985). Petroleum hydrocarbons, such as polycyclic aromatic hydrocarbons (PAHs), can accumulate in aquatic organisms from contaminated water, sediments, and food, and are known to be toxic to aquatic life at low concentrations (USEPA, 2000b). Hydrocarbons can persist in sediments for long periods and result in adverse impacts on the diversity and abundance of benthic communities.

Hydrocarbons can be measured as total petroleum hydrocarbons (TPH), as oil and grease, or as individual groups of hydrocarbons, such as PAHs (see Management Measure 7).

0.3.6.7 Heavy metals

Heavy metals are typically found in urban runoff, with automobiles suspected to be the leading source (CWP, 1994). For example, Klein (1985) reported in a study of the Chesapeake Bay that designated urban runoff was the source for 6 percent of the cadmium, 1 percent of the chromium, 1percent of the copper, 19 percent of the lead, and 2 percent of the zinc.

Heavy metals are of concern because of toxic effects on aquatic life and the potential for ground water contamination. Copper, lead, and zinc are the most prevalent NPS pollutants found in urban runoff. High metal concentrations can bioaccumulate in fish and shellfish, and affect beneficial uses of a water body.

0.3.6.8 Toxic pollutants

Many different toxic compounds (priority pollutants) have been associated with urban runoff. The NURP studies (USEPA, 1983) indicated that at least 10 percent of urban runoff samples contained toxic pollutants. Methylene chloride and bis (2-ethylhexyl) phthalate were the most commonly reported and detected organic constituents in an ongoing evaluation of stormwater data from NPDES Phase 1 Municipal Separate Storm Sewer System permit holders. PAHs were also found in several hundred storm events (Pitt, 2004).

0.3.6.9 Temperature

Temperature changes result from increased flows, removal of vegetative cover, and increases in impervious surfaces. Impervious surfaces act as heat collectors, which heat urban runoff as it passes over them. Data indicate that intensive urbanization can increase stream temperature by as much as 5 to 10°C during storms (Galli and Dubose, 1990). Elevated temperatures can be caused when streambeds become wider and shallower due to higher flows, removal of riparian vegetation along streambanks, and detaining water in runoff management facilities during warm weather. Elevated temperatures disrupt aquatic organisms that have finely tuned temperature limits, such as trout, salmon, and the aquatic insects on which they feed, by decreasing the amount of dissolved oxygen in the water column. Increased water temperatures can also lead to a shift in the algal community, disrupting the aquatic food chain (Galli, 1991).

0.3.7 Nonpoint Source Pollutant Loading

Nonpoint source pollution has been associated with water quality standard violations and the impairment of designated uses of surface waters. The *National Water Quality Inventory: 2000 Report to Congress* (USEPA, 2002b) reported the following:

Siltation, pathogens, oxygen-depleting substances, and nutrients are leading causes of water quality impairments in the nation's rivers and streams; and agriculture, hydromodification, habitat alteration, and urban runoff/storm sewers, all of which are nonpoint sources, were the leading sources of impairment.

The pollutants described previously can have a variety of impacts on coastal resources. Examples of water bodies that have been adversely affected by nonpoint source pollution are varied. The Miami River and Biscayne Bay in Florida have experienced loss of habitat, loss of recreational and commercial fisheries, and decrease in productivity partly as the result of urban runoff (SFWMD, 1988). Additionally, shellfish beds in Port Susan, Puget Sound, Washington, have been declared unsafe for the commercial harvest of shellfish in part because of bacterial contamination from OWTSs (USEPA, 1991). Also, impairment due to toxic pollution from urban runoff continues to be a problem in the southern part of San Francisco Bay (USEPA, 1992). Finally, nonpoint sources of pollution have been implicated in degradation of water quality in Westport River, Massachusetts, which discharges to Buzzards Bay. High concentrations of coliform bacteria have been observed after rainfall, and shellfish bed closures in the river have been attributed to loadings from surface runoff and OWTSs (USEPA, 1992).

0.3.8 Other Impacts of Urban Runoff

Other impacts not related to a specific pollutant can also occur as a result of urbanization. Salinity can be affected by urbanization. Freshwater inflows due to increased runoff can affect estuaries, especially if they occur in pulses, disrupting the natural salinity of an area. Increased impervious surface area and the presence of storm water conveyance systems commonly result in elevated peak flows in streams during and after storms. These rapid pulses or influxes of fresh water into saline receiving waters (i.e., bays, estuaries, and oceans) may be 2 to 10 times greater than normal (ABAG, 1991) This may lead to a decrease in the number of aquatic organisms living in the receiving waters (McLusky, 1989).

The alteration of natural hydrology due to urbanization and accompanying runoff diversion, channelization, and destruction of natural drainage systems have resulted in riparian and tidal wetland degradation or destruction. Deltaic wetlands have also been adversely affected by changes in historic sediment deposition rates and patterns. Hydromodification projects designed to prevent flooding can reduce sedimentation rates and decrease the marsh aggradation that would normally offset erosion and apparent changes in sea level within the delta (Cahoon et al., 1983).

0.3.9 Management Practices

Management practices are specific actions taken to achieve, or aid in the achievement of, a management measure. A more familiar term might be *best management practice* (BMP). The word "best" has been dropped for the purposes of this guidance (as it was in the Coastal Management Measures Guidance) because the adjective is too subjective. The "best" practice in one area or situation might be entirely inappropriate in another area or situation.

Four major runoff management themes dominate the management practices presented in this guidance document:

- Minimize the amount of impervious land coverage and disconnect impervious areas.
- Promote infiltration.
- Prevent polluted runoff by not allowing pollutants and runoff to mix.
- Remove pollutants from runoff before allowing it to flow into natural receiving waters.

The management practices can be grouped into two basic categories:

- *Nonstructural practices*. Nonstructural practices prevent or reduce urban runoff problems in receiving waters by reducing potential pollutants or managing runoff at the source. These practices can take the form of regulatory controls (e.g., codes, ordinances, regulations, standards, or rules) or voluntary pollution prevention practices. Nonstructural controls can be further subdivided:

  - *Land use practices*. Land use practices are aimed at reducing impacts on receiving waters resulting from runoff from new development by controlling or preventing land use in sensitive areas of the watershed. They can also be used to minimize total land used for development while accommodating growth.

  - *Source control practices*. Source control practices are aimed at preventing or reducing potential pollutants at their source before they come into contact with runoff or aquifers. Some source controls are associated with new development. Others are implemented after development occurs and include pollution prevention activities that attempt to modify aspects of human behavior, such as educating citizens about the proper disposal of used motor oil and application of lawn fertilizers and pesticides.

- *Structural practices*. Structural practices are engineered to manage or alter the flow, velocity, duration, and other characteristics of runoff by physical means (USEPA, 1993).

In doing so they can control storm water volume and peak discharge rates and, in some cases, improve water quality. They can also have ancillary benefits such as reducing downstream erosion, providing flood control, and promoting ground water recharge.

0.4 Information Resources

The Center for Watershed Protection is a non-profit organization that provides information concerning watershed restoration, planning, research, and training, storm water management, better site design, education, and outreach. Among other achievements, the Center has completed 20 plans to protect or restore local watersheds and 30 watershed research projects, responded to 5,000 requests for watershed advice, and trained more than 15,000 individuals through workshops. The Center for Watershed Protection's Web site (http://www.cwp.org) provides links to upcoming workshops, current and ongoing projects, surveys, and publications. Example publications available electronically include *Stormwater BMP Design for Cold Climates*, *Codes and Ordinances Worksheet*, and *Site Planning for Urban Stream Protection*. The Center for Watershed Protection also manages the Stormwater Manager's Resource Center Web site, which is designed to provide technical information to storm water managers.

Coordinated through the European Rivers Network, Rivernet is a multilingual service providing information concerning river ecological projects, river basins, and organizations currently working on problems associated with rivers. Access to newsletters, water policy and river management information, educational materials, international news related to rivers, and regional river basin news are available at the Rivernet homepage (http://www.rivernet.org/welcome.htm).

The Natural Resources Defense Council (NRDC), an organization with more than 500,000 members nationwide, seeks to protect and restore the natural environment. Information relevant to storm water management and pollution can be accessed at their Web site (http://www.nrdc.org/water/pollution). An example is *Stormwater Strategies*, which is a publication intended for municipal officials, local decision-makers, citizens, and environmental activists that provides examples of effective storm water management programs employed across the U.S. *Stormwater Strategies* can be downloaded at http://www.nrdc.org/water/pollution/storm/stoinx.asp.

The U.S. Geological Survey's Web site offers water quality and use data; publications, products, and technical resources; and links to water resource-related programs. Individual USGS case studies and reports of grants related to urban runoff programs are available through this site, which is located at http://water.usgs.gov.

Part of EPA's Office of Wetlands, Oceans, and Watersheds, the Nonpoint Source Control Branch provides information on many aspects of nonpoint source pollution. Resources include introductory information about nonpoint source pollution, nonpoint source publications and information resources, funding, information on the Clean Water Act and Coastal Zone Act Reauthorization Amendments, and educational information. More information and access to a full list of available resources can be found at http://www.epa.gov/OWOW/NPS/index.html.

EPA's Office of Wastewater Management (OWM), in cooperation with state and local agencies, administers the NPDES permit program, which includes regulating storm water discharges from municipal separate storm sewer systems. The OWM Web site provides technical and regulatory information on the NPDES Storm Water program as well as publications dealing with urban runoff. The OWM Web site can be accessed at http://www.epa.gov/npdes and information specific to the Storm Water program can be accessed at http://www.epa.gov/npdes/stormwater.

The Water Environment Federation (WEF) is a nonprofit technical and educational organization dedicated to the preservation and enhancement of the global water environment. The Water Environment Federation Web site contains a search engine for periodicals, newsletters, technical magazines, and other publications related to wastewater treatment and water quality protection. Members of the organization provide technical expertise and training on issues, including nonpoint source pollution, hazardous waste, residuals management, and groundwater; sponsor conferences and other special events around the world; and review, testify, and comment on environmental regulations and legislation. More information on WEF is available at http://www.wef.org.

The Sierra Club and American Rivers sponsored the publication of *Where Rivers Are Born: The Scientific Imperative for Defending Small Streams and Wetlands*, which provides an argument for protecting small, intermittent or "headwater" streams and wetlands based on the numerous environmental functions of these systems and their close connectivity with activities on land. The authors detail such functions as flood control, maintenance of water supplies, sediment trapping, and maintenance of biological diversity. The document can be downloaded in PDF format at http://iowa.sierraclub.org/Steve-Sierra%20web%20docs0526/WhereRiversAreBorn.pdf.

0.5 References

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MANAGEMENT MEASURE 1
PROGRAM FRAMEWORK AND OBJECTIVES

1.1 Management Measure

Develop, implement, and enhance a runoff management program framework that

- Has adequate legal authority to implement the program effectively;
- Has an effective institutional structure;
- Has adequate funding and staffing;
- Incorporates comprehensive watershed planning, including watershed/subwatershed goals and objectives; and
- Fosters input from citizens, stakeholders, and technical experts, and coordinates with other agencies.

1.2 Management Measure Description and Selection

1.2.1 Description

The goal of this management measure is to ensure that urban runoff management programs are developed and implemented with a solid institutional foundation. Federal, state, regional, and local governments all play important roles in establishing and maintaining programs. Consequently, a team approach must be taken to avoid overlap of key responsibilities and authorities, and to ensure that the appropriate levels of government function cooperatively.

1.2.1.1 Role of federal government

Because nonpoint source runoff management programs are within the purview of state and local governments, the federal government's primary role in nonpoint source runoff management programs is to develop broad urban runoff control guidance with participation of state, regional, and local governments, and to provide technical and financial assistance to support the implementation of effective programs and practices.

1.2.1.2 Role of state government

State programs play an especially important role in establishing the team approach to runoff management. State officials interpret and coordinate federal mandates for implementation at the local level, establish state performance standards, and design criteria for runoff control. States also typically take the lead in conducting research, providing technical assistance, developing public education programs, running training and certification programs for practitioners of runoff management, and implementing monitoring programs to help evaluate the effectiveness of management practices (WMI, 1997a).

Many states allow runoff management programs to be delegated to local jurisdictions while the states retain important oversight and enforcement responsibilities to ensure statewide consistency. States should maintain the authority to intervene if necessary. The following is a list of regulatory elements that might be included in a state's runoff legislation, or in rules and regulations to help guide local program implementation (WMI, 1997b):

- Criteria for local program implementation or delegation
- Types of activities that require runoff control
- Waivers, exemptions, and variances
- Plan approval and inspection fees, including construction or maintenance performance bonds
- Authority for a local storm water utility
- Specific design criteria
- Permit application and approval process
- Operation permit requirements and time frames
- Development and implementation of mandated educational programs related to site inspection of active and completed storm water management systems
- Requirements for any other educational programs
- Inspection requirements, including certification of inspectors
- Maintenance requirements for postconstruction runoff control facilities
- Penalty provisions in the event of noncompliance with requirements for the design, construction, or operation of storm water management systems

1.2.1.3 Role of regional authorities

Regional authorities often share some of the duties of state agencies but customize their services to fit the needs and attributes of the region. They provide a link between local communities and the state, and often work with state officials to establish region-based performance standards and design criteria for runoff controls. They also serve as a focal point for coordinating issues and interests among communities in the region, especially in terms of implementing the watershed approach, developing watershed plans, ensuring consistency of storm water runoff master planning, and resolving situations that affect downstream communities.

1.2.1.4 Role of local government

Counties and municipalities integrate local runoff management planning with land use and regional watershed management plans, floodplain management, wastewater planning, and other programs that affect the management of urban runoff. They are involved with the day-to-day administrative, operational, and technical aspects of runoff management and are responsible for performing inspections, enforcing compliance, performing operation and maintenance, identifying and removing illicit connections, and coordinating program funding.

Wisconsin DNR Revisits their Approach to Watershed Programs

The Wisconsin Department of Natural Resources (WDNR) recognized a need for a more holistic approach to watershed programs (Nemke, 1997). They recognized the following problems associated with planning, coordination, cooperation, funding, and implementation of watershed initiatives:

- Although money is available for implementing watershed initiatives, no formal mechanisms exist to raise and allocate money needed to carry plans forward.
- There is no single agency or organization that has regulatory authority over all of the resources that are involved in watershed initiatives, which sometimes results in conflicting priorities.
- Groups that plan and implement watershed initiatives typically are made up of a diverse group of stakeholders with different leadership abilities, motivations and priorities, and technical backgrounds. This diversity makes it difficult to keep the group moving in a consistent direction and becomes problematic when a consensus is needed to allocate funding for implementation.
- Rules and guidance documents often dictate inflexible solutions for dischargers and discourage more creative, innovative, or cost-effective solutions that could be equally or more beneficial to the watershed initiative.

WDNR presented the following recommendations for watershed districts to help overcome logistical problems associated with watershed programs:

- Staff should stay current on watershed issues and initiatives by attending conferences and keeping abreast of relevant journal articles and reports to get a better idea of what practices and policies work best.
- Staff should take a leadership role on technical issues relating to evaluation of watershed problems and solutions.
- The district should avoid taking an expanded role in solving watershed problems unless this role is clearly defined in their statutory authority and other government bodies agree that this role is appropriate and prudent.
- The district should only commit funds to initiatives that are clearly tied to potential benefits for the district's users.
- The district should encourage and participate in evaluations of legislative initiatives that will provide adequate authority to implement watershed-based solutions.
- The district should critically evaluate proposed solutions to watershed problems to ensure they will adequately and sensibly address these problems.

All runoff management programs share common needs, including the legal authority to create, adopt, and enforce ordinances; an institutional structure designed to carry out the goals and objectives of the program; and adequate funding for staff and program activities. Planning serves as the foundation for runoff programs; it establishes management measures and determines how and where management practices will be applied. The program framework should also include the input of citizens and other stakeholders, technical experts, and other agencies in the program planning and implementation. Communities will need to balance stakeholder concerns for the environment and the economy. Community groups must work together as they develop their own sustainable development concepts to contribute to the betterment of the environment and the residents of the watershed. Finally, ongoing program evaluation and feedback are critical (see Management Measure 12: Evaluate Program Effectiveness).

1.2.2 Management Measure Selection

This management measure was selected because successful runoff management programs require an established program framework and objectives. The measure is intended to provide general guidance on the common aspects of a program framework that should be considered and addressed when developing a runoff management program. Examples are provided to illustrate how the practices can be used to implement the management measure.

1.3 Management Practices

1.3.1 Establish Legal Authority

A successful urban runoff program must have the legal authority to accomplish its goals and objectives. State-level programs derive their legal authority from various laws, codes, and regulations enacted by the state legislature. Only a few states have passed comprehensive statewide runoff management legislation. States whose laws often serve as models include Delaware, Florida, Maryland, New Jersey, and Washington.

The language in state runoff legislation is usually general and might include the runoff program's goals, procedures, and general requirements for maintenance. Details concerning design, construction, operation, and maintenance of runoff management practices are established by the program's implementing regulations and guidance materials (runoff management manual).

If authorized by state law, the state can delegate program implementation authority to local entities. Delegation is usually beneficial to local governments because they have a direct interest in seeing that practices are installed, operated, and maintained correctly. Delegation also provides them the flexibility to implement the program based on the needs of the community. To aid local communities in this endeavor and to ensure statewide consistency in runoff management, state program officials typically develop a state manual that presents design criteria and guidance for implementing specific management practices. State and local regulation writers typically adopt the state manual by reference into their regulations wherever appropriate to ensure that the information contained in the document is used and applied correctly.

EPA's Office of Wetlands, Oceans, and Watersheds has developed a Web site that has examples of model ordinances that address issues such as aquatic buffers, erosion and sediment control, open space development, storm water control operation and maintenance, illicit discharges, and postconstruction controls (USEPA, 1999b). The Web site, http://www.epa.gov/owow/nps/ordinance, also has materials that support particular ordinances, such as maintenance agreements and inspection checklists. Additionally, the Center for Watershed Protection's Stormwater Manager's Resource Center Web site has a collection of model ordinances, which can be accessed at http://www.stormwatercenter.net/.

The primary focus of the management practices discussed below is on how local governments can increase their ability to manage runoff by developing new ordinances or regulations, or modifying existing ones. It should be noted that many of these practices could also be adopted at the state level to ensure statewide consistency of runoff management practices.

1.3.1.1 Examine existing laws and regulations

The first step in crafting ordinances to improve runoff management controls at the local level is to examine all the existing mandates, authorities, laws, regulations, codes, ordinances, review processes, and so forth that pertain to environmental review in the community. By comparing current rules and practices with the rules needed to achieve the goals and objectives of the runoff management program, a community can identify gaps and weaknesses that need to be addressed.

Frederick County, Maryland, Site Planning Roundtable

The Frederick County Department of Planning and Zoning and the Center for Watershed Protection facilitated a local site planning roundtable in Frederick County, Maryland. The roundtable worked to review the county's current subdivision and zoning codes, define the local hurdles that impede the implementation of more innovative site planning techniques, and hammer out changes to local codes and ordinances that would foster more environmentally friendly development. By January 2000 the diverse group of planners, developers, watershed planners, and other community professionals arrived at a consensus on the modifications necessary to achieve widespread implementation for more environmentally sensitive site designs. The changes the group recommended are designed to guide future site development in the county toward the goals of reducing impervious cover, conserving natural areas, and minimizing storm water pollution.

The resulting document, *Frederick County Roundtable Recommendations: A Consensus Agreement*, was presented to the Frederick County Commissioners in February 2000. While certainly fostering better site design in Frederick County, the successful Frederick County roundtable also is an important example for other communities interested in implementing similar projects. In addition, this project complements other ongoing regional, state, and local growth management efforts occurring throughout Maryland.

For more information on the Frederick County Site Planning Roundtable's recommendations, contact the Center for Watershed Protection, 8391 Main Street, Ellicott City, Maryland 21043; phone 410-461-8323; fax 410-461-8324; e-mail: mailto:center@cwp.org.

Revision of Development Rules for the City of High Point, North Carolina

The state of North Carolina plans to build a reservoir, called Randleman Lake, to meet the growing need for water in North Carolina's Piedmont Triad region (Brewer et al., 2000). Recognizing that the watershed has one of the highest rates of urbanization in the region, the state has developed a set of rules, called the Randleman Lake Water Supply Watershed Protection Rules, to establish requirements for wastewater dischargers, protect and maintain riparian areas, and provide for urban runoff management in areas draining to Randleman Lake. The City of High Point was charged with developing a watershed protection ordinance to comply with the Randleman Lake Rules, which require strict development limitations for areas within the watershed (Table 1.1).

Table 1.1: Summary of the Randleman Lake water supply watershed protection rules.

Development Option	1.1.1.1.1 Description
Critical area low density	– 6% impervious surface limit or 1 dwelling unit per 2 acres. – 50-foot stream buffers around perennial and intermittent streams.
Critical area high density	– 30 percent impervious surface limit. – 100-ft and 50-ft buffers for perennial and intermittent streams, respectively. – Structural controls required for developments with 6 to 30% imperviousness.
General watershed area—low density	– 12% impervious surface limit or 1 dwelling unit per acre. – 50-foot stream buffers around perennial and intermittent streams.
General watershed area—high density	– 50% impervious surface limit. – 100-ft and 50-ft buffers for perennial and intermittent streams, respectively. – Structural controls required for developments with 12 to 50% imperviousness.

The city undertook a two-part study to facilitate development of an ordinance that protects water quality while providing flexibility to accommodate projected growth. The first part of the study involved a committee of stakeholders charged with identifying and evaluating different strategies for watershed protection. The city used an iterative approach to involve the stakeholder groups with an important "feedback loop" and key checkpoints throughout the process to gauge and document each stakeholder group's buy-in and formal approval. The second part of the study involved a comparative analysis of impacts of different protection strategies for the watershed. The comparative analysis focused on phosphorus as an indicator of water quality impacts on Randleman Lake. The analysis involved establishing a baseline of phosphorus loading that is not to be exceeded by alternative strategies for new development. It also involved identifying and estimating additional loadings from areas that are expected to be developed more intensely and are expected to exceed the baseline phosphorus loading. Strategies for offsetting these loadings elsewhere in the watershed or mitigating them with more protective on-site management practices were then developed and evaluated.

The plan (see Figure 1.1) and ordinance adopted as a result of this study were based on a phosphorus banking principle and included the following elements:

- Maintenance of a 6.4-square-mile critical area, which is larger and more restrictive than that required in the Randleman Lake Rules and yields a phosphorus loading reduction/offset of approximately 800 lb/yr.
- Use of 440 lb/yr, or approximately 55 percent of the phosphorus offset, to allow increased imperviousness for planned higher-density nonresidential development.
- Use of the remaining offset as a phosphorus reduction reserve.
- Revision of ordinance(s) and engineering specifications to encourage low-impact design and alternatives to traditional storm water ponds.

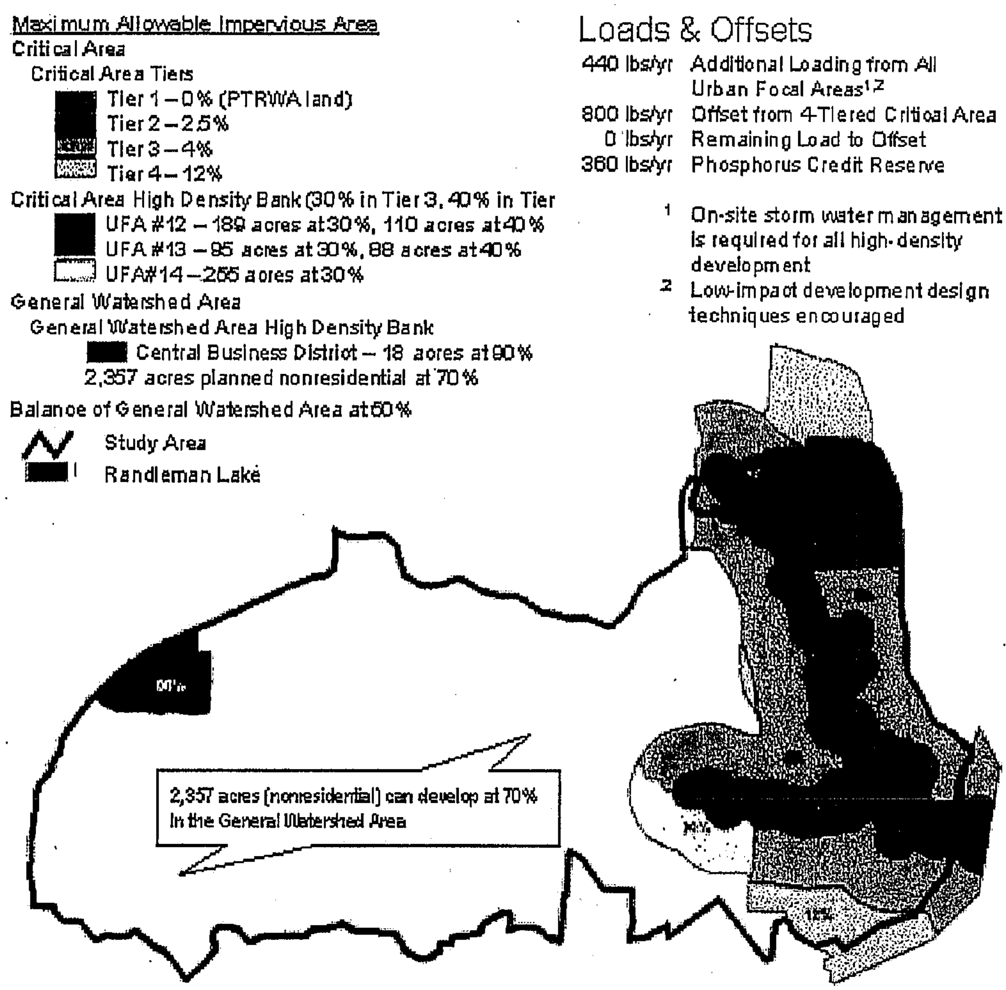

Figure 1.1: Adopted watershed protection plan for the City of High Point, North Carolina.

The city has adopted a watershed protection ordinance for the Deep River 1 watershed that incorporates the strategies listed above and has modified its engineering specifications to allow bioretention facilities and to provide guidance for their design. In the coming year, the city will work to:

- Review local monitoring data and recommend additional monitoring protocols that can track the effectiveness of best management practices used, including new low-impact development design techniques. Possible funding sources for monitoring will be identified.
- Review and revise the city's development ordinance and engineering specifications to further allow and encourage low-impact design techniques.
- Plan and host a spring 2000 low-impact development design workshop for city staff, local contractors, and engineers.

1.3.1.2 Develop or improve ordinances for water quality enhancement

(1) *Aquatic buffer ordinance.* Aquatic buffers serve as natural boundaries between local waterways and existing development. They help protect water quality by filtering pollutants, sediment, and nutrients from runoff. Some other benefits of buffers are flood control, streambank stabilization, controlling stream temperature, and providing room for lateral movement of the stream channel. Good aquatic buffer ordinances specify the size and management of the stream buffer and are a specific planning tool to protect stream quality and aquatic habitat.

Effective buffer ordinances provide guidelines for buffer creation and maintenance and should require:

- Buffer boundaries that are clearly marked on local planning maps;
- Maintenance language that restricts vegetation and soil disturbance;
- Tables that illustrate buffer width adjustment by percent slope and type of stream; and
- Direction on allowable uses and public education.

(2) *Erosion and sediment control ordinance.* A basic goal of erosion and sediment control programs should be to minimize off-site impacts by first preventing erosion and then maximizing control of sedimentation on-site (WMI, 1997a). A key tool for accomplishing this goal is an effective erosion and sediment control (ESC) ordinance.

An ESC ordinance typically requires developers to submit an ESC plan to a state or local regulatory agency for approval prior to initiating construction activities. This plan contains specific practices to prevent erosion and control sediment, as well as information concerning phasing of clearing and grading activities. Once the plan is approved by the regulatory agency, the developer and contractor are responsible for following the plan and implementing the management practices. If follow-up inspection reveals a lack of

Residents' Willingness to Pay for Riparian Buffers

In St. Charles County, Missouri, rapid growth has resulted in serious threats to the environment such as flooding, water pollution, and habitat loss for aquatic organisms and wildlife. To combat these problems, the St. Charles "Natural Watercourse Protection Ordinance" was passed, and requires 50-foot riparian buffer along major streams and a 25-foot buffer along tributaries when adjacent land is being developed for residential or other non-agricultural uses. In anticipation of potential increases in development costs and home prices resulting from the ordinance, a study was conducted in the Dardenne Creek watershed to evaluate the residents' willingness to pay for adopting buffers in newly developed residential communities. Survey respondents identified wildlife, environmental benefits, and natural appearance and sounds as the primary values of Dardenne Creek. Respondents were concerned about the damaging impacts of flooding, erosion, and safety of children on property values. 43.7 percent of the respondents were willing to pay a median value of $1000 for community-owned and open accessible buffers. The study indicates that residents generally recognize the potential environmental benefits of the buffer ordinance, but outreach efforts should focus on informing homeowners that the ordinance may result in increased construction costs and higher home prices. The study's author concludes that the residents' willingness to pay indicates that the real estate market can absorb the possible increases in the construction costs due to implementing the ordinance (Qiu, 2003).

compliance, the inspector may issue a permit violation, stop-work order, or fine, or take other steps to compel action.

Whether program authority is implemented at the state level or delegated to a local government, the ordinance should include goals, performance standards, and design criteria for both erosion prevention and sedimentation control. At a minimum, the ordinance should define the following erosion prevention design criteria:

- The threshold for disturbed areas at which regulatory action/compliance is required; and
- The maximum time frame for permanent site stabilization after final grading or temporary stabilization if construction ceases and the site is left dormant.

(3) *Open space ordinance.* Open space development, also known as "cluster development," is a planning technique that concentrates dwelling units in a compact area and leaves the balance of the site as natural, open space. Lot sizes, setbacks, and frontage distances are minimized, thereby reducing the amount of impervious cover on-site. Open space development reduces the need for clearing and grading by 35 to 60 percent, and increases opportunities for using the reserved land for a variety of purposes such as conservation, recreation, habitat preserves, and storm water management. Table 1.2 shows a summary of studies that contrasted conventional and open space designs in terms of impervious cover and storm water runoff (CWP, 1998a). Specific recommendations on how to limit imperviousness and maximize pervious areas can be found in Management Measure 4: Site Development.

Table 1.2: Redesign analyses comparing impervious cover and storm water runoff from conventional and open space subdivisions (CWP, adapted 1998a).

Residential Subdivisions	Conventional Zoning for Subdivision	Impervious Cover at the Site			Percent Reduction in Runoff
		Conventional Design	Open Space Design	Net Change	
Remlik Hall	5-acre lots	5.4%	3.7%	-31%	20%
Duck Crossing	3- to 5-acre lots	8.3%	5.4%	-35%	23%
Tharpe Knoll	1-acre lots	13%	7%	-46%	44%
Chapel Run	½-acre lots	29%	17%	-41%	31%
Pleasant Hill	½-acre lots	26%	11%	-58%	54%
Prairie Crossing	½- to ⅓-acre lots	20%	18%	-10%	66%
Rapahannock	⅓-acre lots	27%	20%	-24%	25%
Buckingham Greene	⅛-acre lots	23%	21%	-7%	8%
Belle-Hall	High density	35%	20%	-43%	31%

For open space development to be successful, the ordinance needs to be crafted to foster development that is both marketable and environmentally sensitive. The ordinance also needs to effectively address issues such as maintenance, liability, and access by emergency vehicles. In addition, the community needs to be prepared to manage the space or to dedicate open space to a responsible organization.

The Center for Watershed Protection and EPA Present Model Ordinances on the Web

Communities can strengthen the language of their regulations and ordinances to better protect environmental resources by referring to examples of exemplary ordinances from across the country. The following is a list of ordinances available for download from http://www.epa.gov/owow/nps/ordinance.

Aquatic Buffers
- Language from Baltimore County, MD
- Coastal Zone Program, RI (an example of a buffer ordinance in a coastal region)
- Ordinance on Riparian Habitat Areas, Napa, CA
- Portland Metro Floodplain Preservation Ordinance
- Model Land Trust Agreement from the Natural Lands Trust

Erosion and Sediment Control
- Erosion and Sediment Control Ordinance from Minneapolis, MN
- Clearing and Grading Ordinance from Olympia, WA
- Erosion and Sediment Control Inspection Checklist from the Lower Platte South Natural Resources District, NE
- Small Site Design Guideline from the Indiana Department of Natural Resources
- Preconstruction Meeting Notice from Montgomery County, MD

Open Space Development
- Open Space Development Ordinance from Calvert County, MD
- Land Preservation District Model Zoning from Montgomery County, PA
- Open Space Ordinance from Hamburg Township, MI

Storm Water Operation and Maintenance
- Ordinance Language from Grand Traverse County, MI
- Example Maintenance Agreement from Albemarle County, VA
- Easement and Right-of-Way Agreement from Montgomery County, MD
- Inspection Checklist from Anne Arundel County, MD
- Performance Bond from Colorado

Illicit Discharges
- Fort Worth, TX, Environmental Code: Storm Water Protection
- Washentaw County, MI, Regulation for Inspection of Residential Onsite Disposal Systems at Property Transfer
- Metro. St. Louis Sewer District Sewer Use
- City of Monterey, CA, Storm Water Ordinance
- Montgomery County, MD, Illicit Discharge Ordinance

Postconstruction Controls
- Maryland Department of the Environment Proposed Storm Water Management Regulations
- Grand Traverse County, MI, Soil Erosion and Storm Water Runoff Control Ordinance
- City of Seattle Storm Water, Grading, and Drainage Control Code
- St. Johns River Water Management District, FL: Environmental Resource Permits
- City of Santa Monica, CA, Municipal Code of Ordinances: Urban Runoff Pollution

Source Water Protection: Ground Water Ordinances
- Aquifer Protection District Ordinance from Stratham, NH
- Ground Water Protection and Siting Ordinance from Hernando County, FL
- Ground Water Source Protection Overlay District Ordinance from Salt Lake City, UT
- Sinkhole Ordinance from Lexington, KY
- Wellhead Protection District Ordinance from Weston, WI

Source Water Protection: Surface Water Ordinances
- Tahoe Regional Planning Agency Source Water Protection Ordinance
- Shoreland Management Overlay District Ordinance from Buffalo, MN
- Water Supply Watershed District Overlay Ordinance from Greensboro, NC
- Watershed Management and Protection Area Overlay District Ordinance from County of York, VA
- Town of Skaneateles Lake Watershed District Ordinance, NY

Miscellaneous Ordinances
- Lake Travis Nonpoint Source Ordinance
- Storm Water Utility Ordinance from Takoma Park, MD
- Transfer of Development Rights Ordinance from Sarasota, FL
- Golf Course Management Guidelines from Baltimore County, MD
- Wetlands and Watercourses Ordinance from Croton-on-Hudson, NY
- Forest Conservation Ordinance from Frederick County, MD

(4) *Storm water operation and maintenance ordinance.* The expense of maintaining most storm water management practices is relatively small compared to the original construction cost. Too frequently, however, maintenance is not completed, particularly when the practice is privately owned. Improper maintenance decreases the efficiency of management practices and can also detract from the aesthetics of the practices. The operation and maintenance language within a storm water ordinance can ensure that designs facilitate easy maintenance and that regular maintenance activities are completed.

(5) *Illicit discharge ordinance.* An illicit discharge is defined as any discharge to the municipal separate storm sewer system that is not composed entirely of storm water, except for discharges allowed under an National Pollutant Discharge Elimination System permit or waters used for firefighting operations. These non-storm water discharges occur because of illegal connections to the storm drain system from residential, business, or commercial establishments. As a result of these illicit connections, contaminated wastewater enters storm drains or directly enters local waters before it receives treatment at a wastewater treatment plant. Illicit connections might be intentional or can be unknown to the business owner; often they are the result of connection of floor drains to the storm sewer system. Additional sources of illicit discharges include improperly connected sanitary sewer lines, failing septic systems, illegal dumping practices, and the improper disposal of sewage from recreational activities like boating and camping.

Illicit discharge detection and elimination programs are designed to prevent contamination of ground and surface waters by monitoring, inspection, and removal of these illegal non-storm water discharges. An essential element of these programs is an ordinance granting the authority to inspect properties suspected of releasing contaminated discharges into storm drain systems. Another important factor is the establishment of enforcement actions for those properties that are found to be in noncompliance or refuse to allow access to their facilities.

(6) *Postconstruction runoff control.* The management of runoff from sites after the construction phase is vital to controlling the adverse effects of development on urban water quality. The increase in impervious surfaces such as rooftops, roads, parking lots, and sidewalks due to land development can have a detrimental effect on aquatic systems. High amounts of impervious cover have been associated with stream warming, habitat alteration, and decreased aquatic integrity in urban areas (Karr, 1991; May et al., 1997; Schueler, 1995; Shaver et al., 1994). Runoff from impervious areas can also contain a variety of pollutants that are detrimental to water quality, such as sediment, nutrients, road deicers, heavy metals, pathogenic bacteria, and petroleum hydrocarbons.

The main goal of a runoff management ordinance for existing development is to limit surface runoff volumes and reduce runoff pollutant loadings. For example, the ordinance could specify which nonstructural and structural storm water practices are allowed in the community. Communities might also wish to add language pertaining to on-site runoff requirements, and should identify whether off-site treatment is an option. Example ordinances can be found on EPA's Model Ordinances to Protect Local Resources Web site at http://www.epa.gov/owow/nps/ordinance/index.htm.

(7) *Source water protection ordinances*. Source water protection involves preventing the pollution of the ground water, lakes, rivers, and streams that serve as sources of drinking water for local communities. Source water protection ordinances help safeguard community health and reduce the risk of water supply contamination. When drafting an ordinance aimed at protecting these sources, drinking water supplies can be divided into two general sources: ground water (aquifers and wells) and surface water (lakes and reservoirs). Wellhead Protection Zones and Aquifer Protection Areas are two examples of source water protection ordinances that seek to protect ground water sources. Water Supply Watershed Districts and Lake Watershed Overlay Districts are examples of local management tools that provide protection of surface water supplies by restricting land uses around a reservoir used for drinking water.

(8) *Runoff management ordinances/regulations*. The primary purpose of runoff regulations is to ensure that runoff management systems (within the area of jurisdiction) are properly designed, constructed, inspected, operated, and maintained. A comprehensive ordinance should incorporate the issues addressed below (WMI, 1997b).

(a) *Design and review requirements*. Runoff management systems must be properly designed and constructed to function efficiently. A design manual tailored to local topographic, geologic, and climatic conditions and local regulations should be developed to accompany a runoff management ordinance. National and regional guidance is available to assist local governments in developing technical guidance. For example, the National Association of Homebuilders (NAHB, 1995) has produced a guidance manual entitled *Storm Water Runoff and Nonpoint Source Pollution Control Guide for Builders and Developers* that can be used to develop a technical design manual. The design manual is typically referenced in the ordinance to direct users to technical support for their runoff management projects.

(b) *Construction requirements*. Runoff management facilities can fail prematurely if they are poorly constructed or if sediments and other pollutants are not carefully managed during the construction phase. Techniques for protecting structural practices from construction-related pollution are usually addressed in the state runoff management manual and incorporated by reference into the ordinance. Specific practices to mitigate construction site erosion and control sediment are discussed in Chapter 5 under the construction site erosion and sediment control management measure (8).

To ensure that a facility is constructed properly, a runoff management ordinance should include the following:

- *Financial assurances*. A guarantee, usually in the form of a surety or cash bond, should be made that the completed runoff management facility functions properly. The amount typically should not be less than 50 percent of the estimated construction cost of the system (WMI, 1997b).
- *Inspections*. Inspectors should maintain a presence throughout the construction phase and conduct inspections at specified stages of construction, not at assigned time intervals (WMI, 1997b).

- *As-built certifications and record drawings*. Completed facilities should have official documentation prepared and sealed by a professional engineer or other qualified design professional (WMI, 1997b).
- *Allowances for damage to temporary practices*. Funds should be set aside specifically to repair damage to erosion and sediment controls (e.g., silt fences) at temporary construction sites caused by severe storm flows, high winds, or fallen trees. Funds may be used only if documented inspections show erosion and sediment controls are installed and maintained as required. This allowance helps to ensure 100 percent compliance by contractors (Deering, 1999).

(c) *Operation and maintenance requirements*. Ensuring that runoff management facilities are properly operated and maintained, both in the short term and the long term, is another critical element that should be addressed in the design phase. For the short term, the ordinance should stipulate a warranty period (perhaps one or two years) during which the original developer must retain all operation and maintenance responsibilities. The developer should be required to post a bond or other security to ensure that costs will be covered if any design defects or construction failures are discovered during the warranty period.

Several techniques can be used to ensure longevity of management practices, including warranties, operating permits, and maintenance bonds. Specific requirements for operation and maintenance to be set forth in an ordinance might include the following:

- An easement that provides an access road for maintenance equipment
- Ownership of the system and maintenance access road by those who use the system
- Inspection by a certified site inspector at defined intervals
- Land set aside for disposal of sediments removed during maintenance
- Clear documentation of maintenance responsibilities and maintenance schedule
- A written maintenance agreement

When the initial warranty period is over, long-term operation and maintenance responsibilities typically revert to a property owners' association. Unfortunately, in many instances these types of groups do not perform important operation and maintenance tasks because they lack the financial, legal, and/or administrative capability. Very often, this neglect results in failed systems and problems for downstream property owners. The ordinance needs to incorporate specific elements to ensure that a system is in place for collecting fees, contracting for services, and establishing rules and regulations before a property owners' association is granted authority for long-term maintenance. In some cases, it is more prudent for an alternative entity such as local government, special taxing district, or public utility to be responsible for long-term operation and maintenance functions.

(d) *Maintenance inspection requirements*. Periodic inspections and certifications are necessary to ensure that the legal operation and maintenance entity is keeping the storm water system in good working order and making all necessary repairs. An ordinance needs to include language that identifies the inspectors and specifies how often the inspections are to be conducted. Depending on the framework, inspections could be done by the permitting authority or some other public agency. Alternatively, private inspectors might be used. In either case, inspectors should be required to complete a state-sponsored course and receive certification.

The frequency of inspection depends on the type of management practices employed at the site. Some types of facilities (e.g., a wet pond) might need to be inspected only annually. A sand filter, in contrast, might need to be inspected once a month or even more frequently during the wet season. The entity responsible for maintenance inspections should maintain inspection and maintenance records on file. In addition, procedures need to be established to ensure that problems identified during the inspection process are fixed in a timely manner and that reinspection occurs as soon as practicable.

(9) *Wetlands protection ordinance*. Local governments can protect wetlands by adopting a wetland protection ordinance that supplements the permitting program established under Section 404 of the Clean Water Act (for more information on Section 404, see the Introduction (section 1.2.2 Regulatory Context) or http://www.epa.gov/owow/wetlands/facts/fact10.html). Section 404 does not cover all wetlands, nor does it cover all activities that may infringe on a wetland. A local regulatory program can be used to provide additional protection. A local ordinance should, however, be compatible with, supplement, and/or streamline the Section 404 program while tailoring wetland protection plans to meet local conditions and circumstances (Patton et al., 2000).

Following are some of the important components of a wetlands ordinance (Cowles et al., 1991).

- The applicant should be required to submit a detailed wetland analysis, performed by a trained wetland ecologist, of the subject property, including a professional survey of the wetland edge.
- A wetland should be protected by an adequate undisturbed buffer and placed within a permanent open space or protective easement tract to preclude future subdivision of the wetland.
- Wetlands should not be used as surrogate runoff detention structures. Any runoff directed into a wetland should be pretreated.
- Construction near wetland areas should utilize management practices, including proper placement and installation of sedimentation control and clearly marked limits of construction to avoid inadvertent wetland impacts.
- Non-wetland field staff such as building inspectors, grading inspectors, or any other appropriate staff should be trained to recognize wetlands and to ensure management practices are used and enforced during the construction process.

(9) *Miscellaneous ordinances*. Other ordinances capture issues that are important for protection of water resources but do not fall into a single category. The following are examples of miscellaneous ordinances:

- The Nonpoint Source Ordinance for Lake Travis, which is located along the lower Colorado River near Austin, Texas, addresses techniques required to control nonpoint source pollution from permitted and unpermitted activities.
- The Transfer of Development Rights Ordinance of Sarasota, Florida, allows for the transfer of development rights to protect environmentally sensitive areas from impacts caused by new development by directing new development to less-sensitive areas.

1.3.1.3 Explore market-based regulatory approaches

Water quality trading is a market-based approach to improving and preserving water quality. Trading allows one pollution source to meet its regulatory obligation by purchasing pollutant reductions created by another source that reduces pollution below levels required by federal and state regulations. Trading is a cost-effective solution because pollution control is achieved where the cost is lowest.

EPA is currently targeting water quality trading and providing guidance and procedures. Trading is a possibility in all watersheds, even where water quality is not impaired, but the focus is on watersheds with approved TMDLs. Water quality trading is encouraged for nutrients and sediments. For pollutants other than nutrients or sediment, a higher level of scrutiny would be applied. EPA does not support the trading of persistent bioaccumlative toxic pollutants, or trading where water quality standards would be exceeded.

Water quality programs should include the following provisions for trading:

- Permits under Sections 402 and 404.
- For NPDES permits, information on how trading baselines and conditions have been established and how they are consistent with water quality standards.
- Standard methods for measuring compliance.
- Designated uses to be protected (e.g. the antidegradation policy will be upheld).

Credible trading programs generally include:

- Legal authority and mechanisms
- Clearly defined units of trade
- Creation and duration of credits
- Protocols for quantifying credits and addressing uncertainty
- Provisions for compliance and enforcement
- Public participation and access to information
- Periodic program evaluations

This box is intentionally left empty.

EPA's trading Web site (http://www.epa.gov/owow/watershed/trading.htm) provides a number of resources related to the current policy, new developments, case studies, and links to other trading programs.

1.3.2 Develop an Institutional Structure

The following practices follow the approach presented by the Center for Watershed Protection in the *Rapid Watershed Planning Handbook* (CWP, 1998c). This approach applies mainly to local efforts in small watersheds. State and regional agencies might need to conduct their efforts on a larger scale. Other resources that address establishing a watershed planning framework on a larger scales include *Framework for a Watershed Management Program* (Clements et al., 1996) and *Know Your Watershed* (CTIC, 2000).

1.3.2.1 Establish a watershed baseline

The first step in a watershed assessment process is to gather basic background information about the watershed and subwatersheds. This process can be used as a foundation for developing the rest of the watershed plan.

(1) *Define watershed and subwatershed boundaries.* Watershed and subwatershed boundaries need to be mapped on a good topographic map such as those produced by the U.S. Geological Survey. These maps, an example of which is shown in Figure 1.2, can help in identifying the political jurisdictions and citizens that should participate in the watershed planning effort, and the land use patterns in the watershed and each subwatershed (CWP, 1998c).

(2) *Identify "embedded" agricultural areas.* Livestock waste management is typically not considered an issue in urban areas. However, the urban/suburban landscape can build up around an existing agricultural area, or property owners can board animals on residential property, making animal waste management an important component of maintaining water

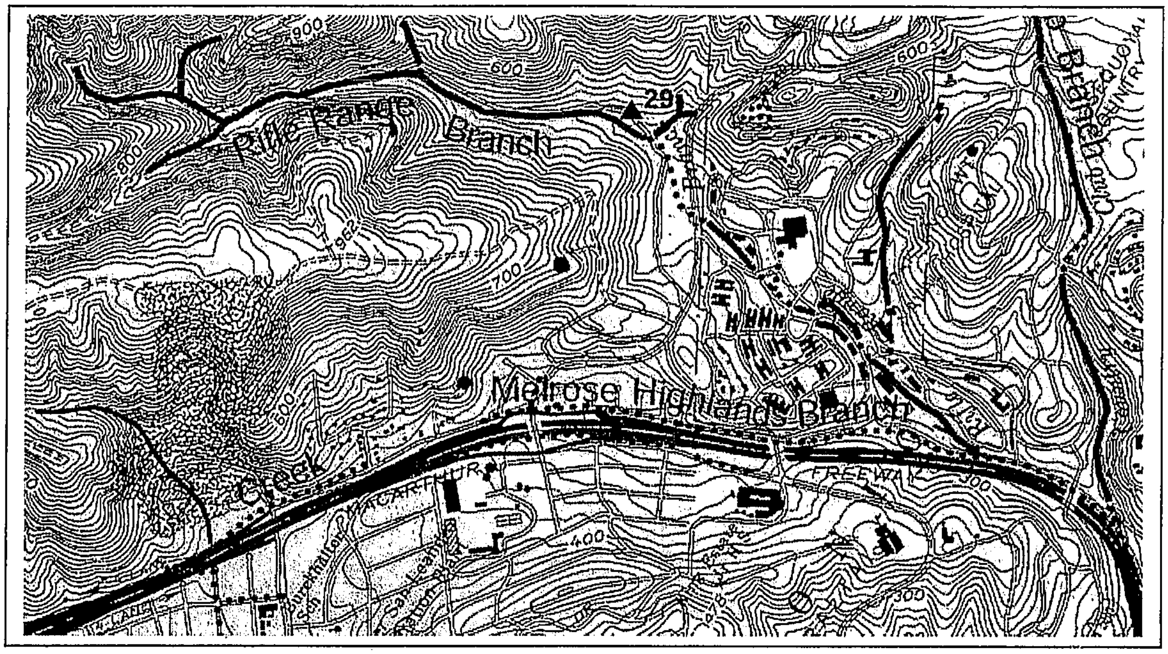

Figure 1.2: Example of part of a subwatershed base map (Oakland Museum of California, No date).

quality in urban areas. Animal wastes from stables or backyard pens contribute nutrients and pathogens to runoff and ground water. Manure can also be a nuisance because of odors and flies, and animals can contribute to the destruction of vegetation through trampling and overgrazing.

Water quality problems can be associated with stables and backyard livestock pens. Management techniques to address these agricultural nonpoint sources include (Terrene Institute, 1994):

- Siting animal areas to drain away from water bodies
- Planting or maintaining as much vegetation as possible between animal areas and water bodies
- Establishing diversions upslope from a high-use area to divert clean water away from bare soils and manure
- Establishing berms or diversions downslope of high-use areas to collect contaminated runoff for treatment
- Establishing fenced areas for animal use to protect vegetation
- Collecting manure and bedding regularly and protecting stored manure from rainfall and runoff

Good Horse Keeping

Horse owners in Massachusetts and the Patriot Resource Conservation and Development (RC & D) Council have launched the Horse Manure Management Initiative (HMMI). The Initiative involves collaboration between horse owners, the Massachusetts Farm Bureau, the Massachusetts Stable Owners, and the Operators and Instructors Association to improve and protect water quality in Essex, Middlesex, Norfolk, and Suffolk counties. The HMMI is focused on education, outreach, and policy initiatives to promote good horse keeping practices and manure management. The Patriot RC&D Council plans to release a *Good Horse Keeping* video and a *Horse Owner Directory and Resource Guidebook* in 2003. For more information, visit http://patriotrcd.org/horse_manure_management.html.

- Applying animal wastes as fertilizer for pastures, croplands, lawns, gardens, nurseries, and greenhouses at rates dictated by soil analyses
- Composting raw manure to reduce bulk, odors, and bacteria

Sources of information for managing pollution from livestock areas include local cooperative extension service offices, soil and water conservation district offices, and U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) offices. NRCS published the *Agricultural Waste Management Field Handbook*, which is a comprehensive guide for livestock operators that provides detailed technical information about practices to properly manage animal wastes (USDA NRCS, 1992). This document can be accessed online at http://www.wcc.nrcs.usda.gov/awm/awmfh.html. Additionally, EPA published *National Management Measures to Control Nonpoint Source Pollution from Agriculture*. This document is available for download from the Office of Wetlands, Oceans, and Watersheds' Web site at http://www.epa.gov/owow.

(3) *Identify possible stakeholders*. Stakeholder participation in planning for watershed management is crucial. Stakeholders have power and a variety of insights that will play a large role in whether the plan succeeds or fails. Stakeholders are affected by the outcome of the watershed plan, have a responsibility for implementing the plan, or have the ability to impede or assist the plan's implementation. See below for a list of organizations and people that might be stakeholders. This group is not limited to people living or working in the watershed or subwatershed delineated on the watershed map. Because several local management units can be encompassed by a single watershed, state, tribal, interstate, and federal officials often are considered stakeholders in a local watershed initiative. In addition to identifying the stakeholders, the planning process should include developing a technical advisory team or committee to assist with the scientific aspects of the watershed program.

Federal Agencies
- Environmental Protection Agency
- Army Corps of Engineers
- Fish and Wildlife Service (Department of the Interior)
- Federal Emergency Management Agency

Nonprofit Organizations
- Greenways coalitions
- "Friends of ..." groups
- Watershed coalitions or foundations
- Anglers' groups
- Volunteer organizations
- Recreation/hiking groups

State/Local Agencies
- Environmental or wildlife agency
- Flood control district
- Water rights agency (primarily in the southwestern United States)
- Public works department
- Planning/zoning department or board
- State department of transportation
- Local conservation commissions
- Extension services from land grant universities

Private Sector
- Consulting engineers
- Local businesses
- Real estate companies
- Builders/developers
- Trade associations

Other Citizens
- Local residents
- Schools/teachers
- "Downstream" users (i.e., drinking water consumers)

(4) *Measure existing impervious cover.* The amount of impervious cover is a key attribute of watersheds. The impervious cover model (CWP, 1998a) directly links imperviousness levels to the quality of water resources at the subwatershed scale. Crucial to the use of the model is an estimation of the percentage of the subwatershed covered by impervious surfaces. A number of practices can be used to make this estimate, ranging from measuring cover directly using aerial photographs to predicting cover based on the relationship between imperviousness and population or road density statistics.

(5) *Assemble historical monitoring data.* Most water resources in urban and suburban areas have been monitored at one time or another. The challenge is to identify who has collected data and whether the data are in an accessible and usable form. Often the people that collect data in a particular watershed are also stakeholders or members of the technical committee. Whatever the source, watershed data need to be assessed in terms of quality and usefulness. The technical advisory team plays an important role in this endeavor. Once organized, historical data provide the background knowledge necessary for guiding the other steps of the local watershed planning process.

(6) *Assess existing mapping resources.* Resource maps are used to present many aspects of the watershed management plan in a clear, reader-friendly format. Natural and cultural features that can be included on a resource map are:

- Floodplain boundaries
- Stream corridors
- Soils and geologic features
- Current and future land use
- Transportation routes
- Buffers
- Wetlands
- Detention/retention ponds
- Direction of drainage

(7) *Conduct an audit of local watershed protection capabilities.* A sometimes overlooked but very important task associated with baseline assessment is a critical evaluation of local capabilities to implement watershed practices. The audit should be as complete as possible and should include examination of local programs, regulations, ordinances, master plans, staff resources, and funding. If deficiencies or potential problems are found, the audit can be used as a basis for making changes.

Watershed Assessment, Tracking, and Environmental Results

EPA has developed an integrated information system for the nation's surface waters that combines data from various EPA Office of Water programs into one large framework. Data from the information system, Watershed Assessment, Tracking and Environmental Results (WATERS), is available online through interactive Web-based applications and mapping tools. The following is a list of programs that are incorporated or scheduled to be incorporated into the database:

- *Water Quality Standards*: The Water Quality Standards Database contains information on designated uses for waterbodies
- *Water Quality Inventory 305(b) Report*: The National Assessment Database includes information on the attainment of water quality standards. Waterbodies are classified as Fully Supported, Threatened or Not Supporting these designated uses.
- *Total Maximum Daily Load 303(d) List*: The TMDL Tracking System provides information on waterbodies that are designated as Not Supporting. These waterbodies are required by law to have TMDLs developed, and the database tracks the status of those TMDLs.
- *Water Quality Monitoring*: The STORET database contains water quality, biological and physical data.
- *NPDES Permits*: The Permit Compliance System stores data on NPDES facilities, permits, compliance status, and enforcement activities for up to six years.
- *Safe Drinking Water*: The Safe Drinking Water Information System contains information on public water systems and drinking water standard violations.
- *Fish Consumption Advisories*: The National Listing of Fish and Wildlife Advisories database includes information on fish consumption advisories issued by states, tribes, and the federal government.
- *Nonpoint Source Pollution*: The Section 319 Grants Reporting and Tracking System is a compilation of information on projects and activities funded by CWA Section 319(h) funds.
- *Nutrient Criteria*: The Nutrient Criteria Database stores and analyzes nutrient water quality data.
- *The BEACH Program*: The Beaches Environmental Assessment, Closure & Health (BEACH) Watch database provides information on whether a specific beach is being monitored for water quality, the party responsible for the monitoring, the pollutants that are being monitored, and advisories or closures that have been issued.
- *Vessel Sewage Discharge*: Vessel sewage discharge is regulated under Clean Water Act Section 312, which mandates the use of marine sanitation devices (on-board equipment for treating and discharging or storing sewage) on all commercial and recreational vessels that are equipped with installed toilets. Under Section 312 States may request a No-Discharge Zone designation that prohibits the discharge of sewage from all vessels into defined waters.

The WATERS database can be accessed online at http://www.epa.gov/waters.

1.3.2.2 Set up an institutional structure

A successful runoff management program requires a strong institutional structure (CWP, 1998c). A typical institution carries out many functions, including:

- Setting goals for the watershed and subwatersheds
- Identifying gaps in monitoring data and taking steps to acquire needed information
- Operating as a forum for stakeholder input
- Reviewing and prioritizing management strategies to achieve maximum watershed protection
- Establishing links with other groups and agencies
- Encouraging cooperative exchanges of information
- Providing funding for planning actions and exploring funding options for management practice implementation
- Ensuring long-term implementation of the runoff management plan

Key attributes needed to perform these functions are:

- Adequate permanent staff to perform facilitation and administrative duties
- A consistent, long-term funding source to ensure a sustainable organization
- Inclusion of all stakeholders in planning efforts
- A core group of dedicated people that have the support of local governmental agencies
- Local ownership of the runoff management plan throughout the process
- A process for monitoring and evaluating implementation strategies
- Open communication channels to increase cooperation among organization members

There are three types of runoff management institution models:

- Government-directed model
- Citizen-directed model
- Hybrid model

The primary difference among the three management options is the authority that is ultimately responsible for directing the watershed plan. In the government-directed model, local or regional agencies assume responsibility for making decisions about how the watershed is managed. The citizen-directed model is driven by citizen activists or grassroots organizations, and the hybrid model combines the best of both models and is recommended for most watersheds. Each paradigm has particular strengths and weaknesses, but whatever form the model takes, the framers of the institution must define its goals and carefully lay out the responsibilities and contributions that will be made by each element. Table 1.3 compares the typical components of the three models, lists advantages and disadvantages associated with each model, and specifies conditions where each model might best be applied.

Table 1.3: Elements of three watershed management structures (CWP, 1998c).

Element	Government-Directed Model	Citizen-Directed Model	Hybrid Model
Formation	Created by legislative authority.	Created at grassroots level by citizens or other interested parties.	Created with some governmental authority and support from citizens.
Membership	Organization membership appointed by governmental authority.	Stakeholder participation is voluntary.	Some members are required to participate, but many are volunteers.
Authority	Structure has regulatory authority over land use and other permits.	Advisory capacity with no regulatory authority over land use or permits.	Some members of the structure have regulatory authority; others act in a volunteer or advisory capacity.
Funding	Funding is through taxes or levied fees.	Funding is by grant, donations, or sometimes local government contributions.	Much of the funding is through a steady source, such as an agreement with a local government, but grants might also compose a significant portion of the budget.
Implementation	Government agencies at the state, local, and federal levels implement the plan.	Local governments implement the plan.	Local governments implement the plan with some assistance from state and federal agencies.
Advantages	Has legal authority to influence development. Has a secure funding source. Consistent staff are available.	Local community has ownership in the plan. No stakeholders are forced to participate. Residents are less intimidated by other citizens than by the government.	Has some authority to implement the plan. Incorporates stakeholders from the public and the government. Usually has some stable funding source and permanent staff. Technical expertise from many sectors can be used to formulate the plan.
Disadvantages	Might not incorporate all interests. Citizens and local governments might not have a sense of ownership in the process.	Might be difficult to secure a stable funding source. Implementation might be difficult without legal authority. Because most members are volunteers, it might be difficult to complete the plan quickly. The most vocal groups might be over-represented.	Demands significant input from citizens and government.
Where best applied	Where the plan will require extensive regulations and land use rules to implement. Where the local community cannot raise the funds to develop and implement a plan. Where the community is not strongly mobilized to take the initiative.	Where the local community has a very strong interest in the water resource. Where the local government has an excellent relationship with local citizens' groups and developers. Where some external funding source, or a steady supply from local governments, can support the citizen groups. Where disagreements between different interests are not expected to slow the group's progress.	Most watersheds.

(1) *Government-directed model.* In this model, an agency of government takes on the responsibility for determining the goals of the runoff management program and directing the means by which those goals are met. Such a structure can consist of one agency vested with regulatory responsibility or a coalition of agencies from the local, state, and federal levels.

The program framework under the government model is strong because of its legal authority and consistent funding, whether required by legislation or instituted as a reflection of an administrative priority. Government involvement ensures that the management process draws on broad public goals and balances the utility of various courses of action. However, government-directed programs often do little to raise public awareness of the need for resource protection, and if a government-led watershed management plan makes inadequate provisions for public input, feelings of disenfranchisement can result. In addition, interagency rivalry can hamper the effectiveness of a government-led management structure.

The government-directed model is frequently employed when a government agency is best positioned to address a particular problem, or when public interest and awareness are not sufficient to motivate citizen participation in the runoff management process.

(2) *Citizen-directed model.* This type of framework is highly legitimate in the public eye because it concentrates heavily on co-opting public involvement throughout the management process and gives the public a strong sense of ownership of the plan. Management recommendations coming solely from the community have no legal authority, however, and community leaders must rely on their ability to engage and motivate governmental entities to accomplish their goals. For that reason, the citizen model usually is effective only where there is a healthy relationship between community leaders and local government.

(3) *Hybrid model.* A quasi-governmental structure, a hybrid runoff management institution is designed to combine legislative authority with technical advice, allowing additionally for stakeholder and citizen input. By representing both government and citizen interests, the model usually provides the most effective means of incorporating public opinion and activity into the needs of the locality and watershed. The specific form that a hybrid management structure takes depends on a variety of factors, but it will usually concentrate heavily on incorporating as many stakeholders as possible into the watershed planning process. Hybrid structures are not vested with regulatory authority but use one of several structures to recommend courses of action to the governing body and plan and implement runoff management practices.

1.3.2.3 Determine budgetary resources available for watershed planning

One of the most important challenges confronting a watershed manager is how to develop watershed and subwatershed plans within existing budget constraints. The manager needs to identify what sources of funding are available and develop budgets for the subwatershed and watershed plans. The cost of a watershed plan varies depending on choices the watershed manager makes regarding mapping, monitoring, modeling, and ongoing management. The budget also depends on the area and complexity of the watershed and its subwatersheds.

1.3.2.4 Project future land use change in the watershed/subwatershed

Land use in a watershed and individual subwatersheds has a strong influence on aquatic ecosystems. Current impervious cover should have been measured as a part of the watershed baseline analysis. The watershed manager needs to forecast the future impervious cover based on available land use planning information, such as existing zoning or master plans.

Impervious cover projection helps watershed managers determine if aquatic resources will degrade from current conditions (see Section 6 of the Introduction for more information about impervious cover). If the analysis indicates that impervious cover will increase to such an extent that it will cause subwatershed quality to decline, a watershed manager should consider shifting impervious cover to another watershed or limiting development.

Southeastern Delaware Whole Basin Management

The Delaware Department of Natural Resources and Environmental Control (DNREC) and Sussex County officials developed a phased process to manage the Inland Bays Basin that combines an assessment program with an implementation plan to solve water quality problems affecting Rehoboth, Indian River, and Little Assawoman Bays (Delaware DNREC, 2000). They identified excessive nitrogen and phosphorus as the most pressing water quality problems in the basin. They attributed the elevated nutrient levels to both urban and agricultural sources, including

- Failing or inadequate septic systems.
- Sewage treatment plant effluent.
- Fertilizer application for residential and commercial landscaping.
- Construction site sediment export.
- Exhaust emissions.
- Open burning.
- Field application of manure to crops.

They also assessed biological populations and identified priority communities and species that warrant special protection.

To begin implementing a whole basin management program, the Delaware legislature established the Center for the Inland Bays in 1994. In 1998 the Center initiated a Tributary Strategy Program that organized stakeholders into three Tributary Action Teams, which assist the Center in reducing nutrient inputs to the bays and restoring habitat. They are also assisting DNREC in developing pollution control strategies to meet TMDLs for nutrients. In 1999 the Delaware House of Representatives passed Resolution 32, which established a multijurisdictional committee to

- Assess progress toward implementation of the Land-Use Action Plan of the Inland Bays Comprehensive Conservation and Management Plan.
- To identify areas where implementation has not been achieved.
- To recommend changes to Sussex County's Comprehensive Plan and implement zoning and subdivision ordinances.

Finally, in 1999 the Delaware Legislature passed the Delaware Nutrient Management Law, which established the Delaware Nutrient Management Commission. The purpose of the Commission is to develop a program to address nutrient inputs from both agricultural sources and urban sources such as golf course landscape operations, residential inputs, and residential and commercial fertilizers.

Regardless of the forecasting option chosen to estimate future impervious cover, it is important to verify and adjust the estimate periodically. This adjustment helps ensure that land use planning tools for the watershed result in the desired level of impervious cover needed to maintain the management strategy of each subwatershed.

1.3.2.5 Develop subwatershed plan

Based on the information obtained in the preceding steps, the watershed manager should determine what goals and objectives are appropriate in the watershed and its individual subwatersheds. Goal-setting is among the most important steps in watershed planning, and the management structure should ensure full involvement from stakeholders at this stage.

A subwatershed plan is a detailed blueprint to achieve the established subwatershed objectives. A typical plan may include revised zoning, management practice regulations, proposed management practice locations, description of proposed new programs, estimates of budget and staff needed to implement the plan, stream buffer widths, or monitoring protocols.

The plan should target the subwatershed objectives with the combination of management practices that is most economical, effective, and feasible. Implementing management practices by planning on the subwatershed scale can increase cost-effectiveness and water quality benefits. A combination of nonstructural, on-site, regional, and channel stabilization practices specifically tailored to the subwatershed will help to maximize these benefits. Pollution prevention and nonstructural practices are key, as they can reduce the generation of pollution and its exposure to rainfall and runoff. In addition, implementing site-dispersed, low-impact development practices can help to control both runoff quality and quantity at the site level. Ensuring that drainage channels and floodplains are stable will provide protection against flooding and serve to buffer receiving waters. Finally, regional runoff control and treatment practices are a last line of defense to control flooding and reduce pollution. The following are descriptions of each type of practice and how they can meet water quality objectives in a subwatershed:

- *Nonstructural practices*. Pollution prevention and nonstructural practices are effective in reducing the generation of pollution and its exposure to rainfall and runoff. These practices help to increase public awareness, and can reduce the need for pollutant removal capacity in runoff treatment controls and the burden of maintaining those controls. Used alone, however, nonstructural practices do not provide a comprehensive solution for runoff management. While various techniques have been developed to qualitatively measure the effectiveness of nonstructural practices, it is difficult to gauge their direct water quality benefits.
- *Site-dispersed (on-site) practices*. Site-dispersed, low-impact development practices control runoff quality and quantity at the site level and reduce the flow volume and pollutant load that reaches drainage channels. In addition to these benefits, infiltration practices can be a source of ground water recharge and reduce the frequency of combined sewer overflows (CSOs). They require less land area and can provide aesthetic benefits. These practices can also provide cost savings from both reduced construction costs and lower maintenance requirements. On the other hand, responsibility might fall on the property owner to inspect and maintain the practices. In addition, on-site treatment

practices only treat the first ½ inch to 1 inch of runoff, and the rest is bypassed. They are, however, good first practices in a system of storm water management practices.

- *Regional (off-site) practices*. Regional runoff control and treatment practices act as a last line of defense to control flooding and reduce pollution. The advantages of regional controls are that they are easier to maintain and do not require the actions of the property owner; they can provide aesthetic and recreational benefits; and they can be cost-effective due to the economy of scale. However, a regional pond offers no protection to upstream tributaries, and placement in low-lying areas may hurt natural wetlands. Communities may also have to address safety and liability considerations.
- *Stable drainage channels*. Stable drainage channels and floodplains are important for protection against flooding and as buffers for receiving waters by filtering pollutants and preventing erosion. Riparian areas can provide aesthetic and recreational benefits as well as wildlife habitat. Restoring stream channels and riparian areas can, however, be expensive, and is not feasible when development exists along drainage channels or restoration conflicts with landowner use of streamside property.

Regional vs. On-Site Development Regulations

In anticipation of dramatic growth in the next decade or two, the city of Seattle, Washington is considering the development of an integrated drainage plan to address storm water at the subwatershed level rather than on a project-by-project basis. One of the options being considered is the establishment of off-site mitigation programs in urban jurisdictions. These programs allow developers to meet on-site development requirements relating to storm water by compensating the municipality to provide equivalent mitigation in an off-site public facility. In a case study, Maupin and Wagner (2003) explore the costs and benefits of regional and onsite management practices. The authors determine that an offsite mitigation program might be beneficial if the municipality has storm water management obligations, has the authority to regulate development, requires on-site storm water management on new development or redevelopment projects, and cost, water quality, or community benefits may result from off-site treatment. Because it shifts the maintenance burden to the municipality, it may not be appropriate in all cases (Maupin and Wagner, 2003).

Targeting Runoff Treatment Practices for Temperature Control

In the Token Creek Watershed in Dane County Wisconsin, a proposed 492-acre development for single-family homes posed concern for regulators regarding Token Creek, a cold water stream that is a major tributary to Lake Mendota. Managers identified three major goals for the watershed: reduce overall sediment and nutrient flows to Lake Mendota; protect the water quality in Token Creek, primarily regarding sediment and water temperature; and implement practices that will be aesthetically pleasing and increase property values. Managers recognized that traditional treatment practices such as storm water ponds and wetlands (for more information, see Management Measure 5) would not protect the stream from the potential thermal impacts of runoff from a highly developed area. Instead, the channel was lined with rock to provide infiltration, heat dissipation, and erosion control, and rock-filled gabion dams were installed. The Temperature Urban Runoff Model (TURM) was used to estimate water quality benefits. Modeling results predicted a 10.7 degree Fahrenheit increase in water temperature with the practices installed, as opposed to a predicted 21.6 degree increase without the practices (Dorava et al., 2003).

1.3.2.6 Adopt and implement the watershed plan

The best way to ensure that a plan is implemented is to incorporate the right stakeholders, realistically assess budgetary resources, develop a scientifically and economically sound plan, and mandate the plan's use and implementation. During and after plan development, watershed managers need to ensure that local governments have both the regulatory authority and the resources to implement the plan.

Watershed managers need to identify funding sources to support plan implementation. One of the greatest costs of watershed implementation is the staff resources needed to continue monitoring in the watershed, design and build retrofits and new management practices, and enforce the ordinance and laws called for in the plan.

1.3.2.7 Revisit and update the watershed and subwatershed plan

A one-time watershed study only identifies the problems that exist in a watershed. Many local governments, for one reason or another, take on watershed planning without realizing that it is a process rather than a report. Watershed and subwatershed plans should continue to be updated and revised as the watershed management process evolves and problems are identified.

1.3.3 Provide Adequate Funding and Staffing

Implementing an urban runoff control program requires funding to support programs and provide staff. Local and state governments can provide revenue from the tax base, but environmental programs often come up short when they compete with other municipally funded projects. Alternative borrowing and fundraising techniques can be used to provide additional money for water quality projects.

A variety of resources for financing information are available. The Environmental Finance Center, sponsored by EPA and the University of Maryland Sea Grant College, was created to assist local communities in finding creative ways to pay for environmental projects. The Center promotes alternative and innovative ways to manage the cost of environmental activities, provides training and development opportunities in environmental management, and works to increase awareness of the benefits associated with sound environmental management policies. In addition, the Center serves as a national repository and clearinghouse for environmental finance-related information, including information from EPA, the Environmental Financial Advisory Board (EFAB), and the Environmental Financing Information Network (EFIN), as well as other Environmental Finance Centers (EFCs) across the nation. More information about the technical assistance and support the Center provides, such as workshop and conference sessions, problem-solving roundtables for communities, watershed management training sessions, and utility rate design assistance, is provided at http://www.mdsg.umd.edu/EFC (EFC, 2000).

Another source of financing information is the Florida Stormwater Association (FSA), which was formed to assist professionals in both the public and private sectors who work in the storm water management and finance areas. FSA provides online services to its members, including a newsletter, storm water utility survey, access to local ordinances, and the FSA membership directory. For more information about FSA, refer to http://www.florida-stormwater.org/ (FSA, 2000).

City of Lenexa, Kansas, Sales Tax Increase

The City of Lenexa, Kansas, passed a 1/8-cent sales tax to help fund a new storm water program. The initiative includes the construction of multipurpose lakes and other storm water facilities to reduce flooding, improve water quality, and provide recreation for the citizens of Lenexa. The program differs from conventional storm water programs in that it also focuses on water quality and recreational opportunities. Most storm water programs focus only on preventing flooding. Revenue from the sales tax will be used to

- Construct lakes, detention basins, and sport fields.
- Acquire land in key locations before development occurs.
- Address existing problems in developed areas.

Other sources of revenue for the program include an annual $30 per home utility charge, a new development charge, and existing revenue sources such as a mill levy and Johnson County storm water funds.

The city's watershed management program will be implemented by constructing new facilities, improving the management of existing facilities, establishing development policies and processes, and implementing activities to ensure compliance with new regulations associated with the Clean Water Act. Lenexa has recently inventoried critical natural areas in the city to provide guidance for conserving, protecting, and restoring natural resources. Stream restoration opportunities in developed areas of the city will be identified, along with measures to address flooding. Lenexa encourages citizens to participate in the Watershed Management Program and offers tips for improving the quality of urban storm water runoff.

For more information about the Lenexa Storm Water Management Plan, contact Lenexa Public Works at 913-477-7680 or refer to http://www.ci.lenexa.ks.us/Stormwater/intro.html (Lenexa, No date).

Finally, the Center for Urban Policy and the Environment at Indiana University–Purdue University Indianapolis (2001) developed *An Internet Guide to Financing Stormwater Management*. This guide, located at http://stormwaterfinance.urbancenter.iupui.edu, is designed to help communities find ways to pay for storm water management projects. The site includes an annotated bibliography of existing storm water finance materials, an archive that contains selected previously published materials concerning storm water finance, a manual that discusses the financing options available to communities for storm water management programs, a set of case studies that describe successful finance mechanisms that have been used in seven communities around the country, and a group of links to other useful Web sites about storm water management.

Several mechanisms that watershed managers can use to secure funding for their storm water programs are described below.

1.3.3.1 Taxes and fees

Municipalities often use taxes to fund environmental programs, but the taxes are not dedicated for a specific purpose and may be allocated to other, non-environmental programs. Fees are another method that can generate money for environmental programs. Table 1.4 outlines several kinds of taxes and fees that are appropriate for financing storm water management programs.

Table 1.4: Types of taxes and fees that can be used to raise money for storm water management programs (adapted from USEPA, 1994).

Tax or Fee	Description
Property and sales taxes	Charged as a percentage of property value or gross sales.
Real estate transfer taxes	Assessed as a percentage of property values when property is sold.
Commodity taxes	Charged on specific items such as gasoline and hunting and fishing equipment.
Tax surcharges	Added to established tax rates.
Tax incentives	Offer tax reductions as state tax credits, deductions, or rebates.
Tax disincentives	Fees, taxes, or price increases to discourage the use of an inefficient product.
Tax differentiation	Tax charged on an inefficient product to encourage the use of an efficient substitute.
Selective sales tax	In the form of a retail tax or an inspection fee.
Tax increment	Financing incremental increases in real estate taxes to repay the original investment in improved public facilities that resulted in increased real estate values.
Plan review fees	Collected to conduct development plan reviews to ensure they meet requirements.
Storm water utility fees	Imposed on property owners based on amount of runoff generated, impervious area on the property, or the assessed value of the property.
Impact fees	The cost of infrastructure services is paid up-front by fees collected from developers or property owners.
Inspection fees	Collected to ensure that development plans are properly implemented.
User fees	Directly tied to the use of a resource or facility and especially useful at the local level where user groups are easily identified.
Capacity credits	Private interests guarantee future capacity in a public facility and provide additional funding to local governments for project completion.
Effluent discharge fees	Levied on an industrial facility based on the volume of pollutants discharged. Can be used to meet water quality objectives, to cover costs of pollution abatement, or to meet effluent standards. Provides economic incentive to reduce pollution output and is an equitable method for funding pollution control projects.

1.3.3.2 Bonds

Several kinds of bonds can be used to fund projects over the long or short term. Long-term bonds provide funding for the duration or life expectancy of the project and can be paid back all at once at the end of the project or little by little until the end of the project. Short-term bonds provide interim funding for long-term projects that have not yet been financed. There are also general obligation bonds, which are issued by state or local governments and are repaid using taxes and other revenues. Revenue bonds are also issued by state or local governments, but they are repaid using income or funds generated by the project itself. Finally, state revolving funds, which are long-term, low-interest loans to local governments or individuals for capital investments, can be used to fund storm water projects. Repayment allows the fund to revolve its lending ability continuously. The fund is intended to provide a permanent source of financing for state and local water quality projects and can be used for many different projects, including:

- Construction of wastewater treatment plants
- Implementation of approved state nonpoint source management programs and ground water protection strategies under section 319 of the Clean Water Act

– Development and implementation of estuary comprehensive conservation and management plans under section 320 of the Clean Water Act

1.3.3.3 Leases

A municipal lease grants the lessee the option of applying lease payments to the purchase of the facility. The lessee is responsible for paying taxes on the property. Leases can be used to finance the purchase of environmentally sensitive areas, land for wetland restoration, or other projects. A sale/lease-back arrangement allows the owner of a facility to sell it to another entity and subsequently lease it back from the new owner. This arrangement can provide alternative financing for a facility and may limit a government's liability.

1.3.3.4 Intergovernmental transfers and assistance

Grants are awarded to state or local governments for assistance in meeting national environmental quality goals. EPA establishes the criteria that must be met before receiving funds, while section 319 of the Clean Water Act allocates federal funds to states for implementing approved nonpoint source management programs. The grant money can also be used for postimplementation monitoring and groundwater assessment as part of an approved NPS pollution control program.

The conservation districts in Delaware have a conservation cost-share program that is funded by the state. Each of the three districts currently receives approximately $300,000, plus an additional $175,000 for nutrient management program practices. Most of the urban management practices involve backyard drainage projects, streambank erosion control, rehabilitation of storm water management ponds, urban flood control projects, tree plantings in community open space, conservation windbreaks, and debris pit remediation, and they can include assisting a community with an engineering study to determine solutions for a problem. Each conservation district determines the priority areas for the conservation funding, with the most urban BMPs implemented in New Castle County. Depending on the practice, the landowner pays 25 to 50 percent of the costs (Mickowski, 2004).

Using Clean Water Act Funds for Water Quality Improvements

The Delaware Department of Natural Resources and Environmental Control (DNREC) is using the Clean Water State Revolving Fund to effect water quality improvements. Practices implemented with the funds include wastewater collection to eliminate 300 failing onsite wastewater treatment systems and prevent 594 new systems; replacement of failing onsite wastewater treatment systems; sediment and storm water management practices; water body restoration practices such as stream bank stabilization, wetland restoration, and riparian buffer installations; land purchases and conservation easements for water quality protection; and implementation of Comprehensive Conservation and Management Plans for the Delaware Estuary and Delaware Inland Bays. For more information on the Clean Water State Revolving Fund, see http://www.epa.gov/owmitnet/cwfinance/cwsrf.

1.3.3.5 Public-private partnerships

The private sector can invest in public-sector facilities. This approach reduces the financial burden for the public sector through cost sharing and is especially appropriate when neither the public nor private entities can fund the projects themselves. However, there might be political opposition from government workers or negative public opinion due to private ownership and operation of a public facility, even though private operations are often more cost-efficient, provide a higher level of service, and require less implementation time than public operations.

1.3.4 Foster Input from Technical Experts, Citizens, and Stakeholders

Most runoff management institutions require input from three groups of people—technical experts, citizens, and stakeholders—to plan and implement successful runoff management practices. Technical committees are often set up to provide expertise on scientific issues, while citizen advisory and stakeholder committees afford the public a chance to include their opinions in the management process.

1.3.4.1 Technical committees

The central principle of technical committees is that proactive involvement of all stakeholders will result in greater watershed improvements because actions will have the approval of all interests. Ideally, members of the technical committee are also agency representatives in the larger management institution. Members may include representatives from the state and county natural resources, environment, planning, health, and water resources management entities. In addition, federal agency representatives and individual citizens with expertise in scientific fields or engineering may participate. The technical committee evaluates monitoring data and identifies data gaps, coordinates monitoring efforts within the watershed to obtain missing data, evaluates proposed regulatory or land use changes with respect to their potential impact on the watershed resource, interprets scientific data for the watershed management institution, and assesses and coordinates currently approved implementation projects.

1.3.4.2 Citizen committees

A citizen committee is open to all citizens and provides direct feedback to the management institution on public sentiments regarding the planning process. The review of citizen concerns in a comprehensive process is critical in gaining community support. Some of the possible functions of a citizen committee include organizing public outreach and community awareness projects, such as tree planting days, stream cleanups, storm drain system stenciling, watershed awareness days, and volunteer activities, and exploring funding sources and grant-writing. In addition, such a committee might organize media relations and publicity programs such as press releases, informational flyers, and watershed awareness campaigns; act as a liaison between citizen groups and government agencies; and establish early stakeholder and public involvement.

Creating Quality Places Program, Kansas City, Missouri

The "Creating Quality Places: Successful Communities by Design" is a program of the Mid-America Regional Council (MARC), which represents city and county governments in the bistate Kansas City metropolitan area. The program, which is partially supported with resources from EPA's Sustainable Communities Challenge Grant Program, is aimed at developing a better quality of life in neighborhoods throughout the Kansas City region. Creating Quality Places is divided into two phases. In the first phase, 20 quality principles were identified to guide future development. These principles offer the best means for the region to grow, while also preserving and enhancing the quality of life enjoyed by residents. The second phase of the program focuses on the means for implementing these principles.

Creating Quality Places was a coordinated effort between multiple stakeholders. In the first phase, a steering committee and three advisory committees were convened by MARC to ensure broad stakeholder representation. The steering committee, which included elected officials, developers, civic leaders, citizens, planners, and representatives of other stakeholder groups, provided input and direction throughout the proceedings. The three advisory committees provided specific and technical input during deliberations. These committees each represented a specific sector of the development arena and included mayors, city council members, county commissioners, planning commissioners, city managers, planning directors, park professionals, public works professionals, developers, builders, architects, and engineers.

The initial quality principles were developed by merging the principles devised by each of the four committees. At a joint session of the four committees, the combined principles were reviewed, strengths and weaknesses of each were identified, and the principles were edited. The edited principles were then reviewed through a questionnaire, which was administered at public forums conducted for each topic area. The steering committee and advisory committees conducted a final review, and the quality principles were finalized. This development and review process allowed stakeholders to be involved throughout the entire process.

MARC also ensured stakeholder involvement by organizing public forums to establish dialogue on quality development issues and to raise awareness about land use and development practices. The forums consisted of two parts. The first part was a session at which national speakers and local panels discussed issues, and the second was a workshop that provided steering and advisory committee members with an opportunity to ask questions and discuss concerns.

For more information about the quality principles, including specifics of the final 20 quality principles, resources for implementing the principles, and case studies of how other communities are using the principles, refer to www.qualityplaces.marc.org (MARC, 2000).

1.3.4.3 Stakeholder committees

Stakeholder committees address the goals and opinions of the agencies, organizations, or individuals directly affected by management activities in the watershed. The incorporation of stakeholder views into the development of the watershed plan is crucial to building consensus and gaining support for future implementation. Typical stakeholders involved in the watershed planning process include:

- Conservation groups (e.g., Trout Unlimited, Save our Streams, Bass Masters)
- Developers
- Homeowners
- Citizen associations

- Farmers
- Industrial and commercial business interests
- Utility companies

Other groups, such as trade associations, research and academic institutions, sporting groups, and individual citizens, might also wish to be involved in the process. When planning occurs at the watershed level or higher, local and regional offices of federal agencies will also often decide to become involved. By placing the emphasis for watershed management on the subwatershed level, the number of stakeholders guiding plan development will be much more manageable.

Early and frequent involvement of stakeholders is a key ingredient in building support for the subwatershed management process. Stakeholders should be given a meaningful and well-defined role in the formulation of management plans. Sharing data and mapping, establishing goals, setting priorities, developing management criteria, measuring success, and reviewing and approving subwatershed plans will strengthen stakeholder ownership in the plan.

1.3.5 Establish Intergovernmental Coordination

The watershed management institution's primary responsibility is to oversee the execution of a watershed management plan. The management institution focuses the diverse stakeholders in a watershed into a viable group capable of guiding implementation. The institution is also responsible for the timely preparation and implementation of the watershed plan and its revision as project goals are achieved or changed. Communities might elect to create a single authority for an entire watershed, or a series of smaller authorities at the subwatershed level. The effectiveness of the management institution is dependent upon its ability to forge all interagency or multi-jurisdictional partnerships and agreements necessary to support the organization over the life of the planning process.

Intergovernmental coordination is essential when establishing a watershed management program, especially when the watershed extends over more than one political jurisdiction. Without the participation of a broad spectrum of local, state, and federal agencies, most watershed planning endeavors will not have the financial or information-gathering resources required to continue beyond initial start-up efforts. Interagency coordination requires sharing of resources and data, joint development and endorsement of a watershed management plan, and continued participation of all agencies. Care must be taken to avoid interagency rivalries or miscommunication.

The first step in fostering interagency coordination is the establishment of a watershed management institution. One instrument that has been used to steer this process is the Memorandum of Understanding (MOU). An MOU is an agreement by government agencies and local stakeholder representatives to work together in the creation of a watershed planning strategy. MOUs are widely used because agencies can enter into these agreements while retaining their jurisdictional and budgetary appropriation authority. MOUs are not legally binding contracts. Instead, the points in an MOU are presented in a broad manner to facilitate consensus. Typically short (one or two pages), these agreements outline the goals and objectives for the watershed management institution. The basic contents of an MOU are:

- Identification of the parties involved in the process
- Vision statement
- Purpose of the MOU (issues to be addressed by the agreement)
- Pact to provide assistance to the partnership for coordination of planning efforts under a central management organization
- Resolution to use the watershed plan as guidance in future land use or water management decisions
- Signatures of all partners involved

Philadelphia's Office of Watersheds

In 1998, the Office of Watersheds was created within the Philadelphia Office of Water. The new department is charged with administering a watershed management program that integrates combined sewer overflow, storm water management, and drinking water source protection. The watershed approach focuses on regional and local partnerships and supports watershed initiatives at the local level through innovations and demonstrations, and by facilitating cooperation between stakeholders. The Office of Water's "watershed technology center" is a central repository of technical support such as Geographic Information Systems, information technology, and model development for the various watershed programs. The office is working with local watershed organizations, academic institutions, and other agencies to pursue funding for demonstration projects, streambank restorations, and information collection for regional watersheds (Neukrug, 2003; WERF, 2000).

1.3.6 Develop Training and Education Programs and Materials

Training programs and educational materials designed for people directly involved in the design and implementation of a runoff management program are essential. Most states and many local governments have developed guidance manuals, workshops, and other educational opportunities to assist developers, site designers, contractors, plan reviewers, consultants, inspectors, and others in understanding and complying with runoff management goals and objectives.

Most states make education and training voluntary. A few states, however, including Delaware, Florida, Maryland, South Carolina, and Virginia, have made professional educational programs mandatory by law or regulation. Delaware, for example, requires that "all responsible personnel involved in a construction project will have a certificate of attendance at a Department-sponsored or approved training course for the control of sediment and storm water before initiation of land disturbing activity." The state provides personnel training and educational opportunities for contractors to meet this requirement, and has delegated program elements to conservation districts, counties, and other agencies.

In addition to professional audiences, the public can greatly benefit from runoff management education and training. Public awareness of program goals leads to greater support. Awareness can be achieved in many ways, including workshops, brochures, meetings, and media campaigns, as well as hands-on projects like storm drain stenciling and stream clean-ups.

Watershed citizens can and do play an important role in controlling nonpoint source pollution. Consequently, they need to acknowledge and be educated on pollution prevention issues and activities. Management practices concerning this topic are discussed in greater detail under the Management Measure 9: Pollution Prevention.

1.4 Information Resources

An Internet Guide to Financing Stormwater Management is a Web site presented by the Center for Urban Policy and the Environment (2001) at Indiana University-Purdue University Indianapolis. The site includes an annotated bibliography of existing storm water finance materials, an archive that contains selected previously published materials concerning storm water finance, a manual that discusses the financing options available to communities for storm water management programs, a set of case studies that describe successful finance mechanisms that have been used in seven communities around the country, and a group of links to other useful Web sites about storm water management. The site can be accessed at http://stormwaterfinance.urbancenter.iupui.edu.

The Center for Watershed Protection's *Rapid Watershed Planning Handbook* (CWP, 1998) describes techniques communities can use to more effectively protect and restore water resources. This document is available for purchase from the Center for Watershed Protection's Web site (http://www.cwp.org).

Framework for a Watershed Management Program (Clements, 1996) develops a specific watershed management protocol to increase the understanding of the critical components in watershed management programs. The publication is available for purchase from the Water Environment Research Foundation by calling 800-666-0206 and specifying publication order number D53016.

Building Local Partnerships, an Internet brochure published by the Conservation Technology Information Center (no date), provides an overview of local partnerships, including the types of partnerships that can be made, a how-to guide for forming partnerships, and caveats, as well as links to other resources pertaining to partnership-building. The publication can be accessed at http://www.ctic.purdue.edu/KYW/Brochures/BuildingLocal.html.

The Environmental Finance Center (2000) was created to assist local communities in finding creative ways to pay for environmental projects. The Center promotes alternative and innovative ways to manage the cost of environmental activities, provides training and development opportunities in environmental management, and works to increase the public and private sector's awareness of the benefits associated with sound environmental management policies. The site includes *Creative Financing Techniques for Establishing Riparian Forest Buffers* (or other land protection efforts), which describes methods such as notification, recognition, and nonbinding agreement programs; management agreements and leases; financing arrangements, such as agreements tied to loans; easements; and land acquisition to encourage conservation and stewardship of ecologically significant properties. The site also includes *Financing Stream Corridor Protection with a Community Quilt*, which describes a method for financing environmental protection and restoration efforts using a "community quilt" of financing techniques that has the potential to cover the variety of activities within the watershed. The Environmental Finance Center is located at http://www.mdsg.umd.edu/EFC.

The Florida Stormwater Association (2000) Web site contains information for storm water managers and stakeholders, including a manual entitled *Establishing a Stormwater Utility in*

Florida, storm water utility surveys, articles, news, and activities, and links to storm water management resources. The site can be accessed at http://www.florida-stormwater.org/.

The National Association of Counties (1999) has assembled a comprehensive kit that provides counties a host of tools for beginning and strengthening programs that favor purchase of products that are energy-efficient, contain recycled materials, and are less hazardous to the environment and human health. The kit includes case studies, a model purchasing resolution, a sample press release, and a comprehensive list of resources. It can be ordered (free for members, $10 for nonmembers) from the National Association of Counties' Web site at http://www.naco.org/Template.cfm?Section=Publications&Template=/cffiles/pubs/publications.cfm&PubCat=EPP.

The *State and Local Government Guide to Environmental Program Funding Alternatives* (USEPA, 1994) provides an overview of traditional (nongovernmental) funding mechanisms and innovative approaches for funding environmental programs. The document can be downloaded from http://www.epa.gov/owow/nps/MMGI/funding.html.

The *Catalog of Federal Funding Sources for Watershed Protection* (USEPA, 1999a) provides a guide for watershed practitioners on federal funds that might be available to support a variety of watershed protection projects. The catalog presents information on 69 federal funding sources (grants and loans) that can be used to fund watershed projects. The information on funding sources is organized into categories including coastal waters, conservation, economic development, education and research, environmental justice, forestry, Indian tribes, mining, pollution prevention, and wetlands. The catalog also includes key words that can be used to search for funding programs for particular subject areas. The document is available in HTML format at http://www.epa.gov/owow/watershed/wacademy/fund.html.

Model Ordinances to Protect Local Resources (USEPA, 1999b), located at http://www.epa.gov/owow/nps/ordinance, is a Web site of model ordinances that can serve as a template for those charged with making decisions concerning growth and environmental protection. For each model ordinance listed, there are several real-life examples of ordinances used by local and state governments around the nation. The ordinances address matters that are often forgotten in many local codes, including aquatic buffers, erosion and sediment control, open space development, storm water control operation and maintenance, illicit discharges, and postconstruction controls. There is also a miscellaneous category containing ordinances that don't fit into these sections. In addition, this Web site has materials that support particular ordinances, such as maintenance agreements and inspection checklists.

EPA's Office of Wastewater Management (USEPA, 2001) has a financing Web site (http://www.epa.gov/OWM/finan.htm) that provides an overview of the many types of assistance they provide to national, state, and local programs to abate and prevent municipal water pollution. Included is guidance information such as *Paying For Water Quality: Managing Funding Programs to Achieve the Greatest Environmental Benefit* and *Guide to Using EPA's Automated Clearing House For the Drinking Water State Revolving Fund Program* as well as information on programs such as the Clean Water State Revolving Fund (SRF), Construction Grants Programs, Section 106 Water Pollution Control Program Grants, Section 104(b)(3) Water Quality Cooperative Agreements, and Indian Set-Aside Grants.

The Watershed Management Institute, Inc. (1997a) printed a book entitled *Institutional Aspects of Urban Runoff Management: A Guide for Program Development and Implementation.* This book presents a comprehensive review of the institutional frameworks of successful urban runoff management programs. It was developed to assist individuals responsible for developing and implementing urban erosion, sediment control, and storm water management programs. The book is available for purchase ($10 for Storm Water Phase II communities, $27 for others) using an order form that can be downloaded at http://www.naco.org/Template.cfm?Section=Publications&Template=/cffiles/pubs/publications.cfm&PubCat=EPP.

The Southeast Michigan Council of Governments (SEMCOG) is a regional planning partnership that supports local planning efforts through technical support, the facilitation of intergovernmental coordination, and the adoption of region-wide plans and policies. SEMCOG partnered with six local communities to assemble a workbook, *Opportunities for Water Resource Protection in Local Plans, Ordinances, and Programs: A Workbook for Local Governments*, which provides guidance on planning to protect water resources. SEMCOG's approach is not prescriptive, but rather provides various options for planners, outlining key programmatic and regulatory components for a range of watershed protection approaches. The workbook emphasizes the need to address the protection of water resources through planning and prevention, and is meant to serve as a basis for local governments to customize their individual plans based on the needs and resources of the community. The book is available for download at http://www.stormwater.ucf.edu/publications/urban_runoff.pdf.

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MANAGEMENT MEASURE 2
WATERSHED ASSESSMENT

2.1 Management Measure

Develop and implement a watershed assessment program to:

- Characterize watershed conditions
- Establish a set of watershed indicators

2.2 Management Measure Description and Selection

2.2.1 Description

Watershed assessment and monitoring are tools used to characterize water quality and to identify trends in water quality over time (USEPA, 1998c). This management measure describes methods that can be used to determine the health of water bodies by using watershed indicators that measure physical, chemical, and biological conditions.

2.2.2 Management Measure Selection

2.2.2.1 Overview

Watershed assessment is a critical component of a watershed-based approach to managing receiving waters. Watershed assessment is needed to develop both protection and restoration strategies, identify priorities, and adjust management prescriptions based on trend analyses. Both rapid and extensive assessments can be performed to determine water body status and trends. Numerous metrics, such as EPA's *Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers: Periphyton, Benthic Macroinvertebrates, and Fish*; *Lake and Reservoir Bioassessment and Biocriteria*; and *Estuarine and Coastal Marine Waters:Bioassessment and Biocriteria Guidance,* are available for determining water body status. In general, the objectives, available funding, and expertise of the assessors will determine the level of assessment conducted.

An assessment and monitoring program is important for effective watershed management because it provides a basis for decisions and actions, and allows managers to continually reassess progress and redefine goals and priorities. Monitoring enables water quality managers to identify existing or emerging problems. Monitoring also facilitates responses to emergencies such as spills and floods, and helps water quality managers target specific pollution prevention or remediation programs to address these problems. Assessment and monitoring can be used to determine whether program goals, such as compliance with pollution regulations and implementation of effective pollution control actions, are being met. Monitoring programs should be established based on indicators of human health and aquatic life. A large number of documents and case studies are available to use as resources (see Information Resources at the end of this chapter).

2.2.2.2 Examples of monitoring and assessment programs and methodologies

State pollution control agencies, Indian tribes, local governments, and federal agencies typically are responsible for watershed assessment and monitoring activities. These entities monitor water quality and identify waters and watersheds that do not meet clean water goals through various programs, which include the following:

- Unified Watershed Assessments (UWAs), developed by states in 1999 to assess the health of watersheds and identify watersheds in need of restoration (i.e., watersheds that do not currently meet clean water and other natural resource goals). UWAs also identified watersheds that need preventive action to sustain water quality using ongoing state, tribal, and federal programs, as well as pristine or sensitive watersheds on federal lands that need an extra measure of protection. The results of these assessments can be obtained from state environmental protection departments.

- Water Quality Reporting Program, established under CWA section 305(b), which mandates the collection of water quality information and reporting on the condition of waters every two years.

- 303(d) program, established under CWA section 303(d), which mandates the use of monitoring and other water quality information to develop lists of waters that do not meet water quality standards.

- Nonpoint Source Program, established under CWA section 319, which involves identifying waterbodies that are impaired by nonpoint sources.

- Source Water Protection Program, established under the Safe Drinking Water Act, which involves assessments of drinking water sources that form a basis for actions to protect such sources.

- State Revolving Fund (SRF) Program, which involves developing and prioritizing clean water projects.

- Federal Emergency Management Agency's National Flood Insurance Program, which involves conducting floodplain studies and developing mitigation plans.

- Marine pollution control programs, which include identification of coastal water quality problem areas as part of efforts to reduce polluted runoff to coastal waters.

- Wetlands Program, which involves developing assessments of wetland areas that need special attention or protection.

One example of a state assessment program comes from the Commonwealth of Pennsylvania. The state's Act 167 requires that watershed assessments consider the following objectives (Pennsylvania DEP, 1999):

- Implement nonpoint source pollutant removal methodologies
- Maintain ground water recharge
- Reduce channel erosion
- Manage overbank flood events
- Manage extreme flood events

The state established four subtasks to achieve these objectives:

- Determine the water quality design storm
- Determine the runoff capture design storm (recharge/retention)
- Establish streambank erosion requirements
- Establish overbank/extreme event requirements (release rates)

To accomplish these subtasks, Pennsylvania developed a process that will ultimately lead to the development of standards for stream bank erosion, infiltration, water quality, overbank flooding, and extreme storm events. The assessment fits into a larger framework for integrated watershed resource management, which includes the following steps:

- Watershed assessment/prioritization
- Watershed evaluation
- Restoration/protection plan development
- Financial resources secured
- Restoration/protection plan implementation
- Results compared to goals

2.3 Management Practices

2.3.1 Characterize Watershed Conditions

2.3.1.1 Establish a reference condition

It is important to establish a reference that characterizes the relatively unimpaired condition of the water body. The reference condition establishes a basis for making comparisons between sites, and is essential for detecting impairment. Conversely, if a water body is found to be impaired, it is important to have an understanding of natural background concentrations before undergoing costly efforts to mitigate anthropogenic inputs.

There are two types of reference conditions—site-specific and regional. Site-specific reference conditions are determined from one or more sites in a watershed or stream from a point where discharges (nonpoint source, point source, or a combination) are occurring. Regional reference conditions typically are established from a population of relatively unimpaired sites within a relatively homogeneous region and habitat type. An ecoregional framework based on land surface form, soil, potential natural vegetation, and land use has been developed by Omerink (1987) to interpret spatial patterns in data (USEPA, 1999); these ecoregions can be used to help develop a reference condition for a relatively homogeneous region. Regional reference conditions are often preferable to site-specific conditions because they are more widely applicable, they produce a larger sample of unimpaired sites, and they allow more robust statistical comparisons.

The U.S. Geological Survey (USGS) developed a model for determining ecoregional background concentrations of nitrogen and phosphorus as a function of annual runoff, basin size, atmospheric nitrogen deposition rate, and region-specific factors. Background total nitrogen (TN) concentrations ranged from 0.02 mg/L in the western United States to more than 0.5 mg/L in the southeastern United States. Background total phosphorus concentrations ranged from less than 0.0006 mg/L in the western United States to more than 0.08 mg/L in the Great Plains (Smith et al., 2003).

2.3.1.2 Model pollutant sources and loads

Watershed managers can use models to estimate storm water pollutant loads in receiving waterbodies. Modeling of pollutant loadings can help watershed managers target specific areas for nonpoint source control. More specifically, runoff models can accomplish one or more of the following:

- Simulate the generation and movement of water and pollutants from their point of origin to a place of treatment or disposal into receiving waters
- Perform frequency analyses on water quality parameters to determine the return periods of concentrations or loads
- Provide input for an analysis of receiving water quality
- Determine the relative effects of pollution control options
- Determine optimal locations and combinations of management practices
- Provide input to cost-benefit analyses

Selecting the model that is most appropriate to fulfill watershed management goals requires careful consideration of trade-offs with respect to level of detail, data requirements, cost, and accuracy. For example, a high level of detail requires a more complex model. Data requirements are also important: a complex model might require more data than one has or is willing to collect. Sometimes published data can be substituted for field-collected data. The advantage of using published data is avoidance of costly, labor-intensive fieldwork. A major data source is the USEPA National Urban Runoff Program (NURP) database, which contains concentration values measured for 30 cities (USEPA, 1983). Information generally required for models includes the following:

Quantity Parameters

- Rainfall information
- Catchment area

- Imperviousness
- Runoff coefficient

Quality Parameters

- Constant concentrations (event mean concentrations or EMCs)
- Constituent median and coefficient of variation (CV)
- Regression relationships
- Buildup and wash-off parameters

Calibration/Verification Parameters

- Measured rainfall
- Measured runoff
- Water quality samples

While model calibration is beneficial, models generally used for watershed assessments do not strictly require calibration and precision to determine compliance with permit requirements or Clean Water Act requirements. Therefore, these models can be simpler and less expensive, while still providing watershed managers with information on pollutant loadings and sources.

Another consideration when choosing a model is its reputation. Watershed managers should become familiar with the model's concepts, assumptions, and limitations, as well as the experiences of other users. In choosing the most appropriate model, watershed managers should:

- Use the simplest model that will satisfy the project's objectives
- Use a model that is consistent with available data
- Predict only the water quality parameters of interest
- Make predictions over the broadest time scale that will satisfy the objectives
- Become familiar with the characteristics and assumptions of the model

Using pollutant loading models has advantages and disadvantages. Measured data are preferable to simulated data, especially when characterizing the magnitude of a pollution problem, because accurate concentration values are important. Models cannot substitute for good field-sampling programs, but they can be used to extrapolate and to augment field-sampling results.

To ensure quality results from a modeling effort, sensitivity analyses should be performed when uncertainty exists regarding data quality or model assumptions. Also, if possible, models should be calibrated and validated using measured values (field monitoring). This process is labor-intensive and can add to the expense of the modeling effort, but it is worthwhile to ensure accuracy when making management decisions.

A detailed description of water quality models of all types can be found in the *Compendium of Tools for Watershed Assessment and TMDL Development* (USEPA, 1997a). In general, watershed managers can choose from several different methodologies depending on the specific goals of the modeling effort, including the following:

– *Constant concentration or published yield values.* This method involves calculating loads as the product of the proportion of land area in a particular land use and the published loading rates for that land use. A disadvantage is that the catchments from which the published values are derived may not represent the catchment of interest. However, the calculations are very simple and easy to use for general loading assessments. Options include coupling constant concentrations with a hydrologic model so that loading will vary with flow, or calculating a confidence interval for loading to determine the level of uncertainty that can be tolerated before conclusions change. This method might be robust enough to answer straightforward management questions despite assumptions.

– *Unit loads.* This method involves calculation of the mass of the pollutant of interest per area of watershed per unit of time. It is site-specific (demographic and hydrologic factors are important determinants) and is based on average runoff volume (not coupled to a hydrologic model). Also, loading rates are variable and difficult to extrapolate from one area to another. This is a relatively simple method that does not require a great deal of data collection. Published values can be used at the expense of some accuracy.

– *Simple empirical model.* This method uses spreadsheet calculations to combine precipitation data with a runoff coefficient and land use-specific constant concentrations. This method easily simulates a mixture of land uses, allowing the study area to extend over a large area without compromising the quality of results. The model can quantify relative contributions from different land uses, and can be expanded readily to incorporate more complex calculations. The hydrologic modeling is very simple, however, and the model does not necessarily work well for short-term predictions. Also, using published constant concentrations in the model introduces errors; locally measured concentrations would greatly improve the model's performance.

– *Statistical method.* The statistical method uses a derived, usually lognormal frequency distribution of estimated mean concentrations (EMCs) of pollutants. This method is useful for assessing the frequency of exceedance of water quality standards, but it has weak hydrologic assumptions. The model can be coupled with stream flow, storage, and treatment data to improve accuracy and estimate the effects of management practices on water quality. Estimates can be improved by using measured EMC values rather than published ones. EMCs can vary widely because of seasonal and watershed land use variations, and might require at least one year and often two years of field verification to be statistically significant.

– *Regression equations.* Regression equations are published equations from the U.S. Geological Survey (USGS) (Driver and Tasker, 1990) that relate loads and EMCs to catchment, demographic, and hydrologic characteristics. They usually incorporate total storm loads and runoff flows or volumes. They require neither preliminary estimates of EMCs nor local monitoring data, and standard errors are provided for a measure of uncertainty. They are more or less accurate depending on the pollutant of interest and the level of precipitation (arid vs. humid). The equations predict only the mean rather than a frequency distribution of EMCs or loads, and they are subject to error when extrapolating to conditions that are different from those used to derive the equations. A related approach uses rating curves to relate pollutant loads or EMCs to flow rates or volumes, thereby allowing quantification of intra-storm variations in these measures.

— *Buildup and washoff.* This method is used to determine loadings by estimating the buildup of pollutants during dry weather and estimating washoff during rainfall events. This method quantifies intra-storm variations in pollutant loading and is good for comparing the relative effects of management practices. However, processes of sediment transport and erosion that are fundamental to this method are still poorly understood. Moreover, this method requires averaging the extent of pollutant buildup on heterogeneous urban surfaces. This averaging can result in erroneous predictions because actual values vary widely over relatively small areas. Assumptions include linear buildup and generic washoff coefficients that might or might not represent actual conditions. Estimates can be improved by using local monitoring data such as site-specific buildup and washoff estimates for model calibration.

— *Mechanistic models.* Mechanistic models contain hydrologic and water quality components and use mathematical algorithms to represent the mechanisms that generate and transport runoff and contaminants. They are the most comprehensive models in that they incorporate many variables to produce the best estimations of the numerous mechanisms that affect pollutant loading. However, they require substantial local data to set and verify parameters, and they demand both skill and commitment from staff. Users must ensure that the models are documented, supported, and proven through the experience of other users. There are several commercially available mechanistic models, including STORM by the U.S. Army Corps of Engineers and SWMM and HSPF by EPA. (See Web references and resources below.)

The confounding factors for load estimation models are:

— Inputs from atmospheric deposition (H_2SO_4, NO_3, etc.)

— Ground water inputs

— Pervious surfaces that confound runoff estimates

— Sediment transport and erosion

— Pollutants adsorbed to solids. These pollutants, namely metals and organics, can be estimated as a proportion of the total suspended solids concentration or annual load.

— Point sources in the watershed (e.g., industrial and commercial sources and publicly owned treatment works)

All of these factors can be included in the surface runoff model at the expense of time and simplicity and can improve the accuracy of loading estimates. Before they are included, consideration should be given to the level of detail needed for the analysis.

Application of a GIS Decision Support Tool to Urban Watershed Management in Fulton County, Georgia

The high density of development in Sandy Springs, a suburban area northwest of Atlanta, reduces the opportunities for new, areawide management practices such as regional detention ponds. Instead, multiple on-site or local management practices are recommended. In response to the need for developing storm water and water quality plans, a GIS application called LORELEI was developed (Slawecki et al., no date). LORELEI allows users to rapidly develop and compare watershed management alternatives for catchments with hundreds of management practices. It was developed to

- Keep track of hundreds of candidate management practice sites.
- Develop management scenarios using different combinations of management practices.
- Evaluate the practices' impact on water quality.
- Compare scenario results.
- Present the information to a wide range of people.

LORELEI provides decision support through data management, scenario development and evaluation, and enhanced involvement in and understanding of the watershed management process. LORELEI stores data about potential management practice locations and associated costs, practice types, and effectiveness data, as well as standard geographic information such as natural features, watershed delineations, and property ownership. Through scenario development, the program allows for rapid selection of individual projects and entire categories of management practices to build various scenarios. LORELEI then evaluates the scenarios to estimate and compare their costs and benefits. Finally, with enhanced involvement and understanding, LORELEI uses GIS to give decision makers an opportunity to participate directly in the watershed management process and to clearly understand issues, components, and cost and benefit implications of different management scenarios. GIS linkages allow for fine-tuning of the scenarios to determine the cost and performance effects of different suggestions made by participants at public meetings.

2.3.1.3 Model receiving water quality

Receiving water quality models identify impacts from runoff inputs and help watershed managers determine whether receiving waters meet water quality standards. Usually, computer models are used because of the complexity of calculations. Models are available for streams, lakes, reservoirs, estuaries, bays, and coastal segments. Most models couple quantity (hydrodynamic) and quality parameters, but some consider these parameters separately.

A useful water resource impact model is the Long-Term Hydrologic Impact Assessment (L-THIA), which was developed by Purdue University (2000) for land use planners to provide site-specific estimates of changes in runoff, recharge, and nonpoint source pollution resulting from past or proposed land use changes. The model uses regional climate data and user-provided location, land use, and soil group data for up to three different scenarios (past, present, and future). The results are in the form of tables, bar charts, and pie charts. The model is available at http://danpatch.ecn.purdue.edu/~sprawl/LTHIA7.

The best sources of information for receiving water quality models are either government agencies or product vendors. The following is a list of government agencies that can provide the information needed to choose the most appropriate model:

- USEPA Center for Exposure Assessment Modeling, Athens, Georgia
- US Army Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi
- US Army Corps of Engineers, Hydrologic Engineering Center, Davis, California
- USGS, Reston, Virginia
- National Oceanic and Atmospheric Administration (NOAA), Silver Spring, Maryland—estuaries and bays
- Tennessee Valley Authority (TVA), Knoxville, Tennessee—rivers and reservoirs

Additional guidance regarding load estimation and receiving water quality modeling is provided in *Compendium of Tools for Watershed Assessment and TMDL Development* (USEPA, 1997a), which supports the watershed approach by summarizing available techniques and models that assess and predict physical, chemical, and biological conditions in water bodies. This document is intended to provide watershed managers and other users with information helpful for selecting models appropriate to their needs and resources. The *Compendium* includes information on the following:

- A wide range of watershed-scale loading models
- Field-scale loading models
- Receiving water models, including eutrophication/water quality models, toxics models, and hydrodynamic models
- Integrated modeling systems that, for example, link watershed-scale loading with receiving water processes
- Ecological techniques and models that can be used to assess and/or predict the status of habitat, single species, or biological communities

An additional modeling resource is *Modeling of Nonpoint Source Water Quality in Urban and Non-Urban Areas*, which is a major nonpoint source model review effort published by EPA in 1991. It focuses on nonpoint source assessment procedures and modeling techniques for both urban and non-urban land areas (Donigian and Huber, 1991). The report provides detailed reviews of specific methodologies and models, as well as overview discussions and model comparison tables. Simple procedures, such as regression and loading function approaches, are also described in the report, along with complex models like SWMM, HSPF, STORM, CREAMS/GLEAMS, SWRRB, AGNPS, and others. Brief case studies of modeling efforts are summarized, with emphasis on the use of nonpoint and comprehensive watershed models for watershed management activities. This publication can be found at http://yosemite.epa.gov/water/owrccatalog.nsf/0/b28aec046488178585256fc700700b24?OpenDocument.

EPA has assembled a Web site with information about and links to water quality models. This site includes basic information, EPA-supported models, other federal government-supported models, technical guidance for models, and model training and meetings. The Web site can be accessed at http://www.epa.gov/waterscience/wqm/.

2.3.2 Assess Cumulative Effects

A watershed assessment should include an evaluation of cumulative effects, which are combined effects of multiple activities over space or time. Such effects can be difficult to assess because a large number of resources can be affected and often there are multiple pathways through which these effects can occur. In addition, the appropriate spatial and temporal scales for the analysis usually are uncertain. Because many environmental assessments do not take cumulative effects into account, most likely because there is no explicit process for analyzing them, MacDonald (2000) developed a conceptual process to guide their assessment and management. The process is divided into three phases: the scoping phase, the analysis phase, and the implementation and management phase. Within each phase are a group of interrelated steps that, if followed, typically lead to a complete analysis of the cumulative effects on a watershed. The three phases and their steps are shown in Figure 2.1.

2.3.3 Estimate the Effectiveness of Treatment Programs

A useful tool to estimate the effectiveness of treatment practices on water quality is the Watershed Treatment Model (WTM), which was developed by the Center for Watershed Protection (Caraco, 2001). The WTM is a simple model for rapidly assessing how various management programs influence pollutant loadings and/or habitat quality in urban watersheds. It incorporates many simplifying assumptions that allow watershed managers to assess various programs and sources that are not typically tracked in more complex models. The WTM consists of two basic components: pollutant sources and treatment options. The pollutant sources component estimates the load from a watershed without treatment measures in place. It assesses two broad categories of pollutant sources: primary land uses and secondary sources. The treatment options component estimates the reduction in the uncontrolled load resulting from a wide range of treatment measures. Treatment options are broadly defined in the model as storm water treatment practices and storm water management programs. The most current version of the WTM, version 3.0, can track sediment, nutrients, and bacteria. The WTM can be a useful tool for managers who are analyzing the effectiveness of current watershed restoration programs, preparing Total Maximum Daily Loads (TMDLs), or evaluating the watershed benefit of National Pollutant Discharge Elimination System (NPDES) storm water programs. For more information about the WTM, contact the Center by e-mailing center@cwp.org or visit their Web site at http://www.cwp.org.

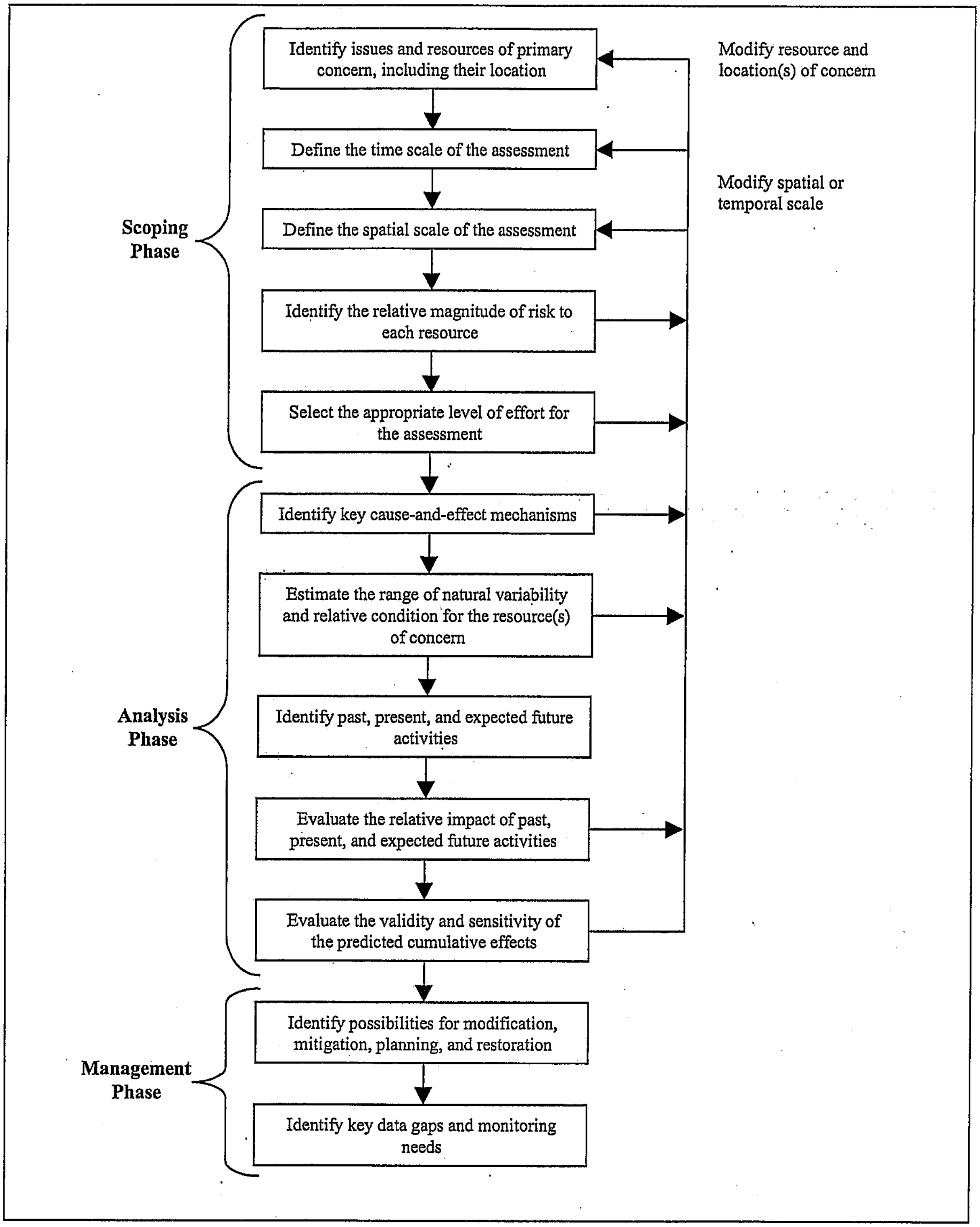

Figure 2.1: Conceptual process for assessing cumulative effects (MacDonald, 2000).

Indicators of Storm Water Program Effectiveness

The Hampton Roads Planning District Commission in Chesapeake, Virginia, has developed a database to track and evaluate various indicators of the effectiveness of the storm water program. The indicators fall into four basic categories: water quality, physical & hydrological, socioeconomic, and programmatic. This database tracks the indicators as listed below (Hillegass, 2003):

- *Water quality*: pollutant loadings for nutrients
- *Physical and hydrological*: acres of open space land protected from development
- *Socioeconomic*: inventory of public education efforts, such as number of publications produced and distributed, Web site hits, media campaigns, stream cleanup activities
- *Programmatic*: the following are programmatic indicators:
  - Number of approved erosion and sediment control plans and disturbed acreage
  - Number of inspections and enforcement actions for erosion and sediment controls
  - Number of citizen calls about flooding and drainage problems, and number of responses
  - Cost and number of flooding and drainage projects
  - Investigative and corrective actions for illicit discharge detection and elimination
  - Operation and maintenance activities
  - Number of approved site and subdivision plans, and acreage served
  - Number and type of BMPs installed, the number of acres served by each BMP, and installation and maintenance information

Under the Phase II Storm Water Rule, communities are required to go beyond chemical pollutant monitoring to track the implementation of storm water management programs. This database can serve as a useful tool in fulfilling this requirement and can be used as a model for the development of varied indicators of program success (Hillegass, 2003).

2.3.4 Establish a Set of Watershed Indicators

Watershed indicators are monitoring parameters or techniques used to measure the effectiveness of management practices in meeting watershed and subwatershed goals and objectives. Indicators range from complex chemical or toxicity testing methods to simple public perception surveys. Watershed managers can choose one or more of these indicators to better focus their monitoring efforts. Regardless of the parameters or technique, to be effective, an indicator must accomplish the following:

- Reflect a measurable attribute of a watershed goal or subwatershed management objective
- Be measured using scientifically valid protocols, quality controls, and assessment techniques to ensure that results are replicable, consistent, compatible with other data collection efforts, and statistically valid
- Be measured at one or more locations that will adequately characterize "typical" conditions in the management unit and establish reference conditions against which future data comparisons can be made

- Be monitored over a long enough period to establish observable trends
- Be compatible with available finances, personnel, and other resources. The cost of implementing the watershed indicator is an important consideration.

The Center for Watershed Protection and EPA published a reference to help municipalities select a suite of indicators that will most effectively measure conditions in their watershed (Claytor and Brown, 1996). This publication, *Environmental Indicators to Assess Stormwater Control Programs and Practices*, presents profiles with information such as advantages, disadvantages, cost, and applicability for 26 indicators, which include water quality, physical/hydrological, biological, social, programmatic, and site indicators. The document is available online at http://www.cwp.org.

2.3.5 Establish Water Quality Indicators

Conduct water quality monitoring. This type of monitoring involves measuring pollutants in both runoff and baseflow conditions. The most commonly measured constituents are oxygen demand, nutrients, metals, pH, temperature, flow or discharge, solids (e.g., total suspended solids or turbidity), fecal coliform, and a measure of oil and hydrocarbons (e.g., total petroleum hydrocarbons [TPH] or polycyclic aromatic hydrocarbons [PAHs]). Measurements can be taken at management facilities or in receiving waters. This method allows for the identification of trends in water quality over time and can identify areas that are degraded relative to low-impact reference sites. Changes in water quality that result from changes in land use or from the implementation of management practices can be detected to prioritize future conservation or restoration efforts. The specific constituents found in receiving waters can aid in identifying the source of the pollution problem and help target management practices effectively. The methodology for water quality monitoring is well-outlined in specific protocols, and results are quantitative and easy to present and compare to other monitoring databases. However, the monitoring effort must be long-term because of the high variability in constituent concentrations, and it might be expensive because of labor requirements or equipment costs for automation. Volunteer monitoring programs can reduce some of the expense of monitoring while providing the additional benefit of educating the public. EPA's Volunteer Monitoring Web site has more information about volunteer monitoring (http://www.epa.gov/owow/monitoring/volunteer).

(1) *Conduct toxicity testing.* These methods, often called whole effluent toxicity (WET) tests, involve exposing standardized freshwater, marine, and estuarine vertebrates, invertebrates, and plants to water samples to directly measure the adverse effects of effluents. Both acute and short-term chronic effects can be assessed. The test organisms can be either resident species or species that will be restocked or reintroduced. Toxicity reduction evaluation (TRE) can be used to identify the agent of toxicity, which helps to identify the pollutant source and indicates which management practices would be appropriate to treat the problem. Although this method allows managers to distinguish among a range of conditions and chemicals, species' responses vary substantially with respect to the choice of species, location (laboratory or in situ), and duration of the test. Also, chronic toxic effects, which may take a long time to manifest, are not measured with this type of testing. The TRE process can be expensive and is often used to specifically identify pollutants when receiving waters have previously been identified as impaired through other, less-expensive methods.

More information on WET methods is available at http://www.epa.gov/OST/WET. Descriptions and guidance on other analytical methods are provided at http://www.epa.gov/ost/methods (USEPA, 2000d).

(2) *Measure the frequency at which water quality standards are exceeded.* This method is usually based on chemical standards and can be derived from existing data or as part of the biennial 305(b) reporting process. It can identify long-term trends in water quality, storm water impacts, and the effectiveness of management practices. However, because the ability to detect exceedances is highly dependent on the frequency and timing of sample collection, brief periods of exceedance might be missed (during storm flow) and long-term conditions inaccurately represented. Also, exceedance frequencies provide little information about causes and sources of pollution. Costs associated with this method are minimal because data are usually collected through other programs. Guidance and information on EPA and state water quality standards and criteria can be found at http://www.epa.gov/ost/standards (USEPA, 2001c).

(3) *Determine sediment pollutant levels.* This type of monitoring involves the determination of pollutant load carried by sediments and deposited in slow-moving receiving waters. Analysis is usually conducted using spectrophotometry and chromatographic tests of samples from natural or artificial water bodies. The extent of toxicity in sediments can be determined by comparing sample results to reference samples that are known to be relatively unimpacted. Measured pollutant levels can also be compared to existing standards for typical contaminants in sediment (USEPA, 2000d). Using sediment contamination as an indicator of water quality is often confounded by uncertainty related to levels of concern and long-term impacts, the inability to identify pollutant sources, and lag time between discharge and settling. However, long-term trends in sediment pollutant loading can be detected if monitoring is conducted over a long period.

(4) *Measure microbial contamination.* This type of monitoring involves measuring concentrations of microbes such as fecal coliform or *Escherichia coli* to ascertain the probable presence of pathogens in the water column. These pathogens result in the closure of beaches, fishing areas, and shellfish beds. Tracking the frequency of such closures may indicate contamination in effluent from industrial or municipal facilities or septic systems, or runoff from agricultural areas. In areas where no treatment facilities or septic systems are present, runoff can be identified as the main source of pathogens. Measuring microbe concentrations can help determine the effectiveness of management practices in removing this type of contamination from receiving waters.

Trends in beach or shellfish closures over time may indicate a developing problem if high concentrations or counts become more frequent, or they may demonstrate the effectiveness of management efforts if decreasing trends occur. However, many of the bacteria measured have a variety of nonhuman sources, making it difficult to identify the source of the pollution. In addition, they are short-lived in the water column, so depending on when samples are collected, the occurrence of high bacterial concentrations may not be detected even though they are present at certain times (e.g., during storm flows).

Bacterial source tracking refers to a family of methods that can be used to distinguish among sources of fecal contamination and can aid in tracking illicit discharges to storm sewer systems. Bacterial source tracking requires development of a database of known sources against which samples can be compared (Zhang et al., 2003). The methods can be molecular (e.g. DNA fingerprinting, or more specifically, ribotyping, pulsed-field gel electrophoresis [PFGE], polymerase chain reaction, terminal restriction fragment length polymorphism) or non-molecular. Non-molecular procedures can be biochemical (e.g., antibiotic resistance analysis, carbon utilization, F-specific coliphage typing, cell wall fatty acid methyl ester) or chemical (e.g., caffeine detection, optical brightener detection). In general, molecular methods can offer the most precise identification of specific types of sources, but they also have the highest unit costs and the most time-consuming procedures. Biochemical procedures are simpler, less expensive, and faster, and allow a larger number of samples to be analyzed in a shorter period of time (USEPA, 2002). The technology in this subject area is constantly evolving and new procedures and more refined methods may be available as research progresses.

Zhang et al. (2003) described the use of the PFGE method of bacterial source tracking analysis on *E. coli* samples from Four Mile Run in Northern Virginia, which is a highly urbanized watershed with approximately 40 percent impervious surface. Four Mile Run is impaired due to bacterial contamination and has a TMDL in place to control bacterial sources. The PFGE analysis identified that waterfowl contribute 38 percent of the bacteria, humans and pets (combined) accounted for 26 percent, and raccoons contributed 25 percent. Deer (9 percent) and rats (11 percent) also contributed bacteria to Four Mile Run.

DNA testing is an expensive but effective molecular method for identifying the primary animal or animals (human, duck, dog, etc.) that contribute microbes to the water column. More information about bacterial source tracking can be found in a two-part article in *Stormwater* available at http://www.forester.net/sw_0105_detecting.html (Hager, 2001).

Antibiotic resistance analysis (ARA) is the most commonly used non-molecular method for tracking sources of bacteria. ARA is used to distinguish among sources by looking at patterns of antibiotic resistance found in bacteria from human and animal sources. Fecal bacteria from humans can exhibit greater resistance to certain antibiotics than bacteria from wildlife feces (Hager, 2001; USEPA, 2002). However, this method may be confounded by the presence of bacteria from agricultural operations such as feedlots or poultry operations where antibiotics are used.

EPA's Office of Research and Development's National Risk Management Research Laboratory (NRMRL) is working to develop an integrated system for screening fecal bacteria contamination from various animal sources. NRMRL is working to match the best molecular method to its target bacteria for rapid screening and identification of sources of fecal contamination in watersheds (Simpson, 2003).

(5) *Measure nonpoint source loadings.* It is possible to estimate the amount of pollutants transported in storm water runoff from various land uses by using empirical monitoring data, land use imperviousness and cover, area, and rainfall volume. Modeling of pollutant loads can establish baselines that can be used to determine whether changes have occurred as a

Maryland's Environmental Indicators

The state of Maryland has compiled several indicators to characterize environmental quality (MDE, 1999). These indicators embody a range of environmental attributes, from air quality to drinking water quality to public understanding and community support. The Non-Tidal Aquatic Systems category, which encompasses the range of plants and animals found in free-flowing rivers, streams, lakes, and most wetlands, includes several indicators that appropriately address Maryland's habitat and land uses and include physical, chemical, and biological measures:

- Miles of Streams Degraded by Abandoned Mine Drainage.
- Stream Miles Open to Migratory Fish.
- Physical Habitat Index (Non-Tidal).
- Benthic Macroinvertebrate Index of Biotic Integrity (Non-Tidal).
- Fish Index of Biotic Integrity (Non-Tidal).
- Riparian Forest Buffers.

The biological indicators consider communities of living organisms as found throughout the water column rather than any individual species, and their values reflect the physical and chemical water quality conditions described by other indicators. The Riparian Forest Buffers indicator was chosen because of its importance to physical and chemical habitat and its contribution in cycling nutrients to aquatic species and because a statewide benchmark had already been established through the Chesapeake Bay Program. More information on Maryland's environmental indicators is available at http://www.mde.state.md.us/enpa/ 2000_enpa/envi_indicators.

result of land use changes or implementation of management practices. Loadings can be calculated for small-scale studies using the Simple Method as described in *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs* (Schueler, 1987), which is available for purchase at http://www.mwcog.org. Alternatively, several computer simulation models are available to model changes in nonpoint source loads under different scenarios.

Another source of information for estimating pollutant releases is the Healthy Community Environmental Mapping program, called HUD E-MAPS (HUD and USEPA, 2000). HUD E-MAPS, which was developed by the Department of Housing and Urban Development (HUD) and EPA, combines EPA environmental data with information on HUD's community development and housing programs. The program provides location, type, and performance information on HUD-funded activities throughout the country, and select EPA pollution release information. The maps help communities to plan by allowing them to identify areas of pollutant releases when planning economic development and housing projects. The HUD E-MAPS program can be accessed at http://www.hud.gov/emaps.

2.3.6 Establish Physical and Hydrological Indicators

EPA's *Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers* (USEPA, 1999) and *Volunteer Stream Monitoring: A Methods Manual* (USEPA, 1997c) provide guidance on how to conduct assessments of a water body's physical, habitat, and hydrological characteristics. Both documents are available on the Internet: the former can be found at http://www.epa.gov/owow/monitoring/rbp, and the latter is located at http://www.epa.gov/owow/monitoring/volunteer/stream.

EPA also provides guidance for lake and reservoir monitoring in *Lake and Reservoir Bioassessment and Biocriteria* (USEPA, 1998b), which is available at http://www.epa.gov/owow/monitoring/tech/lakes.html. Monitoring guidance for estuarine and coastal marine waters can be found in *Estuarine and Coastal Marine Waters: Bioassessment and Biocriteria Guidance* (USEPA, 2000a), located at http://www.epa.gov/ost/biocriteria/States/estuaries/estuaries1.html.

Additional monitoring guidance can also be obtained from EPA's Environmental Monitoring and Assessment Program (EMAP), a research program designed to develop the necessary tools for monitoring and assessing the nation's ecological resources. The objective of the program is to guide national monitoring initiatives and activities with improved scientific understanding of ecosystem integrity and dynamics. Information about the EMAP program is available at http://www.epa.gov/emap.

Methods for characterizing streams are contained in *Applied River Morphology* (Rosgen, 1996). Rosgen discusses geomorphic characterization of streams, which helps to differentiate between degraded and stable stream systems. This book also contains methods used to assess the current conditions of a stream and the departure from its potential. The Bank Erodibility Hazard (BHI) Rating Guide can be used to quickly determine bank erosion potential.

(1) *Measure stream widening/downcutting*. Measurements of stream width, depth, and bank characteristics taken over time can be used to indicate changes in the magnitude and frequency of storm flows caused by land use changes that affect stream geometry. Such measurements are also useful in identifying stream segments that are especially susceptible to erosion and areas where habitat is degraded to target areas for implementation of management practices. Many stream channels are already modified, so baseline conditions need to be established. This method cannot be used to predict changes, but it can help to diagnose a problem after it has occurred. Booth (1994) presents excellent guidance for conducting measurements of stream cross-sectional area.

(2) *Conduct physical habitat monitoring*. Monitoring of physical habitat is used to assess the potential of the stream to support different kinds of biota. Parameters such as weather, stream type and origin, land use, erosion, reach width and depth, canopy, proportion of stream morphological type (pool, riffle, and run), and presence or absence of large woody debris and aquatic vegetation can be measured easily and inexpensively and can provide information about which taxa would likely be found in the stream without water quality impacts (reference condition). If conducted over time, monitoring can provide information about past, present, and future changes in channel morphology. Although this method detects impacts from relatively low levels of development, it is not useful in pinpointing sources of degradation, nor does it offer insight into other water quality impacts.

(3) *Assess dry weather flows*. This method is used to assess the impact of urbanization on base flows, either as compared to a non-urbanized stream in the same ecoregion, or as a change over time. Impacted streams in humid areas show decreased flow, whereas perennial streams in arid regions show increased flow, as a result of urbanization. Evaluating pipe installations and impervious surfaces in humid regions and water use in arid regions allows this method to be used to identify causes of baseflow alteration. This method works well in conjunction

with stream widening/downcutting studies. It cannot be used to distinguish between urbanization and other causes of stream flow alteration such as irrigation, long-term drought, and the like, unless these factors are taken into account explicitly. Also, it is difficult to establish trends without extensive long-term data and knowledge about certain geologic conditions.

(4) *Measure flooding*. It is important to quantify changes in stream morphology over time because alterations in stream size or shape or in floodplain boundaries indicate that hydrologic changes have resulted from development in the watershed. These changes can be identified by comparing historical floodplain records to current floodplain maps, called Flood Hazard Boundary Maps (FHBMs). They are official maps issued by a community administrator that detail the boundaries of the flood, mudslide, and related erosion areas having special hazards that have been designated (FEMA, 2000). The maps can be obtained from local community map repository sites, from the Federal Emergency Management Agency (FEMA) online at http://msc.fema.gov, or through FEMA by phone, fax, or mail from the Map Service Center, P.O. Box 1038, Jessup, Maryland 20794-1038; telephone 800-358-9616; fax 800-358-9620.

(5) *Monitor stream temperature*. This method identifies areas where stream temperature has increased as a result of urbanization and loss of shading and buffers. Stream temperature can be measured over time or compared to other, low-impact watersheds. This monitoring method can be used to identify areas that would potentially benefit from riparian buffer enhancement and to measure the effectiveness of management practices used to regulate stream temperature. Changes in stream temperature can be an early warning sign that sensitive species will be lost without intervention. Climatic conditions can cause variability in stream temperature that is extraneous to trends caused by urbanization and can confound analyses. In addition, in should be noted that some management practices, such as ponds and wetlands, can result in increased temperature.

2.3.7 Establish Biological Indicators

Bioassessments are useful for detecting aquatic life impairments and identifying the causative agents and possible mitigation strategies. Additional bioassessments can indicate whether mitigation was successful and can direct further management activities. Monitoring of biological communities offers the following advantages:

- Biological communities reflect overall ecological integrity and directly relate to the primary goal of the Clean Water Act.

- Biological communities integrate the effects of different stressors and provide a broad measure of their aggregate impact.

- Biological communities provide an ecological measure of changes in environmental conditions.

Development and Evaluation of Ecosystem Indicators for Urbanizing Midwestern Watersheds

Researchers at Purdue University are undertaking a study to develop predictive indicators of urbanization that are applicable to midwestern watersheds (Spacie et al., 2000). The objectives of this study are as follows:

- Quantify impacts on hydrologic regimes, water quality, and habitat structure of stream ecosystems using paired experimental watersheds.
- Develop linked models to accurately predict these impacts.
- Use the models to generate and test indicators of urbanization and hydrologic change with respect to biological responses to these changes.
- Use these indicators with the models to assess biological responses to alternative urbanization scenarios on larger scales.

Data from satellite imagery, intensive water quality and biological sampling, stream cross-section measurements, and physical habitat assessments will be used to develop and test the models. A dynamic hydrology model that can simulate cross-sectional averaged velocities, shear stress velocities, and water depth variability during storm peaks has been developed. Functional biological metrics and habitat quality indices will be correlated not only to land use but also to channel morphometry and flow variability.

For more information contact Anne Spacie, Department of Forestry and Natural Resources, Purdue University, 1159 Forestry Building, West Lafayette, Indiana 47907-1159; telephone 765-494-3621; e-mail aspacie@purdue.edu.

- Routine biological monitoring is inexpensive compared to chemical monitoring and toxicity tests.
- Biological monitoring is useful for evaluating impairment when criteria for specific ambient impacts do not exist.

Bioassessments can include evaluation of fish populations, benthic macroinvertebrate communities, periphyton, and single species monitoring. EPA's *Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers* (USEPA, 1999) contains descriptions of various methods for each community type. EPA (2000b) also published the *Stressor Identification Guidance Document*, which outlines a process to identify causes of biological impairment. The stressor identification process is outlined in Figure 2.2 and includes three major steps: (1) listing candidate causes of impairment; (2) analyzing new and existing data to generate evidence for each candidate cause; and (3) producing a causal characterization with the evidence generated in step 2 to draw conclusions about the stressors most likely to have caused the impairment. The *Stressor Identification Guidance Document* is available for download in PDF format at http://www.epa.gov/waterscience/biocriteria/stressors/stressorid.html or can be ordered through EPA's National Service Center for Environmental Publications at http://www.epa.gov/ncepihom/index.htm.

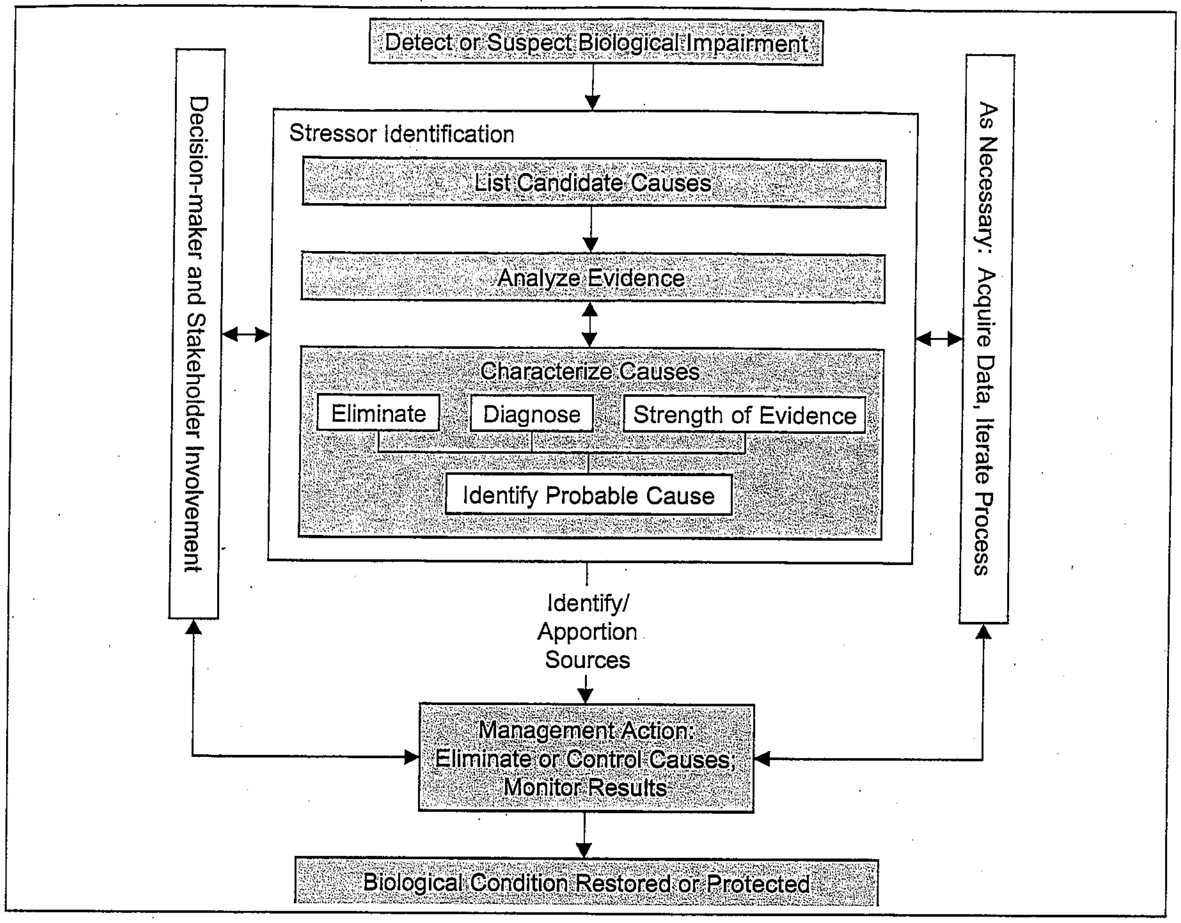

Figure 2.2: Conceptual diagram of the stressor identification process (USEPA, 2000b).

The Biological Assessment of Wetlands Workgroup (BAWWG) (USEPA, 2001b) provides information for establishing monitoring protocols for wetlands through its series of "state of the science" reports. These reports include introductory modules on wetland bioassessments and modules on specific methods, such as bioassessments for macroinvertebrates. Although the reports do not provide specific prescriptive guidance, they summarize current knowledge and provide options and recommendations to states for developing wetland bioassessment methods and programs. The modules also point out limitations of current methods and identify research needs. Information from BAWWG is available at http://www.epa.gov/owow/wetlands/bawwg/index.html.

(1) *Assess periphyton populations.* Changes in periphyton or plankton community structure and distribution patterns can indicate a water quality problem stemming from thermal pollution, toxic chemicals, nutrients, and sedimentation. Because periphyton have a short life cycle, they are especially good indicators of short-term impacts. Measurements of chlorophyll, a chemical common to all periphyton, can also be used as an indicator of eutrophication. Although there are several levels of sampling and analysis of periphyton populations, rapid sampling can be relatively easy and inexpensive and has little impact on the ecosystem.

Also, standardized methods (biomass, chlorophyll) can be used to analyze and interpret algal communities without doing an extensive taxonomic evaluation, which requires specialized training. One problem with these indicators is that plankton populations vary seasonally and are highly transient, making them a poor indicator of site-specific conditions.

(2) *Assess macroinvertebrate assemblages.* Macroinvertebrates are relatively immobile and are good indicators of site-specific effects. They have a short life cycle and therefore are good indicators of short-term stress. Measurements of invertebrate populations are usually compared to populations from a reference condition to determine the severity of pollutant impacts. The presence or absence of particular species can be used to infer poor aquatic integrity because macroinvertebrate assemblages typically cover a broad range of trophic levels and pollution tolerances that allow interpretation of multiple effects. Macroinvertebrate sampling has some drawbacks, including the fact that populations are highly habitat-dependent and vary with season, stream flow, and region, which can confound results. In addition, taxa identification requires training and can be complex and time-consuming. Despite these drawbacks, volunteer monitoring programs can be used to collect macroinvertebrate data. Both *Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers* (USEPA, 1999) and *Volunteer Stream Monitoring: A Methods Manual* (USEPA, 1997c) provide guidance on how to conduct benthic macroinvertebrate assessments.

(3) *Assess fish assemblages.* Measurements of fish diversity, species richness, species pollutant tolerance, disease prevalence, and a variety of other metrics can be used to identify the nature and extent of a pollution or habitat problem. Measurements are taken in several different habitats within the stream or other water body and are usually compared to a regional reference condition to determine the extent of impairment. The methods can also be used to evaluate the success of management practices. Because fish have a relatively long lifespan, they often react to chronic levels of pollutants and long-term impacts. Fish are also easy to collect and identify. However, fish populations are influenced by many other variables, such as stream size, region, season, temperature, and flow conditions, that need to be taken into account when analyzing the data. Also, fish that migrate may be affected by conditions in another area that is not the area of interest. It is sometimes difficult to identify the source of problems in fish populations because of the prevalence of confounding factors that make interpretation of results difficult.

Biodiversity information on the Web via NatureServe

NatureServe, a nonprofit organization, partners with a network of natural heritage programs and conservation data centers to conduct expert local biodiversity inventories and analyze the results both nationally and internationally. Their Web site offers such data products as the NatureServe Explorer, which compiles conservation data on more than 50,000 plants, animals, and ecological communities in the United States and Canada. Users can search the database by any combination of name, location, and conservation status. The Web site also links to online data resources available from natural heritage programs and conservation data centers via the "Local Program Data" link. NatureServe provides links to ecology, animal, and plant data for download and provides links to other biodiversity resources on the Web. The NatureServe Web site can be accessed at http://www.natureserve.org.

(4) *Assess single species indicators.* Trout, salmon, and freshwater mussels are often used for this type of assessment. Some species are popular with the public, and their popularity can help in rallying support for better management. Measuring only one species is relatively easy and inexpensive and might provide early diagnosis of degradation, which can facilitate remediation efforts. However, natural population fluctuations in a single species can skew results, and without corroborating evidence there is no way to prove conclusively that degradation has occurred. It should be noted that focusing on protecting a single species may decrease protection of other threatened species.

(5) *Measure composite indicators.* This method typically involves developing an index that incorporates the results of several different bioindicators. Several metrics can be combined into a single integrity index, such as the number of native fish species or the number of intolerant macroinvertebrate taxa. Composite indicators provide a more comprehensive evaluation of storm water impacts than fish, macroinvertebrate, or single species indicators alone. Both long-term and short-term effects can be evaluated by using this type of metric. As with the other biological methods, populations are dependent on region, season, and flow. Reference site measurements are essential for valid comparisons when determining the extent of storm water impacts. Note: other measurements may be needed to identify sources of degradation.

2.3.8 Establish Programmatic Indicators

It is important to assess the effectiveness of a runoff management program. Claytor and Brown (1996) present several programmatic indicators that can be used to estimate the success of a management program and help to direct future efforts. These include:

- Number of illicit connections identified or corrected
- Number of management practices installed, inspected, and maintained
- Permitting and compliance
- Growth and development

Management Measure 12 discusses other ways to determine the effectiveness of runoff management programs.

2.3.9 Develop a Suite of Social Indicators

Watershed managers can use several methods to gauge public perception of water quality issues and nonpoint source programs. These "social indicators" include:

- Public attitude surveys
- Industrial/commercial pollution prevention
- Public involvement and monitoring
- User perception

More information about these indicators can be found in *Environmental Indicators to Assess Stormwater Control Programs and Practices* (Claytor and Brown, 1996).

2.4 Information Resources

USGS's NAWQA Data Warehouse provides online access for invertebrate community data from 1,700 stream sites in more than 50 major river basins across the nation. Data from more than 5,000 invertebrate community samples that were collected from 1993 through 2002 can be found here. The data warehouse also provides data on fish communities from more than 1,000 stream locations, as well as data from thousands of water quality samples from approximately 6,400 stream sites, 7,000 wells, and streambed sediment and aquatic animal tissue. Samples have been analyzed for a number of constituents. The NAWQA Data Warehouse can be accessed at http://water.usgs.gov/nawqa/data.

The Caltrans *Guidance Manual: Storm Water Monitoring Protocols* (Caltrans, 2000a) provides step-by-step descriptions of the processes used to plan and implement a successful water quality monitoring program specific to runoff from transportation-related facilities. Although the guidance manual emphasizes uniform policies and procedures for monitoring, the *Statewide Storm Water Management Plan* (Caltrans, 2000b) describes minimum procedures and practices Caltrans uses to reduce pollutants discharged from storm water drainage systems. These documents, along with other storm water-related documents, can be downloaded in PDF format http://www.dot.ca.gov/hq/env/stormwater/special/index.htm.

Donigan and Huber (1991), in *Modeling of Nonpoint Source Water Quality in Urban and Non-Urban Areas*, reviewed nonpoint source assessment procedures and modeling techniques for both urban and non-urban land areas. Detailed reviews of specific methodologies and models are presented, along with overview discussions focusing on both urban and non-urban methods and models. Brief case studies of ongoing and recently completed modeling efforts are described and recommendations for nonpoint runoff quality modeling are presented. This document can be ordered from the National Technical Information Service at *www.ntis.gov* or by calling 800-553-6847.

EPA has assembled a Web site with information about and links to water quality models. This site includes basic information, EPA-supported models, other federal government-supported models, technical guidance for models, and model training and meetings. The Web site can be accessed at http://www.epa.gov/waterscience/wqm/.

Patten et al. (2000) have undertaken a study to develop improved indicators and innovative techniques for assessing and monitoring ecological integrity at the watershed level in the western United States. Their objectives are to develop practical, scientifically valid indicators that span multiple resource categories, are relatively scale-independent, address different levels of biological organization, can be rapidly and cost-effectively monitored by remote sensing, and are sensitive to a broad range of anthropogenic and natural environmental stressors. More information about this project can be found at http://es.epa.gov/ncer_abstracts/grants/99/ecological/patten.html (NCER, 2001).

Compendium of Tools for Watershed Assessment and TMDL Development (USEPA, 1997a) supports the watershed approach by summarizing available techniques and models that assess and predict physical, chemical, and biological conditions in water bodies. The publication contains descriptions of three major categories of models: watershed loading, receiving water, and ecological. Watershed loading models can be used to simulate the generation and movement of pollutants from the source to discharge into receiving waters. Receiving water models can be used to simulate the movement and transformation of pollutants through lakes, streams, and rivers. Ecological models can be used to simulate plant and animal communities and their response to pollutants and habitat modification. This document is available through EPA's National Service Center for Environmental Publications at http://www.epa.gov/ncepihom/index.htm.

EPA's *Monitoring Guidance for Determining the Effectiveness of Nonpoint Source Controls* (USEPA, 1997b) contains an overview of nonpoint source pollution and covers the development of a monitoring plan, data analysis, quality assurance/quality control, and biological monitoring. The manual was written to assist users in the design of water quality monitoring programs to assess both impacts from nonpoint source pollution and the effectiveness of control practices and management measures. It is available through EPA's National Service Center for Environmental Publications at http://www.epa.gov/ncepihom/index.htm.

Volunteer Stream Monitoring (USEPA, 1997c) serves as a tool for program managers who want to launch a new stream monitoring program or enhance an existing program. It contains methods that have been adapted from those used successfully by existing volunteer programs. The guidance is available in HTML and PDF formats at http://www.epa.gov/owow/monitoring/volunteer/stream.

The *Lake and Reservoir Bioassessment and Biocriteria* (USEPA, 1998b) guidance was developed through the experience of existing state, regional, and national lake monitoring programs and is oriented toward practical decision-making rather than research. Its primary target audiences are state and tribal natural resource agencies. It is intended to provide managers and field biologists with functional methods and approaches that will facilitate the implementation of viable lake bioassessment and biocriteria programs that meet their needs and resources. The document can be obtained in HTML format at http://www.epa.gov/owow/monitoring/tech/lakes.html.

Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers: Periphyton, Benthic Macroinvertebrates, and Fish (USEPA, 1999) is a practical technical reference for conducting cost-effective biological assessments of lotic systems. This guidance is intended to provide basic, cost-effective biological methods for states, tribes, and local agencies that: (1) have no established bioassessment procedures; (2) are looking for alternative methodologies; or (3) may need to supplement their existing programs (not supersede other bioassessment approaches that have already been successfully implemented). The scope of this guidance is considered applicable to a range of planning and management purposes, i.e., the methods may be appropriate for priority-setting, point and nonpoint source evaluations, use-attainability analyses, and trend monitoring, as well as initial screening. The guidance is available in HTML and PDF formats at http://www.epa.gov/owow/monitoring/rbp.

The *Estuarine and Coastal Marine Waters: Bioassessment and Biocriteria Guidance* (USEPA, 2000a) provides an extensive collection of methods and protocols for conducting bioassessments in estuarine and coastal marine waters, as well as the procedures for deriving biocriteria from the results. Several case studies illustrate the bioassessment process and biocriteria derivation procedures. This document can be downloaded in PDF format at http://www.epa.gov/ost/biocriteria/States/estuaries/estuaries1.html.

The *Stressor Identification Guidance Document* (USEPA, 2000b) leads water resource managers through the process of stressor identification and evidence assembly. The guidance can be used whenever biological impairment is present in an aquatic ecosystem and the cause is unknown. The stressor identification process combines multiple methods to determine the causes of impairment, and the methods are presented in order of the kinds of evidence used, from site-specific to more general information. The *Stressor Identification Guidance Document* is available in PDF format at http://www.epa.gov/waterscience/biocriteria/stressors/stressorid.html.

Techniques for Tracking, Evaluating, and Reporting the Implementation of Nonpoint Source Control Measures: Urban (USEPA, 2000c) was written to assist local officials in focusing limited resources by using statistical sampling methods to assess, inspect, or evaluate a representative set of management practices, erosion and sediment controls, and onsite wastewater treatment systems. The document can be downloaded in PDF format at http://www.epa.gov/owow/nps/urban.pdf, or it can be ordered through EPA's National Service Center for Environmental Publications at http://www.epa.gov/ncepihom/index.htm.

EPA's Web site titled "An Introduction to Water Quality Monitoring" contains a wide variety of resources for those interested in learning more about water quality monitoring, automated data management, and geographic information systems (USEPA, 2001). Many EPA guidance documents, fact sheets, and final reports are available from this site, which can be accessed at http://www.epa.gov/owow/monitoring/monitor.html.

EPA's Web site, "Water Quality Criteria and Standards Plan" (USEPA, 1998d), describes six new criteria and standards program initiatives that EPA and the states and tribes will take over during the next decade. The plan presents a "vision" and strategy for meeting these important new initiatives and improvements and will guide EPA, states, and tribes in developing and implementing criteria and standards that provide a basis for enhancements to the TMDL program, NPDES permitting, nonpoint source control, wetlands protection, and other water resource management efforts. The Web site is located at http://www.epa.gov/ost/standards/quality.html.

EPA's Volunteer Monitoring Program provides technical assistance, serves as a regional contact for volunteer programs, manages grants to state agencies that undergo volunteer water monitoring and conduct public participation programs, and provides information exchange services for volunteers. The program's Web site (http://www.epa.gov/owow/monitoring/volunteer) provides a link to a listserver is available for volunteer monitoring program coordinators, as well as a national newsletter for volunteer monitors, a directory of volunteer monitoring programs, and manuals on volunteer monitoring methods and on planning and implementing volunteer programs.

EPA's Watershed and Water Quality Modeling Technical Support Center provides information and services to federal agencies, state and local governments, businesses, and individuals to help support implementation of the Clean Water Act. Support includes reviewing proposed TMDLs, providing oversight to TMDL development nationwide, serving as technical advisors, applying models for TMDL development, assisting in data acquisition and analysis, assisting in TMDL implementation, analyzing BMP design and performance, and researching models for regulatory applications. The center's Web site can be accessed at http://www.epa.gov/athens/wwqtsc/index.html.

The P8—Urban Catchment Model by Walker (2000) is designed to predict the generation and transport of runoff pollutants in urban watersheds. The model was developed to design and evaluate runoff treatment control combinations in developments for pollutant removal efficiency. The most recent version of this DOS-based program (Version 2.4, published in February 2000), as well as data files and program documentation, is available for download from http://wwwalker.net/p8.

A useful water resource impact model is the Long-Term Hydrologic Impact Assessment (L-THIA), which was developed by Purdue University (2000) for land use planners to provide site-specific estimates of changes in runoff, recharge, and nonpoint source pollution resulting from past or proposed land use changes. The model uses regional climate data and user-provided location, land use, and soil group data for up to three different scenarios (past, present, and future). The results are in the form of tables, bar charts, and pie charts. The model is available at http://danpatch.ecn.purdue.edu/~sprawl/LTHIA7.

Vermont's Water Resources Board developed "A Scientifically Based Assessment and Adaptive Management Approach to Stormwater Management" as an appendix to the *Investigation into Developing Cleanup Plans for Stormwater Impaired Waters* (Docket No. INV-03-01). The assessment paper describes a framework for identifying storm water runoff problems and providing adaptive management to address controls for and treatment of runoff in problem areas. The framework represents a balance of the interests of many diverse constituents, focusing on surface water impairments and improvements to identify problems due to runoff and improvements due to runoff controls. The report, part of the Vermont Water Resources Board's Stormwater Docket, can be accessed at http://www.state.vt.us/wtrboard/docs/inv-03-01report.pdf.

NatureServe, a nonprofit organization, partners with a network of natural heritage programs and conservation data centers to conduct expert local biodiversity inventories and analyze the results both nationally and internationally. Its Web site offers such data resources as the NatureServe Explorer, which compiles conservation data on more than 50,000 plants, animals, and ecological communities in the United States and Canada. Users can search the database by any combination of name, location, and conservation status. The Web site also connects to online data resources available from natural heritage programs and conservation data centers via the "Local Program Data" link. NatureServe provides links to ecology, animal, and plant data for download and to other biodiversity resources on the Web. The NatureServe Web site can be accessed at http://www.natureserve.org.

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MANAGEMENT MEASURE 3
WATERSHED PROTECTION

3.1 Management Measure

Develop a watershed protection program to:

- Avoid development of areas that are particularly susceptible to erosion and sediment loss.
- Preserve areas that provide important water quality benefits and/or are necessary to maintain riparian vegetation and aquatic biota.
- Site development projects, including roads, highways, and bridges, to protect the natural integrity of water bodies and natural drainage systems.

3.2 Management Measure Description and Selection

3.2.1 Description

The purpose of this management measure is to reduce the generation of nonpoint source pollutants and to mitigate the impacts of urban runoff and associated pollutants from new development and redevelopment, including the construction of new and relocated roads, highways, and bridges. It is intended to provide general goals for local agencies and urban communities in developing comprehensive programs for guiding future development and land use activities in a manner that will prevent and mitigate the effects of nonpoint source pollution.

Although the goals of this management measure and Management Measure 4 (Site Development) are similar, this measure is intended to apply to larger watersheds or regional drainage basins rather than individual sites. The watershed protection and site development management measures are intended to be complementary. They can be used together with the other management measures in a comprehensive framework to control runoff and reduce nonpoint source pollution. (See Chapter 1 for a description of the runoff management program framework.)

Comprehensive planning is an effective nonstructural tool to control nonpoint source pollution. Where possible, growth should be directed toward areas where it can be sustained with minimal impact on the natural environment (Meeks, 1990). Poorly planned growth and development have the potential to degrade and destroy natural drainage systems and surface waters (Mantel et al., 1990). By making proper planning and zoning decisions, water quality managers can direct development and land disturbance away from areas that drain to sensitive waters. Land use designations and zoning laws can also be used to protect environmentally sensitive areas such as riparian corridors and wetlands.

Riparian buffers and wetlands can have the benefit of providing long-term pollutant removal capabilities without the comparatively high costs usually associated with constructing and maintaining structural controls. Conservation or preservation of these areas is important to protect the water quality of streams, wetlands, lakes, and reservoirs. Land acquisition programs help to preserve areas considered critical to maintaining surface water quality. Adequate buffer strips along streambanks provide protection for stream ecosystems, help stabilize the stream, and can prevent streambank erosion (Holler, 1989). Buffer strips can also protect and maintain near-stream vegetation that attenuates the release of sediment into stream channels. Levels of suspended solids have been shown to increase at a slower rate in stream channel sections with well-developed riparian vegetation (Holler, 1989).

3.2.2 Management Measure Selection

This measure was selected for several reasons. First, watershed protection is a technique that provides long-term water quality benefits, and many states and local communities have adopted this practice. Numerous state and local governments have already legislated and implemented detailed watershed planning programs that are consistent with this management measure. For example, Oregon, New Jersey, Delaware, and Florida have passed legislation that requires county and municipal governments to adopt comprehensive plans, including requirements to direct future development away from sensitive areas. Many municipalities and regions have adopted land use and growth controls, including the towns of Amherst and Norwood and the Cape Cod region of Massachusetts; Narragansett, Rhode Island; King County, Washington; and many others.

Second, there is general recognition that the protection of sensitive areas and areas that provide water quality benefits is integral to maintaining or minimizing the impacts of development on receiving waters and associated habitat. Without a comprehensive planning approach that includes the use of riparian buffers, open space, bioretention, and structural controls to maintain the predevelopment hydrologic characteristics of the site, significant water quality and habitat impacts are likely. The experience of communities across the country has shown that the use of structural controls without adequate local land use planning and zoning often does not adequately protect water quality and might even cause detrimental effects such as increased temperature.

Third, this measure is effective in producing long-term water quality benefits without the high operation and maintenance costs associated with structural controls. The Michigan Department of Environmental Quality (no date) compared the costs of two nonpoint source projects. One involved preserving an urbanizing watershed, and the other entailed restoring an urban watershed. Table 3.1 is a side-by-side cost comparison demonstrating that it is generally less costly to protect high-quality streams than to restore them.

Table 3.1: Cost comparison of stream preservation vs. stream restoration (Michigan Department of Environmental Quality, no date).

	Bear Creek	York Creek
Type of nonpoint source project	Preservation	Restoration
Setting	Grand Rapids, MI, area stream	Grand Rapids, MI, area stream
Size	20,096 acres	2,110 acres
Level of urbanization	9.5% (1991)	19% (1993)
Stream category	High-quality trout stream	Former trout stream
Storm water ordinance	$10,000	$10,000
Decision-making GIS	$10,000	$10,000
Information/education program	$100,000	$80,000
Streambank stabilization	$15,000	$130,000
Storm water basin retrofits	–	$180,000
Additional storm water basins	–	$75,000
Other practices (habitat improvement, repairing road crossings, etc.)	$75,000	$190,000
Total cost	$210,000[a]	$675,000

[a] Total cost does not take into account the purchase cost or opportunity cost for not developing the land

3.3 Management Practices

A comprehensive watershed approach requires constant adjustments based on development patterns, population increases, changing land uses, the state of the resources, and the institutional capacity of the community to manage its resources. The practices listed below provide an overview of the approaches communities around the country are adopting or experimenting with to protect their water resources in a cost-effective way.

3.3.1 Resource Inventory and Information Analysis

Before a comprehensive program can be developed, communities should define the watershed boundaries, target areas, and pollutants of concern, and conduct resource inventory and information analysis. These activities can be done by using the best available information or collecting primary data, depending on funding availability and the quality of available data. Activities pursued under this process include assessment of ground water and surface water hydrology; evaluation of soil type and ground cover; identification of areas with water quality impairments; and identification of environmentally sensitive areas, such as steep or erodible uplands, wetlands, riparian areas, floodplains, aquifer recharge areas, drainageways, and unique geologic formations. Once environmentally sensitive areas are identified, those that are integral to the protection of surface waters and the prevention of nonpoint source pollution can be protected.

The City of Virginia Beach, Virginia, conducted a three-phase inventory of natural areas to help planners and public officials develop practices for resource protection. The data collection phase cost $13,867 (1991 dollars); the field inventory (Phase II), cost $54,624; and Phase III, preparation of a final report, cost $15,255 (Jenkins, 1991).

Richmond County, Virginia, developed the Richmond County Resource Information System (RIS) to provide a basis for responsible planning and development of shoreline areas. The

Watershed Approach to Storm Water and Flood Management

The Planning Department of Delaware County, New York, is leading the effort to develop long-term solutions to water quality impairment from urban runoff. The county's Stormwater and Flood Management program uses a two-phase approach: (1) inventorying and assessing sources of urban runoff and storm water infrastructure, and (2) local implementation and municipal plan development.

The inventory and assessment component involves a detailed evaluation of point and nonpoint sources of pollution in the Cannonsville Basin. Locations of potential sources were documented using a Global Positioning System and site characteristics such as soil type and land use were recorded. A GIS database was used to store this information along with existing infrastructure, topographic maps ,and planimetric maps.

The local implementation and municipal plan development component involves working with local municipalities as part of its Town Planning Advisory Service (TPAS) to develop local initiatives for water quality protection and to demonstrate the role of water quality in community economic development. The municipal plans help local officials integrate wellhead protection into water quality planning, prioritize management needs, establish maintenance programs, and incorporate runoff management into capital planning (Delaware County Departments of Planning and Public Works, 2003).

compilation and mapping of resource information are part of the county's planning and zoning program. In 1990, the program was supported by a $39,000 Federal Coastal Zone Management Grant, $45,000 from the Chesapeake Bay Foundation through a Virginia Environmental Endowment Grant, and $96,000 from the county's comprehensive plan budget (Jenkins, 1991).

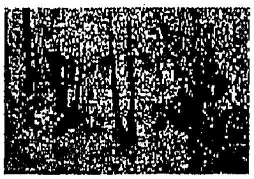
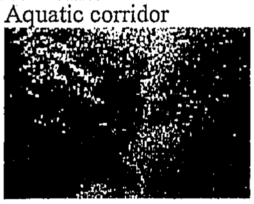
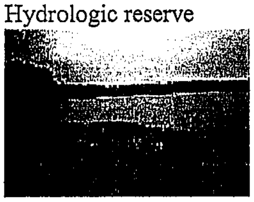
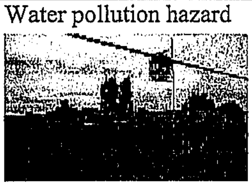
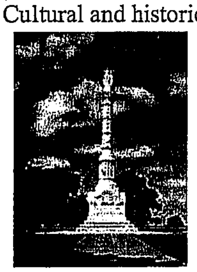
3.3.1.1 Identify environmentally sensitive, critical conservation areas

The identification of environmentally sensitive areas, also referred to as critical conservation areas, is an essential component of a watershed protection program. These areas need to be identified to: (1) avoid developing areas susceptible to erosion and sediment loss; and (2) preserve areas that provide important water quality benefits, such as wetlands, permeable soils, forested buffers, and riparian areas. These types of lands are described in Table 3.2. Inventories of these areas can be developed using wetland inventories, soil maps, maps of critical habitat for endangered species, GIS tools, remote sensing, vegetative cover inventories/maps, and forest inventories, among other sources.

GIS Mapping for Open Space and Water Resource Protection

The towns of Westford, Littleton, Chelmsford, and Boxborough, located in the Merrimack River Watershed north of Boston, Massachusetts, are using GIS as a tool to guide efforts to protect critical open space lands and aquifers. The effort is part of Massachusetts' Community Preservation Initiative, which helps local officials address the tradeoff between environmental planning issues, such as habitat and watershed protection, and the growing needs of the community in terms of economic development, housing, and transportation. GIS provides local officials with the capability of identifying open space lands that are critical to protecting water resources and exploring the implications of various build-out scenarios, land preservation strategies, land uses, and densities (NALGEP, 2003).

Table 3.2: Types of lands that should be preserved for watershed protection (adapted from Caraco et al., 1998).

Conservation Area	Description	Examples
Critical habitat 	Essential spaces for plant and animal communities or populations	Tidal wetlands, freshwater wetlands, large forest clumps, springs, spawning areas in streams, habitat for rare or endangered species, potential restoration areas, native vegetation areas, coves
Aquatic corridor 	Areas where land and water interact	Floodplains, stream channels, springs and seeps, steep slopes, small estuarine coves, littoral areas, stream crossings, shorelines, riparian forest, caves, and sinkholes
Hydrologic reserve 	Undeveloped areas responsible for maintaining the predevelopment hydrologic response of a subwatershed	Forest, meadow, prairie, wetland, cropland, pasture, or managed forest
Water pollution hazard  Source: Stapleton, 1999.	Any land use or activity that is expected to create a relatively high risk of water pollution	Septic systems, landfills, hazardous water generators, aboveground or underground tanks, impervious cover, surface or subsurface discharge of wastewater effluent, land application sites, storm water "hot spots," pesticide application, industrial discharges, and road salt storage areas
Cultural and historic sites  Source: NPS, 2001.	Areas that provide a sense of place in the landscape and are important habitats for people	Historic or archaeological sites, trails, parkland, scenic views, water access, bridges, and recreational areas

3.3.1.2 Identify and protect drinking water sources

All drinking water sources, including surface and ground waters, should be considered for protection, and unfiltered sources will require the most stringent protection. More than 200 cities, towns, and tribes protect ground water public drinking water systems from contamination using a variety of local government tools such as zoning, subdivision controls, and transfer of development rights. The ordinances implementing these tools are varied and include measures such as regulating onsite wastewater treatment systems and limiting nitrogen loading within wellhead protection areas (see section 1.3.1.2 in Management Measure 1, which describes different types of ordinances, including source water protection ordinances). This section introduces several tools to protect surface and ground water sources. Also, more information about identifying and protecting drinking water sources can be found at EPA's Office of Ground Water and Drinking Water Web site at http://www.epa.gov/ogwdw.

(1) *Delineate a Source Water Protection Area.* Delineation of a Source Water Protection Area requires identifying the boundaries of the area from which drinking water supplies are drawn. This information can be obtained from states, which are required to conduct an assessment of all public water systems. These assessments include a delineation, contaminant inventory, and susceptibility determination (see http://www.epa.gov/safewater/protect/swap.html for more information about state Source Water Assessment Programs). Local governments may choose to elaborate on the state's assessment before planning management activities.

(2) *Protect Sole Source Aquifers.* Sole Source Aquifer (SSA) designations are one tool to protect drinking water supplies in areas with few or no alternative sources. These areas are of special significance because if contamination occurred, using an alternative source would be prohibitively expensive. The designation protects an area's ground water resource by requiring EPA review of any proposed projects within the designated area that are receiving federal financial assistance. All proposed projects receiving federal funds are subject to a review to ensure they do not endanger the water source. Between January 1997 and January 1999, EPA reviewed 439 projects, 60 of which required modifications that were deemed necessary to protect the Sole Source Aquifers. Examples of federally funded projects that have been reviewed by EPA under the SSA protection program include highway improvements and new road construction, public water supply wells and transmission lines, wastewater treatment facilities, construction projects that involve disposal of storm water, agricultural projects that involve management of animal waste, and projects funded through Community Development Block Grants.

EPA has developed Memoranda of Understanding (MOU) with other agencies to help establish review responsibilities under the Sole Source Aquifer Protection Program and to clarify what types of projects should or should not be referred to EPA. If you have questions about whether EPA needs to review a project in a particular Sole Source Aquifer, please contact the Sole Source Aquifer Coordinator for your state or territory (see http://www.epa.gov/safewater/swp/sumssa.html for lists and maps of Sole Source Aquifers in each of the EPA regions along with contact information for Sole Source Aquifer Coordinators).

(3) *Develop a local wellhead protection ordinance.* Wellhead protection refers to implementing pollution prevention and source controls to protect underground sources of drinking water. The Safe Drinking Water Act requires that State Wellhead Protection Programs be approved by EPA and incorporate delineation, contaminant source inventory, and source management. Local governments can also develop local wellhead protection ordinances to further protect drinking water supplies from contamination.

(4) *Purchase property or development rights*. This practice is meant to guarantee community control over the activities conducted on lands that contribute to aquifers or surface waters. This may involve outright purchase of the land or just surface-use rights (see section 3.3.5 for a discussion of land acquisition options). New funds from the Safe Drinking Water Act allow land trusts and other local organizations to work with state agencies and water suppliers to identify and acquire critical lands and conservation easements.

3.3.2 Development of Watershed Management Plan

The resource inventory and information analysis component provides the basis for a watershed management plan, which is a comprehensive approach to addressing the needs of a watershed, including land use, urban runoff control practices, pollutant reduction strategies, and pollution prevention techniques.

For a watershed management plan to be effective, it should have measurable goals describing desired outcomes and methods for achieving the goals. Goals, such as reducing pollutant loads to surface water by 25 percent, can be articulated in a watershed management plan. Development and implementation of urban runoff practices, both structural and nonstructural, can be incorporated as methods for achieving the goal. The following describes the general steps for developing a watershed management plan (Livingston and McCarron, 1992):

1. Delineate and map watershed boundaries and subbasins within the watershed.
2. Inventory and map natural runoff conveyance and storage systems.
3. Inventory and map the manmade storm water conveyance and storage system.
4. Inventory and map land use by subbasin.
5. Inventory and map detailed soils by subbasin.
6. Establish a clear understanding of water resources in the watershed. Analyze water quality, sediment, and biological data. Analyze subjective information on problems such as citizen complaints. Evaluate water body use impairment, including the frequency, timing, and seasonality of the problem. Conduct a water quantity assessment (e.g., low flows, seasonality).
7. Inventory pollution sources in the watershed, including point sources (location, pollutants, loadings, flow capacity, etc.) and nonpoint sources (type, location, pollutants, loading, etc.). Include a land use/loading rate analysis for storm water, a sanitary survey for septic tanks, and dry weather flow monitoring to locate illicit discharges.
8. Identify and map future land use by subbasin. Conduct land use loading rate analyses to assess potential effects of various land use scenarios.
9. Identify planned short-term (five years) and long-term (20 years) infrastructure improvements. Runoff management deficiencies should be coordinated and scheduled with other infrastructure or development projects.
10. Determine infrastructure and natural resource management needs within each watershed.

11. Set resource management goals and objectives. Before corrective actions can be taken, a resource management target must be set. The target can be defined in terms of water quality standards, attainment of beneficial uses, or other local resource management objectives.
12. Determine pollutant reduction for existing and future land uses needed to achieve water quality goals.
13. Select appropriate management practices for both point and nonpoint sources that can be used to achieve the goal. Evaluate pollutant removal effectiveness, landowner acceptance, financial incentives and costs, availability of land operation and maintenance needs, feasibility, and availability of technical assistance.
14. Develop a watershed management plan. Since the problems in each watershed will be unique, each watershed management plan will be specific. However, all watershed plans will include elements such as an existing and future land use plan; a master storm water management plan that addresses existing and future needs; a wastewater management plan, including septic tank maintenance programs; and an infrastructure and capital improvements plan.

Development of a watershed management plan may involve establishing general land use designations that define allowable activities on a parcel of land. For example, land designated for low-density residential use would be limited to a density of two houses per acre, provided that all other regulations and requirements are met. All development activities allowed in a use category should be defined. By guiding uses within the planning areas, impacts to surface waters from urban runoff can be controlled. Those areas identified in the resource inventory and information analysis phase as environmentally sensitive and important to maintaining water quality can be preserved through various measures supported by state or local goals, objectives, and policies.

In Florida, local governments (counties and incorporated municipalities) were required to develop comprehensive plans based on existing information to guide short-term (five years) and long-term (20 to 25 years) growth and development. Local plans were required to be consistent with the state plan and the state growth management law and needed to identify environmentally sensitive areas and areas with water quality problems.

The Environmental Quality Corridor (EQC) System was established in Fairfax County, Virginia, to preserve floodplains, wetlands, shoreline areas, and steep valley slopes. EQCs were defined in the county's comprehensive plan and identified on the county land use map. If a parcel of land subject to a zoning or land use designation change contained an EQC, it was required to be set aside by the developer as part of development approval. Since its initiation, tens of thousands of acres have been set aside through the EQC program. The cost of implementing the program is part of the operating budget of the county planning department.

Howard County, Maryland, developed a Land Preservation and Recreation Plan as part of the county comprehensive plan. Under this plan, open space resources are purchased for preservation and recreation. The annual cost to update the plan, $25,000 (in 1991 dollars), is funded by the state. In FY 1990, the county received $1.14 million in state funds to update the plan and acquire land (Jenkins, 1991).

3.3.3 Implement the Plan

Once critical areas have been identified, land use designations have been defined, and goals have been established to guide activities in the watershed, implementation strategies can be developed. At this point, the requirements of future development are defined. These requirements include, but are not limited to, permitted uses, construction techniques, and protective maintenance measures. Land development regulations may also prescribe natural performance standards, such as "rates of runoff or soil loss should be no greater than predevelopment conditions."

A useful planning tool is the Long-Term Hydrologic Impact Assessment (L-THIA), which was developed by Purdue University (2000) for land use planners to provide site-specific estimates of changes in runoff, recharge, and nonpoint source pollution resulting from past or proposed land use changes. The model uses regional climate data and user-provided location, land use, and soil group data for up to three different scenarios (past, present, and future). The results are in the form of tables, bar charts, and pie charts. The model is available at http://danpatch.ecn.purdue.edu/~sprawl/LTHIA7.

Listed below are examples of the types of development regulations and other implementation tools that have been successful at controlling nonpoint source pollution.

3.3.3.1 Develop ordinances or regulations requiring nonpoint source pollution controls for new development and redevelopment

These ordinances or regulations should address, at a minimum:

- Control of off-site urban runoff discharges (to control potential impacts of flooding);
- The use of source control BMPs and treatment BMPs;
- The performance expectations of BMPs, specifying design storm size, frequency, and minimum removal effectiveness, as specified by the state or local government;
- The protection of stream channels, natural drainageways, and wetlands;
- Erosion and sediment control requirements for new construction and redevelopment; and
- Treatment BMP operation and maintenance requirements and designation of responsible parties.

3.3.3.2 Plan infrastructure

Infrastructure planning is the multiyear scheduling and implementation of infrastructure improvements, such as roads, sewers, potable water delivery, landfills, public transportation, and urban runoff management facilities. Infrastructure planning can be an effective practice to help guide development patterns away from areas that provide water quality benefits, are susceptible to erosion, or are sensitive to disturbance or pollutant loadings. Where possible, long-term comprehensive plans to prevent the conversion of these areas to more intensive land uses should be drafted and adopted. Infrastructure should be planned for and sited in areas that have the capacity to sustain environmentally sound development. Development tends to occur in response to infrastructure availability, both existing and planned. New development should be targeted for areas that have adequate infrastructure to support growth in order to promote infill development, prevent urban sprawl, and discourage the use of septic tanks where they are inappropriate (International City/County Management Association, 1979). Infill development may have the added advantage of municipal cost savings.

To discourage development in the environmentally sensitive East Everglades area, Dade County, Florida, has developed an urban services boundary (USB). In areas outside the USB, the county will not provide infrastructure and has kept land use densities very low. This strategy was selected to prevent urban sprawl, protect the Everglades wetlands (outside of Everglades National Park), and minimize the costs of providing services countywide. The area is defined in the county comprehensive plan, and restrictions have been implemented through the land development regulations (Metro-Dade Planning Department, 1988).

Congress has enacted similar legislation for the protection of coastal barrier islands. In 1981, the availability of federal flood insurance for new construction on barrier islands was discontinued. In 1982, Congress passed the Coastal Barriers Resources Act, establishing the Coastal Barrier Resource System (CBRS), and terminated a variety of federal assistance programs for designated coastal barriers, including grants for new water, sewage, and transportation systems. In 1988, similar legislation was passed for the Great Lakes area, adding 112 Great Lakes barrier islands. Additions to the CBRS in 1990 included parts of the Florida Keys, the U.S. Virgin Islands, Puerto Rico, and the Great Lakes (Simmons, 1991).

The result of the legislation and subsequent additions to the CBRS has been the establishment of approximately 1,326,000 acres of barriers that are ineligible for federal assistance for infrastructure and flood insurance (U.S. Fish and Wildlife Service (USFWS), 2002). This act has helped to guide development away from these sensitive coastal areas to more suitable locations. USFWS (2002) estimates that more than a billion dollars may be saved between 1983 and 2010 due to reduction of disaster relief and infrastructure construction costs.

3.3.3.3 Revise local zoning ordinances

Zoning is the division of a municipality or county into districts for the purpose of regulating land use. Usually defined on a map, the allowable uses within each zone are described in an official document, such as a zoning ordinance. Zoning is enacted for a variety of reasons, including preservation of areas that are environmentally sensitive or necessary to maintain environmental integrity (International City/County Management Association, 1979).

Within zoning ordinances, subdivision regulations govern the process by which individual lots are created out of larger tracts of land. Subdivision regulations are intended to ensure that subdivisions are appropriately related to their surroundings. General site design standards, such as preservation of environmentally sensitive areas, are one example of subdivision regulations (International City/County Management Association, 1979).

There are specific types of zoning ordinances that can be particularly useful in protecting water resources, including performance-based zoning, overlay zones, bonus or incentive zoning, large-lot zoning, agricultural protection zoning, watershed-based zoning, and urban growth boundaries. The following provides an overview of each of these types of zoning:

3.3.3.3.1 Performance-based zoning

In performance-based zoning, developers are allowed flexibility in planning and designing the development as long as they meet minimum requirements set by the local government. These minimum requirements vary based on the particular resource protection objectives of the community but might include limiting the amount of impervious surfaces or preserving sensitive features such as wetlands or steep slopes with high erosion potential. Developers can choose lot sizes, building types, site layouts, and other development characteristics as long as they meet the minimum criteria. Performance-based zoning offers protection of natural resources for the community and increased flexibility for the developer. It requires greater effort on the part of the local government, however, to carefully tailor the language of the ordinance to ensure that resources are adequately protected, and to carefully review development proposals to ensure that performance criteria are met.

Officials in Columbia, Missouri, were interested in developing a uniform policy to deal with storm water pollution (Tritto, 2000). This effort was initiated in response to a recent back-and-forth battle between a developer and the Columbia City Council. Officials are reviewing a report developed by Missouri University researchers that evaluated the environmental sensitivity of 13 watersheds in the Columbia area using 12 criteria focused on human health and environmental protection. The report recommended limits on the percentage of impervious surfaces for developments based on categories of watershed sensitivity. Developers would be allowed to exceed these limits only by taking additional steps to control storm water pollution through the use of management practices. The approach recommended in the report would provide a financial incentive for developers to direct high-density developments to less-sensitive watersheds because tougher standards on impervious areas and the costs of storm water controls would make it more expensive to develop in environmentally sensitive watersheds. City officials are also reviewing storm water management policies in other cities to develop uniform guidelines so that developers are better-informed about what is expected of them.

3.3.3.3.2 Overlay zones

Overlay zones superimpose additional restrictions on existing zoning categories to provide extra protection for a particular natural resource. For example, if a wetland or endangered species habitat crosses the boundaries of several development zones, an overlay zone can be established to limit development in areas that affect the wetland. Overlay zones can also be used to limit development in areas with highly permeable soils to protect an underground drinking water source from contamination. The overlay zones would maintain the general land use category, such as residential or commercial, but would require additional protection, such as greater limits on impervious area or special vegetation protection requirements.

3.3.3.3.3 Bonus or incentive zoning

Bonus or incentive zoning is another method to allow developers greater flexibility in return for preservation of open space and sensitive or environmentally significant features. With incentive zoning, a developer might be allowed to develop at a higher density than normally allowed if in return he or she preserves additional open space, creates a wetland, or reduces the site's overall impervious area with underground parking, transportation modifications, or innovative site layouts. The success of bonus or incentive zoning is highly dependent on an individual developer's perception of the economic benefits of additional density credits; therefore, this type of zoning cannot be relied upon to protect natural resources. However, bonus or incentive zoning can encourage voluntary and economically beneficial protection for open space and sensitive features.

3.3.3.3.4 Large-lot zoning

Large-lot zoning establishes a very low density of development; individual dwellings are built on lots of 5 acres or more. Large-lot zoning is most effective when lots are very large (5 to 20 acres) (Caraco et al., 1998). The purpose of large-lot zoning is to spread development thinly, thereby conserving a large proportion of open space on each lot and reducing impacts on water resources. This method can produce undesirable results, however, including

- Promoting sprawl;
- Fragmenting habitats with more extensive infrastructure and lawns;
- Increasing reliance on automobile transportation; and
- Excluding lower-income residents who cannot afford to purchase large parcels of land.

One approach to minimizing the negative impacts of large-lot zoning is to combine it with cluster zoning. In this way, a large area of open space can be protected, while accommodating new development in a more concentrated manner. Although used in many areas, large-lot zoning is not considered to be any more protective than other zoning tools.

3.3.3.3.5 Farmland preservation zoning

Farmland preservation ordinances are another type of measure to provide open space retention, habitat protection, and watershed protection. Farmland protection may be a less-costly means of controlling pollutant loadings than the implementation of urban runoff structural control practices. Much of the farmland currently being converted has soils that are stable and not highly erodible. Conversion of these farmlands often displaces farming activities to less-productive, more-erodible areas that may require increased nutrient and pesticide applications.

Many communities consider both agriculture and forestry to be an integral part of rural heritage and strive to preserve these industries and the open space associated with them. According to the 1997 National Resources Inventory, nearly 16 million acres of forest, cropland, and open space were converted to urban and other uses from 1992 to 1997. The average rate for those five years—3.2 million acres per year—is more than twice the conversion rate of 1.4 million acres per year recorded from 1982 to 1992 (USDA-NRCS, 2000).

Agricultural lands can be protected by implementing a modified large-lot zoning ordinance that makes residential development less economically attractive. Alternatively, a cluster development ordinance can be established that specifies a density for an agricultural development and also requires that dwellings be built on small lots, leaving the remainder of the site as agricultural open space. The ordinance can also specify that development must occur on the least-productive part of the lot so the richest soils can be reserved for cultivation.

Agricultural zoning ordinances can be combined with other initiatives to promote farming and forestry and to protect rural areas from being overtaken by urban sprawl (Sims, 2000b). The King County, Washington, executive official has undertaken several initiatives to promote diversity in lifestyle choices, encourage the continuation of farming and forestry, protect environmental quality and wildlife habitat, and maintain a link to the county's heritage by preserving rural areas. So far the county has reduced its development rate in rural areas from 15 percent in 1980 to 6 percent at present. The target is to further reduce the development rate to 4 percent. The county issued orders to close loopholes in subdivision and land segregation regulations, and it tightened subdivision requirements for rural lands. These efforts will ensure that new development is consistent with current environmental and development standards.

The county's initiatives include maintaining an agricultural district as an "unincorporated urban area" to permanently protect this area from development pressures, establishing the Puget Sound Fresh program to promote locally grown and produced products, establishing a Farm Link program to connect farmers with land to sell or lease with those wishing to farm, and providing improved services for rural community centers. The county also established a Rural Forest Commission to encourage forestry and maintain the forest land base in the county's rural areas. The county implemented a Farmlands Preservation Program, which has preserved 12,793 acres of agricultural lands through purchase or donation of development rights. Additionally, the county is able to preserve hundreds more acres of rural land each year through incentive-based taxation programs. Finally, King County's 2000 Comprehensive Plan includes the following goals and initiatives:

- Ensure that zoning complies with goals to reduce the rate of growth and protect the environment;
- Ensure that the types and scale of development in the rural area blend with traditional rural development;
- Implement recommendations from the forest commission to bolster King County's forest and farming economies; and
- Consider alternative uses of agricultural land, such as for wetland mitigation or recreation, such that these uses will not harm the integrity of agriculture in the county.

More information about King County's growth management initiatives can be found on the SmartGrowth Rural Legacy Web site at http://www.metrokc.gov/smartgrowth/rural.htm.

3.3.3.3.6 Watershed-based zoning

Historically, zoning has been used to establish limits on building density and to separate uses believed to be inherently incompatible (Arendt, 1997). Watershed-based zoning, in contrast, uses watershed and subwatershed boundaries as the basis for making land use decisions. Typically, zoning objectives focus on maintaining or reducing impervious cover in sensitive subwatersheds and redirecting development to subwatersheds that are better able to absorb their influence (Caraco et al., 1998).

Local, state, and federal officials recently approved the Riverside County (California) Plan, which involved multi-agency cooperation in identifying where development may occur and where land should be preserved (Verden, 2000). Over the next 50 years, the Riverside County Plan will serve as a blueprint for building new roads, shopping centers, and homes, while also preserving rapidly disappearing habitat. The plan is designed to avoid costly delays and confrontations between regulators and developers. With the population of Riverside County expected to double in 20 years, the plan will help developers accommodate growth while it also protects rare plants and animals. State and federal land, transportation, and wildlife managers hope the Riverside County Plan will be a model for other communities struggling to balance development and preservation.

In 1992 Maryland enacted the Economic Growth, Resource Protection, and Planning Act to organize and direct comprehensive planning, regulating, and funding by state, county, and municipal governments in furtherance of a specific economic growth and resource protection policy (Maryland Department of Planning, no date). The policy is organized around seven statutory vision statements that must be pursued in county and municipal comprehensive plans where priorities for land use, economic growth, and resource protection are established. The seven statutory vision statements are:

- Development is concentrated in suitable areas.
- Sensitive areas are protected.
- In rural areas, growth is directed to existing population centers and resource areas are protected.
- Stewardship of the Chesapeake Bay and the land is a universal ethic.
- Conservation of resources, including a reduction in resource consumption, is practiced.
- To assure the achievement of the above, economic growth is encouraged and regulatory mechanisms are streamlined.
- Funding mechanisms are addressed to achieve these visions.

The visions must also be followed by the state in undertaking its various programs. Both state and local funding decisions on public construction projects must adhere to the visions. The Act also established an Economic Growth, Resource Protection, and Planning Commission to oversee, study, and report on progress towards implementation of the visions. More information about the act can be found at http://www.mdp.state.md.us/planningact.htm.

3.3.3.3.7 Urban growth boundaries

Urban growth boundaries are lines drawn around metropolitan areas to delineate where urban development can take place (inside the boundary) and where it may not (outside the boundary). Outside of urban growth boundaries, land use is restricted to agriculture, forestry, and open space (Nelson and Moore, 1993). The boundaries encourage more compact (i.e., infill) development, control urban sprawl, and help protect rural heritage. The approval process for new development can be streamlined within the growth boundary to further encourage development in these areas.

The duration or lifespan of growth boundaries is normally related to planning periods or cycles, typically 10 to 20 years. Boundaries should be examined at regular planning intervals, however, to assess whether conditions have changed since they were established.

Establishing the location of urban growth boundaries sometimes requires complex decision-making. Officials should be reasonably sure that there is sufficient land within the boundary to meet projected growth over the planning period and that public facilities and services can be provided at reasonable cost in a timely fashion. The potential impact of growth within the boundary on existing natural resources also needs to be determined. In the context of watershed planning, it is advantageous to use watershed boundaries or other natural features as urban growth boundaries. In this manner, key or sensitive watersheds can be protected from the impacts of development.

In Arizona, the 1998 Growing Smarter Act and its 2000 addendum, Growing Smarter Plus, were signed into law by Governor Jane Hull (Morrison, 2000). This legislation addresses the issue of development by strengthening the ability of communities in Arizona to plan for growth and to acquire and preserve open space. The Growing Smarter legislation requires communities to address growth and growth-related pressures by mandating general plans that identify growth areas, establish policies and strategies for new growth, identify open space needs, regionally plan for interconnected open space, and analyze the environmental impacts of the development anticipated by the general plan (City of Tucson, no date).

3.3.3.4 Establish limits on impervious surfaces, encourage open space, and promote cluster development

As described earlier, urban runoff contains high concentrations of pollutants washed off impervious surfaces (roadways, parking lots, loading docks, etc.). By retaining the greatest area of pervious surface and maximizing open space, nonpoint source pollution due to runoff from impervious surfaces can be kept to a minimum. Refer to section 4.3.2 for a detailed discussion of site design practices to reduce impervious surfaces in new developments.

The following are examples of successful implementation of open space requirements and cluster development:

- Brunswick, Maine, recently adopted an allowable impervious area threshold of 5 percent of any site to be developed in the defined coastal protection zone. The remaining 95 percent is required to be left natural or landscaped. The threshold was developed and adopted using a $28,000 grant.

- Virginia provides general guidance with regard to minimum open space and maximum impervious areas to local governments within the Chesapeake Bay watershed. While specific requirements are not associated with the guidance, local plans are required to contain criteria and must be approved by the Chesapeake Bay Local Assistance Board.

- Carroll County, Maryland, is a community with substantial farmland and open space. Because it is located close to both Baltimore and Washington, DC, the county amended its zoning ordinance to encourage cluster development and preserve open space. This and land protection efforts by Carroll County have resulted in protection of 33,000 acres by agricultural easements (Maryland Environmental Trust Land Conservation Center, 2002).

- Maryland adopted the Forest Conservation Act of 1991, which requires all public agencies and private landowners submitting a subdivision plan or application for a sediment control permit for an area greater than 40,000 square feet to develop a plan for retention of existing forest cover on-site. The act allows clearing that is essential to site development, and it established a forest conservation fund for reforestation projects. In the first five years of implementation, the Forest Conservation Act has produced 22,508 acres of retained forest and 4,313 planted acres, while 12,210 acres of existing forest have been cleared (Honeczy, 2000).

- Broward County, Florida, has an open space program and encourages cluster development to reduce impervious surface area, protect water quality, and enhance aquifer recharge (Broward County, Florida, 1990).

- New Hampshire has a model shoreland protection ordinance that encourages grouping of residential units, provided a minimum of 50 percent of the total parcel remains as open space.

One way to increase open space while allowing reasonable development of land is to encourage cluster development. Clustering entails decreasing the allowable lot size while maintaining the number of allowable units on a site. Such policies provide planners the flexibility to site buildings on more suitable areas of the property and leave environmentally sensitive areas, such as wetlands or steep slopes, undeveloped. Criteria can vary. Advantages of cluster development include:

- Reducing the costs of infrastructure;
- Preserving sensitive areas;
- Increasing property values with proximity to open space; and
- Preserving ecological, aesthetic, and recreational values.

Planned unit development is a type of zoning that encourages the use of cluster development but does not require it. For example, a set number of units could be spread across the site under typical residential zoning, but under cluster zoning, the same number of units could be concentrated on smaller lots on only a portion of the site, preserving the other portion for common open space to protect sensitive features or for use as a recreation area.

3.3.3.5 Revitalize existing developed areas

Redeveloping existing areas can alleviate water quality impacts by reducing the strain of development on open space land and minimizing the amount of impervious surface added to the watershed. Existing impervious surfaces, such as declining shopping malls and retail centers, can provide large tracts of developable land and are a prime opportunity for mixed-use infill development. For additional discussion of options for revitalizing urban areas, see Management Measure 10—Existing Development.

3.3.3.6 Establish setback (buffer zone) standards

In coastal areas, setbacks or buffer zones adjacent to surface water bodies, such as rivers, estuaries, or wetlands, provide a transition between upland development and these water bodies. The use of setbacks or buffer zones may prevent direct flow of urban runoff from impervious areas into adjoining surface waters and provide pollutant removal, sediment attenuation, and infiltration. Riparian forest buffers function as filters to remove sediment and attached pollutants, as transformers that alter the chemical composition of compounds, as sinks that store nutrients for an extended period of time, and as a source of energy for aquatic life (USEPA, 1992). Setbacks or buffer zones are commonly used to protect coastal vegetation and wildlife corridors, reduce exposure to flood hazards, and protect surface waters by reducing and cleansing urban runoff (Mantel et al., 1990). The types of development allowed in these areas are usually limited to non-habitable structures and those necessary to allow reasonable use of the property, such as docks and unenclosed gazebos.

Factors for delineating setbacks and buffer zones vary with location and environment and include:

- Seasonal water levels;
- Nature and extent of wetlands and floodplains;
- Steepness of adjacent topography;
- Type of riparian vegetation;
- Quantity and velocity of runoff entering the buffer;
- Soil types and infiltration capacity;
- Density of development adjacent to the riparian corridor; and
- Wildlife values.

It is important that sheet flow, not concentrated flow, be directed to the buffer. High-velocity runoff from steeply sloped or highly impervious areas can promote excessive erosion and decreased pollutant removal. A flat, grassy area or a level spreader can be installed at the upland part of the buffer to slow the velocity of runoff and promote sheet flow. It is also important to consider that the pollutant removal capacity of a buffer is finite and can be exceeded in areas with high concentrations of pollutants in runoff.

Buffer width is an important measure of pollutant removal effectiveness. Buffers typically range from 20 to 200 feet wide and should include the 100-year floodplain, riparian areas including adjacent wetlands, steep slopes, or critical habitat areas (Schueler, 1995). A buffer at least 100 feet wide is recommended for water quality protection, and a 300-foot buffer is recommended to maintain a wildlife habitat corridor. Wider buffers offer increased detention times, infiltration rates, and diversity of soil, vegetation, and wildlife.

According to Herson-Jones et al. (1995), forested buffers achieve 50 percent TSS removal; 23 to 96 percent phosphorus removal depending on the extent of TSS removal; greater than 40 percent lead removal; more than 60 percent copper, zinc, aluminum, and iron removal; and more than 70 percent oil and grease removal.

Overall, aquatic buffers are highly effective at removing particulate pollutants, but less effective in removing soluble pollutants (such as nitrogen, for which documented removal rates range from -15 to 99 percent). Proper siting and design and regular maintenance enhance removal efficiency.

In general, EPA recommends that no habitat-disturbing activities should occur within tidal or non-tidal wetlands. In addition, a buffer area should be adequate to protect the identified wetland values. Minimum widths for buffers should be 50 feet for low-order headwater streams, with expansion to as much as 200 feet or more for larger streams. In coastal areas, a 100-foot minimum buffer of natural vegetation landward from the mean high tide line helps to remove or reduce sediment, nutrients, and toxic substances entering surface waters.

3.3.3.6.1 Buffer ordinance

Buffer ordinances provide guidelines for buffer creation and maintenance. They should include the following provisions:

- Buffer boundaries to be clearly marked on local planning maps;
- Maintenance language that restricts vegetation and soil disturbance;
- Tables that illustrate buffer width adjustment by percent slope and type of stream; and
- Direction on allowable uses and public education.

A model ordinance and examples of buffer ordinances from across the country can be found at http://www.epa.gov/owow/nps/ordinance. Buffer ordinances and other water resource-related ordinances are also described in section 1.3.1.2.

The following are examples of setback or buffer requirements:

- Town commissioners in Apex and Cary, North Carolina, have agreed to set wider buffers between development and streams (Price, 2000). Under the new ordinance, buffers must be at least 50 feet wide along intermittent streams and must average 100 feet wide along perennial streams. The towns chose to use an average rather than a strict 100-foot minimum to allow landowners flexibility. In addition to the buffer ordinance, Apex and Cary halved the limit of impervious surfaces on a given tract of land over which retention ponds are required to control runoff (from 24 percent to 12 percent). Town officials will hold a public hearing to vote on the new regulations.

- Monroe County, Florida, requires a setback of 20 feet from high water on man-made or lawfully altered shorelines for all enclosed structures and 50 feet from the landward extent of mangroves or mean high tide line for natural water bodies with unaltered shorelines (Monroe County, Florida, Code, Section 9.5-286).

- Brunswick, Maine requires a buffer of 125 to 300 feet from mean high water within the Coastal Protection Zone (Section 315 of the Brunswick Zoning Ordinance), depending on the slope of the buffer, as designated on the town's land use map.

- Queen Anne's County, Maryland, established a standard shore buffer of 300 feet from the edge of tidal water or wetland, 50 percent of which must be forested.

- Maryland's Critical Area Act requires the establishment of a minimum buffer of 100 feet of natural vegetation landward from the mean high-water line of tidal waters or the edge of tidal wetlands and tributary streams. Unless a property owner can demonstrate unwarranted hardship and prove no negative impact to water quality, plant, fish or wildlife habitat, the local jurisdiction will not permit disturbance or new development within the buffer except for access or water-dependent facilities. Any clearing that occurs for access or water-dependent facilities must be mitigated through a buffer management plan approved by the local jurisdiction (Critical Area Commission for the Chesapeake and Atlantic Coastal Bays, no date).

3.3.3.6.2 Vegetative and use strategies within management zones

Buffers can be divided into three zones—the streamside, middle, and upland zones (Herson-Jones et al., 1995). Dense vegetation in the streamside zone (recommended to be approximately 25 feet wide) prevents excessive activity in this sensitive area, maintains the physical integrity of the stream, and provides shade, litter, debris, and erosion protection. The width of a grassed or mostly forested middle zone (minimum of 50 feet) depends on the size of the stream and its floodplain and the location of protected areas such as wetlands or steep slopes. The upland zone, typically 25 feet wide, is an additional setback from the buffer and usually consists of lawn or turf. Zones in the buffer should be delineated to determine the types of vegetation that should be maintained or established.

Allowable land uses in the three zones vary. The streamside zone is limited to footpaths, runoff channels, and utility or roadway crossings. The middle zone may be used for recreation and runoff control practices. The upland zone may be used for many purposes, with the exception of septic systems, permanent structures, or impervious covers. A depression incorporated into the design of the upland zone can detain runoff during storms. This runoff is released slowly to the middle zone as sheet flow, which is then transferred to the dense streamside zone, designed to have minimal to no discharge of surface water to the stream.

3.3.3.6.3 Provisions for buffer crossings

Stream crossings should minimize impacts on buffer integrity while providing crossing points for linear forms of development such as roads, bridges, golf course fairways, underground utilities, enclosed storm drains, and outfall channels (Schueler, 1995). They should also be designed to provide fish passage and to withstand overbank flows from the 100-year storm event. Design considerations for buffer crossings include: minimizing the width of the crossing; orienting the crossing at a right angle to the stream; limiting the total number of crossings; ensuring that outfalls discharge at the invert elevation of the stream channel; and burying utility crossings at least 3 feet below the channel's invert elevation. An outfall should not be placed directly in the main channel. Energy-dissipating devices can be installed in outfalls to protect the streambed and adjacent banks.

3.3.3.6.4 Integration of structural runoff management practices where appropriate

Depressions can be incorporated into the upland part of a stream buffer to provide runoff detention during storms and to promote sheet flow over the middle zone of the buffer. A flat, grassed area or level spreader can also be used in the upland part of the buffer to create sheet flow and to promote infiltration over the rest of the buffer.

Storm water ponds and wetlands can be located inside or outside the buffer. According to Schueler (1995), ponds inside the buffer should be used only for runoff quantity control. Although ponds in the buffer treat the greatest possible drainage area, are more likely to maintain their water level during dry periods, provide a diversity of aquatic habitats, and can increase the total width of the buffer, they displace vegetation and might cause barriers to fish migration, modification of existing wetlands, and stream warming.

3.3.3.6.5 Development of buffer education and awareness programs

Buffer education efforts should foster community awareness and encourage stewardship. These objectives can be met by posting signs along the buffer boundaries that describe allowable activities in different parts of the buffer. Buffer owners can be educated by distributing pamphlets, hosting stream walks, and holding meetings. New owners should be made aware of buffer limits and allowable uses when the property is transferred. Buffer stewardship can be encouraged through reforestation and "bufferscaping" programs. Annual inspections can be done with "buffer walks" to determine the extent of encroachment, devegetation, erosion, or excessive sediment deposition.

3.3.3.7 Establish slope restrictions

Slope restrictions can be effective tools to control erosion and sediment transport. Erosion rates depend on several site-specific factors including soil type, vegetative cover, and rainfall intensity. In general, as slope increases, there is a corresponding increase in runoff water velocity, which may result in increased erosion and sediment transport to surface waters (Dunn and Leopold, 1978).

3.3.3.8 Promote urban forestry

Urban forestry is an effective tool for protecting watersheds because it can provide some of the storm water management required in urban areas. Trees decrease runoff by intercepting rain and promoting infiltration. This reduces the peak runoff flow and the total runoff volume that communities must manage, which can be financially beneficial to communities that have to build and maintain sewer and drainage systems (ENN, 2001). Also, trees provide shade, which lowers the temperature of urban heat islands and runoff. Erosion and leaf litter in forested areas can contribute sediment and nutrients to receiving waters; therefore, an effort should be made to establish and maintain stable vegetation and to keep leaf litter on-site.

Several organizations dedicated to promoting urban forestry can provide information and other resources to interested groups or individuals. For example, American Forests (http://www.americanforests.org) is a conservation organization that is working to improve the environment with trees and forests. The organization's Urban Forest Center offers tools to measure the environmental benefits of trees, such as pollution reduction and storm water management. These tools include the Regional Ecosystem Analysis (REA) and CITYgreen software packages. REA uses a combination of satellite data, field surveys, CITYgreen software, and other GIS technology to measure a region's or city's tree canopy and calculate its dollar value. CITYgreen allows users to compare the economic benefits of various planning scenarios by testing landscape ordinances, evaluating site plans, and modeling development scenarios that capture the benefits of trees. An application of this tool in Fayetteville, Arkansas, found that increasing the city's tree cover from 27 to 40 percent could result in cost savings from runoff reduction of up to $135 million (NALGEP, 2003). Information about the software is available at http://www.americanforests.org/productsandpubs/citygreen/.

TreePeople is another forestry organization. It works with the U.S. Forest Service and has enlisted the help of thousands of students and volunteers to plant seedlings in the mountains around Southern California. Its mission is to inspire people to take responsibility for improving their immediate environment. Information about TreePeople is available at http://www.treepeople.org/.

Houston's Urban Forests

American Forests conducted a study of a 3.2 million-acre area in Houston to document urban forest cover (ENN, 2001). They also analyzed 25 individual sites with aerial photography using CITYgreen to map and measure tree cover and to calculate the benefits of Houston's trees. Study results show that trees provide significant benefits in storm water runoff reduction, energy savings, and pollutant removal. The study found that Houston's tree cover reduces the need for storm water management by 2.4 billion cubic feet per peak storm event, saving $1.33 billion in one-time construction costs. As a result, American Forests made the following recommendations to the city of Houston:

- Improve green infrastructure by using tree cover data in land-use planning; growth management; and all transportation, public works, and development decision-making.
- Encourage the use of increased tree cover to met storm water needs.
- Work to increase tree cover in the metropolitan area.

3.3.3.9 Use site plan reviews and approval

A site plan review involves review of specific development proposals for consistency with the laws and regulations of the local government of jurisdiction. Potential development sites should be inspected to ensure that natural resources necessary for protecting surface water quality are preserved. Inspection ensures that the information presented in any application for development is accurate and that sensitive areas are noted for preservation. Inspections should also be conducted during and after development to ensure compliance with development conditions. Depending on the size of the local government and the amount of new development, this inspection could be incorporated into the duties of existing staff at minimal additional cost to the local government, or the inspection could require the addition of staff to conduct onsite inspections and monitoring. The effectiveness of such a program depends on the ability of the inspectors to evaluate property for its natural resource value and the practices used to protect areas necessary for the preservation of water quality.

Development approvals should contain conditions requiring maintenance of the area's environmental integrity and prevention of degradation from nonpoint source pollution, consistent with the goals, objectives, and policies of the comprehensive program and the requirements of the land development regulations. The criteria for new development are outlined as part of a development permit. Examples include the following:

- Areas for preservation or mitigation may be identified, similar to the Fairfax County Environmental Quality Corridor System (see section 3.3.2).

- The use of nonstructural and structural management practices described in this chapter for controlling nonpoint source pollution may be a condition of development approval.
- Setbacks and limits on impervious areas may be clearly defined in a condition for development approval, as is being done in the programs discussed above.
- Reduction in the use of pesticides and fertilizers on landscaped areas by encouraging the use of vegetation that is adaptable to the environment and requires minimal maintenance. (Xeriscaping techniques are described in Management Measure 4 and lawn and garden activities are described in Management Measure 9.)

3.3.3.10 Designate an entity or individual responsible for maintaining the infrastructure, including urban runoff management systems

The responsible party should be trained in the maintenance and management of urban runoff management systems. If desired, the local government could be designated to maintain urban runoff systems, with financial compensation from the developer. Because they are not usually trained in infrastructure maintenance, homeowners groups are not the best entity for monitoring infrastructure for adequacy, especially urban runoff management systems. This responsibility should belong to a responsible party that understands the complexity of urban runoff management systems, can determine when such systems are not functioning properly, and has the resources to correct the problem. Again, this is a duty that the local government can assume, with either existing staff or additional staff, depending on the size of the local government and the amount of new development occurring. The amount of funding needed depends on the size of the local government.

3.3.3.11 Use official mapping

Official maps can be used to designate and/or protect environmentally sensitive areas, zoning districts, identified land uses, or other areas that provide water quality benefits. When approved by the local governing body, these maps can be used as legal instruments to make land use decisions related to nonpoint source pollution.

3.3.3.12 Require environmental impact assessment statements

To evaluate the impact that proposed development may have on the natural resources of an area, some counties and municipalities require an environmental assessment as part of the development approval processes. These assessments can be incorporated into the land development regulation process. Areas to be covered include geology, slopes, vegetation, historical features, wildlife, and infrastructure needs (International City/County Management Association, 1979).

3.3.4 Cost of Planning Programs

The cost of planning programs depends on a variety of factors, including the level of effort needed to complete and implement a program. Many of the practices described in this section can be incorporated into ongoing activities of a state or local government.

The Florida legislature funded the development of comprehensive programs and land development regulations required by the Local Government Comprehensive Planning and Land Development Regulation Act (1985). Distribution of funds was based on population according to formulas used for determining funding for the plan and land development regulations. A base amount was given to all counties that requested it. The balance of the monies was allocated to each county in an amount proportionate to its share of the total unincorporated population of all the counties. A similar distribution process was used for local governments. A total of $2.1 million was allocated for plan development; however, not all components of the plans address nonpoint source issues.

The effect of planning programs depends on many variables, including implementation of programs and monitoring of conformance with conditions of development approval.

3.3.5 Land or Development Rights Acquisition Practices

An effective way to preserve land necessary for protecting the environmental integrity of an area is to acquire it outright or to limit development rights. Land conservation includes more than simply preserving land in its current state. It also means taking responsibility for restoration of areas of the property that might already have been affected by urban runoff. Stewardship activities for land conservation might include:

- Resource monitoring
- General maintenance
- Control of exotic species
- Installation of structural runoff management practices

A government agency or a nonprofit organization, such as a land trust, often has a greater capacity to take on the responsibility of stewardship than do private owners. Consequently, many of the practices discussed below focus on how conservation lands, or at least property rights to those lands, can be transferred to such entities. In many instances, however, private owners successfully accomplish stewardship without any formal or binding relationship with a public or private conservation agency or organization.

Several organizations provide educational materials and training to help landowners learn to manage conservation areas for the benefit of water quality, wildlife, and other purposes. For example, the Land Trust Alliance, an organization that "promotes voluntary land conservation and strengthens the land trust movement by providing the leadership, information, skills, and resources land trusts need to conserve land for the benefit of communities and natural systems," has compiled a list of links to local land trust organizations. This list can be accessed at http://www.lta.org/resources/links (Land Trust Alliance, 2001). Other information on land conservation policy, news, success stories, training opportunities, and technical guidance is provided on the Land Trust Alliance's Web site at http://www.lta.org.

Additionally, The Conservation Fund Web site, at http://www.conservationfund.org, provides information on land acquisition, community initiatives, leadership training, and sustainable conservation solutions emphasizing the integration of economic and environmental goals.

Another resource is the Natural Lands Trust whose Web site, at http://www.natlands.org, provides information and resources pertaining to land preservation and land use planning.

The practices described below can be used to protect beneficial uses.

3.3.5.1 Fee simple acquisition/conservation easements

The most direct way to protect land for preservation purposes and associated nonpoint source control functions is fee simple acquisition, through either purchase or donation. Once a suitable area is identified for preservation, the area may be acquired along with the development rights. The more development rights that are associated with a piece of property, the more expensive it will be. Many state and local governments and private organizations have programs for purchasing land.

Conservation easements are legal restrictions on the present and future use of land. For preservation purposes, the easement holder, who is usually not the owner of the property, is able to control the rights of the property when the landowner might adversely impact resources on the property. In effect, the property owner gives up development rights within the easement while retaining fee ownership of the property (Mantel et al., 1990; Barrett and Livermore, 1983). The agreement between the easement holder and property owner is permanent, legally enforceable, and not subject to alteration unless permission is received in writing by the easement holder and all other cosigners (Arendt, 1997).

A conservation easement is a flexible tool that can be customized to set different levels of restrictions among different types of conservation areas in a parcel. In addition to protecting and maintaining environmental benefits in perpetuity, landowners who donate conservation easements to a government agency or nonprofit group typically realize substantial income, property, and estate tax benefits resulting from the charitable donations. Their property value might be lowered, however, because the development rights were removed. Consequently, tax and estate planning professionals need to be consulted when a conservation easement is being contemplated.

As an alternative, agricultural and forestry easements are specific types of conservation easements that allow continued use of land as farms or forests and prevent the land from being sold for commercial or residential development. The USDA Natural Resource Conservation Service currently manages the Farm and Ranch Lands Protection Program (FRPP), a voluntary program that provides matching funds to state, tribal, or local governments and non-governmental organizations with existing farm and ranch land protection programs to purchase conservation easements. FRPP is reauthorized in the Farm Security and Rural Investment Act of 2002, also known as the Farm Bill (NRCS, 2003).

3.3.5.2 Leases, deed restrictions, and covenants

Even though government agencies, land trusts, and other nonprofit organizations would prefer that conservation lands be acquired by donation or that conservation easements be placed on the property, some lands hold so much value as conservation areas that leasing is worth the expense and effort. Leasing a property allows the agency, trust, or organization to actively manage the land for conservation.

Deed restrictions are included in deeds for the purpose of constraining use of the land. In theory, deed restrictions are designed to perform functions similar to those of conservation easements. In practice, however, deed restrictions have proven to be much weaker substitutes because unlike conservation easements, they do not necessarily designate or convey oversight responsibilities to a particular agency or organization to enforce protection and maintenance provisions. Also, deed restrictions can be relatively easy to modify or vacate through litigation. Modifying or nullifying an easement is difficult, especially if tax benefits have already been realized. For these reasons, conservation easements are generally preferred over deed restrictions.

A covenant is similar to a deed restriction in that it restricts activities on a property, but it is in the form of a contract between the landowner and another party. The term *mutual covenants* is used to describe a situation where one or more nearby or adjacent landowners are contracted and covered by the same restrictions.

3.3.5.3 Transfer of development rights

The principle of transfer of development rights (TDR) is based on the concept that ownership of real property includes the ownership of a bundle of rights that goes with it. These rights may include densities granted by a certain use designation, environmental permits, zoning approvals, and others. Certain properties have a bigger bundle of rights than others, depending on what approvals have been received by the owner. The TDR system takes all or some of the rights on one piece of property and moves them to another parcel. The purpose of TDRs is to shift future development potential from an area that is determined to be unsuitable for development (sending site) to an area deemed more suitable (receiving site). The development potential can be measured in a variety of ways, including number of dwelling units, square footage, acres, or number of parking spaces. Most TDR systems require a legal restriction for future development on the sending site. TDR programs can be either fixed so that there are only a certain number of sending and receiving sites in an area, or flexible so that a sender and receiver can be matched as the situation allows (Mantel et al., 1990; Barrett and Livermore, 1983).

This system is useful for the preservation of those areas considered necessary for maintaining the quality of surface waters, in that development rights associated with the environmentally sensitive areas can be transferred to less-sensitive areas. There are several examples of TDR use in the United States. The more successful projects include preservation of the New Jersey Pine Barrens and the Santa Monica Mountains in California. For the TDR concept to work, receiving and sending sites should be identified and evaluated, a simple, flexible program should be developed, and the use of the program should be promoted and facilitated (Mantel et al., 1990).

In contrast to a conventional down-zoning approach, which withholds from landowners the value associated with the right to develop, TDR systems allow a landowner to be compensated for that value by developing at another site.

Most TDR systems require a legal restriction to ensure that future development will not occur on the "sending" site. Also, TDR programs can be fixed so that there are only a certain number of sending and receiving sites in an area, or they can be flexible so that a sender and receiver can be matched as the situation allows. The following are general steps for setting up a TDR program (Redman/Johnston Associates, 1997):

- *Provide education and outreach.* The public should be familiar with the overall objectives of the program. Landowners and developers also need to be educated on how they will be affected.
- *Conduct an analysis of market conditions.* A successful program requires a market for TDR transfers.
- *Identify and designate TDR "receiving areas."* Receiving areas should be capable of supporting growth. Factors include adequate land area, infrastructure, public services, and consideration of environmental constraints.
- *Identify and designate TDR "sending areas."* Sending areas should support preservation and protection goals. Specific areas should be delineated to the parcel level.
- *Determine the nature of program.* Programs can be voluntary or mandatory. If mandatory, sending areas should be down-zoned to control growth.
- *Determine development potential and allocate TDRs.* Compute current allowable densities in both receiving and sending areas, and then allocate TDRs from sending areas based on desired densities. For example, down-zoning from a yield of 1 lot per 5 acres to 1 lot per 25 acres equates to 4 TDRs.
- *Consider a TDR Bank.* A TDR bank buys, holds, and sells TDRs. The bank can be either a government organization or a quasi-governmental entity.

Transfer of Development Credits Pilot Program, King County, Washington

King County, Washington's Transfer of Development Credits (TDC) Pilot Program is a voluntary initiative that allows residential densities to be transferred from rural areas to urban areas better suited to absorb additional density (King County Office of Regional Policy and Planning, 2001). The following provisions were made:

- A $1.5 million TDC bank was established to purchase and sell density credits.
- $500,000 was appropriated for urban amenities to improve neighborhoods that will receive increased density.
- An extensive outreach effort has been launched to inform stakeholders about the program and identify potential receiving sites.
- The Rural Forest Commission has reviewed and approved sending site criteria to be used by the TDC bank.

The first successful TDC was finalized in 2000 (Sims, 2000a). Forest land totaling 313 acres was protected from development. The density credits were transferred to a developer to add 500,000 square feet of commercial space in the nearby city of Issaquah.

More information about this TDC is presented at ww.metrokc.gov/exec/news/2000/032800.htm. More information about the King County TDC Pilot Program can be obtained from the program's Web site at http://www.metrokc.gov/exec/orpp/tdc or by contacting Mark Sollitto at 206-205-0705.

– *Provide adequate resources.* A TDR program does not run itself. It needs staff and resources to administer and manage the program.

3.3.5.4 Purchase of development rights

In this process, the rights of development are purchased while the remaining rights remain with the fee title holder. Restrictions in the deed make it clear that the land cannot be developed based on the rights that have been purchased (Mantel et al., 1990).

Howard County, Maryland, has the goal of preserving 20,000 acres of farmland. Development rights are acquired in perpetuity with ¼th of 1 percent of the local land transfer tax used as funding. There is no cap on the percentage of assessed value that may be considered development value, and payment for development rights may be spread over 30 years to ease the capital gains tax burden on the landowner (Jenkins, 1991).

3.3.5.5 Land trusts

Land trusts may be established as publicly or privately sponsored nonprofit organizations with the goal of holding lands or conservation easements for the protection of habitat, water quality, recreation, or scenic value, or for agricultural preservation. A land trust may also pre-acquire properties that are conservation priorities if it enters the development market when government funds are not immediately available by securing bank funding with the government as guarantor (Jenkins, 1991).

3.3.5.6 Agricultural and forest districts

Agricultural or forest districting is an alternative to acquisition of land or development rights. Jurisdictions may choose to allow landowners to apply for designation of land as an agricultural or forest district. Tax benefits are received in exchange for a commitment to maintain the land in agriculture, forest, or open space.

Fairfax County, Virginia, taxes land designated as an agricultural or forest district based on the present use valuation rather than the usual potential use valuation. A commitment to agricultural or forestry activities must be shown, and sound land management practices must be used. The districts are established and renewed for eight-year periods (Jenkins, 1991).

3.3.5.7 Cost and effectiveness of land acquisition programs

The costs associated with land acquisition programs vary depending on the desired outcome. If land is to be purchased, the cost depend on the value of the land. An additional cost to be considered is the maintenance of the property once it is in public ownership. Easements and development rights are less expensive, and maintenance responsibility is retained by the owner. Depending on the size of the local government, implementation of these programs is usually part of the operating budget of the appropriate agency (planning department or parks and recreation department, for example).

The effectiveness of a land acquisition program is determined by the size of the parcel and the difference between predevelopment and potential postdevelopment pollutant loading rates. In addition, wetlands and riparian areas have been shown to reduce pollutant loadings. The acquisition and preservation of these areas can be extremely important to water quality protection and decrease the cost of implementing structural BMPs. However, the use of wetlands for urban runoff treatment, in general, should be discouraged. Where no other alternative exists, states and local governments can target upland areas for acquisition to minimize the impacts to and preserve the function of wetlands. One option for acquiring land is a public/private partnership. For example, Harford County, Maryland, has targeted areas for purchase of conservation easements. The county staff is working jointly with a local land trust to acquire conservation easements and to educate people in environmentally sound land-use practices. The estimated cost for the program is $60,000 per year (Jenkins, 1991). To aid in the establishment of two local land trusts, Anne Arundel County, Maryland, provided $350,000 in seed money for capital expenditures such as land and easement procurement. The county also gives staff assistance to volunteers; additional support comes from contributions of money or land, grants, and fundraisers (Jenkins 1991).

3.4 Information Resources

The Center for Watershed Protection's *Rapid Watershed Planning Handbook*, published in 1998, describes techniques communities can use to more effectively protect and restore water resources. This document is available for purchase from the Center for Watershed Protection's Web site (http://www.cwp.org).

The Chesapeake Bay Program's (1997) *Protecting Wetlands: Tools for Local Governments in the Chesapeake Bay Region* is available from the Chesapeake Bay Program's Web site at http://www.chesapeakebay.net.

The Conservation Fund's Web site, located at http://www.conservationfund.org, provides information on land acquisition, community initiatives, leadership training, and sustainable conservation solutions emphasizing the integration of economic and environmental goals.

Correll's (2000) Web site, entitled *Vegetated Stream Riparian Zones: Their Effects on Stream Nutrients, Sediments, and Toxic Substances*, presents an annotated and indexed bibliography of buffer strip literature. See http://www.unl.edu/nac/ripzone03.htm.

Eco-Compass (Island Press, 2000) is an information resource for urban sprawl issues. Developed by Island Press, Eco-Compass is an Internet guide to a wide range of environmental information, including ecosystems, communities, global change, and economics. The urban sprawl feature of Eco-Compass provides a summary of the major issues relating to sprawl as well as an examination of the lessons that can be learned from Atlanta, a city that has experienced tremendous growth in the past decade. The site also includes links to more than 50 of the best sprawl-related Web sites and publications. More information about Eco-Compass is available at http://www.islandpress.org/.

The Natural Lands Trust's 1997 publication, *Growing Greener: Putting Conservation into Local Codes,* is available from Natural Land Trust, 1031 Palmers Mill Road, Media, PA 19063; telephone 610-353-5587; e-mail planning@natlands.org. Other information and resources pertaining to land preservation and land use planning can be found at the Natural Lands Trust's Web site at http://www.natlands.org.

Schueler's (1995) manual, *Site Planning for Urban Stream Protection,* is available for download from the Center for Watershed Protection's Web site at http://www.cwp.org/SPSP/TOC.htm.

Based on the Local Government Commission's research of more than 150 "smart growth" zoning codes from across the nation, *Smart Growth Zoning Codes: A Resource Guide* will help planners design a zoning code that encourages the construction of walkable, mixed use neighborhoods and the revitalization of existing places. Each chapter analyzes a critical issue, such as design, streets, and parking, and highlights exemplary codes from across the country. The guidebook comes with a CD-ROM that contains copies of some of the best zoning codes in the United States and other resources. The guide is available for purchase ($25) from the LGC bookstore at http://www2.lgc.org/bookstore/detail.cfm?itemId=34.

The Smart Growth Network is a nationwide effort coordinated by EPA's Urban and Economic Development Division (International City/County Management Association, 2000). Through cooperative partnerships with a diverse network of organizations, EPA is working to encourage development that better serves the economic, environmental, and social needs of communities. The network provides a forum for information sharing, education, tool development and application, and collaboration on smart growth issues. Smart growth approaches focus on flexible zoning, preventive planning, intelligent management of natural resources and water quality, and implementation of treatment and control technologies at multiple scales from development sites to watershed planning. For more information about the Smart Growth Network, visit http://www.smartgrowth.org or contact ICMA—Smart Growth Network, 777 North Capitol St., NE, Suite 500, Washington, DC 20002-4201; telephone 202-962-3591; e-mail nsimon@icma.org.

The Mid-America Regional Council (MARC) initiated a project to raise awareness of the relationship between land development and transportation systems. In *Principles of Transit Supportive Development*, MARC (no date) presents alternative approaches to land development that encourage a more sustainable and balanced transportation system. The organization promotes community designs that enable citizens to walk, bike, ride transit, and drive from home to shops, schools, and services. For more information about the potential of transit supportive development, contact MARC at 816-474-4240 or visit their Web site at http://www.marc.org/transportation.

The Local Government Commission (http://www.lgc.org) is a nonprofit organization that provides peer networking opportunities, acts as an interface between city and county officials, and provides practical policy ideas for addressing serious environmental and social problems. The commission provides guidelines and resources for communities to improve their design, transportation, economic development, environment, energy, and waste prevention. A list of publications can be found at http://www2.lgc.org/bookstore/list.cfm?categoryId=1.

The Northeastern Illinois Planning Commission published *Model Stream and Wetland Protection Ordinance for the Creation of a Lowland Conservancy Overlay District: A Guide for Local Officials*, which can be ordered from its Web site at http://www.nipc.org/pubs-services/.

The National Association of Conservation Districts' Web site (http://www.nacdnet.org) contains a list of conservation districts across the country as well as conservation resources for districts, educators, and the public.

In July 2001 the National Governors' Association Center for Best Practices published *New Community Design to the Rescue: Fulfilling Another American Dream* (Hirschhorn and Souza, 2001), which provides alternatives to sprawl through "new community design." The book includes a checklist for local governments to evaluate communities and development projects for consistency with smart growth principles and provides examples of infill, suburban redevelopment, and greenfields projects that have successfully incorporated new community design principles. Innovative policies and actions taken by states to encourage new community design are also included. This publication can be purchased at the National Governors' Association Web site at http://www.nga.org or downloaded in PDF format at http://www.nga.org/cda/files/072001NCDFull.pdf.

"Protecting Water Resources with Smart Growth" is intended for audiences such as communities, local governments, state and regional planners already familiar with smart growth who are now seeking additional ideas on how to protect their water resources. The document is a compilation of 75 policies designed to protect water resources and implement smart growth. The majority of these policies (46) are oriented to the watershed, or regional level; the other 29 are targeted for specific development sites. The document is available for download in PDF format at http://www.epa.gov/smartgrowth/water_resource.htm.

Getting to Smart Growth: 100 Policies for Implementation was produced by the Smart Growth Network. The document highlights and describes techniques to help policymakers put smart growth principles into practice. The policies and guidelines, which have proven successful in communities across the U.S., range from formal legislative or regulatory efforts to informal approaches, plans, and programs. The primer describes 10 smart growth principles, specific policies for each principle, illustrations of their application in a community, and additional resources to aid communities in implementation. The document is available online in PDF format at http://www.smartgrowth.org/pdf/gettosg.pdf.

The concept of creating and maintaining an interconnected network of protected land and water, called "Green Infrastructure," is presented at http://www.greeninfrastructure.net. Green Infrastructure supports native species, maintains natural ecological processes, sustains air and water resources, and contributes to health and quality of life. This Web site, developed by The Conservation Fund with support from USDA Cooperative Forestry, contains information to aid in implementing a comprehensive conservation program and includes resources such as searchable profiles, training information, events, and references databases.

The Southeast Michigan Council of Governments (SEMCOG) published *Opportunities for Water Resource Protection in Local Plans, Ordinances and Programs: A Workbook for Local Governments*, which is a guide for local communities to protect water resources. The workbook provides checklists that guide users through the process of establishing a water resource protection program. It covers a wide range of topics, including land conservation, erosion and sediment control, public education, and pollution prevention. For each of these topics, case studies and checklists guide users through basic tools available for master planning, regulatory controls, and design standards. The document can be downloaded from http://www.semcog.org or ordered by calling 313-961-4266.

EPA's Green Communities Program encourages successful community-based environmental protection and sustainable community development. The Green Communities Assistance Kit provides technical assistance and training for planning green communities. Information about the Green Communities Program can be found at http://www.epa.gov/greenkit.

Other useful EPA publications:

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MANAGEMENT MEASURE 4
SITE DEVELOPMENT

4.1 Management Measure

Plan, design, and develop sites to:

- Maintain predevelopment site hydrology by using site design techniques that store, infiltrate, evaporate, or detain runoff;
- Protect areas that provide important water quality benefits or are particularly susceptible to erosion and sediment loss;
- Limit effective impervious area[a] by design and the use of management practices;
- Limit land disturbance activities, such as clearing and grading and cut-and-fill, to reduce erosion, sediment loss, and soil compaction; and
- Preserve natural drainage features and vegetation to the extent possible.

4.2 Management Measure Description and Selection

4.2.1 Description

The goals of this management measure are to reduce the generation of nonpoint source pollution, maintain predevelopment hydrology, and mitigate the impacts of urban runoff and associated pollutants from all site development, including activities associated with roads, highways, and bridges. Included in this section are management practices that can be applied during the site planning and review process to ensure that nonpoint source pollution and increases in the volume and rate of runoff are appropriately managed before, during, and after construction.

Although the goals of Management Measure 3 (watershed protection) are similar, this measure is intended to apply to individual sites at the catchment level (see Figure 1.3) rather than larger watersheds or regional drainage basins. The site development and watershed protection management measures are intended to complement each other and be used together within a comprehensive framework to control runoff and reduce nonpoint source pollution.

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[a] Effective impervious area is the portion of total impervious cover that is directly connected to the storm drain network (Sutherland, 1995). These surfaces usually include street surfaces and paved driveways and sidewalks connected to or immediately adjacent to them, parking lots, and rooftops that are hydraulically connected to the drainage network (e.g., downspouts run directly to gutters or driveways).

Programs designed to control increased runoff and nonpoint source pollution resulting from site development should include:

- Predevelopment planning and review processes to ensure watershed/subwatershed and site-level natural resource and performance goals are achieved;

- Guidance on assessing and designing sites to maintain predevelopment site hydrology;

- Appropriate pollution prevention practices to be incorporated into site development and use.

- Site plan review and conditional approval processes to ensure the preservation of environmentally sensitive areas and areas necessary for maintaining natural hydrology and water quality; and

- Requirements for erosion and sediment control plan review and approval prior to issuance of appropriate development permits.

In addition to the preceding provisions, the following objectives should be incorporated into the site development process:

- During site development, disturb only the smallest area necessary to perform current activities to reduce erosion and off-site transport of sediment.

- Avoid disturbance of unstable soils or soils particularly susceptible to erosion and sediment loss.

- Favor sites where development will conserve natural drainage areas and sensitive environmental features, and minimize erosion, sediment loss, and soil compaction.

- Revegetate the site as soon as possible after disturbance, preferably with native vegetation.

- Protect and retain existing vegetation to decrease concentrated flows, maintain site hydrology, and control erosion.

- Minimize imperviousness to the extent practicable.

- Develop and implement inspection and maintenance procedures to ensure that landscapes are maintained to avoid water quality impacts.

- Use natural hydrology as a design element, and avoid alteration, modification, or destruction of natural drainage features.

- Design sites to preserve vegetated or natural buffers adjacent to receiving waters.

- Reforest areas within the same watershed in proportion to the acreage cleared of trees.
- Use porous pavements for areas of infrequent use (see section 5.3.2.3 in Management Measure 5).

The use of site planning and evaluation can significantly reduce the size of controls required to retain runoff and sediment on-site. Long-term maintenance burdens can also be reduced. Good site planning can attenuate runoff from development and can improve the effectiveness of the conveyance and treatment components of an urban runoff management system (Anacostia Restoration Team, 1992).

4.2.2 Management Measure Selection

This management measure was selected because the practices associated with it have been shown to be effective in protecting natural drainage features, reducing runoff quantity, and improving runoff quality. Site evaluation and protection of features that promote infiltration, filtration, and on-site detention will protect receiving water quality, maintain baseflow in receiving waters, and prevent or reduce further degradation of stream channels. Development in and around urban areas is inevitable as population growth puts pressure on suburbs and rural areas. This management measure recommends standards for new development that reduce environmental damage caused by development.

4.3 Management Practices

Many of the management practices in this section are considered "better site design techniques," planning techniques that are intended to be used to guide the layout of new developments to reduce the total effective impervious area, conserve natural habitats, and better distribute and infiltrate runoff. All aspects of an individual site, including soil types, slopes, and the location of environmentally sensitive features such as wetlands, forests, and meadows, should be examined to identify areas that should be preserved or restored. Better site design techniques can be used to identify the most efficient building and infrastructure layouts. It can also be used to develop a comprehensive strategy to reduce the quantity of runoff leaving the site and minimize the amount of pollutants generated on-site.

There are many advantages to better site design. Environmentally friendly site designs are more likely to be accepted by local governments and the community, thereby speeding plan approval. Site designs that preserve community open space also reduce the burden on the local government to provide recreational areas. In addition, better site design techniques reduce the amount and cost of infrastructure, which also in turn reduce engineering and maintenance costs. For example, runoff storage requirements for a low-impact development neighborhood in Pierce County, Washington, were reduced by more than 75 percent and the cost was 20 percent less than for conventional designs. These cost savings resulted primarily from the reduced size of runoff detention structures and the elimination of catch basins and pipes (Zickler, 2002).

Low-impact development practices can provide substantial benefits in terms of reducing the occurrence of combined sewer overflows (CSOs). Temporarily storing runoff in urban areas can greatly reduce the peak flow into storm water systems and provide a cost-effective way to mitigate basement flooding and CSOs (USEPA, 1999). Two communities in Indiana successfully implemented street surface storage of runoff to reduce the occurrence of CSOs in a cost effective manner while also reducing peak flows to wastewater treatment plants. The distributed storage controls also offered some water quality benefits by temporarily detaining runoff during storms (USEPA, 1999).

From a marketing perspective, studies have shown that lots abutting forested or other open space are initially valued higher than lots with no adjacent open space, and over time they appreciate more than lots in conventional subdivisions (Arendt, 1996). For example, lots in an open space subdivision in Amherst, Massachusetts, experienced a 13 percent greater appreciation in value compared to a conventional development after 20 years, even though the lots in the conventional development were twice as large (Arendt, 1996).

From a quality-of-life standpoint, site designs that incorporate pedestrian paths and common open space foster a greater sense of community among residents. House lots are closer together, encouraging communication among neighbors. Additionally, common open space provides recreational opportunities that further encourage community interaction.

Finally, better site design offers environmental benefits, including protection of ecologically significant natural resources, reduction of runoff, and preservation of open space and wildlife habitat. Maintaining open space also increases the opportunity for alternative sewage and wastewater disposal and treatment practices such as land treatment, spray irrigation, and reclamation and reuse. In addition, the flexibility of better site design allows designers to site these wastewater treatment systems in the areas of the development best suited for them.

Overall, the practices presented in this management measure provide many advantages over conventional developments and can be implemented in most communities. In some cases, however, outdated development rules can discourage or prohibit some of these practices. Watershed managers should review the local building codes and regulations that govern new developments to determine whether better site design techniques are allowed or encouraged and work with the appropriate authorities to remove these impediments.

The second edition of the Bay Area Stormwater Management Agencies Association's *Start at the Source*, which was originally published in 1997, is an excellent resource on site design issues for watershed managers. This publication emphasizes the importance of considering runoff quality in the early stages of land planning and design. The new edition has been updated and expanded to include commercial, industrial, and institutional development, as well a technical section that provides more detailed information on the characteristics, applications, design criteria, maintenance, and economics of the practices discussed in the document. More information about ordering this publication when it becomes available is provided on the Bay Area Stormwater Management Agencies Association's Web site at http://www.basmaa.org/ (BASMAA, no date).

Pembroke Woods Subdivision, Emmittsburg, Maryland

Pembroke Woods is a 43-acre low impact development residential subdivision that the designers hail as the first subdivision designed and under construction using the *Low-Impact Development Design Strategies: An Integrated Design Approach* manual developed by Prince George's County, Maryland (2000a). The designers have identified significant cost savings for this development compared to the traditional development plan created in the 1990s. These include

- Eliminating the need for 2 storm water management ponds that had been envisioned in a prior concept plan for the site, yielding construction cost savings of $200,000.
- In place of those 2 storm water management ponds, 2.5 acres of undisturbed open space and wetlands were conserved, with cost savings realized in eliminating wetland mitigation costs.
- An additional 2 lots were created by revising the site plan, increasing the site yield from 68 to 70 lots and adding $90,000 to the project value.
- Approximately 3,000 linear feet of roads were converted from urban road to rural road, replacing curb & gutter with grass bioswales, yielding a savings of $60,000 in construction costs. Also, reducing the road with from 36 feet to 30 feet in the rural road section of the development reduced paving costs by 17 percent.

A brief project overview and contact information can be found at http://www.buckeyedevelopment.net/lowimpactdevelopment.htm.

4.3.1 Site Planning Practices

4.3.1.1 Select site designs that preserve or minimize impacts to predevelopment site hydrology and topography

Retaining the existing topography of a development site assists in maintaining natural drainage features and depressional storage areas that help infiltrate and attenuate flows and filter pollutants. Depressional storage areas, commonly found as ponded areas after storms or during the wet season, aid in reducing runoff volumes and trapping pollutants. To help preserve natural drainage, a developer can (Goldman et al., 1986):

- Construct buildings and parking areas on existing flat terrain;
- Locate buildings and roads along existing contours;
- Orient long buildings with the major portion parallel to contours;
- Stagger floor levels to adjust to gradient changes; and
- Fit the development to the topography.

4.3.1.2 Protect environmentally sensitive areas

Sites should be developed to avoid destroying wetlands, seeps, bogs, fens, springs, surface water bodies, and catchment areas that are important for sustaining the hydrology of the land. In addition, riparian buffers, both forested and covered with grasses, should be preserved to protect surface water bodies. Steep slopes and highly erodible areas need to be protected to avoid landslides and soil movement into water bodies.

The increase in storm water runoff that results from urban development can dramatically impact the ecology of wetlands and other areas by altering characteristics of hydrology, water quality, and soil (USEPA, 1996). Urban development can also result in ecological changes due to fragmentation and habitat destruction. If the development of a site changes runoff characteristics, measures should be taken to prevent negative impacts to wetlands and other features. For example, Pohlig Builders of Malvern, Pennsylvania, incorporated measures to protect wetlands into its building plan after homeowners opposed the construction of seven high-end homes adjacent to a wetland area. Pohlig designed a vegetative filter strip to buffer runoff from the homes and provide treatment before runoff reached the wetlands. The filter strip was designed to eventually grow into a wooded area to enhance aesthetics and benefit water quality. A level spreader was added to convert concentrated runoff to sheet flow that can be more effectively treated, and extra erosion and sediment control measures were used during construction. The total additional cost of these measures was $30,000 (NAHB, 2003).

4.3.1.3 Practice site fingerprinting

The total amount of disturbed area in a site can be reduced by "fingerprinting" development, i.e., placing development in the most environmentally sound locations on the site and minimizing the size of the disturbed area and ultimate development footprint. Fingerprinting places development away from environmentally sensitive areas (wetlands, steep slopes, etc.), future open spaces and restoration areas, areas with trees to be saved, and temporary and permanent vegetative forest buffer zones. At a subdivision or lot level, ground disturbance is confined to areas where structures, roads, and rights-of-way will exist after construction is complete. Other site-level fingerprinting practices include reducing paving and compaction of highly permeable soils, minimizing the size of construction easements and material storage areas, minimizing impervious areas in the site design, clearly demarcating the disturbance area, maintaining existing topography and drainage divide, and disconnecting impervious areas (Prince George's County, Maryland, Department of Environmental Resources, 2000a).

4.3.1.4 Use cluster development

Cluster development is used to concentrate development and construction activity on a limited portion of a site, leaving the remainder undisturbed. Figures 4.1 and 4.2 show schematics of a residential cluster development and a rural cluster development. Clustering allows the design of more effective urban runoff management systems and reduces overall site-level erosion and sediment impacts. It also provides a mechanism to preserve environmentally sensitive areas and reduce infrastructure such as wastewater treatment systems, roads, sidewalks, and parking areas.

In addition to its environmental benefits, clustering can result in cost savings for municipalities because clustering and infill development typically require less new infrastructure, such as urban runoff treatment systems. The imposition of density controls may preclude clustering. Although minimum lot size requirements are useful in some instances, such as farmland preservation (see

Management Measure 3), zoning ordinances should not preclude the implementation of clustered development as an alternative to.conventional suburban development.

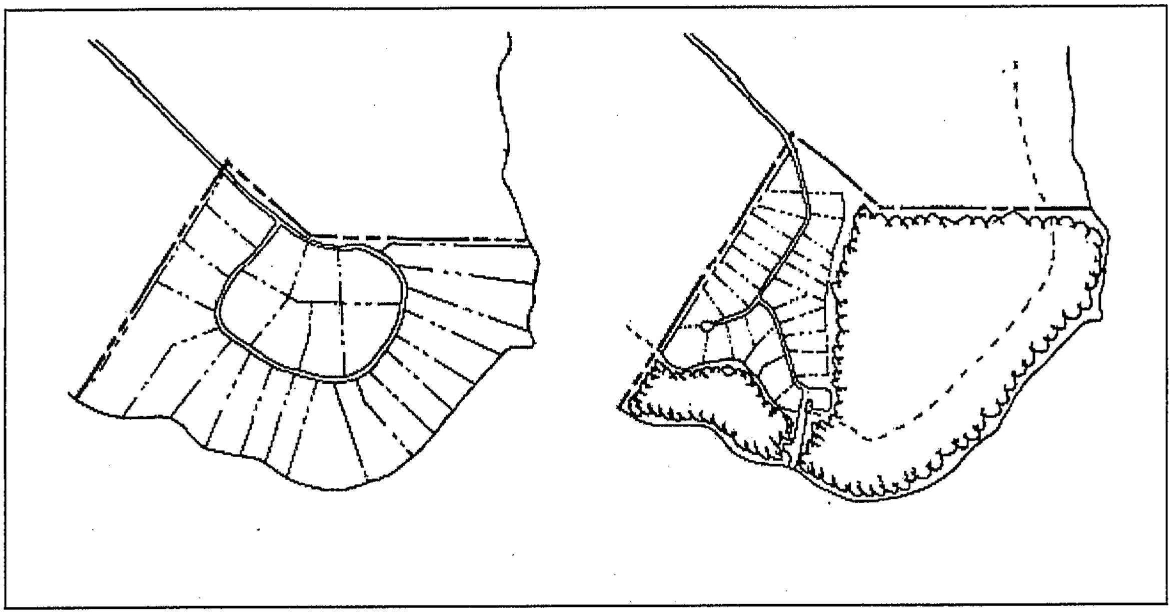

Figure 4.1: Schematic of a residential cluster development (Schueler, 1995).

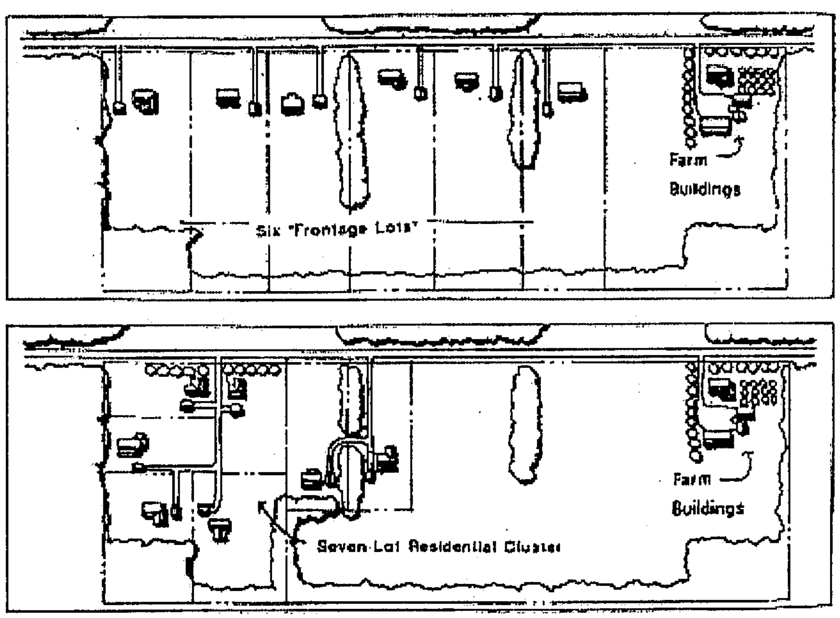

Figure 4.2: Schematic of a rural cluster development (Schueler, 1995).

4.3.1.5 Create open space

Open space development is a technique that concentrates development on one area of a site in exchange for open space in another area. Benefits associated with open space design include:

- A 40- to 60-percent reduction in impervious cover compared to conventional development designs;
- Increased property values;
- Reduced construction and development costs;
- Common recreational facilities (i.e., pedestrian paths, picnic areas, and athletic fields);
- Reduced infrastructure;
- Improved quality of life; and
- The use of community onsite/decentralized systems (see Nutrient Export case study below).

The following are some techniques for conserving open space:

- *By-right open space development.* This technique allows increased density on one portion of a site in exchange for open space on another portion. A large percentage of this open space can be dedicated as conservation land. To encourage open space development, municipalities can draft ordinances so that this is a "by-right" option, as opposed to a special exception or variance.
- *Density compensation.* This technique allows developers to increase housing density to offset potential housing lots lost to on-site buffers or other conservation lands.
- *Storm water credits*. Credit is given for implementation of source controls that reduce runoff volumes and pollutant concentrations before the remaining runoff reaches structural controls. Because performance is typically measured by comparing influent runoff to effluent runoff, storm water credits benefit operators of structural controls because credit for pollutant removal occurs before treatment.
- *Property tax credit.* The property tax credit is a technique for reducing, deferring, or exempting property taxes on conservation land. Typically, conservation easements are exchanged for the property tax credit.
- *Density bonus*. This bonus allows developers to increase density above base zoning density in exchange for conserving natural areas.
- *Off-site mitigation*. This term refers to the restoration or creation of wetlands in a designated off-site area if on-site wetlands are adversely affected and on-site mitigation is not feasible.

Randall Arendt (1996), in his book, *Conservation Design for Subdivisions: A Practical Guide for Creating Open Space Networks*, presents a plain-language, illustrated guide for designing open space subdivisions. This publication is available from Natural Lands Trust, Inc., 1031 Palmers Mill Road, Media, PA 19063; phone 610-353-5587. The following topics are covered:

- Open space vs. conventional developments;
- Economic, social, and environmental benefits of open space designs;
- Roles and responsibilities of stakeholders in site development;
- A stepwise approach to designing an open space subdivision (discussed below);
- Ideas for creating an interconnected open space network;
- Seven case studies;
- Methods to modify existing regulations to encourage open space design;
- Management techniques for conservation lands;
- Sample house plans for open space subdivisions;
- Sample advertisements for developers to capitalize on open space design benefits; and
- Model ordinance provisions.

Arendt's multi-step process for creating conservation subdivisions involves two stages. The first, called the background stage, involves identifying the characteristics of the surrounding landscape and existing development and analyzing and delineating significant features of the site. The second stage involves integrating the site's feature information into a map and prioritizing conservation lands based on the features deemed most important, while maintaining the quantity of land necessary to develop the site to the desired density.

The background stage involves examining the surrounding landscape and existing development to identify conservation areas. It includes the following practices:

(1) *Understanding the locational context.* The layout of new development should consider proximity to traditional small towns or villages; if existing development is nearby, the design of the new community should reflect and extend the historical streetscape and pattern. In rural areas located away from existing development, informal, irregular, "organic" layouts can be used successfully without detracting from the surrounding landscape.

(2) *Mapping natural, cultural, and historic features.* A thorough analysis of a site's special features that may enhance or constrain development is an important step in planning a new development. Special features might already have been identified in a natural resources inventory conducted by local government or land trust organizations. The site analysis should include site visits and identify the conservation areas described in this section.

    The following conservation areas are legally or logistically unbuildable and therefore must be avoided:

    - *Wetlands*. Tidal and non-tidal saltwater and freshwater wetlands and the dry upland buffers surrounding them should be identified as areas to be conserved because they filter runoff, provide critical habitat at the land-water interface, and offer opportunities for recreation and environmental education. Soil survey maps, National

Wetlands Inventory maps, state or environmental agency wetland maps, or on-site delineations can be used to determine the extent of wetland habitat on the site.

- *Floodplains*. The 100-year floodplain, which can be determined from floodplain maps published by the Federal Emergency Management Agency (FEMA) (see Management Measure 2), should be left undeveloped to preserve a continuous riparian greenway and to prevent damage to property from flooding. To preserve views of the water on wooded sites, lower tree limbs can be removed. (This may be a reasonable alternative to developing closer to the water's edge.) Zoning requirements might dictate an additional 50- to 100-foot setback from the 100-year floodplain.

- *Slopes*. Slopes of more than 25 percent should not be developed because of their high potential for erosion. Slopes between 15 and 20 percent can be developed using special site planning but should be avoided when possible. Slope maps can be prepared from USGS topographic maps by an engineer, planner, or landscape architect, but site visits should confirm these conditions.

The following conservation areas typically are legally buildable but are historically or ecologically significant or desirable, and therefore they should be avoided when other land is available for development.

- *Soils*. Soil surveys, whether they are based on existing maps produced by NRCS or data gleaned from on-site testing, identify well-drained soils suitable for treating wastewater, poorly drained soils that might result in leaky basements or wetland conditions, and steep or stony soils that would be difficult to build on. Existing soil survey data might not be detailed enough to characterize site conditions, depending on the spatial variability of soil types in the region. High-intensity soil surveys and site surveys that are accurate to 0.1 acre should be used in highly variable circumstances.

- *Significant wildlife habitats*. Habitat for threatened or endangered wildlife, including travel corridors to food sources, homes, and breeding grounds, should be conserved. An additional buffer of open space is recommended. These habitat locations might have been officially documented already by state or local agencies. Habitat for wildlife species that are not threatened or endangered should also be considered for conservation areas where possible. Continuity in habitat areas is important; land that connects two isolated habitat areas provides a valuable corridor that extends the usable habitat for the species of concern.

- *Woodlands*. Woodlands often provide valuable wildlife habitat and contribute to the aesthetic value of a property. Where areas are mostly forested and clearing is required for site development, however, areas of mature forest or areas with unique species composition should be of higher conservation priority. In areas where woodland is not the predominant land use, as much of the existing tree cover as possible should be conserved on the property. An effort should be made to maintain corridors that connect forested areas to provide as much continuous forested habitat as possible.

- *Farmland.* Agricultural lands can be conserved as open space if desired, although relatively small fields might not be lucrative and could pose a more significant water quality risk compared to residential development due to specific land management practices (tilling, fertilizer application) associated with agriculture. Another option for agricultural fields is to let them succeed to a more natural meadow state with grasses, wildflowers, and shrubs that could provide habitat for many birds and small mammals.

- *Historic, archaeological, and cultural features.* Areas with historic significance can be identified from official lists such as the National Register of Historic Places and state and local inventories of historic and cultural resources. Landowners and local historians should also be consulted for detailed information about a site's history. Although historic areas are not always protected from demolition, if other areas of the property are equally suitable for development, historic resources should be preserved.

- *Views into and out from the site.* Development should be designed to blend well with the surrounding landscape. Because developers typically want to site buildings to take advantage of attractive views, they often build in areas where structures are highly visible. Siting buildings away from the pinnacles of ridges and hills, designing buildings with lower profiles, and preserving or planting trees to shield buildings from view are all techniques that can be used to reduce the visual impact of development on the landscape. Views can be created by cutting a limited number of trees to create "view tunnels," or trimming lower limbs to create "view holes" through the foliage.

- *Aquifers and their recharge areas.* An aquifer recharge area is where water moves downward to the water table. In other words, recharge areas replenish groundwater. Unconfined aquifers are not covered by a layer of impermeable rock and are open to receive water from the land surface. Unconfined aquifers are typically recharged in topographically high areas or through sandy or gravelly soils. These areas should be conserved as open space to maintain ground water recharge. They should also be buffered with vegetation to filter solids and associated pollutants from runoff.

After background information has been obtained, the next step is to integrate the information and prioritize conservation areas. Typically, all of the features mentioned above are drawn onto overlay sheets or entered into a geographic information system (GIS). Once the significant features are shown together, areas most suitable for development become obvious. Where some conservation areas need to be sacrificed to achieve the development objectives, decisions must be made regarding ranking the conservation areas based on how special, unique, irreplaceable, environmentally valuable, historic, or scenic they are. Figure 4.3 shows an example site before development, developed with a conventional strategy, and developed with consideration of locational context and conservation areas (Arendt, 1996).

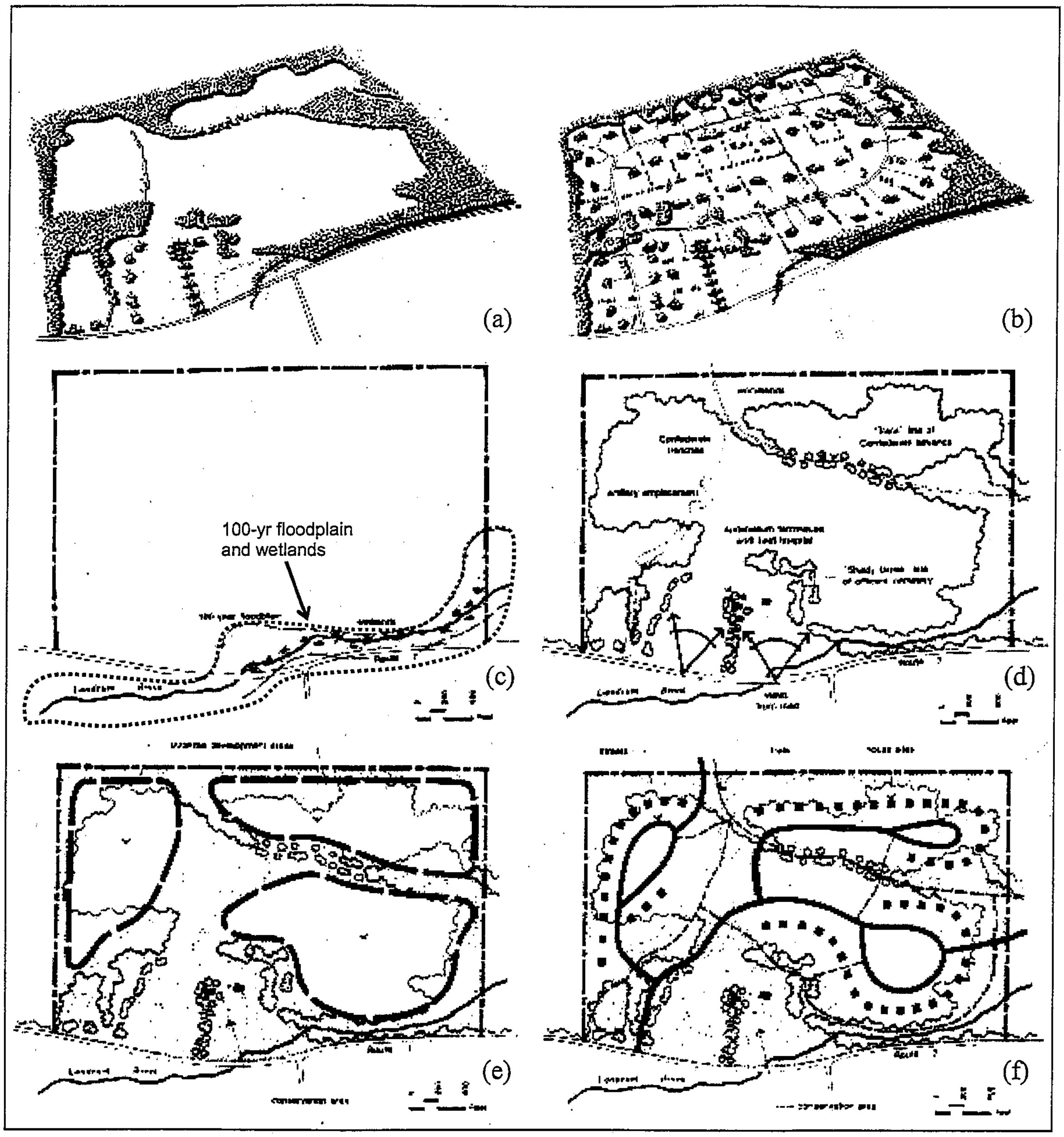

Figure 4.3: Development of a conservation subdivision. The site before development (a) and as designed with conventional development (b); identification of legally unbuildable (c) and legally buildable (d) conservation areas with features to be protected; and delineation of potential development areas (e and f) (adapted from Arendt, 1996).

Comparison of Traditional and Low Impact Development Scenarios in Delaware

The Brandywine Conservancy and the Delaware Department of Natural Resources and Environmental Control presented a case study in *Conservation Design for Stormwater Management* (Delaware DNREC and the Brandywine Conservancy, 1997). The case study compares conventional site development to several alternative, low impact development scenarios at Chapel Run, a 96-acre site in Sussex County, Delaware. The Chapel Run site is located in a rural area and is categorized by Sussex County as a primarily agricultural area where low-density residential development is permitted. Conservation areas that were identified through a site investigation include a large area of woodland, much of which is on well-drained soils that generate little or no runoff, and a small area with steep slopes.

The proposed conventional design dictates dividing the site into 142 lots ½ acre in size. The conventional design does not take into consideration the sensitive areas identified in the site assessment and results in a site with 100 percent of the area disturbed after clearing and grading. Overall site imperviousness under conventional development would be 29 percent, assuming conventional road widths. On-site runoff management would be accomplished by a curb and gutter system that conveys runoff to two detention basins.

Two alternative designs were developed for the Chapel Run site: the parkway design and the village cluster design. Figure 4.4 shows lot layouts for the conventional and conservation designs. Table 4.1 shows a theoretical side-by-side comparison of the three types of developments with respect to lot size and layout, amount of disturbed and impervious area, hydrology, and costs. Table 4.2 shows differences in itemized costs for infrastructure and management practices between conventional and low impact alternative designs.

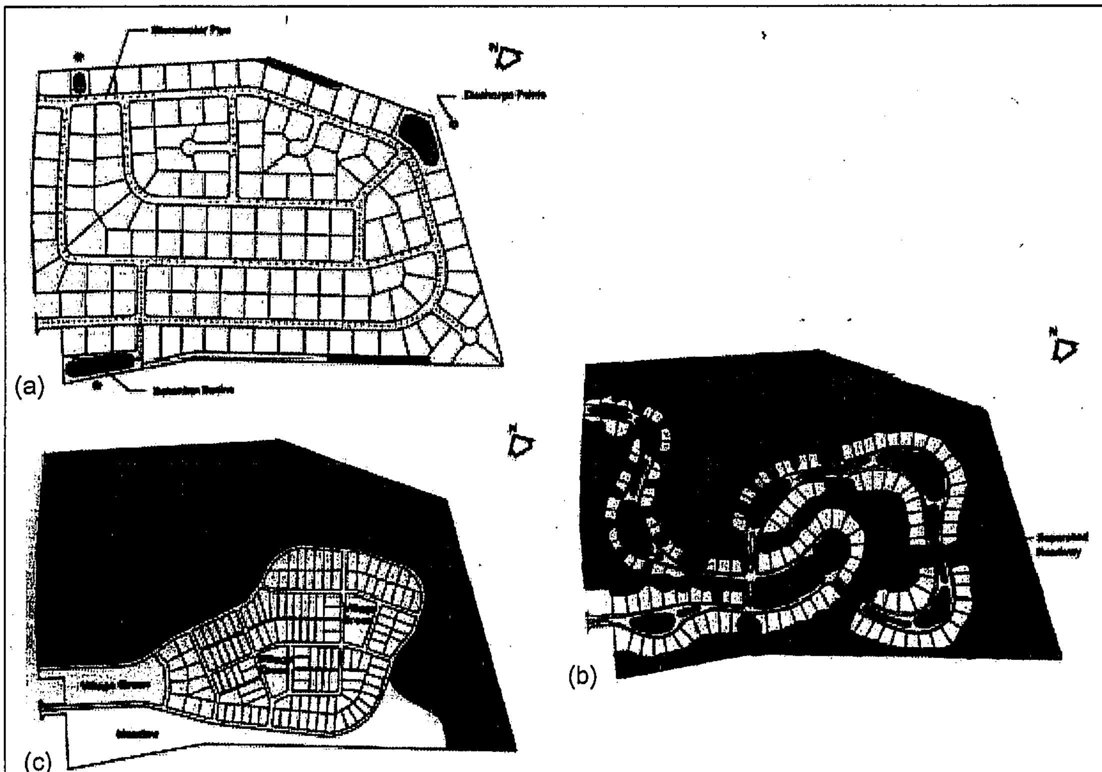

Figure 4.4: Schematic drawings of conventional (a), parkway (b), and clustered (c) development scenarios for the Chapel Run subdivision (Delaware DNREC and the Brandywine Conservancy, 1997).

Comparison of Traditional and Low-Impact Development Scenarios in Delaware (continued)

Table 4.1: Theoretical comparison of conventional and low-impact alternative designs for the Chapel Run site (DE DNREC and the Brandywine Conservancy, 1997). (Reductions are compared to the conventional design.)

Name	Conventional	Village	Parkway
Layout type	Conventional	Condensed cluster	Lots configured along curving road
Number of lots	142	142	142
Lot size	1/2-acre	1/8-acre	1/4-acre
Areas conserved	None	Woodland and high recharge areas	Woodland and high recharge areas
Percent of site in open space	0%	72.7%	49.7%
Impervious cover	29%	17.7%	14.9%
Impervious cover reduction	—	38%	48%
Street width	28 feet	20 feet	Two one-way lanes 12 feet wide with a pervious median
Undisturbed areas	0%	67.5%	59.6%
Runoff management system	Curb and gutter system that conveys runoff underground to two detention basins.	Swale conveyance system along roads that directs runoff to retention/ infiltration areas with level-spreading devices and low berms. These retention/infiltration areas are located throughout the site. Several village greens established on well-drained soils function as both recreation and infiltration areas.	Infiltration of runoff into depressed median (swales) along streets. Wide oval parkway centers used for retention/infiltration. These areas are designed with overflow piping to prevent flooding.
Average curve number[a]	78	66	65
Peak runoff rate for a 10-yr storm[a]	—	53 cfs	51 cfs
Water budget (gal)			
Precipitation	114,082,682	114,082,682	114,082,682
Runoff	31,584,217	21,812,868	17,782,776
Recharge	31,280,103	34,001,079	35,502,938
Evapotranspiration	51,223,261	58,208,796	60,802,278
Costs[b]			
Total	$2,460,200	$1,174,716	$887,705
Per lot	$17,325	$8,273	$6,259

[a] From USDA-NRCS's TR-55 model.

[b] Total cost for the Parkway design shown here differs from total cost published in DE DNREC and the Brandywine Conservancy (1997). Total cost shown here is based on itemized costs, provided in Table 4.2. These are conservative estimates, as in most cases additional costs such as grading have not been taken into account.

Comparison of Traditional and Low-Impact Development Scenarios in Delaware (continued)

Table 4.2: Theoretical comparison of itemized costs for conventional and low-impact alternative designs for the Chapel Run site (DE DNREC and the Brandywine Conservancy, 1997).

Name	Conventional	Village	Parkway
Street			
Length installed	13,388 ft	11,828 ft	7,800 ft
Unit cost	$150/linear ft	$85/linear ft	$85/linear ft
Total cost	**$2,008,200**	**$1,005,380**	**$663,000**
Storm water detention ponds			
Number installed	3	0	0
Unit cost	$16,000 per pond		
Total Cost	**$48,000**	**$0**	**$0**
Storm water pipe			
Length installed	16,000 ft	2,000 ft	3,000 ft
Unit cost	$22/linear ft	$22/linear ft	$22/linear ft
Total cost	**$352,000**	**$44,000**	**$66,000**
Endwalls/inlets			
Number installed	40	5	10
Unit cost	$1,300 each	$1,300 each	$1,300 each
Total cost	**$52,000**	**$6500**	**$13,000**
Berms			
Length installed	0	1050 ft	1000 ft
Unit cost		$10/linear ft	$10/linear ft
Total cost	**$0**	**$10,500**	**$10,000**
Swales			
Length installed	0	22,570 ft	20,600 ft
Unit cost		$4.50/linear ft	$4.50/linear ft
Total cost	**$0**	**$101,565**	**$92,700**
Check dams			
Number installed	0	90	82
Unit cost		$75 each	$75 each
Total cost	**$0**	**$6771**	**$6150**
Reforestation			
Acres reforested	0	0	12.8
Unit cost			$2,925/ac
Total cost	**$0**	**$0**	**$36,855**
Total[a]	**$2,460,200**	**$1,174,716**	**$887,705**

[a] Total cost for the Parkway design shown here differs from total cost published in DE DNREC and the Brandywine Conservancy (1997). Total cost shown here is based on itemized costs. These are conservative estimates, as in most cases additional costs such as grading have not been taken into account.

4.3.2 On-Lot Impervious Surfaces

4.3.2.1 Reduce the hydraulic connectivity of impervious surfaces

Pollutant loading from impervious surfaces can be reduced by preventing the direct connection of the impervious area to an impervious conveyance system. This can be done in a number of ways, including:

(1) Routing runoff over lawn areas to increase infiltration;

(2) Discouraging the direct connection of downspouts to storm sewers, or the discharge of rooftop downspouts to driveways, parking lots, and gutters;

(3) Substituting swale and pond systems for curbs and gutters to increase infiltration; or

(4) Reducing the use of storm sewers to drain streets, parking lots, and backyards by routing runoff overland using curbless systems, curb cuts, sloped sidewalks, and bioretention cells.

If runoff is directed over lawns, care should be taken to alleviate soil compaction. Urban lawns that are highly disturbed and compacted do not necessarily function as pervious surfaces (for more information on managing runoff from lawns and landscaping, see Management Measure 9).

Figure 4.5 shows schematic representations of impervious areas that are directly connected and not directly connected (BASMAA, 1997).

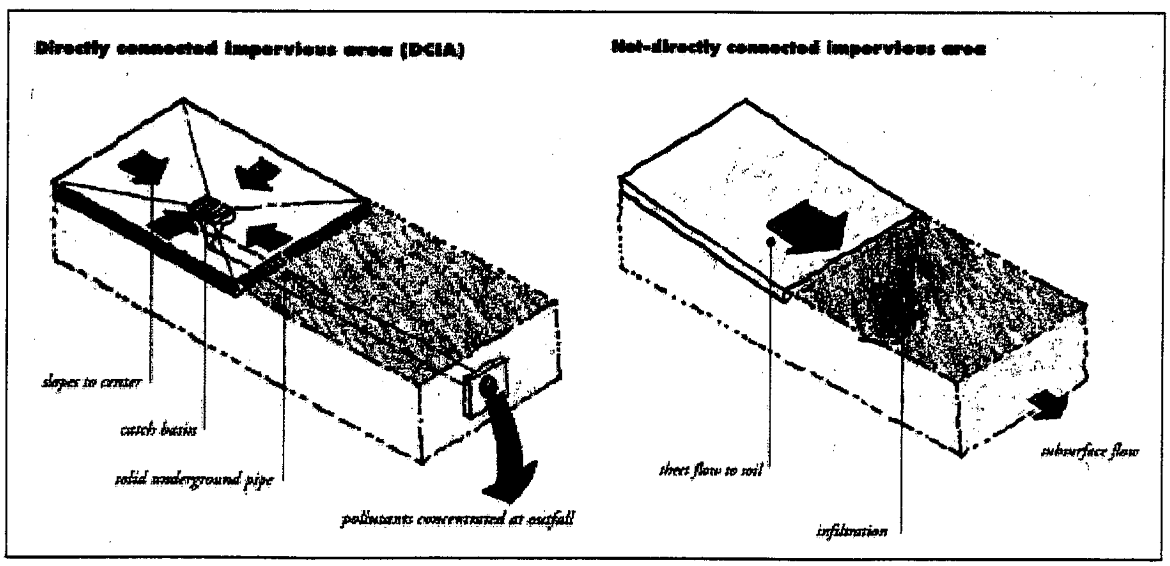

Figure 4.5: Schematic representation of directly connected and not-directly connected impervious areas (BASMAA, 1997).

The Urban Runoff Pollution Mitigation ordinance passed by the City of Santa Monica, California, requires new developments to implement management practices to collect precipitation, increase infiltration, and manage urban runoff on-site rather than after it enters the storm drain system. Infiltration trenches are the most common on-site practices for single-family homes in the city, but biofilters, swales, and porous pavement are also used. Since 1995, when the ordinance came into effect, 600 new developments have implemented management practices, resulting in a 1.2 million-gallon decrease in storm water runoff for each storm of 0.1-inch rainfall or greater (Shapiro, 2003).

In Prince George's County, Maryland, Cheng et al. (no date) measured runoff from adjacent watersheds to compare the effects of conventional versus low-impact subdivision design. One watershed was developed using conventional subdivision design (curb, gutter, and pipe storm drainage), while the other watershed was developed using low-impact development (LID) techniques, including curbless roads, networks of grassy swales to convey runoff, and bioretention areas (with drop inlet structures where necessary to convey concentrated flows during larger storms). After two years of monitoring, the researchers found that the average peak flow rate of the LID site was 56 percent of that of the conventional site, and surface runoff volume for the LID site was 60 percent of that of the conventional site. Only 15 percent of rainfall was converted to runoff in the LID watershed compared to 19 percent in the conventional watershed, and the LID site had delayed runoff hydrographs and a higher frequency of small flow rates compared to the conventional site, which had a higher frequency of larger flow rates.

Gap Creek Low Impact Development Subdivision, Sherwood, Arkansas

The Gap Creek subdivision in Sherwood, Arkansas, was designed using a low impact development approach that involved implementing such practices as street designs that flow with the existing landscape, minimal site disturbance and preservation of native vegetation, preservation of natural drainage features, and a network of buffers and greenbelts that protect sensitive areas. The approach resulted in significant economic benefits arising from lower development costs, higher lot yield, and greater lot values (NRDC, 1999).

The developer took advantage of the open space that was preserved to maximize the number of lots that were adjacent to the uncleared areas, enhancing their marketability and increasing the value of those properties. The LID plan reduced the amount of site clearing and grading, yielding lower site preparation costs.

Additionally, enhancing natural drainage features resulted in less money spent on drainage infrastructure such as piping, curbs, gutters, and other runoff conveyance features. An additional cost savings was realized with shorter and narrower streets, which also reduced imperviousness. For example, the developer reduced street width from 36 to 27 feet and retained trees close to the curb line, resulting in savings of nearly $4,800 per lot.

The greater lot yield and high aesthetic curb appeal also resulted in larger profits. The developer was able to sell lots for $3,000 more than larger lots in competing areas and sold nearly 80 percent of the lots within the first year. Additional benefits can be found in 23.5 acres of green space and parks (Toolbase Services, no date).

The economic benefits are expected to exceed $2 million over original projected profits. Additional benefits of the LID design include lower landscaping and maintenance costs and more common open space and recreational areas.

4.3.2.2 Practice rooftop greening

Rooftop greening has become an increasingly common practice in Europe and other parts of the world. This practice involves growing vegetation on the roofs of businesses and homes to intercept rainfall and promote evaporation rather than runoff (Natural Carpets, 1998). Rooftop mats are typically multilayered and include prevegetated coir fiber mats, a mineral-based substrate, and a synthetic matrix (see Figure 4.6). The coir fiber mat absorbs rainfall; the mineral substrate provides the plants with nutrients; and the synthetic matrix promotes drainage. Mats can be used on roofs with slopes of up to 30 degrees and are capable of reducing runoff by two-thirds (see Figure 4.7). These mats provide benefits other than runoff reduction, including:

- Visual aesthetics
- Protection of roofs from damaging solar radiation, wind, and precipitation
- Insulation
- Noise reduction
- Habitat for wildlife

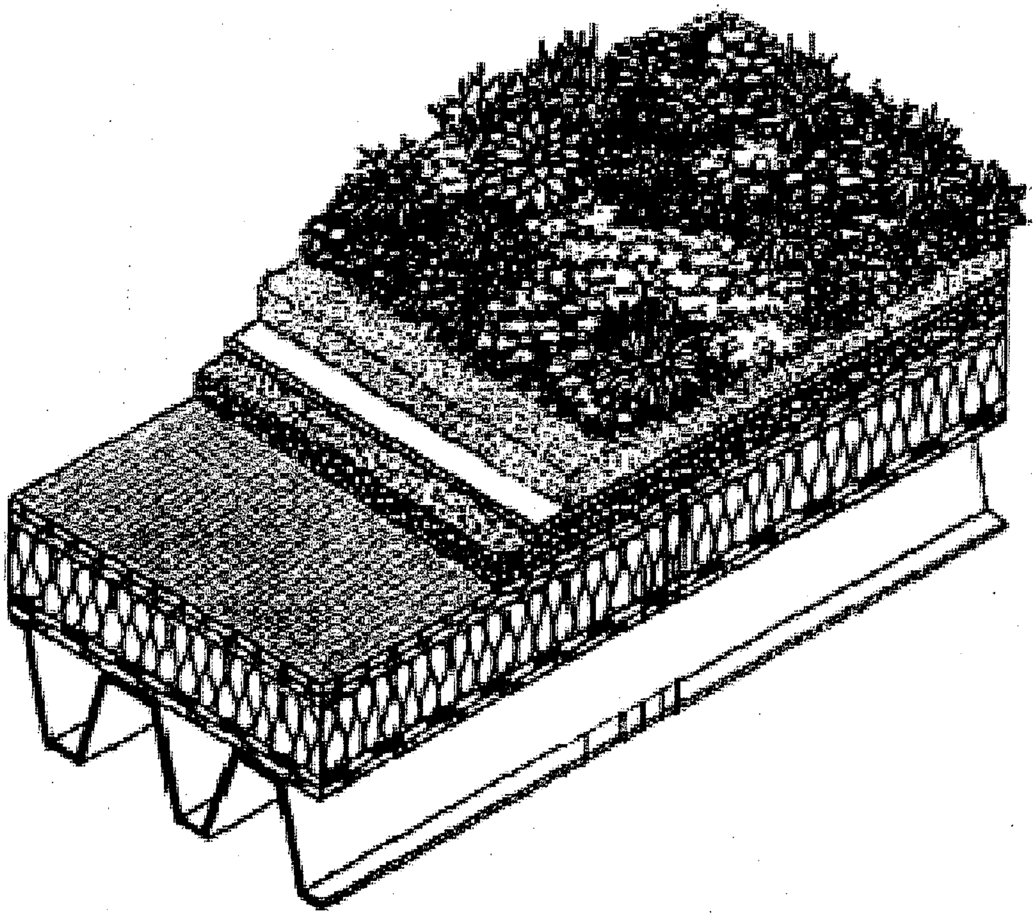

Figure 4.6: Components of the vegetated roof cover (USEPA, 2000).

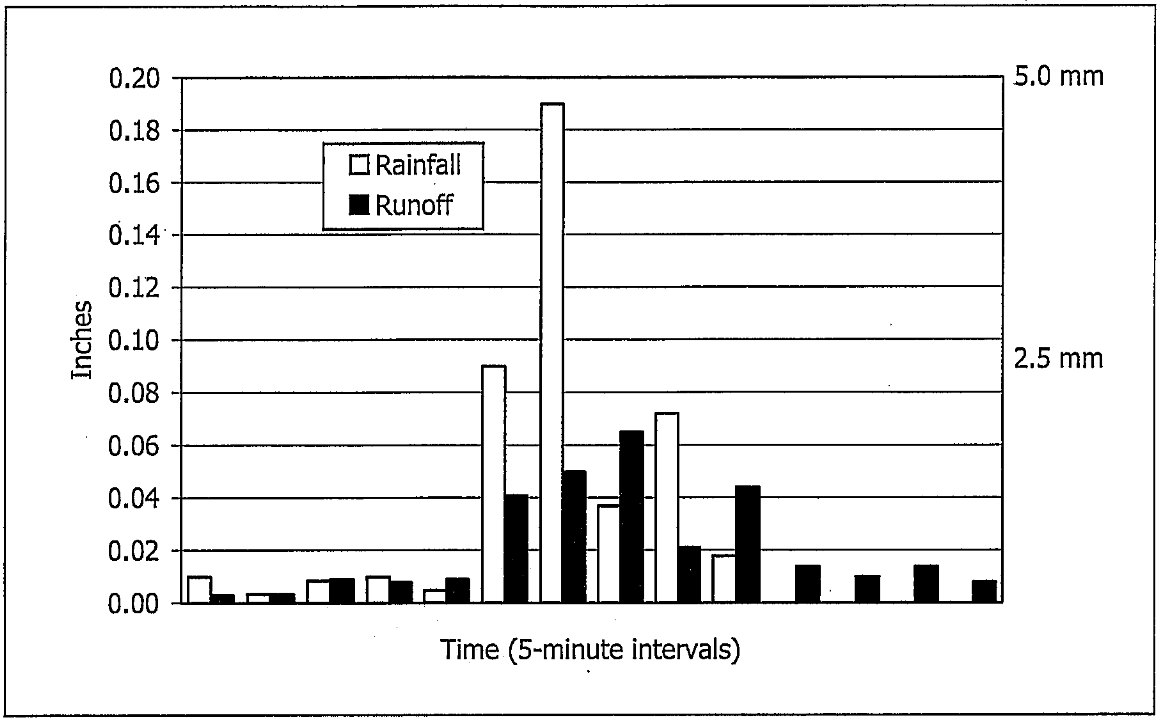

Figure 4.7: Runoff attenuation efficiency for a 0.4-inch rainfall event with saturated media (USEPA, 2000).

- Dust-trapping
- Evaporation and ambient cooling

Vegetation should be well-adapted to the growing conditions of the area where it is installed. Maintenance includes a limited amount of irrigation on steep slopes and periodic fertilization and weeding. Additional roof support might be necessary because the mats, when saturated with water, can add 5 to 17 pounds per square foot.

In response to a court order requiring $3 billion in storm water improvements, Atlanta is targeting commercial buildings for the installation of green roofs, with the anticipation that the resulting decrease in storm water runoff volume will provide water quality benefits. Commercial buildings are being targeted because commercial rooftops cover a huge amount of surface area in the city (Copeland, 2002).

Moran et al. (2004) studied runoff quality from two green roofs installed in North Carolina. They found that each green roof retained approximately 60 percent of the total recorded rainfall during a nine-month observation period. The green roofs reduced average peak flow by approximately 85 percent. Water quality data indicated higher concentrations of total nitrogen and total phosphorus were present in the green roof runoff than in the control roof runoff and in the rainfall at each green roof site. The researchers attribute this to nitrogen and phosphorus leaching from the soil media, which was composed of 15 percent compost. A soil column test of three different green roof soil media indicated that reducing organic matter in the soil media will

Rooftop Meadow Demonstration Project, Philadelphia, Pennsylvania

Rooftop meadows typically use foliage and a lightweight soil mixture to either absorb or filter and detain rainfall (Miller, 1998). Roof meadows are designed to control low-intensity storms by intercepting and retaining or storing water until the peak storm event has passed, while allowing the runoff from higher-intensity storm events to be safely conveyed away from the building. The plants help retain the hydrologic function of intercepting and delaying rainfall runoff by capturing and holding precipitation in the foliage, absorbing water in the root zone, and slowing the velocity of direct runoff by extending the flowpath through the vegetation.

A rooftop meadow demonstration project in Philadelphia, Pennsylvania, consists of a 3,000-ft^2 roof installed and monitored on top of an existing structure. The roof system was intended to mimic natural hydrologic processes of interception, storage, and detention to control the 2-year, 24-hour storm event. There are several distinguishing features of this rooftop meadow: (1) a synthetic underdrain layer that promotes rapid drainage of water from the surface of the roof deck; (2) a thin, lightweight growth medium that permits installation on existing conventional roofs without the need for structural reinforcement; and (3) a meadow-like setting of perennial *Sedum* varieties that have been selected to withstand the range of seasonal conditions typical of the Mid-Atlantic region without the need for regular maintenance.

The installed roof meadow is 3.4 inches thick, including the drainage layer, and weighs less than 5 lb/ft^2 when dry and less than 17 lb/ft^2 when saturated. The moisture content of the medium at field capacity is 45 percent of the volume. The saturated infiltration capacity is 3.5 inches per hour.

The runoff characteristics of the roof were simulated using rainfall records for 1994 from eastern Pennsylvania. The model predicted a 54 percent reduction in annual runoff volume and attenuation of 54 percent and 38 percent, respectively, for the 2- and 10-year, 24-hour Type II storm events. Monitoring of the pilot project for real and synthetic storm events was also conducted for a period of 9 months at 28- and 14-ft^2 trays. The most intense storm monitored was a 0.4-inch, 20-minute thunderstorm. The storm event occurred after an extended period of rainfall had fully saturated the medium. Although 44 inches of rainfall were recorded during this period, only 15.5 inches of runoff were generated from the trays. Runoff was negligible for storm events with less than 0.6 inch of rainfall. This demonstration project shows the advantages of reducing peak runoff rates on overloaded systems for a majority of the storm events and shows that some existing structures can be retrofitted to reduce runoff.

reduce the amount of nutrient leaching. Based on the results of this study, caution should be used when implementing green roofs in nutrient-sensitive watersheds; green roof components such as soil media composition should be selected with consideration of receiving water limitations.

Dunnett and Kingsbury (2004) describe examples of both large-scale and residential applications of green roofs and living walls, and they include technical information about constructing these structures in *Planting Green Roofs and Living Walls*. The authors cover structural engineering concerns as well as factors such as plant selection and environmental considerations that are important for the success of green roofs and living walls. The book is available for purchase at the Timber Press Web site at http://www.timberpress.com.

Another resource for information about green roofs is the proceedings of a conference entitled Green Roofs for Healthy Cities. A CD-ROM of the proceedings can be purchased from http://www.greenroofs.org/portland/proceedings.php and includes information on green roof design and implementation, technical research, and policy developments.

A Better Site Design Approach to Runoff Management: Low Impact Development

The goal of low impact development (LID) is to maintain and enhance the predevelopment hydrologic regime of urban and developing watersheds. LID focuses on managing runoff in small, cost-effective landscape features on each lot rather than conveying runoff to large, costly storm water ponds located at the bottom of large drainage areas. Hydrologic functions such as infiltration, ground water recharge, and depressional storage are maintained using simple, small-scale practices such as bioretention facilities. A key objective of LID is to reduce the hydraulic connectivity of impervious surfaces. For example, instead of allowing storm water to run from a downspout down a driveway and into a storm sewer, direct the runoff onto a lawn or other pervious area. By disconnecting rooftop runoff from the storm drainage system, a community can decrease the volume of water conveyed to a storm drain by as much as 50 percent (Pitt, 1986) and avoid treatment and storage costs, decrease system maintenance costs, and reduce instream impacts. To avoid soggy areas in lawns, water can be directed to specially designed depression storage areas such as bioretention or infiltration areas.

The following is a list of fundamental practices of the LID approach that can be included in runoff management plans. These practices are presented in two publications by the Department of Environmental Resources of Prince George's County, Maryland: *Low-Impact Development Design Strategies: An Integrated Design Approach* (2000a) and *Low Impact Development Hydrologic Analysis* (2000b).

- *Use hydrology as the integrating framework.* Hydrology is used as the key feature when designing a development. Areas that play a critical role in the movement of water (e.g., streams, riparian and buffer areas, floodplains, wetlands, and ground water recharge sites) are identified first. Alternative layout schemes are then evaluated in terms of their impact on site hydrology. Key objectives are to minimize the amount of impervious cover created and to make created impervious areas function as "ineffective" impervious areas that are not directly connected to a storm drain network.
- *Think micromanagement.* Site hydrology is analyzed and dealt with at small scales. Using natural drainage as a design element, integrated management practices are scattered throughout the site, allowing for runoff distribution and the retention of natural hydrologic functions such as infiltration, depressional storage, and interception.
- *Control runoff at the source.* Management of runoff at or near the sources eliminates the need for large-scale runoff management practices such as concrete conveyance systems and storm water ponds.
- *Incorporate safety features into the design of management practices.* LID practices can require diversions or drainage to allow for overflow of runoff from large storms and storm events that occur during saturated conditions. This emergency drainage will protect the longevity of the structural practice against damage from high runoff volumes and flow velocities and enhance the acceptance of LID in the community.
- *Use simple, nonstructural methods.* Natural hydrologic functions rely on simple processes that promote infiltration, depressional storage, and interception of storm water. These characteristics can be implemented throughout the site using simple methods that incorporate native plants, soil, and gravel.
- *Create a multifunctional landscape.* A goal of the LID approach is to create a landscape where runoff is micromanaged and controlled at the source. Runoff management practices and natural landscape features can be used in tandem to reduce postdevelopment runoff volume and maintain the predevelopment time of concentration.

The Prince George's County LID publications can be ordered through the Internet at EPA's National Service Center for Environmental Publications Web site at http://www.epa.gov/ncepihom. They can also be ordered by phone, fax, or mail from USEPA/NSCEP, P.O. Box 42419, Cincinnati, Ohio 45242-2419, toll-free 800-490-9198, fax 513-489-8695.

4.3.2.3 Relax frontage and setback requirements

Developers interested in increasing open space or conservation areas typically increase housing density by creating smaller lots or clustered developments and pool the space "savings" in a large open area accessible to all. This can be accomplished by reducing front, side, and rear yard setbacks and decreasing frontage distances. In addition to increasing housing density for open space development designs, relaxing frontage and setback requirements also decreases impervious cover. This occurs because narrower side yards mean narrower lots, which can in turn lead to shorter subdivision streets; shorter front yard setbacks lead to shorter driveways and sidewalks.

Frontage distance can be reduced by providing garage access through rear alleys. This approach eliminates driveways and allows homes to be sited on narrower lots. This helps reduce road frontage requirements and accommodate more homes on a given amount of road. Because of their limited traffic, the alleys can be paved with alternative treatments to retain more pervious area.

Areas with high potential for significant storm damage, earthquakes, or other catastrophes should take into consideration the appropriate setback distance to ensure emergency access in case of building collapse.

4.3.2.4 Modify sidewalk standards

Many conventional subdivision codes require paved sidewalks on both sides of the street in widths that range from 4 to 6 feet. Communities that want to reduce impervious cover and increase the use of pervious areas for runoff treatment should consider the following (always considering public safety first):

- Allowing sidewalks on only one side of the street or building them only where there is pedestrian demand;

- Increasing the distance between sidewalks and the street so sidewalk runoff has a better chance of infiltrating into the grass border area and not becoming street runoff. This will provide water quality as well as safety benefits;

- Grading sidewalks so that runoff drains into the yard rather than toward the street;

- Reducing the width of very wide sidewalks. Communities should consider the implications of reducing sidewalk widths, including pedestrian demand and wheelchair access, on a case-by-case basis. Three feet will typically allow passage for one wheelchair. Sidewalks in highly commercial areas and government centers should accommodate two wheelchairs abreast, but it may be appropriate for some residential areas to reduce sidewalk width to three feet.

- Maintain sidewalk widths but use porous pavement (see Management Measure 5).

4.3.2.5 Modify driveway standards

In a sense, driveways are small-scale parking lots that are designed to accommodate two to four cars. Typical residential driveways and parking pads often total 400 to 800 square feet. Communities that want to reduce driveway impervious cover should consider:

- Shortening driveway length by shortening front yard setback requirements;
- Narrowing driveway widths;
- Encouraging the use of driveways that are shared by two or more homes; and
- Providing incentives for use of alternative driveway surfaces that allow for infiltration, such as porous pavers, gravel, or a two-track surface with grass in between.

4.3.3 Residential Street and Right-of-Way Impervious Surfaces

The largest percentage of impervious cover in residential neighborhoods is typically associated with the streets, driveways, and sidewalks that together aid in the transport of people to and from their various destinations. Management practices associated with residential streets and their rights-of-way typically are focused on minimizing impervious cover or treating runoff. In general, these objectives can be achieved by developing, updating, or revising codes, ordinances, and standards that determine the size, shape, and construction of residential streets and their rights-of-way.

4.3.3.1 Decrease street pavement width and length

Streets typically make up the largest percentage of transport system impervious cover in residential neighborhoods. Communities can significantly reduce this type of cover in new developments by revising street standards so that street pavement widths are based on traffic volume, on-street parking needs, and other variables rather than requiring all streets to have one universal width. Additionally, communities can encourage developers to design street networks that minimize the total length of pavement. The length of residential streets can be reduced by altering the design and placement of new development. Techniques include:

- Reducing frontage distances and side yard setbacks;
- Allowing narrower lots;
- Clustering smaller lots;
- Reducing the number of non-frontage roads; and
- Eliminating long streets that serve only a small number of homes.

4.3.3.2 Decrease street right-of-way width

A street right-of-way is a public easement corridor through which people, vehicles, runoff, utility services, and other items and materials move in, out, and around the development. A right-of-way usually includes the street itself, its gutters and curbs, and some amount of land on either side of the street, which might contain sidewalks, utility easements, or other components. Options for minimizing right-of-way widths include:

- Eliminating some right-of-way components;
- Placing sidewalks on only one side of the street;
- Running utility pipes, cables, and other infrastructure underneath street pavement (this can result in traffic congestion from road construction if the infrastructure needs to be repaired or replaced); or
- Reducing street and sidewalk widths where appropriate.

On-street parking is a variable that should be closely examined in communities where reducing impervious cover is a goal. Some communities have implemented a concept known as "queuing streets." Queuing streets generally have one travel lane and one or two parking lanes. Cars wait between parked cars until approaching traffic passes before proceeding to the travel lane. This approach also helps slow traffic, which can improve safety.

Street width must provide for utility work (common utilities include water, sewer, gas, cable, phone, power, and fiber optics). If the street width is reduced, utilities can be installed together in a concrete trench with a removable top for maintenance access (Matsuno, 2003).

When considering these options, it is important to remember that public safety should not be compromised and traffic engineering principles must still be a significant design factor. In addition, areas with high potential for significant storm damage, earthquakes, or other catastrophes should take into consideration the appropriate right-of-way width to enable passage of emergency vehicles.

The Headwaters Project: A Sustainable Community

In 1998 the Department of Planning and Development in Surrey, British Columbia, initiated the Headwaters Project to develop a real example of a sustainable community. Part of this project is the *East Clayton Neighbourhood Concept Plan* (The Headwaters Project, 2000), a green infrastructure plan that is an integrated system of "green" streets and affordable housing sites. It has narrow streets that use one-third less blacktop than typical roadways. Storm water management is achieved through natural infiltration, which minimizes runoff and avoids downstream flooding events. Information about East Clayton and a copy of the concept plan are available at http://www.sustainable-communities.agsci.ubc.ca/projects/Headwaters/PDF/toc.pdf

4.3.3.3 Use alternative cul-de-sac designs

Cul-de-sacs (roads with one open and one closed end) are a popular design element in community road networks. The intent of cul-de-sacs is to provide more homebuyers with premium, "end-of-the-road" lots. The typical "bulb" found at the closed end of a cul-de-sac, however, represents a particularly large concentration of impervious cover. Communities can reduce the amount of impervious cover created by bulb-ending cul-de-sacs by

- Eliminating cul-de-sac streets altogether;
- Using alternative designs for turnarounds, such as a T-shaped turnaround or a looped road;
- Reducing the radius of the turnaround bulb; or
- Incorporating a pervious cover island in the center of the turnaround bulb that accepts runoff.

As with modifications of street right-of-way width, public safety should not be compromised and traffic engineering principles must still be a significant design factor for this practice. Existing fire codes may dictate cul-de-sac width. Figures 4.8 and 4.9 show five turnaround options at the end of a residential street and the amount of impervious cover created by each option (Schueler, 1995).

4.3.4 Parking Lot Impervious Surfaces

Parking lots are considered by some to be one of the most damaging land uses in the urban landscape (CWP, 2000). Not only are parking lots very efficient at concentrating and delivering a large amount of runoff to receiving waters, thus exacerbating erosion problems, but they also act as a repository for pollutants associated with automobiles, which include nutrients, trace metals, and hydrocarbons.

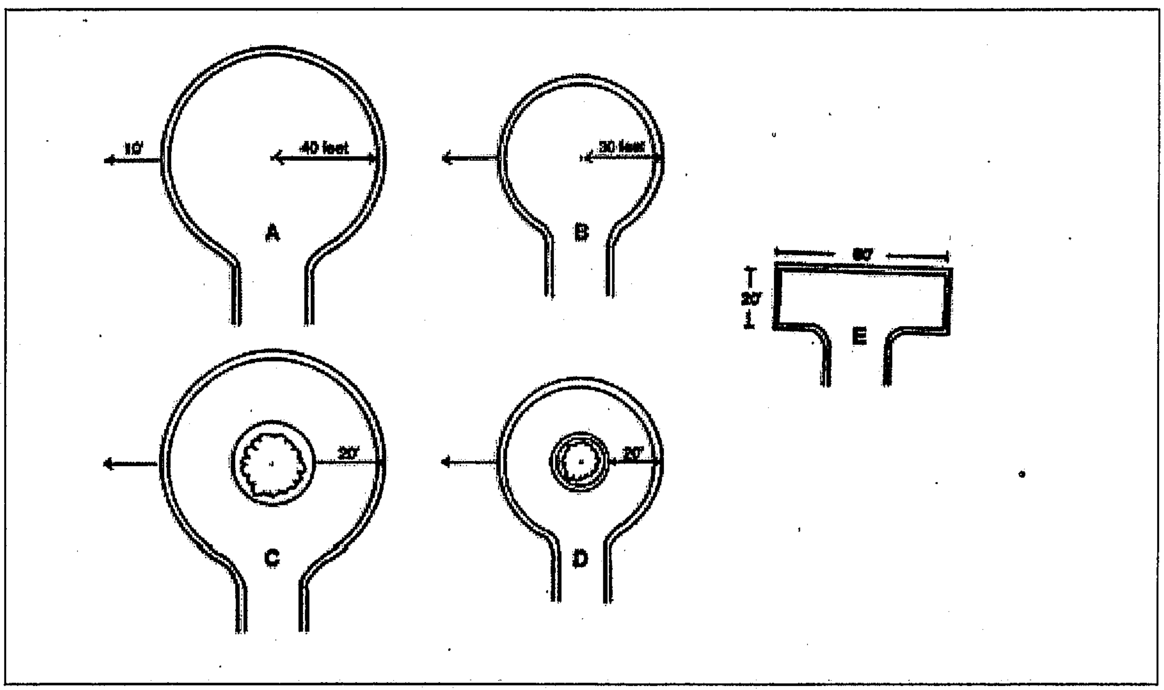

Figure 4.8: Five turnaround options at the end of a residential street (Schueler, 1995).

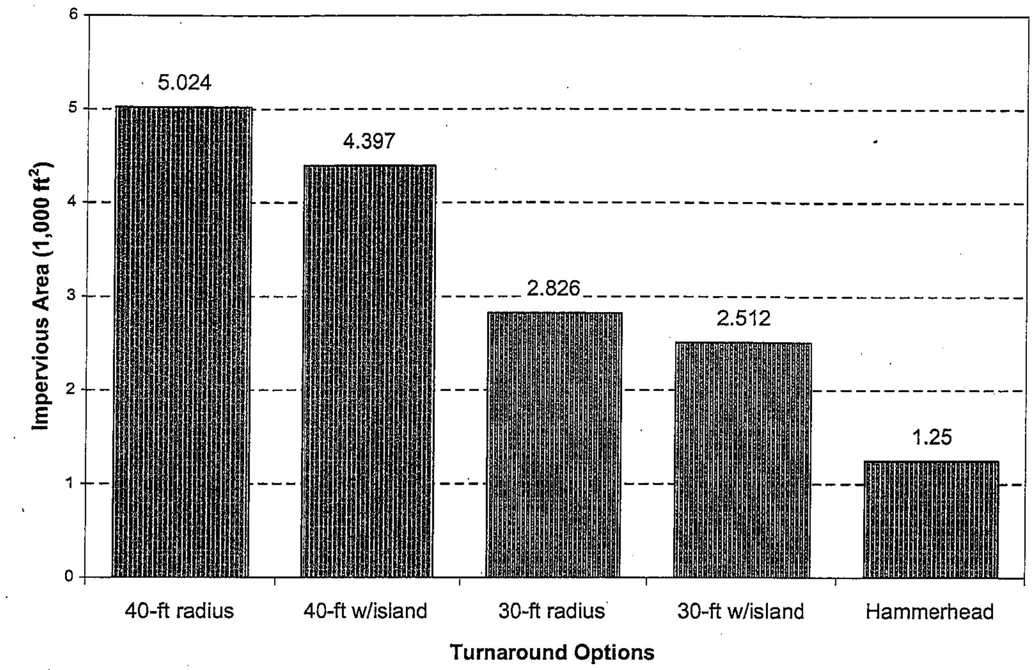

Figure 4.9: Impervious cover created by each turnaround option shown in Figure 4.8 (Schueler, 1995).

Innovative Turf Parking Lot Installation at a Connecticut Shopping Mall

The owners of Westfarms Mall, in the suburbs of Hartford, Connecticut, planned a 310,000-ft^2 expansion that required an additional 4 acres of overflow parking (Wilson et al., 1998). Local zoning boards and members of the community balked at this proposal because of the high ratio of impervious-to-pervious surfaces and concern for the quality and quantity of runoff generated by the new additions.

The traditional solution for handling the increased runoff was to install a large runoff detention pond, which would have cost $1million and was looked upon unfavorably by both the community and the mall owner. A 4-acre turf parking lot was implemented as an alternative and allows rainfall to infiltrate and recharge the ground water supply. To better support automobile traffic, the lot consists of a plastic honeycomb grid filled with sand and soil and laid atop a bed of crushed stone. Additionally, rooftop runoff is diverted to a tank located under the lot and the collected runoff is used to irrigate the turf. The turf would not hold up to everyday traffic, but overflow parking is needed only during the Christmas shopping season when the grass is dormant.

The cost of installing the turf lot was $500,000, which is half the cost of installing a pond. Even though the turf installation was more expensive than traditional pavement installation, the mall owner estimated that the installation would break even within 5 years because of lower maintenance requirements. An additional benefit of this innovative design was for the mall owner to gain the support of community members and local planning commissions.

Traditionally, developers have provided an overabundance of parking as a convenience for shoppers, workers, and landowners. A goal of watershed managers should be to reduce the surface area of parking lots and integrate runoff treatment practices to reduce adverse impacts, while still providing enough spaces to meet the expected parking demand. This reduction can be accomplished by implementing better site design practices, such as:

- Redesigning building and parking area layouts to reduce walking distances and provide more efficient layouts.

- Ensuring that the number of spaces built reflects actual demand. Site planners should design the lot size to correspond to minimum local parking requirements and consider ways in which this requirement can be reduced. For example, less parking is needed if access to public transportation is provided. Also, a parking area can be shared if localities in close proximity have different peak parking times. For instance, a retail establishment with peak demand during weekdays can share parking with a church whose peak demand is on the weekend.

- Sizing parking lot dimensions to meet everyday demand and designating additional "spillover" parking areas to handle peak demand. Because these spillover areas will receive less traffic, alternative paving techniques (see Management Measure 5) can be used to increase infiltration.

- Reducing the dimensions of the normal parking spaces if allowable. Also, developers can designate a percentage of the available parking spaces for use by compact cars and reduce their dimensions correspondingly.

- Building multilevel parking structures when feasible. (Parking structures can sometimes be impractical from a cost standpoint.) Green roofs can be used on these parking garages to reduce imperviousness.

- Converting parking lot islands to bioretention areas (see Management Measure 5).

- Building below-grade parking where it does not affect groundwater or other subsurface resources.

- Working with municipalities to regulate the maximum number of parking spaces allowed in development, rather than a minimum.

When parking area is reduced, functional landscaping can be used to improve the aesthetics of the site and to allow room for the installation of runoff treatment practices such as infiltration basins, filter strips, and dry swales or detention practices like those described in Management Measure 5.

4.3.5 Xeriscaping Techniques

Xeriscaping is a landscaping concept that maximizes water conservation by using site-appropriate plants and an efficient watering system. It involves the use of landscaping plants that need minimal watering, fertilization, and pesticide application, and practices that reduce water demand. For instance, mulching can help retain water and humidity and reduce the need for irrigation. Shading and windbreaks can reduce evaporation, particularly from young plants. In contrast to overhead sprinklers, drip irrigation waters plants directly on the roots without wetting plant leaves, helping to reduce evaporation and control disease. Timers are available that allow automatic watering with drip irrigation systems. Watering early in the morning can also reduce evaporation, and prevent the propagation of disease that often results from leaving foliage wet overnight (Relf, 1996). Xeriscaping can reduce the contribution of landscaped areas to nonpoint source pollution, and it can reduce landscape maintenance by as much as 50 percent, primarily as a result of the following (Clemson University Cooperative Extension Service, 1991):

- Reduction of water loss and soil erosion through careful planning, design, and implementation;
- Reduction of mowing by limiting lawn areas and using proper fertilization techniques; and
- Reduction of fertilization through soil preparation.

The specific benefits resulting from xeriscaping will vary based on the local climate and site conditions.

In 1991 the Florida legislature adopted a xeriscape law that requires state agencies to adopt and implement xeriscaping programs. The law requires that rules and guidelines be adopted for the implementation of xeriscaping along highway rights-of-way and on public property associated with publicly owned buildings constructed after July 1, 1992. Local governments are tasked with determining whether xeriscaping is a cost-effective measure for conserving water. If so, local governments are to work with the state water management districts in developing their xeriscape guidelines. Water management districts will provide financial incentives to local governments for developing xeriscape plans and ordinances. These plans must include:

- Landscape design, installation, and maintenance standards;
- Identification of prohibited plant species (invasive exotic plants);
- Identification of controlled plant species and conditions for their use;
- Specifications for maximum percentage of turf and impervious surfaces allowed in a xeriscaped area;
- Specifications for land clearing and requirements for the conservation of existing native vegetation; and
- Monitoring programs for ordinance implementation and compliance.

The law also includes a provision requiring local governments and water management districts to promote the use of xeriscape practices in existing developed areas through public education programs. California has passed a law requiring all municipalities to consider enacting water-efficient landscape requirements.

Water Conservation and Xeriscaping in Albuquerque, New Mexico

The City of Albuquerque, New Mexico, recently adopted a new strategy to encourage water conservation and to ensure a lasting water supply for years to come (Bennett, 1999). The strategy includes

- Reducing per capita water consumption by 30 percent.
- Developing facilities to treat and distribute city-owned surface water in combination with more limited use of the aquifer.
- Developing systems to use reclaimed wastewater and low-quality shallow ground water to irrigate landscaped areas in specific corridors of the community.
- Aggressive preservation of ground water quality.

The city also developed a new ordinance, the Water Conservation Landscaping and Water Waste Ordinance, that includes the following provisions:

- Prohibits irrigation water from flowing or spraying into streets, storm drains, or adjoining property.
- Limits high-water-use turf to 20 percent of the total landscape for all new developments.
- Establishes design requirements to discourage turf on steep slopes or adjacent to streets.
- Establishes water budget goals for parks and golf courses.
- Requires that new sprinkler systems on large turf areas meet minimum uniformity standards.
- Requires spray irrigation to occur between 6:00 p.m. and 10:00 a.m. from April to September.

The full text of the ordinance can be found at *www.cabq.gov/resources*.

As a result of these changes in Albuquerque's water conservation policy, the city's water consumption has decreased by 24 percent and its irrigation professionals have experienced a substantial increase in business as landowners seek smarter solutions to irrigation problems. Improvements in irrigation technology and increased public awareness are likely to further decrease water consumption.

4.4 Information Resources

In 1991 the Center for Watershed Protection published the *Consensus Agreement on Model Development Principles to Protect Our Streams, Lakes, and Wetlands*, which outlines the series of 22 nationally endorsed principles developed by the Site Planning Roundtable, a national cross-section of diverse planning, environmental, homebuilder, fire, safety, public works, and local government personnel, and details the basic rationale for their implementation. The *Consensus Agreement* can be purchased at http://www.cwp.org/.

The Center for Watershed Protection also published *Better Site Design: A Handbook for Changing Development Rules in Your Community* in 1998. This document outlines 22 guidelines for better developments and provides a detailed rationale for each principle. *Better Site Design* also examines current practices in local communities, details the economic and environmental benefits of better site designs, and presents case studies from across the country. It can be purchased at http://www.cwp.org/.

Wildlife Reserves and Corridors in the Urban Environment: A Guide to Ecological Landscape Planning and Resource Conservation, by Lowell Adams and Louise Dove (1989) reviews the knowledge base regarding wildlife habitat reserves and corridors in urban and urbanizing areas, and it provides guidelines and approaches to ecological landscape planning and wildlife conservation in such areas. It can be purchased from the Urban Wildlife Resources Bookstore at http://users.erols.com/urbanwildlife/bookstor.htm.

In 1997 Randall Arendt of the Natural Lands Trust, Inc., published *Growing Greener: Putting Conservation into Local Codes*. *Growing Greener* is a statewide community planning initiative designed to help communities use the development regulation process to their advantage to protect interconnected networks of greenways and permanent open space. The booklet can be downloaded in PDF format at http://www.dcnr.state.pa.us/growinggreener/growing.pdf.

The Low Impact Development Center was established to develop and provide information to individuals and organizations dedicated to protecting the environment and our water resources through proper site design techniques that replicate preexisting hydrologic site conditions. More information about this organization can be found on the Low Impact Development Center Web site at http://www.lowimpactdevelopment.org/ or by contacting the Center at 301-345-0440.

The Prince George's County, Maryland, Department of Environmental Resources produced two documents, *Low-Impact Development Design Strategies: An Integrated Design Approach* (EPA-841-B-00-003) and *Low-Impact Development Hydrologic Analysis* (EPA-841-B-00-002), that discuss site planning, hydrology, distributed integrated management practice technologies, erosion and sediment control, and public outreach techniques that can reduce storm water runoff from new and existing developments. Both publications can be ordered free of charge through EPA's National Service Center for Environmental Publications at http://www.epa.gov/ncepihom/index.htm.

Residential Streets, prepared by the American Society of Civil Engineers, the National Association of Home Builders, and the Urban Land Institute (1990), discusses design considerations for residential streets based on their function and their place in the neighborhood.

The publication presents guidance on street widths, speeds, pavement types, streetscapes, rights-of-way, intersections, and drainage systems.

The Institute of Transportation Engineers (ITE) published *Traditional Neighborhood Development—Street Design Guidelines* (1997), in which traditional neighborhood designs that support pedestrian movement over automobile traffic are discussed, and design concepts such as on-street parking, street width, and sight distances are presented. The publication also includes a practical discussion of the time needed for community acceptance and travel behavior changes. ITE also published *Guidelines for Residential Subdivision Street Design* (1993), which presents a discussion of the overall design of a residential subdivision with respect to the adequacy of vehicular and pedestrian access, minimizing excessive vehicular travel, and reducing reliance on extensive traffic regulations. It also provides design considerations for local and collector streets and intersections, including such topics as terrain classifications, rights-of-way, pavements, curb types, and cul-de-sacs. These publications are available through the Institute of Transportation Engineers, 525 School Street, SW, Suite 410, Washington, DC 20024-2797, (202) 863-5486.

Street Design Guidelines for Healthy Neighborhoods is a guidebook intended to help communities implement designs for streets that are safe, efficient, and aesthetically pleasing. This publication can be purchased from the Local Government Commission's Center for Liveable Communities Web site at http://www2.lgc.org/bookstore/topic.cfm?topicId=11.

The Congress for the New Urbanism has compiled a database of jurisdictions across the country that have adopted reduced-width street standards (Cohen, 2000). The database also includes resources related to neighborhood design and transportation. The database can be viewed at http://www.sonic.net/abcaia/narrow.htm.

EPA has compiled a number of resources on its *Low Impact Development (LID)* Web page, with links to Web sites, a literature review, fact sheets, and technical guidance. The Web site is accessible at http://www.epa.gov/owow/nps/lid/.

The Local Government Commission has published a guidebook to assist local communities in overcoming regulatory obstacles to smart growth. *Smart Growth Zoning Codes: A Resource Guide* helps planners design zoning codes that encourage the construction of walkable, mixed-use neighborhoods. The guidebook comes with a CD-ROM containing examples of the best U.S. zoning codes and other resources. The book can be purchased for $25 from http://www2.lgc.org/bookstore/topic.cfm?topicId=1.

Dunnett and Kingsbury (2004) describe examples of both large-scale and residential applications of green roofs and living walls and include technical information about constructing these structures in *Planting Green Roofs and Living Walls.* The authors cover structural engineering concerns as well as factors such as plant selection and environmental considerations that are important for the success of green roofs and living walls. The book is available for purchase at the Timber Press Web site at http://www.timberpress.com.

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MANAGEMENT MEASURE 5
NEW DEVELOPMENT RUNOFF TREATMENT

5.1 Management Measure

By design or performance (a) reduce the postdevelopment loadings of total suspended solids (TSS) so that the average annual TSS loadings[a] are no greater than the predevelopment loadings, or (b) reduce the average annual TSS loadings by a minimum of 80 percent of the influent concentration of TSS[b].

Maintain the postdevelopment average volume and peak runoff rates at levels that are similar to predevelopment[c] levels or, through planning and/or design, control offsite discharges of runoff to prevent erosive impacts to downstream channels or shorelines.

Maintain discharge temperatures in runoff at levels similar to predevelopment levels or at levels that will protect aquatic communities from the thermal impacts of runoff.

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[a] In general, calculations of average annual TSS loadings will be based on TSS loadings from all storms below or equal to a predetermined maximum storm size. The most commonly used upper threshold that states use to calculate annual average TSS loadings is the 2-year, 24-hour storm. However, some states have recently reevaluated the benefits of controlling the 2-year versus the 1-year, 24-hour storm and, as a result, have adopted standards that require the control of all storms less than or equal to the 1-year, 24-hour storm.

EPA interprets predevelopment conditions to mean those conditions that exist prior to the current land use. In situations where the previous land use has resulted in unacceptable erosion and significant sediment movement offsite, a baseline reference condition can be used (e.g., the typical TSS loading rates from forested sites or meadows in the area). Average annual TSS loading calculations also should be based on the TSS discharge concentrations that occur after the site has been permanently stabilized.

[b] It is anticipated that the total TSS reductions will be calculated based on all reductions achieved through a system of structural and nonstructural management practices. The intent of this guidance is to promote the implementation of runoff management programs that protect receiving waters from increases of suspended solids that may, on an individual or cumulative basis, threaten or impair surface waters. Management practices and systems of practices should be selected based on achievement of water quality standards throughout the receiving watershed. TSS loading reduction goals therefore should be determined by assessing the capacity of the receiving water body to assimilate TSS from all contributing sources. EPA acknowledges that, in some jurisdictions, reducing 80 percent of the influent TSS concentration is not reasonable due to the presence of significant concentrations of colloidal particles. EPA also understands that treatment of these particles in many cases is not necessary to protect receiving waters and meet state or local water quality standards. In such cases, design or performance requirements should protect receiving waters from impairment from TSS loadings above the ambient TSS in receiving waters that are not due to anthropogenic sources.

[c] As with the TSS element of the measure, term *predevelopment* refers to runoff rates and volumes that exist on-site immediately before the planned land disturbance and development activities occur. Predevelopment is not intended to be interpreted as that period before any human-induced land disturbance activity has occurred. Watershed managers need to determine an appropriate reference or management condition as an objective to achieve. Also, for the purposes of this element of the management measure, the term *similar* is defined as "resembling though not completely identical."

5.2 Management Measure Description and Selection

5.2.1 Description

During the development process, both the existing landscape and hydrology are altered. As development occurs, the following changes are likely to occur:

- Soil porosity decreases due to removal of vegetation and compaction of topsoil by construction equipment;
- Impermeable surfaces (paving and rooftops) increase (see Introduction);
- Artificial conveyances such as pipes and concrete channels are constructed;
- Slope angles become less acute;
- Vegetative cover decreases; and
- Surface roughness decreases.

These changes result in increased runoff volume and velocity, which may lead to accelerated erosion of streambanks, steep slopes, and unvegetated areas (Novotny, 1991). The grading of urbanized areas can increase the downward slope to a water body and destroy riparian buffer zones, or developers may level a site to facilitate construction activities. Destruction of in-stream and riparian habitat, increases in water temperature, streambed scouring, and downstream sedimentation of streambed substrates, riparian areas, and estuarine habitats may occur.

Everyday activities that occur after development may cause the discharge of pollutants in runoff that can have harmful effects on waters and habitat. Pollutants related to vehicle petroleum and coolant leaks and overflows, tire and brake wear, pet waste, pesticides, and fertilizers can be carried into estuaries, streams, rivers, and lakes through runoff. Soils and sediment can constitute a significant fraction of the solids on urban surfaces. Weather related erosion and transport of eroded soil (e.g., by wind and rain) increases solids in urban areas. Other sources of solids on urban surfaces are wear of automotive parts (brake pads, tires), combustion products from diesel- and gasoline-fueled engines, fireplaces, construction sites, and industrial facilities. An extensive discussion of these pollutants is presented in Chapter 1.

The goals of the new development runoff treatment management measure are to:

- Retain the predevelopment or pre-disturbance hydrological conditions of both surface and ground water;
- Remove suspended solids and associated pollutants entrained in runoff that result from activities occurring during and after development;
- Decrease the erosive potential of increased runoff volumes and velocities associated with development-induced changes in hydrology;

- Preserve natural systems, including in-stream habitat, riparian areas, and wetlands; and

- Reduce the thermal impacts that result from impervious surfaces and treatment devices with large amounts of surface exposed to sunlight such as wet ponds.

Several issues require clarification to fully understand the scope and intent of this management measure. The watershed protection (3), site development (4), and new development runoff treatment (5) management measures are intended to be used together within a comprehensive framework to reduce nonpoint source pollution. Applied on-site and throughout watersheds, these three management measures can be used together to provide increased watershed protection and help prevent erosion, flooding, and increased pollutant loads generally associated with poorly planned development. Implementation of the watershed protection and site development management measures can help achieve the goals of the new development runoff treatment management measure.

5.2.1.1 Pollutants and total suspended solids

Many pollutants bind to and are entrained in sediment or particulate loadings. Particulates include suspended, settleable, and bedload solids. Metals, phosphorus, nitrogen, hydrocarbons, and pesticides are commonly found in urban sediments. The correlation between total suspended solids (TSS) and specific pollutants may vary (URS Greiner Woodward Clyde, 1999).

TSS is a measure of the concentrations of sediment and other solid particles suspended in the water column of a stream, lake, or other water resource. TSS is an important parameter because it quantifies the amount of sediment entrained in runoff. This information can be used to link sources of sediments to the resulting sedimentation in a stream, lake, wetland, or other water resources. As shown previously, TSS is also an indirect measure of other pollutants carried by runoff, because nutrients (phosphorus), metals, and organic compounds are typically attached to sediment particles. For these reasons TSS was selected as the prime or sole parameter associated with the first element of this management measure.

Sansalone and Buchberger (1997) found that the relative proportional mass of heavy metals (Zn, Cu, Pb) in highway runoff and snowbank samples increased with decreasing particle size. This effect was attributed to the increase in surface area binding sites that were present with smaller particles. In another study, Sansalone et al. (1998) observed that the greatest mass of contaminants in highway runoff is found on particles in the 425 to 850 micron (μm) range. Because average particle size varies across the U.S., it makes sense to address the particle size that most effectively captures the highest percentage of associated pollutants.

The quantity and size range of the suspended particles measured and reported as TSS at any given time depends on many factors including:

- The composition and extent of the sources of suspended solids in the watershed;

- The magnitude and duration of storms or dry weather periods preceding the sampling;

- Flow velocity, turbulence, and other conditions that promote the suspension of solids in the water column; and

- The sampling techniques employed.

Generally, individual particles found in a TSS sample are 62 μm (0.062 μm) or less in diameter and classified as either silts or clays (Table 5.1). Solids greater than 62 μm can also be found in the water column if conditions are turbulent enough to keep them in suspension.

Table 5.1: Sediment particle size distribution (shaded classes are found in a typical urban TSS sample).

General Class	Class Name	Diameter (μm)
Sand	Very coarse sand	2000–1000
	Coarse sand	1000–500
	Medium sand	500–250
	Fine sand	250–125
	Very fine sand	125–62
Silt	Coarse silt	62–31
	Medium silt	31–16
	Fine silt	16–8
	Very fine silt	8–4
Clay	Coarse clay	4–2
	Medium clay	2–1
	Fine clay	1–0.5
	Very fine clay	0.5–0.24
	Colloids	< 0.24

Erosion and entrainment of solids in runoff occur primarily during rainfall. Rainfall varies in magnitude through time, with large rainstorms occurring less frequently than small showers. Collectively, all the rainfall occurring during the year contributes to the annual sediment yield from a site. In order to focus on typical annual yields, however, the management measure states that yield calculations are to be based on the average annual TSS loadings from all storms less than or equal to the two-year, 24-hour storm. Setting this threshold eliminates the need to calculate or integrate the impacts of larger infrequent storms into the average annual sediment yield calculation.

The annual TSS loadings can be calculated by adding the TSS loadings that can be expected during an average one-year period from precipitation events less than or equal to the two-year, 24-hour storm. Removal of 80 percent of TSS can be achieved by reducing, over the course of the year, 80 percent of these loadings.

Critics of the TSS standard suggest that the sampling and analysis protocols employed for this measure do not fully capture the entire range of particle sizes found in some kind of samples. More specifically, TSS protocols tend to under-sample larger solids and therefore yield lower-than-actual values for management practice pollutant removal efficiency. However, under-sampling the larger particles that would easily settle out in a runoff treatment control results in higher overall removal rates of solids and fewer solids discharged to surface waters.

There are alternatives to the TSS method, including turbidity and suspended sediment concentration (SSC). Monitoring turbidity in urban runoff is advantageous because the measurements can be conducted in situ using continuous methods (e.g., Secchi disk). It should be noted, however, that using turbidity as a surrogate for TSS may be appropriate only in instances where a strong statistical correlation has been established, such as in low-energy environments like lakes and estuaries. This correlation should be established on a case-by-case basis if turbidity is to be used as a surrogate.

The SSC method is used by the U.S. Geological Survey (USGS) as the standard for determining concentrations of suspended material in surface water samples (USGS, 2000). Gray et al. (2000) examined the comparability of SSC and TSS measurements. SSC and TSS are the predominant analytical methods used to quantify concentrations of solid-phase material in surface waters. SSC values are obtained by measuring the dry weight of all the sediment from a known volume of a water-sediment mixture. TSS data are produced by several methods, most of which involve measuring the dry weight of sediment from a known volume of a subsample of the original. Analysis of paired SSC and TSS data showed bias in the relationship between SSC and TSS. In samples where sand-size material was greater than nearly a quarter of the dry sediment mass, SSC values tended to be higher than corresponding paired TSS values.

According to Gray, the SSC method produces relatively reliable results for natural water samples, regardless of the amount or percentage of sand-size material in the samples. SSC and TSS are not comparable and should not be used interchangeably. Rather, the authors suggest using the SSC analytical method to enhance the accuracy and comparability of suspended solid-phase concentrations of natural waters (Gray et al., 2000). More information about the SSC analytical method can be found at http://www.astm.org/ by searching for standard number ASTM D 3977-97, *Standard Test Method for Determining Sediment Concentration in Water Samples* (ASTM International, 2002).

5.2.1.2 Runoff

Runoff management programs have traditionally focused on reducing or preventing induced flooding from new development. Performance standards were typically developed to control large storms, e.g., 50- or 100-year storms. Although the control of these large storms is still essential, it has become apparent in the last 20 years that a broad range of storms must be managed to prevent streambed and streambank erosion. Recent research points to the need to control total discharge volumes and rates so that they do not result in stream channel degradation. As a result, some states and local governments have developed performance requirements that are intended to prevent stream channel erosion as well as flooding of downstream properties.

This management measure was written to address the control of both peak runoff rates and average runoff volumes with the intent to maintain postdevelopment runoff characteristics at predevelopment levels. Even though EPA recommends that structural runoff controls be designed to control all storms less than or equal to the two-year, 24 hour storm, state and local governments should determine the locally appropriate storm size threshold to control based on local hydraulics, hydrology, meteorology and other regional and local factors. Watershed managers also should consider the development and implementation of volume and peak discharge performance standards to address problems associated with the frequency and duration of erosive flows (MacRae and Rowney, no date). The use of low-impact development (LID) techniques may be one way to achieve these goals (Prince Georges' County, Maryland, Department of Environmental Resources, 2000a, 2000b).

5.2.2 Management Measure Selection

This management measure was selected because of the following factors:

- Removal of 80 percent of TSS is assumed to control heavy metals, phosphorus, and other pollutants.

- Several states and local governments have implemented a TSS removal treatment standard of at least 80 percent. Table 5.2 presents TSS reduction standards and design criteria for select state and local runoff management programs.

- Analysis has shown that constructed wetlands, wet ponds, and infiltration basins can remove 80 percent of TSS, provided they are designed and maintained properly. Other practices or combinations of practices can also be used to achieve the goal.

- A number of flood control practices can control postdevelopment volume and peak runoff rates and maintain predevelopment hydrological conditions, which will reduce or prevent streambank erosion and stream scouring. Table 5.3 presents peak discharge and volume standards and design criteria for select local runoff management programs.

- Urban streams often experience elevated temperatures due to an increase in impervious areas and a decrease in vegetative cover that would normally provide shading for wetlands and stream channels. Many of the practices presented in this management measure and throughout this guidance, such as infiltration practices, riparian buffers, and urban forestry, help to lower stream temperatures. Practices such as retention ponds may contribute to temperature elevation and should not be used in areas with temperature-sensitive fish or macroinvertebrates unless the other measures are taken to counteract this effect (i.e., plant vegetation to shade ponds, wetlands, or channels).

Table 5.2: Select local and state programs with TSS performance standards (adapted from Watershed Management Institute [WMI], 1997a).

Community/State	Standard	Criteria
Olympia, WA	80 percent removal of suspended solids.	Treat runoff volume of six-month, 24 hr storm
Orlando, FL	Reduce average annual TSS loading by 80 percent.	Treat first half-inch of runoff or the runoff from the first inch of rainfall, whichever is greater.
Winter Park, FL	Reduce average annual TSS loading by 80 percent.	Treat the first inch of runoff by retention.
Baltimore Co., MD	Remove at least 80 percent of the average annual TSS loading.	Treat the first half-inch of runoff from the site's impervious area.
South Florida Water Management District	Remove at least 80 percent of the average annual TSS loading.	Treatment volume varies from 1.0 to 2.5 inches times percent impervious area.

Table 5.2 (continued).

Community/State	Standard	Criteria
Delaware	Remove at least 80 percent of the annual TSS loading.	Treat the first inch of runoff by approved management practices.
Florida	Remove at least 80 percent of the average annual TSS loading.	Treatment volume varies from 0.5 to 1.5 inches depending on the practice.
New Jersey	80 percent reduction in TSS.	Treat runoff volume of a storm of >1.25inches in two hours or the one-yr, 24-hr storm.
South Carolina	Remove at least 80 percent of the average annual TSS loading.	Treatment volume varies from 0.5 to 1.0 inch depending on the practice.

Table 5.3: Select local programs with peak discharge and/or runoff volume performance standards (adapted from WMI, 1997a).

Community/State	Peak discharge	Volume
Alexandria, VA	Postdevelopment rate cannot exceed predevelopment rate for two-yr and 10-yr, two-hr storm.	None
Austin, TX	Postdevelopment rate cannot exceed predevelopment rate for two-, 10-, 25-, and 100-yr, 24-hr storm.	None
Bellevue, WA	Postdevelopment rate cannot exceed predevelopment rate for two- and 10-yr, two-hr storm.	Multiple release rates for detention systems.
Olympia, WA	Postdevelopment rate cannot exceed predevelopment rate for two-yr and 100-yr, 24-hr storm.	Must infiltrate all of the 100-yr vol. on-site if percolation rate greater than 6 inches per hr.
Orlando, FL	Postdevelopment rate cannot exceed predevelopment rate for 25-yr, 24-hr storm.	In closed basins, retain runoff from 100-yr, 24-hr storm.
Washington, DC	Postdevelopment rate cannot exceed predevelopment rate for two-, 10-, and 100-yr, 24-hr storm.	None
Clark Co., WA	Postdevelopment rate cannot exceed predevelopment rate for two-, 10- and 100-yr, 24-hr storm.	Post-development vol. cannot exceed predevelopment vol. for two-yr, 24-hr storm.
SW Florida Water Management District	Postdevelopment rate cannot exceed predevelopment rate for 25-yr, 24-hr storm.	Post-development vol. cannot exceed predevelopment vol. for 25-yr, 24-hr storm.

General Performance Standards for Storm Water Management in Maryland

To prevent adverse impacts from runoff, the Maryland Department of the Environment (MDE, 2000) developed 14 performance standards for development sites. These standards apply to any construction activity disturbing 5,000 or more square feet of land. The following standards are required at all sites where runoff management is necessary:

- Site designs shall minimize runoff generation and maximize pervious areas for runoff treatment.
- Runoff generated from development and discharged directly into a jurisdictional wetland or waters of the State of Maryland shall be adequately treated.
- Annual ground water recharge rates shall be maintained by promoting infiltration through the use of structural and nonstructural methods. At a minimum, the annual recharge from postdevelopment site conditions shall mimic the annual recharge from predevelopment site conditions.
- Water quality management shall be provided through the use of structural and nonstructural controls.
- Structural management practices for new development shall be designed to remove 80 percent and 40 percent of the average annual postdevelopment TSS and total phosphorus loads, respectively. It is presumed that a management practice complies with this performance standard if it is sized to capture the prescribed water quality volume, designed according to the specific performance criteria outlined in the Maryland Stormwater Design Manual (MDE, 2000), constructed properly, and maintained regularly.
- On the Eastern Shore, the postdevelopment peak discharge rate shall not exceed the predevelopment peak discharge rate for the 2-year frequency storm event. On the Western Shore, local authorities may require that the postdevelopment 10-year peak discharge not exceed the predevelopment peak discharge if the channel protection storage volume (Cp_v) is provided. In addition, safe conveyance of the 100-year storm event runoff control practices shall be provided.
- To protect stream channels from degradation, Cp_v shall be provided by 12 to 24 hours of extended detention storage for the 1-year storm event. Cp_v shall not be provided on the Eastern Shore unless the appropriate approval authority deems it necessary on a case-by-case basis.
- Runoff to critical areas with sensitive resources may be subject to additional performance criteria or may need to use or restrict certain management practices.
- All management practices shall have an enforceable operation and maintenance agreement to ensure the system functions as designed.
- Every management practice shall have an acceptable form of water quality pretreatment.
- Redevelopment, defined as any construction, alteration, or improvement exceeding 5,000 square feet of land disturbance on sites where existing land use is commercial, industrial, institutional, or multi-family residential, is governed by special sizing criteria depending on the increase or decrease in impervious area created by the redevelopment.
- Certain industrial sites are required to prepare and implement a storm water pollution prevention plan (SWPPP) and file a notice of intent (NOI) under the provisions of Maryland's Storm Water NPDES general permit. The SWPPP requirement applies to both existing and new industrial sites.
- Runoff from land uses or activities with higher potential for pollutant loadings, sometimes referred to as hotspots, may require the use of specific structural runoff control and pollution prevention practices. In addition, runoff from a hotspot land use may not be infiltrated without proper pretreatment.
- In Maryland, local governments are usually responsible for storm water management review authority. Prior to design, applicants should always consult with their local reviewing agency to determine if they are subject to additional storm water design requirements. In addition, certain earth disturbances may require NPDES construction general permit coverage from MDE.

Delaware Urban Runoff Management Model

The Delaware Department of Natural Resources and Environmental Conservation (2005) developed the Delaware Urban Runoff Management Model (DURMM) to quantitatively estimate how "green technology" management practice designs achieve pollutant removal and flow reductions. Green technology includes the following management practices:

- Conservation site design
- Source area disconnection
- Biofiltration swales/grassed swales
- Terraces
- Bioretention structures
- Infiltration practices

These green technologies address some of the drawbacks of traditional runoff controls, including the following:

- Ponds and wetlands do not necessarily protect against streambank erosion
- Ponds and wetlands do not recharge groundwater.
- Ponds and wetlands require substantial land area
- Ponds and wetlands require significant maintenance.
- Discharges from multiple structural practices can overlap, resulting in downstream flooding.
- Discharges can elevate stream temperatures and sometimes contain high levels of algae.

DURMM provides a quantitative approach to define the benefits of conservation design and quantifies runoff reductions and pollutant reductions from filter strips, biofiltration and grassed swales, terraces, bioretention structures, and infiltration trenches. It also quantifies runoff reductions from source area disconnection. The Delaware Department of Natural Resources and Environmental Conservation is also developing a companion document specifically focused on riparian buffer system design.

Additional information on green technology BMPs or DURMM can be obtained by contacting Delaware's Division of Soil & Water Conservation at 302-739-4411.

5.2.3 General Categories of Urban Runoff Control

Structural practices to control urban runoff rely on several basic mechanisms:

- Infiltration;
- Filtration;
- Detention/retention; and
- Evaporation.

5.2.3.1 Infiltration practices

Infiltration facilities are designed to capture a treatment volume of runoff and percolate it through surface soils into the ground water system. This process:

- Reduces the total volume of runoff discharged from the site, which, in turn, decreases peak flows in storm sewers and downstream waters;

- Filters out sediment and other pollutants by various chemical, physical, and biological processes as runoff water moves through the bottom of the infiltration structure and into the underlying soil; and

- Augments ground water reserves by facilitating aquifer recharge. Groundwater recharge is vital to maintain stream and wetland hydrology. During dry weather, ground water recharge helps to assure baseflow necessary for survival of biota in wetlands and streams.

Treatment effectiveness depends on whether the facility is sited on-line or off-line, and on the sizing criteria used to design the facilities. Online systems receive all of the runoff from an area. Off-line practices receive diverted runoff for treatment and isolate it from the remaining fraction of runoff, which must still be controlled to prevent flooding. Off-line infiltration practices prevent all of the TSS and other pollutants contained in the volume of runoff infiltrated from exiting the site. Thus, the total annual load reduction depends on how much of the annual volume of runoff is diverted to the infiltration structure. On-line infiltration practices, on the other hand, have lower treatment effectiveness, averaging approximately 75 percent removal of TSS (WMI, 1997b).

The overall hydrologic benefits of infiltration practices may also vary depending on site characteristics and the frequency and intensity of storms. Holman-Dodds et al. (2003) modeled the potential for infiltration techniques to reduce the adverse hydrologic effects of urbanization. The study indicated that the greatest reductions in flow are achievable when rainfall is limited and relatively frequent, and when soils are relatively porous.

Infiltration facilities require porous soils (i.e., sands and gravels) to function properly. Generally, they are not suitable in soils with 30 percent or greater clay content or 40 percent or greater silt/clay content (WMI, 1997b). They are also not suitable:

- In areas with high water tables;
- In areas with shallow depth to impermeable soil layers;
- On fill sites, which have low permeability, or on steep slopes;
- In areas where infiltration of runoff would likely contaminate ground water;
- In areas where there is a high risk of hazardous material spills; or

- Where additional groundwater could form sinkholes.

Special protection for ground water is needed when runoff is used as a drinking water source in urban areas (see Management Measure 3—Watershed Protection). Certain types of infiltration facilities, called Class V injection wells, may be regulated as part of the federal Underground Injection Control (UIC) Program, authorized by the Safe Drinking Water Act. Class V wells discharge fluids underground. Class V wells include French drains, tile drains, infiltration sumps, and percolation areas with vertical drainage. Dry wells, bored wells, and infiltration galleries are all Class V wells. Class V wells do not include infiltration trenches filled with stone (with no piping), or excavated ponds, lagoons, and ditches (lined or unlined, without piping or drain tile) with an open surface. Compliance with federal regulations may include submitting basic inventory information about the drainage wells to the state or EPA and complying with specific construction, operation, permitting, and closure requirements (USEPA, 2003). Any questions regarding the applicability of the UIC regulations to a storm water facility should be directed to federal or state UIC contacts. This information is available at http://www.epa.gov/safewater/uic.html.

The effect of infiltration practices on ground water quality is unclear, but a few studies exist that indicate potential ground water quality concerns from infiltrating urban runoff (Pitt, et al., 1994; Fischer, no date; Ging et al., 1997, Morrow, 1999). For example, Fischer (no date) studied the effects of infiltration of urban runoff on ground water quality in the New Jersey Coastal Plain. He found that although many pollutants were removed from runoff before reaching the water table, elevated concentrations and occurrences of certain compounds and ions indicated contributions from urban runoff, implying that infiltration practices could have a detrimental effect on ground water quality. Conversely, Fischer hypothesized that infiltrating runoff would have the beneficial effect of diluting other compounds frequently present in ground water.

Pitt et al. (1994) summarized the potential for 25 pollutants to contaminate ground water, categorizing each as low, low/moderate, moderate, or high. Of these 25 pollutants, only one, chloride, has a high potential, and only fluoranthene and pyrene have a moderate potential. Nitrate, a highly soluble and mobile contaminant, was categorized as having a low/moderate potential for contamination, and the other 21 pollutants had low potential.

Heavy metals and hydrocarbons may pose a low risk of contamination, but several studies have indicated that concentrations of these pollutants decrease rapidly with depth (Barraud et al., 1999; Legret et al. 1999). Similarly, Dierkes and Geiger (1999) found that polycyclic aromatic hydrocarbons (PAHs) in highway runoff were removed in the top four inches of soil.

The presence of volatile organic compounds (VOCs) in ground water is another concern. A USGS study (Ging et al., 1997) analyzed the occurrence and distribution of VOCs in ground water in south-central Texas. Although less than 50 percent of the samples taken had VOC detections, 28 VOCs were detected in samples from 89 wells. Based on the results of this study, VOC contamination in ground water appears to be associated with urban development (Ging et al., 1997).

VOC contamination has also been detected in the ground water of the Lower Illinois River Basin. In 1996, water samples collected from 60 wells in the basin were sampled and analyzed for VOCs. There were only six VOC detections in more than 4,300 analyses of the ground water samples (although at least three of these detections may have been caused by well disinfection practices). Additionally, a VOC was detected in one sample from deep glacial drift, indicating that shallow aquifers may be more susceptible to VOC contamination than deep aquifers. Based on these results, the authors concluded that VOC contamination does not appear to be a major concern for ground water quality in rural areas of the Lower Illinois River Basin (Morrow, 1999).

Several studies have found that the potential for ground water contamination, particularly from heavy metals and hydrocarbons, is low when porous pavement and stone-filled subsurface infiltration beds are used. These systems provide treatment through adsorption, filtration, sedimentation, and biodegradation before runoff reaches the underlying soil (Balades et al., 1995; Legret and Colandini, 1999; Newman et al., 2002; Pratt et al., 1999; Swisher, 2002).

5.2.3.2 Filtration practices

Filtration practices are so named because they filter particulate matter from runoff. The most common filtering medium is sand, but other materials, including peat/sand combinations and leaf compost material, have been used. Filtration systems provide only limited flood storage; therefore, they are most often implemented in conjunction with other types of quantity control management practices. Most filtration techniques require a forebay or clarifier to remove larger particles in runoff from clogging the filter media.

Biofiltration refers to practices that use vegetation and amended soils to retain and treat runoff from impervious areas. Treatment is through filtration, infiltration, adsorption, ion exchange, and biological uptake of pollutants.

5.2.3.3 Detention/retention practices

Runoff *detention* facilities provide pollutant removal by temporarily capturing runoff and allowing particulate matter to settle prior to release to surface waters. Dry detention runoff management ponds are one type of detention facility. Peak flows are reduced in drainage systems/receiving waters downstream of detention facilities.

Runoff *retention* facilities are used to capture runoff, which is subsequently withdrawn or evaporated. Therefore, peak flows and total flow volume can be reduced in downstream drainage systems/receiving waters. Wet runoff management ponds are one type of retention facility. These retention facilities can be designed to accept flow from receiving streams/drainage systems offline.

Both detention and retention facilities can use biological uptake as a mechanism for pollutant removal. Runoff management ponds can be designed to control the peak discharge rates, thereby reducing excessive flooding and downstream erosion in reaches of the drainage system/receiving stream immediately downstream. At some point downstream, however, runoff flow that is not retained will increase the volume of total flow, thereby increasing the risk of flooding and erosion if the receiving stream at that point does not have a stable channel and riparian area or floodplain.

Constructed wetlands are engineered systems designed to employ the water quality improvement functions of natural wetlands to treat and contain surface water runoff pollution and decrease pollutant loadings to surface waters. They can be designed with extended detention to control runoff peak flow and volume. Where site-specific conditions allow, constructed wetlands and retention basins should be located to minimize the impact on the surrounding areas (e.g., in upland areas of the watershed). Ponds, constructed wetlands, and other structural management practices degrade the functions of natural buffer areas and natural wetlands, and they may also interrupt surface water and ground water flow when soils are disturbed for installation. Therefore, the placement of structural management practices in natural buffers and natural wetlands should be avoided where possible.

5.2.3.4 Evaporation practices

Runoff detention and retention facilities and other practices that temporarily store runoff can also evaporate it. Evaporation from runoff detention and retention areas such as rooftops, streets, basins, and ponds can be an important mechanism for runoff management in warm, dry climates.

5.3 Management Practices

Management practices to control urban runoff can be classified in seven categories. The following practices are described for illustrative purposes only. EPA has found these practices to be representative of the types of practices that can be applied successfully to achieve the new development runoff treatment management measure. As a practical matter, EPA anticipates that the management measure can be achieved by applying one or more management practices appropriate to the source(s), location, and climate. Thus, practices that by themselves do not achieve 80 percent TSS removal can be combined with other practices to achieve 80 percent removal (such that x + y + z = 80 percent). This is the "treatment train" approach, in which several types of practices are used together and integrated into a comprehensive runoff management system (WMI, 1997b). The seven categories include:

- Infiltration practices;
- Vegetated open channel practices;
- Filtering practices;
- Detention ponds or vaults;
- Retention ponds;
- Wetlands; and
- Other practices such as water quality inlets.

5.3.1 Infiltration Practices

These practices capture and temporarily store runoff before allowing it to infiltrate into the soil over several days. Design variants include:

- Infiltration basins;
- Infiltration trenches; and
- Pervious or porous pavements.

To prevent premature clogging, these practices must not receive drainage from a construction activity or site. Infiltration practices can be placed in service after the construction activity is complete or the site is stabilized.

5.3.1.1 Infiltration basins

Infiltration basins (Figure 5.1) are impoundments created by excavation or creation of berms or small dams. They are typically flat-bottomed with no outlet and are designed to temporarily store runoff generated from adjacent drainage areas (from 2 to 50 acres, depending on local conditions). Runoff gradually infiltrates through the bed and sides of the basin, ideally within 72 hours, to maintain aerobic conditions and ensure that the basin is ready to receive runoff from the next storm. Infiltration basins are often used as an off-line system for treating the first flush of runoff flows or the peak discharges of the two-year storm.

The key to successful operation is keeping the soils on the floor and side slopes of the basin unclogged to maintain the rate of percolation. This is usually much easier said than done. For example, Schueler (1992) reported infiltration basin failure rates ranging from 60 to 100 percent

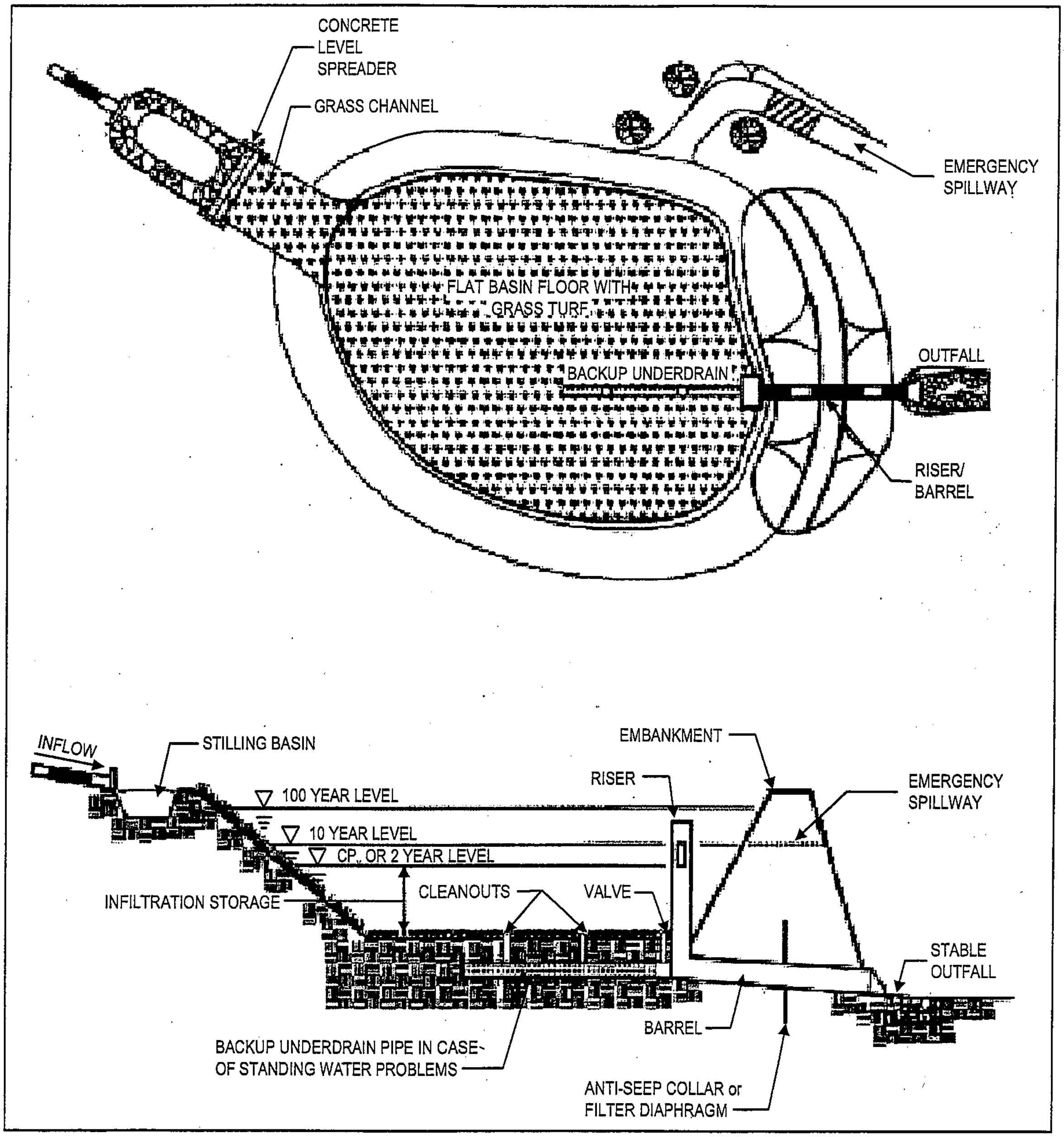

Figure 5.1: Schematic of an infiltration basin (MDE, 2000).

in the mid-Atlantic region. To help keep sediment out of the basin, incoming runoff should be pretreated using vegetated filter strips, a settling forebay, or other techniques. Grasses or other vegetation should also be planted and maintained in the basin. If soil pores become clogged, the basin bottom should be roughened or replaced to restore percolation rates.

5.3.1.2 Infiltration trenches

Infiltration trenches (Figure 5.2) are shallow (2- to 10-feet deep) excavated ditches with relatively permeable soils that have been backfilled with stone to form an underground reservoir. The trench surface can be covered with a grating or can consist of stone, gabion, sand, or a grass-covered area with a surface inlet. Runoff diverted into the trench gradually infiltrates into the subsoil and, eventually, into the ground water. Trenches can be used on small, individual sites or for multi-site runoff treatment. Pretreatment controls such as vegetated filter strips should be incorporated into the design to remove sediment and reduce clogging of soil pores. More expensive than pond systems in terms of cost per volume of runoff treated, infiltration trenches are best-suited for drainage areas of less than 5 to 10 acres, or where ponds cannot be used.

Variations in the design of infiltration trenches include dry wells, which are pits designed to control small volumes of runoff (such as rooftop runoff) and exfiltration trenches. A typical dry well design includes a perforated pipe 3 to 4 feet in diameter that is installed vertically in deposits of gravely/sandy soil. Rock is then backfilled around the base of the well. An exfiltration trench is an infiltration trench that stores runoff water in a perforated or slotted pipe and percolates it out into a surrounding gravel envelope and filter fabric. Dry wells and other infiltration practices that involve subsurface drainage may be regulated by EPA's Underground Injection Control Program. See the EPA's Underground Injection Control Program Web site at http://www.epa.gov/safewater/uic.html for more information.

5.3.1.3 Pervious or porous pavements

Pervious pavement has the approximate strength characteristics of traditional pavement but allows rainfall and runoff to percolate through it. The key to the design of these pavements is the elimination of most of the fine aggregate found in conventional paving materials. There are two types of pervious pavement, porous asphalt and pervious concrete (WMI, 1997b). Porous asphalt has coarse aggregate held together in the asphalt with sufficient interconnected voids to yield high permeability. Pervious concrete, in contrast, is a discontinuous mixture of Portland cement, coarse aggregate, admixtures, and water that also yields interconnected voids for the passage of air and water. Underlying the pervious pavement are a filter layer, a stone reservoir, and a filter fabric. Stored runoff gradually drains out of the stone reservoir into the subsoil. Figure 5.3 shows several types of porous pavement. More information about pervious pavement can be found at http://www.gcpa.org/pervious_concrete_pavement.htm (Georgia Concrete & Products Association, 2003).

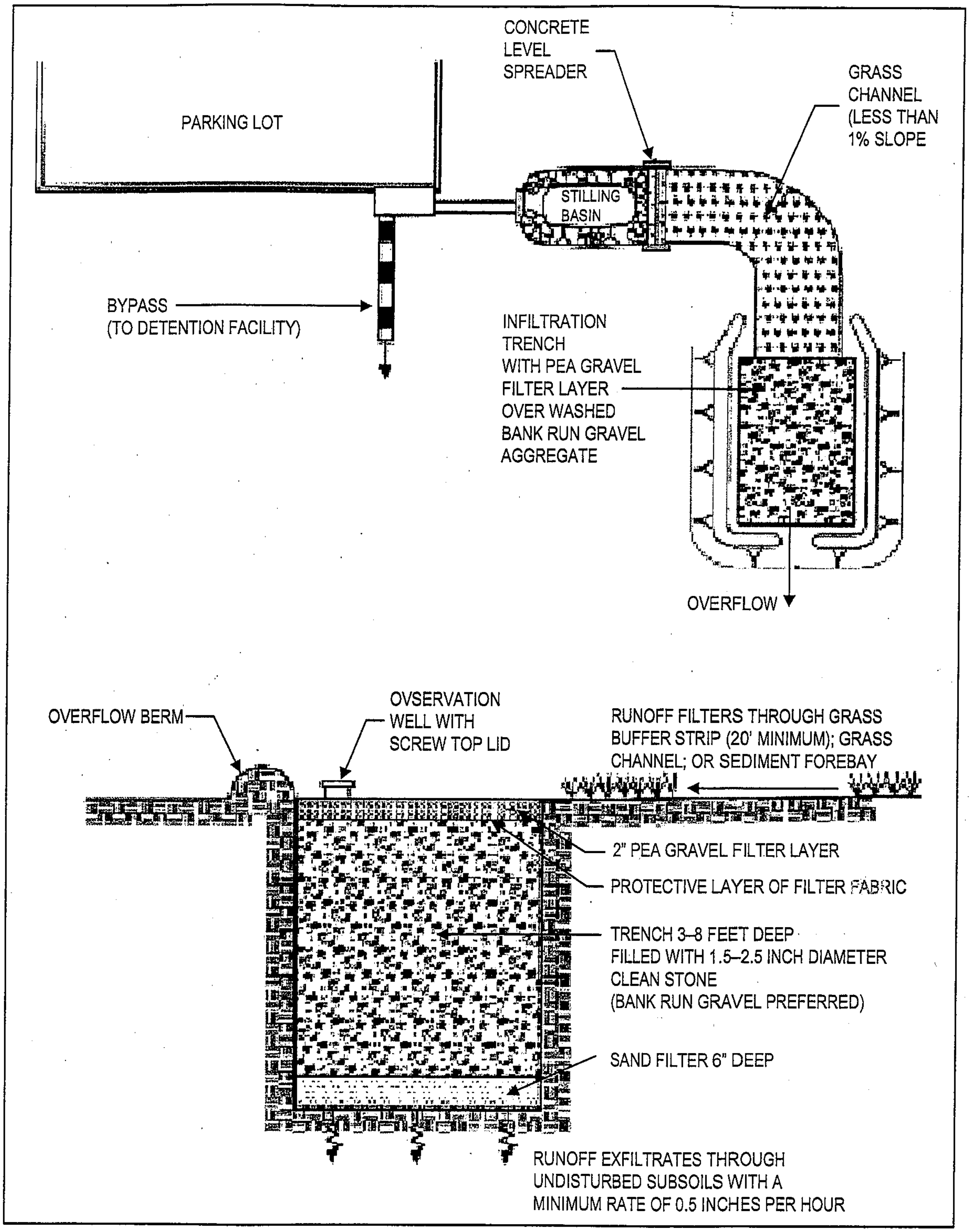

Figure 5.2: Schematic of an infiltration trench (MDE, 2000).

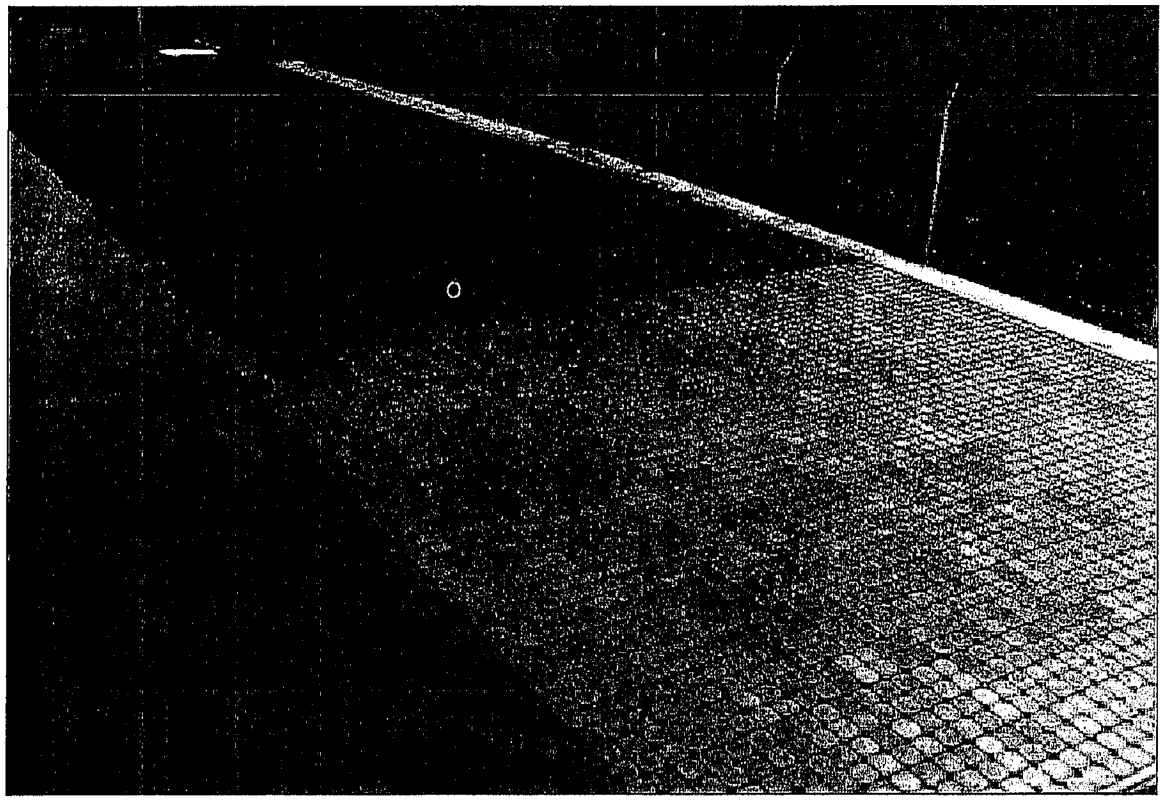

Figure 5.3: Photo showing several types of pervious modular pavement installations.

Modular pavement consists of individual blocks made of pervious material such as sand, gravel, or sod interspersed with strong structural material such as concrete. The blocks are typically placed on a sand or gravel base and designed to provide a load-bearing surface that is adequate to support personal vehicles, while allowing infiltration of surface water into the underlying soils. They usually are used in low-volume traffic areas such as overflow parking lots and lightly used access roads. An alternative to pervious and modular pavement for parking areas is a geotextile material installed as a framework to provide structural strength. Filled with sand and sodded, it provides a completely grassed parking area. More information about concrete pavers can be found at http://www.concretenetwork.com/concrete/porous_concrete_pavers/ (Concretenetwork.com, 2003).

Some states no longer promote the use of porous pavement because it tends to easily clog with fine sediments (Washington Department of Ecology, 1991). If this type of pavement is installed, a vacuum-type street sweeper should be used regularly to maintain porosity. Frequent washing with a high-pressure jet of water can also keep pores clear of clogging sediments. Sites where pervious pavement is to be installed must have deep, permeable soils, slopes of less than 5 percent, and no heavy vehicle traffic.

The City of Kinston, North Carolina, installed a permeable pavement parking lot as a demonstration and research project and to meet the daily parking needs of city employees (Hunt and Stevens, 2001). The final parking lot design included 26 stalls; 20 of the stalls were

The Bath Club Concourse Storm Water Rehabilitation Project, Florida

The Bath Club Concourse is located on a small barrier island community in North Redington Beach, Florida. A combination roadway and parking area, which connects Bath Club Circle and Gulf Boulevard, was previously an impervious slab of concrete pavement. The concourse could not absorb falling rain, which caused runoff to flow directly into a single storm sewer. The sewer would then carry pollutants directly to Boca Ciega Bay. In August 1990, the Water Management District and the town agreed to construct a stormwater rehabilitation project using pervious concrete pavement at the Bath Club Concourse (USEPA, 1999).

The main objective of the rehabilitation project was to reduce nonpoint source pollutant loading by reducing the volume of runoff discharging directly into Boca Ciega Bay. A second objective was to demonstrate an innovative way to treat or improve the quality of runoff in highly urbanized areas, where it can sometimes be difficult or expensive to manage runoff because of land constraints.

To maximize infiltration of runoff and reduce the amount of untreated runoff discharged directly into storm sewers, drainage was directed toward two pervious concrete parking areas. These areas were separated by an unpaved island in the center of the concourse, which also provides infiltration. Engineers installed two 150-foot under-drains to maximize infiltration by allowing subsurface soils to drain beneath the parking areas.

The rehabilitation project resulted in a significant reduction of direct discharge of runoff from the site. Estimates indicate that these improvements resulted in a 33 percent reduction in total on-site runoff volume. Additionally, the volume of surface runoff discharging directly to Boca Ciega Bay was reduced by nearly 75 percent. Overall removal efficiencies for the project, which are based on the pollutant removal efficiency of the under-drain/filter system, indicate that the project can remove 73 percent of lead (Bateman et al., no date). Other removal efficiencies and additional information about the project are available at http://www.stormwaterauthority.org/assets/103BFloridaRetrofits.pdf.

constructed using a concrete block paver filled with and overlaying sand, while the other six were constructed using a plastic grid paver with sandy soil and Bermuda grass. Monitoring results from a two-year study showed a 3- to 5-time reduction in peak runoff for storms greater than 0.5 inches based on calculated runoff coefficients (using the rational method). Of 48 rainstorms, only 11 (less than 25 percent) resulted in runoff generated from the parking lot The researchers found that annual maintenance to scarify the surface of the lot with a street sweeper helps to maximize permeability of the pavement. More information about the study, including several design recommendations, can be found at http://www5.bae.ncsu.edu/programs/extension/wqg/issues/101.pdf.

Brattebo and Booth (2003) examined the long-term effectiveness of permeable pavement by testing four commercially available permeable pavement systems for six years of regular parking use. The systems included the following:

- A flexible plastic grid system with virtually no impervious area, filled with sand and planted with grass;
- An equivalent plastic grid, filled with gravel;
- A concrete block lattice with approximately 60 percent impervious coverage, filled with soil and planted with grass; and

- Small concrete blocks with approximately 90 percent impervious coverage, with the spaces between blocks filled with gravel.

At the end of the study, none of the systems showed major signs of wear. The pavements infiltrated nearly all rainwater, generating almost no surface runoff. The researchers compared the quality of infiltrated water to surface runoff from an asphalt area and found significantly lower levels of copper and zinc in the infiltrated water. Motor oil was not detected in infiltrated water but was detected in 89 percent of samples of surface runoff from asphalt. Measurements of infiltrated rainwater from five years earlier showed significantly higher concentrations of zinc and lower concentrations of copper and lead.

5.3.2 Vegetated Open Channel Practices

Vegetated open channels are explicitly designed to capture and treat runoff through infiltration, filtration, or temporary storage.

A vegetated swale is an infiltration practice that usually functions as a runoff conveyance channel and a filtration practice. It is lined with grass or another erosion-resistant plant species that serves to reduce flow velocity and allow runoff to infiltrate into ground water. The vegetation or turf also prevents erosion, filters sediment, and provides some nutrient uptake benefits. These practices are also known as biofiltration swales. Check dams are often used to reduce flow velocity. When used, sediment that collects behind check dams should be removed regularly.

Two types of channels are typically used in residential landscapes:

- *Grass channels*. These have dense vegetation, a wide bottom, and gentle slopes (Figure 5.4). Usually they are intended to detain flows for 10 to 20 minutes, allowing sediments to filter out.

- *Dry swales*. As with grass channels, runoff flows into the channel and is subsequently filtered by surface vegetation (Figure 5.5). From there, runoff moves downward through a bed of sandy loam soil and is collected by an underdrain pipe system. The treated water is delivered to a receiving water or another structural control. Dry swales are used in large-lot, single-family developments and on campus-type office or industrial sites. They are applicable in all areas where dense vegetative cover can be maintained. Because of a limited ability to control runoff from large storms, they are often combined with other structural practices. They should not be used in areas where flow rates exceed 1.5 feet per second unless additional erosion control measures, such as turf reinforcement mats, are used.

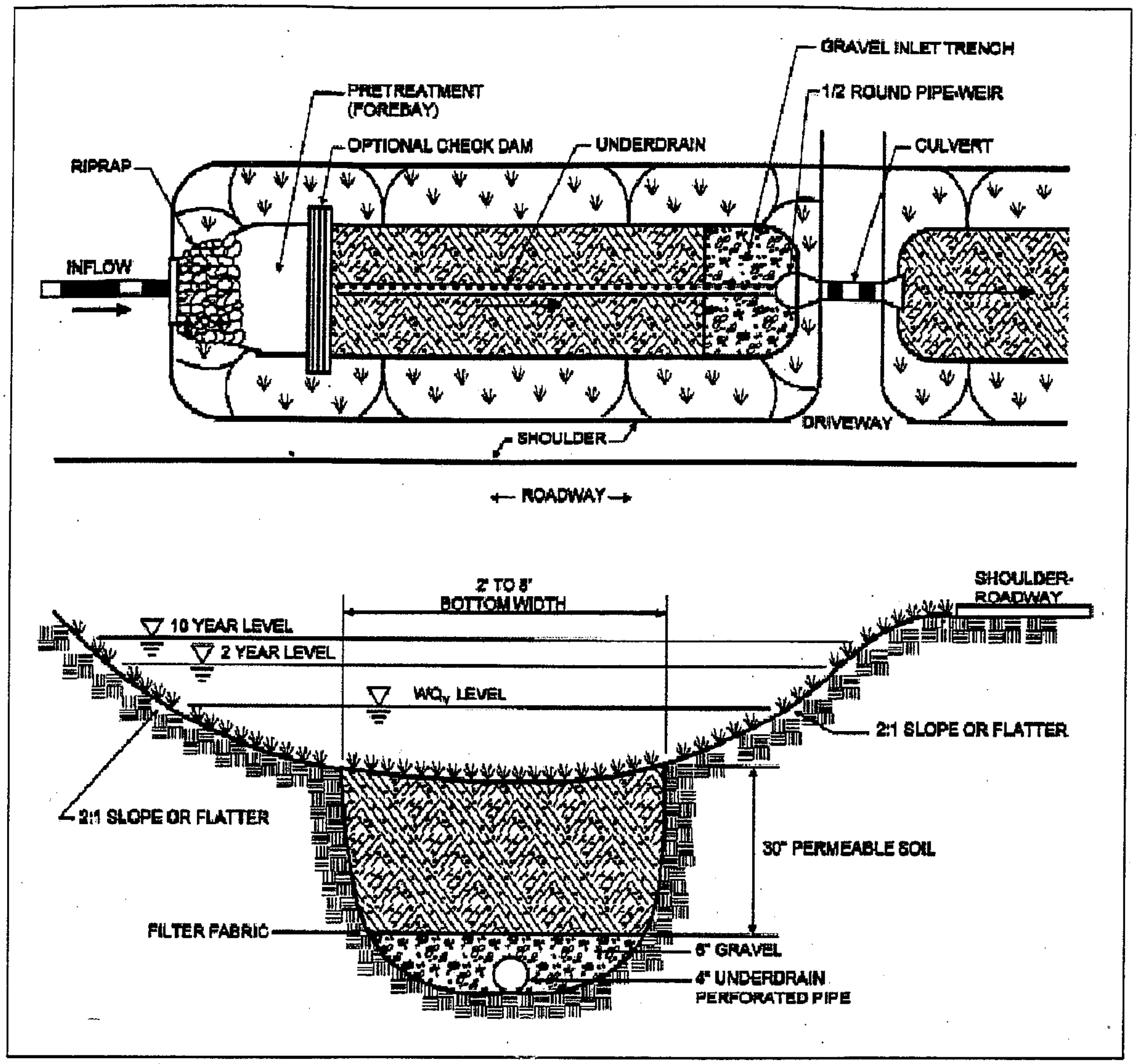

Figure 5.4: Schematic of a grass channel (Claytor and Schueler, 1996).

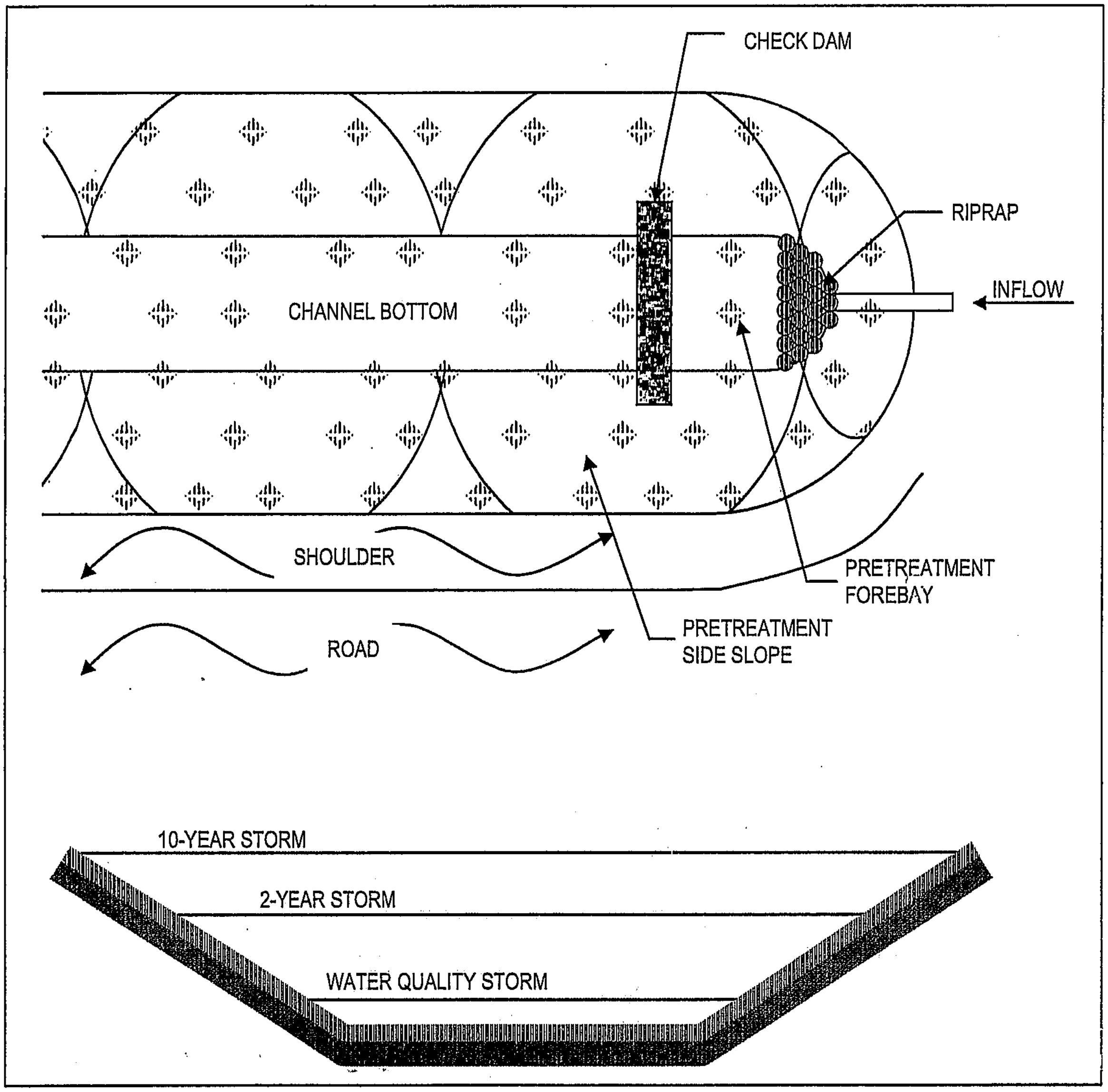

Figure 5.5: Schematic of a dry swale (adapted from MDE, 2000).

In a research study conducted by J.F. Sabourin and Associates (1999), two grass swale/perforated pipe systems and one conventional curb-and-gutter system were compared. Flow monitoring results indicate that much less water reached the outlet of the perforated pipe systems than the conventional system. Peak flows and total runoff volumes from the outlet of the perforated pipe/grass swale system were 2 to 6 percent of those of the conventional system, and total runoff volumes were 6 to 30 percent of conventional system volumes. Water quality monitoring results indicate that for most elements, concentrations measured in the perforated pipes were the same or lower than in the conventional system. Chloride concentrations were found to be higher in the perforated pipe system, most likely from the use of road salt. However, a loading analysis indicated that the perforated pipes released significantly fewer pollutants than the conventional system.

The authors also performed video inspections of the swale/perforated pipe sewershed. These inspections revealed a few interesting issues that can affect the performance of perforated pipe systems. Several unauthorized sanitary sewer connections had been made by some residents, and several raccoons were found living inside the pipes. Both can contribute to nutrient and pathogen problems in receiving waters.

J.F. Sabourin and Associates concluded that infiltration capacities of grass swales are optimum when they allow for proper drainage and hold enough moisture for sustaining grass and plant life. Exfiltration tests indicated that runoff volumes can be reduced by 40 to 60 percent by grass swales and perforated pipe drainage systems. With a direct connection, peak outflows can be 45 percent of the inflow.

5.3.3 Filtering Practices

Filtering practices capture and temporarily store runoff and pass it through a filter bed of sand, organic matter, soil, or other media. Filtered runoff may be collected and returned to the conveyance system, or allowed to exfiltrate into the soil. Design variants include:

- Surface sand filter;
- Underground sand filter;
- Organic filter;
- Pocket sand filter; and
- Bioretention areas.

5.3.3.1 Filtration basins and sand filters

Filtration basins are impoundments lined with a filter medium such as sand or gravel. Runoff drains through the filter medium and through perforated pipes into the subsoil. Detention time is typically four to six hours. Sediment-trapping structures are often used to prevent premature clogging of the filter medium (NVPDC, 1980; Schueler et al., 1992).

Sand filters are usually two-chambered practices: the first is a settling chamber and the second is a filter bed filled with sand or another filtering medium. As runoff flows into the first chamber, large particles settle out and finer particles and other pollutants are removed as runoff flows through the filtering medium. There are several modifications of the basic sand filter design, including the surface sand filter, underground sand filter, perimeter sand filter, organic media filter, and multi-chambered treatment train (Robertson et al., 1995). All of these filtering practices operate on the same basic principle. Modifications to the traditional surface sand filter were made primarily to fit sand filters into more challenging site designs (e.g., underground and perimeter filters) or to improve pollutant removal (e.g., organic media filter). The following are design variations for sand filtration devices:

(1) *Surface sand filter*. The surface sand filter (Figure 5.6) is an aboveground filter design. Both the filter bed and the sediment chamber are aboveground. The surface sand filter is designed as an off-line practice; only the water quality volume is directed to the filter. The surface sand filter is the least-expensive filter option and has been the most widely used.

(2) *Underground sand filter*. The underground sand filter (Figure 5.7) is a modification of the surface sand filter, where all of the filter components are underground. Like the surface sand filter, this practice is an off-line system that receives only flows from small rainstorms. Underground sand filters are expensive to construct but consume very little space. They are well-suited to highly urbanized areas, and often included in groups of practices known as "ultra-urban BMPs."

(3) *Perimeter sand filter*. The perimeter sand filter (Figure 5.8) also includes the basic design elements of a sediment chamber and a filter bed. In this design, however, flow enters the system through grates, usually at the edge of a parking lot. The perimeter sand filter is the only filtering option that is on-line; all flow enters the system, but a bypass to an overflow chamber prevents system flooding. One major advantage of the perimeter sand filter design is that it requires little hydraulic head and thus is a good option in areas of low relief.

(4) *Organic media filter*. Organic media filters (Figure 5.9) are essentially the same as surface filters, with the sand replaced with or supplemented by another medium. Two examples are the peat/sand filter (Galli, 1990) and the compost filter system. It is assumed that these systems will provide enhanced pollutant removal for many compounds because of the increased cation exchange capacity achieved by increasing organic matter content.

(5) *Multi-chambered treatment train*. The multi-chambered treatment train (Figure 5.10) is essentially a "deluxe sand filter" (Robertson et al., 1995). This underground system consists of three chambers. Runoff enters into the first chamber where screening occurs, trapping large sediments and releasing highly volatile materials. The second chamber provides settling of fine sediments and further removal of volatile compounds and floatable hydrocarbons through the use of fine bubble diffusers and sorbent pads. The final chamber provides filtration by using a sand and peat mixed medium for reduction of the remaining pollutants. The top of the filter is covered by a filter fabric that evenly distributes the water volume and prevents channelization. Although this practice can achieve very high pollutant removal rates, it might be prohibitively expensive in many areas. It has been implemented only on an experimental basis.

(6) *Exfiltration/partial exfiltration*. In exfiltration designs, all or part of the underdrain system is replaced with an open bottom that allows infiltration to the ground water. When the underdrain is present, it is used as an overflow device in case the filter becomes clogged. These designs are best applied in the same soils where infiltration practices are used.

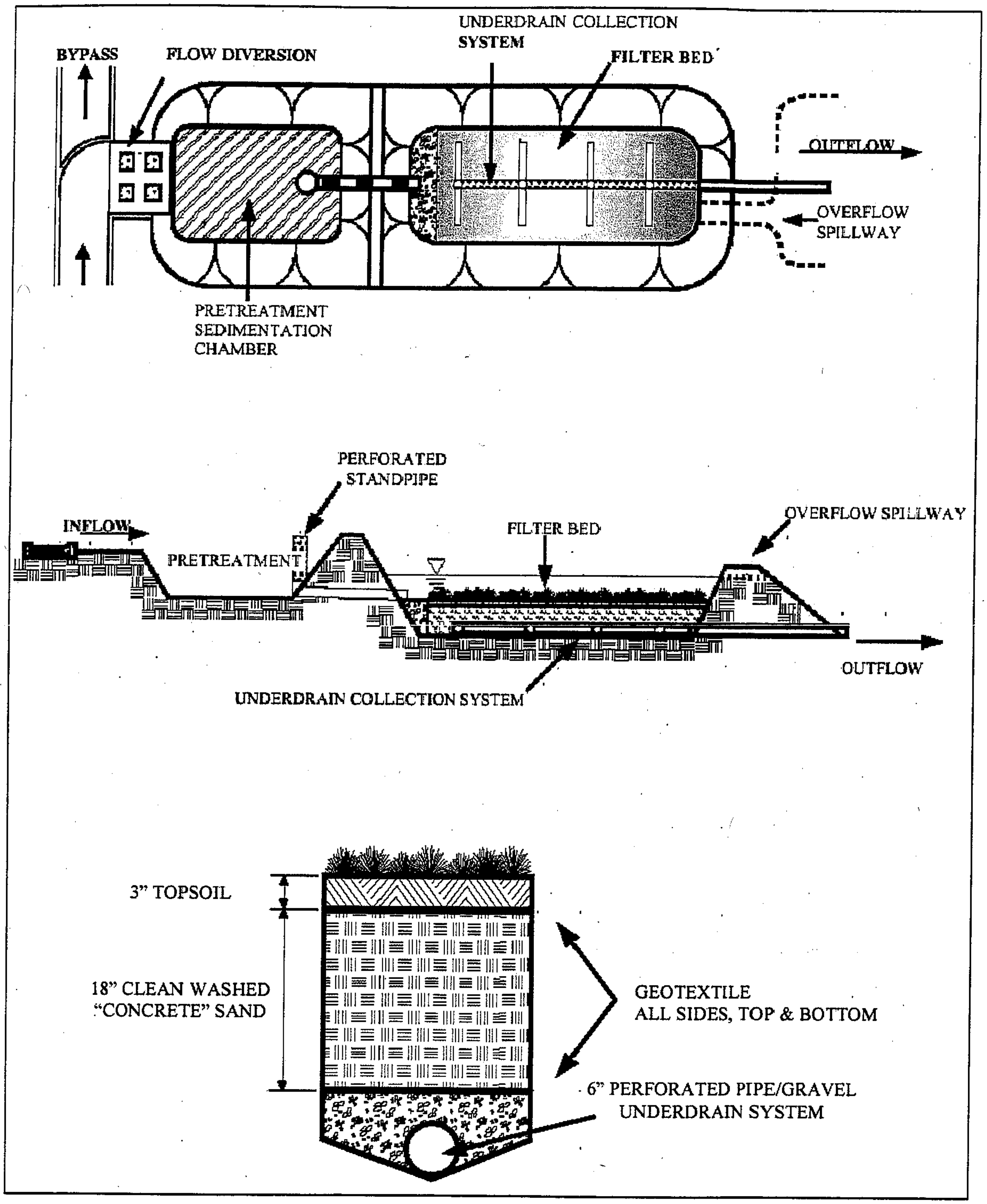

Figure 5.6: Schematic of a surface sand filter (MDE, 2000).

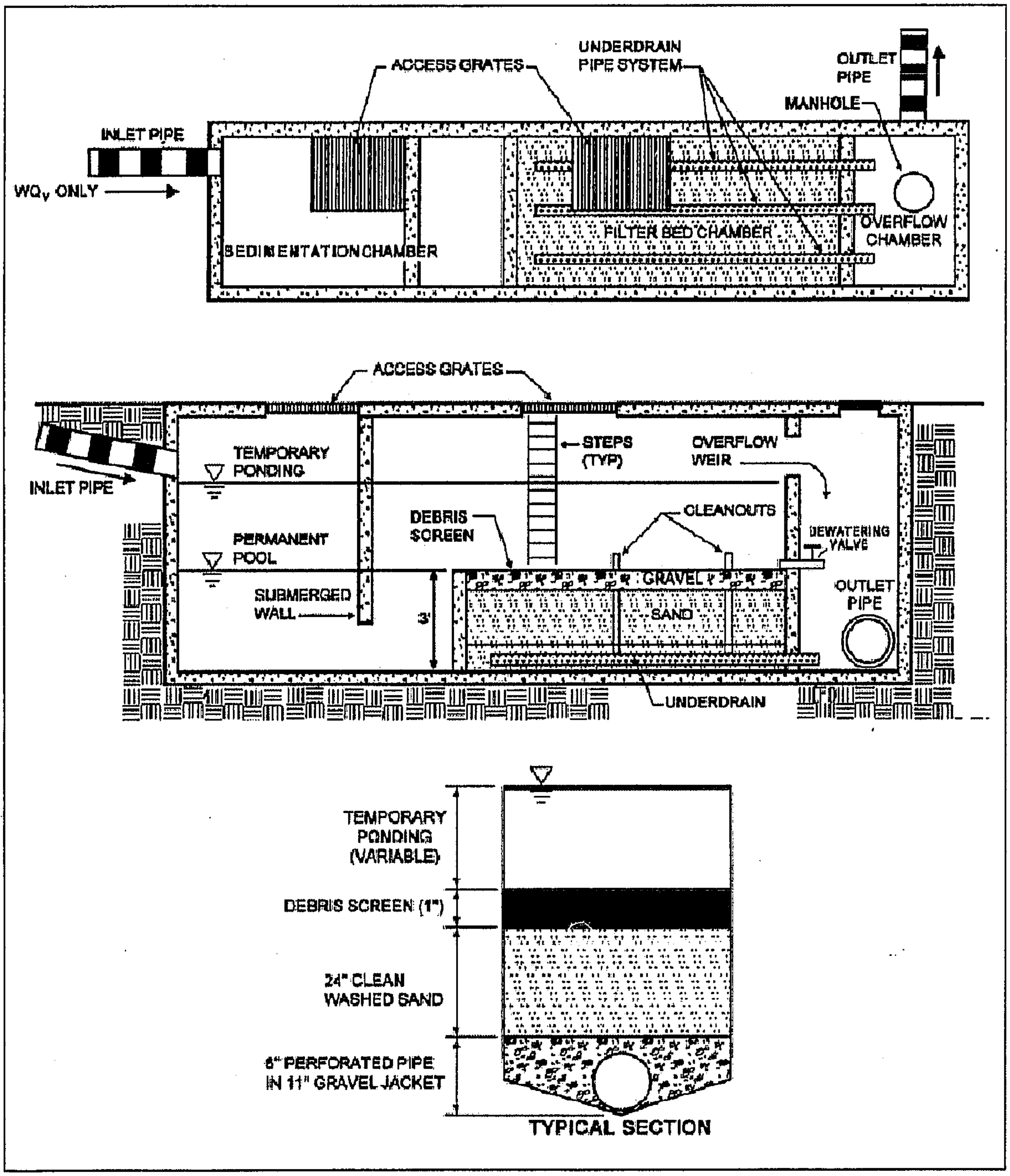

Figure 5.7: Schematic of an underground sand filter (MDE, 2000).

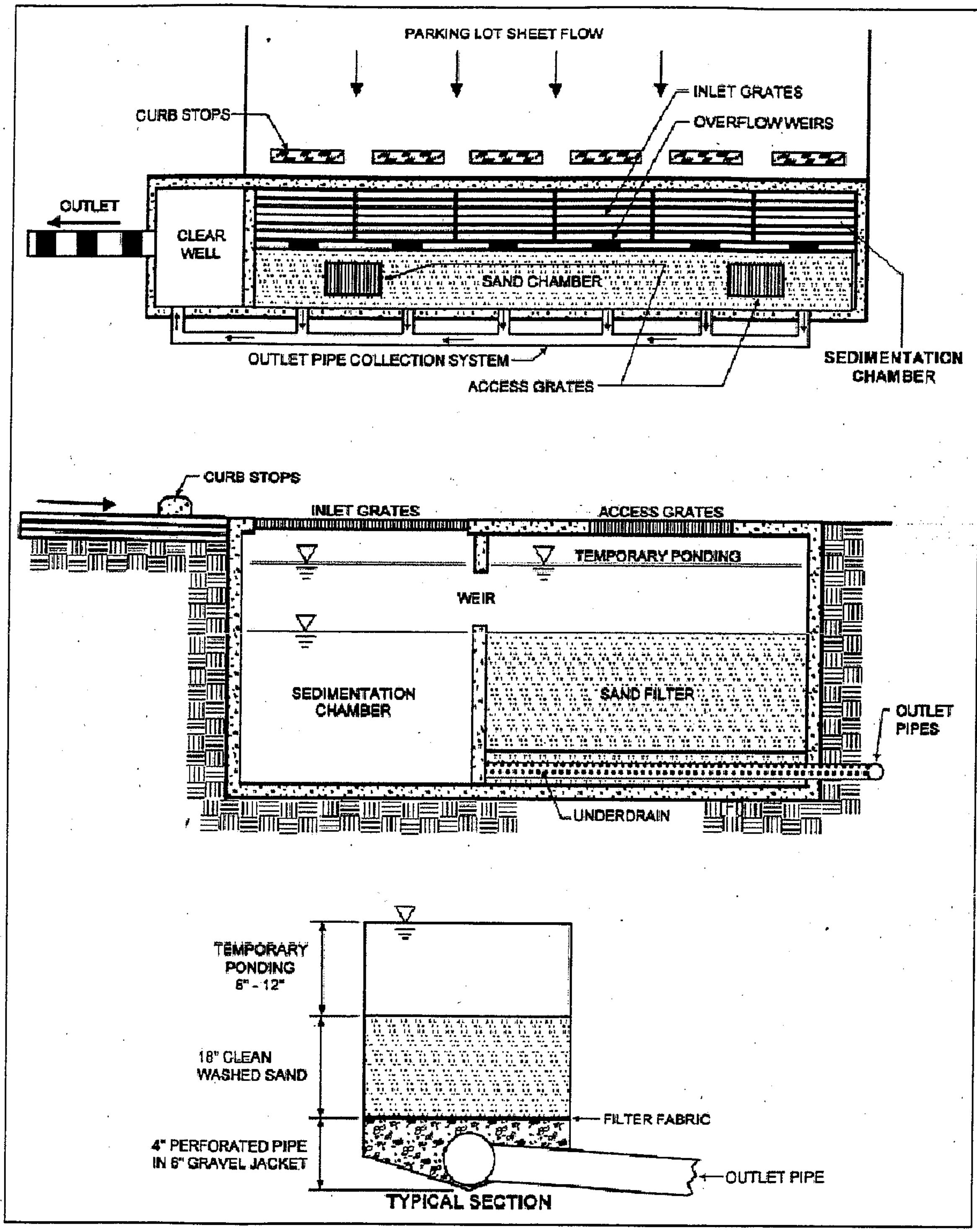

Figure 5.8: Schematic of a perimeter sand filter (MDE, 2000).

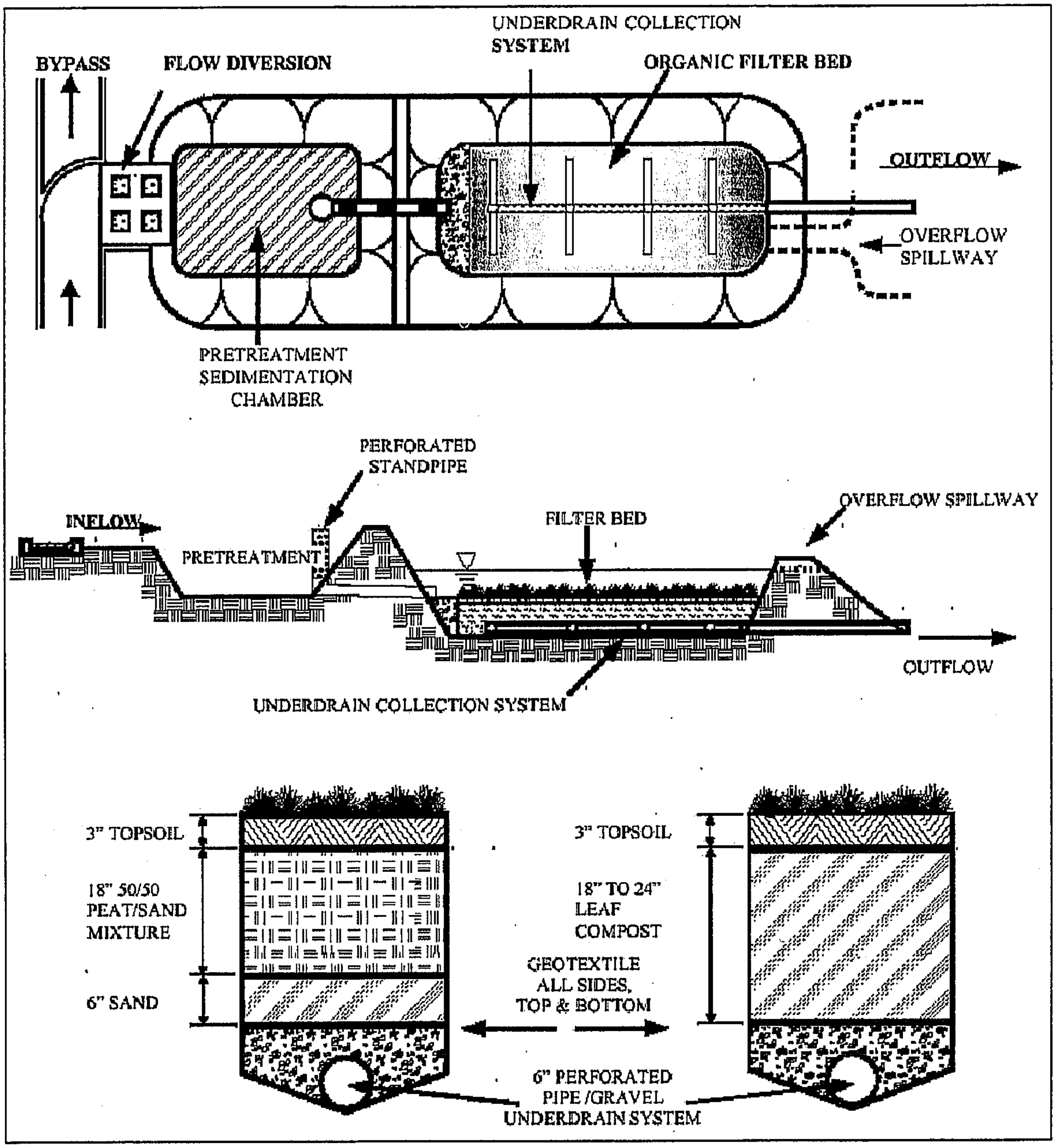

Figure 5.9: Schematic of an organic media filter (MDE, 2000).

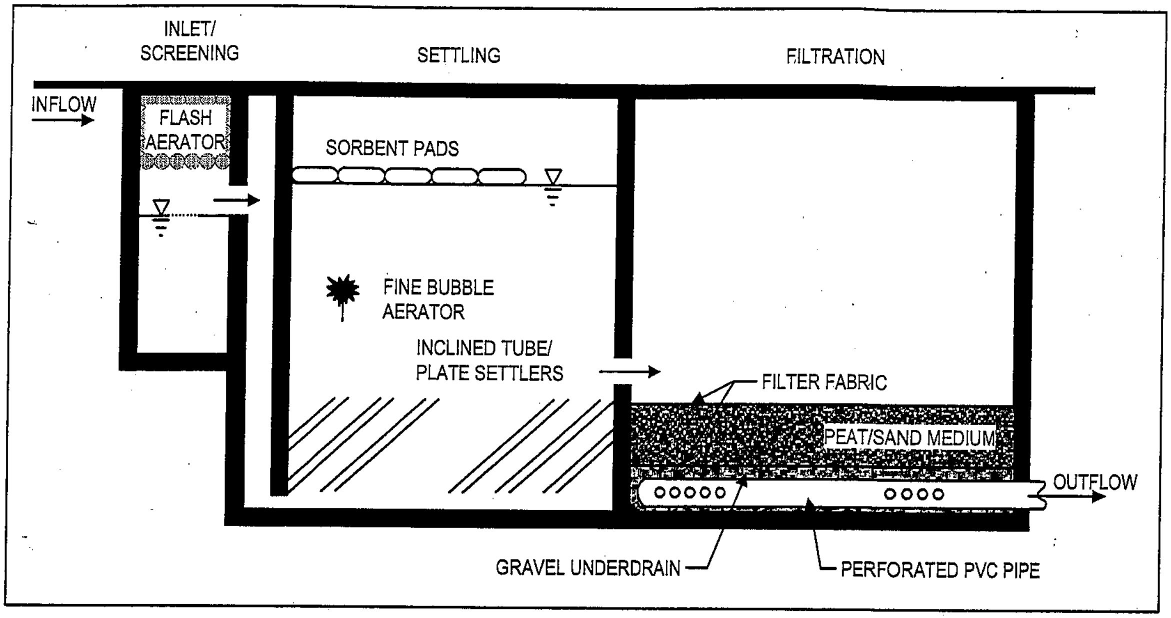

Figure 5.10: Schematic of a multi-chambered treatment train (Pitt, 1996).

5.3.3.2 Media filtration units

Similar to wastewater treatment technology, passive filtration units can be used to capture pollutants from runoff. Media filtration practices commonly use trenches filled with sand or peat. Other media, including types of crushed rock and composted leaves, can also be used. A basin collects the runoff and gradually routes discharge through cartridges filled with filter media. An emergency bypass prevents system flooding during large rainstorms. According to the Unified Sewerage Agency of Washington County in Oregon (WEF, 1998), composted leaf media trap particulates, adsorb organic chemicals, and remove 90 percent of solids, 85 percent of oil and grease, and 82 to 98 percent of heavy metals through cation exchange from leaf decomposition. Similar types of systems with various filter media are available commercially.

Performance of a Compost Storm Water Treatment System in Hillsboro, Oregon

A compost storm water treatment facility was constructed to treat runoff from 3.9 acres of 5-lane arterial road and 70.1 acres of mixed residential land use in Hillsboro, Oregon (FHWA, no date). The system consists of a discharge pipe that conveys runoff from the drainage area into a forebay. Runoff then flows over a wooden baffle into two consecutive cells filled with Portland leaf compost material. After runoff filters through the compost medium, it is discharged to a rock drainbed separated from the compost by a layer of filter fabric.

Monitoring of the effluent between 1991 and 1994 showed average mass balance pollutant removals of 81 percent for oils and grease, 84 percent for petroleum hydrocarbons, 58 percent to 94 percent for nutrients, and 68 percent to 93 percent for metals. See Table 5.4 for additional pollutant removal results. More details on the design and performance of this study are available at http://www.fhwa.dot.gov/environment/ultraurb/5mcs5.htm.

Table 5.4: Pollutant removal efficiencies for the compost storm water treatment facility from 1991 to 1994.

Parameter		1991-1992	1992-1993	1993-1994
Turbidity	Combined	84.2 %	78.4 %	78.4 %
	First Flush	93.4 %	85.3 %	81.4 %
Total Suspended Solids	Combined	94.8 %	88.5 %	86.0 %
	First Flush	98.3 %	91.4 %	89.0 %
Chemical Oxygen Demand	Combined	66.9 %	76.3 %	74.0 %
	First Flush	89.5 %	82.1 %	79.8 %
Total Phosphorus	Combined	40.5 %	53.2 %	65.5 %
	First Flush	67.3 %	68.9 %	72.9 %
Total Kjeldhal Nitrogen	Combined	55.9 %	50.5 %	66.7 %
	First Flush	84 %	60.8 %	69.0 %
Iron	Combined	89 %	95.5 %	79.6 %
	First Flush	94 %	97.5 %	82.9 %
Chromium	Combined	61.2 %	74.5 %	64.3 %
	First Flush	92.4 %	80.8 %	72.8 %
Copper	Combined	66.7 %	63.5 %	64.1 %
	First Flush	83.7 %	73.9 %	70.7 %
Lead	Combined	N/A	85.1 %	81.4 %
	First Flush	N/A	89.0 %	84.0 %
Zinc	Combined	88.3 %	75.8 %	79.9 %
	First Flush	92.8 %	83.1 %	83.1 %

5.3.3.3 Bioretention systems

Bioretention systems (Figure 5.11 and Figure 5.12) are suitable to treat runoff on sites where there is adequate soil infiltration capacity and where the runoff volumes that are not infiltrated do not present a safety or flooding hazard. Typical applications for bioretention include parking areas with or without curbs, traffic islands, and swales or depressed areas that receive runoff from impervious areas.

Bioretention system designs are very flexible, can be adapted to a wide range of commercial, industrial, and residential settings, and can be linked in series or combined with structural devices to provide the necessary level of treatment depending on expected runoff volumes and pollutant loading. A common technique is to use bioretention areas to pre-treat sheet flow before it is channelized or collected in an inlet structure.

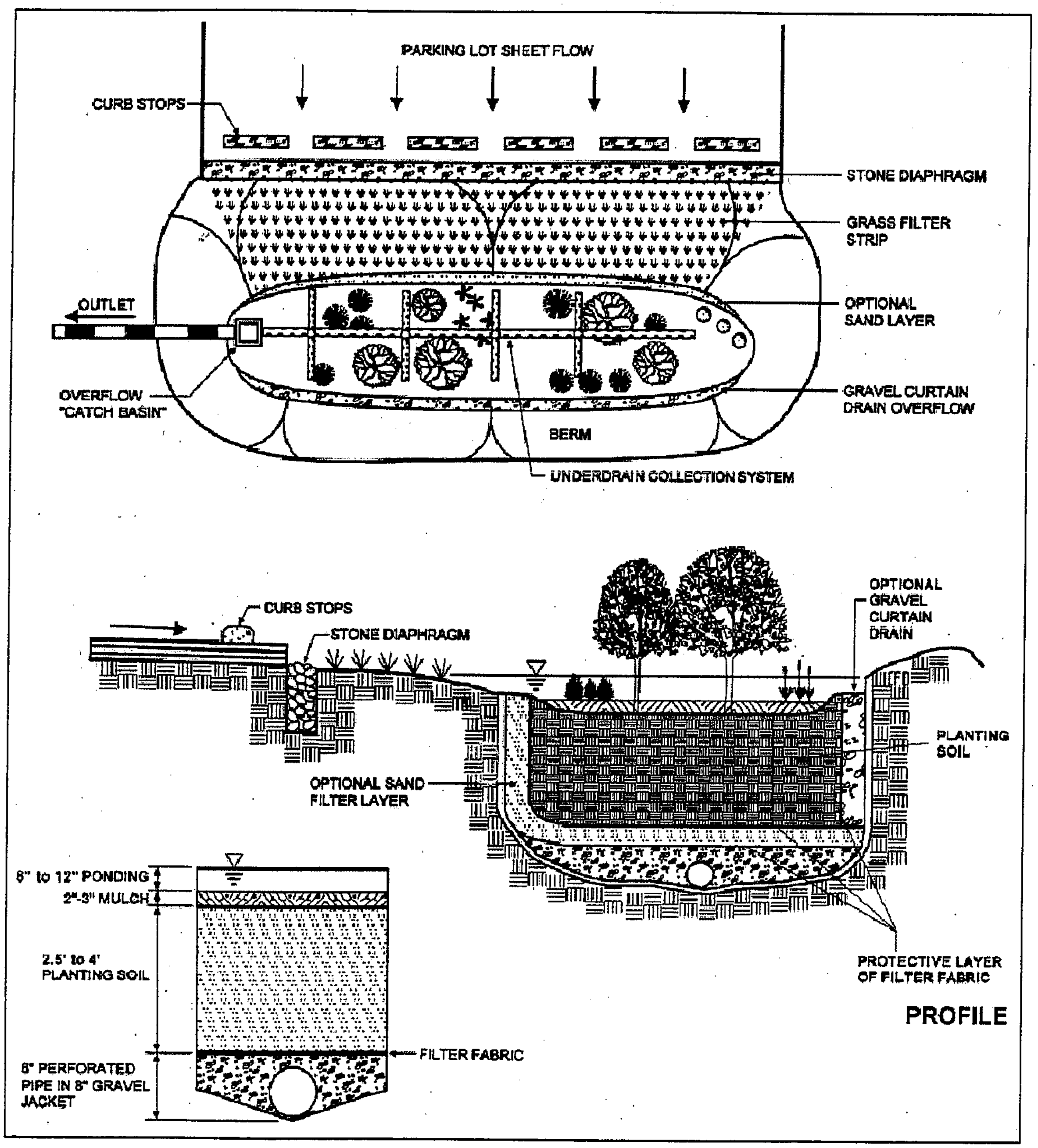

Figure 5.11: Schematic of a bioretention system (MDE, 2000).

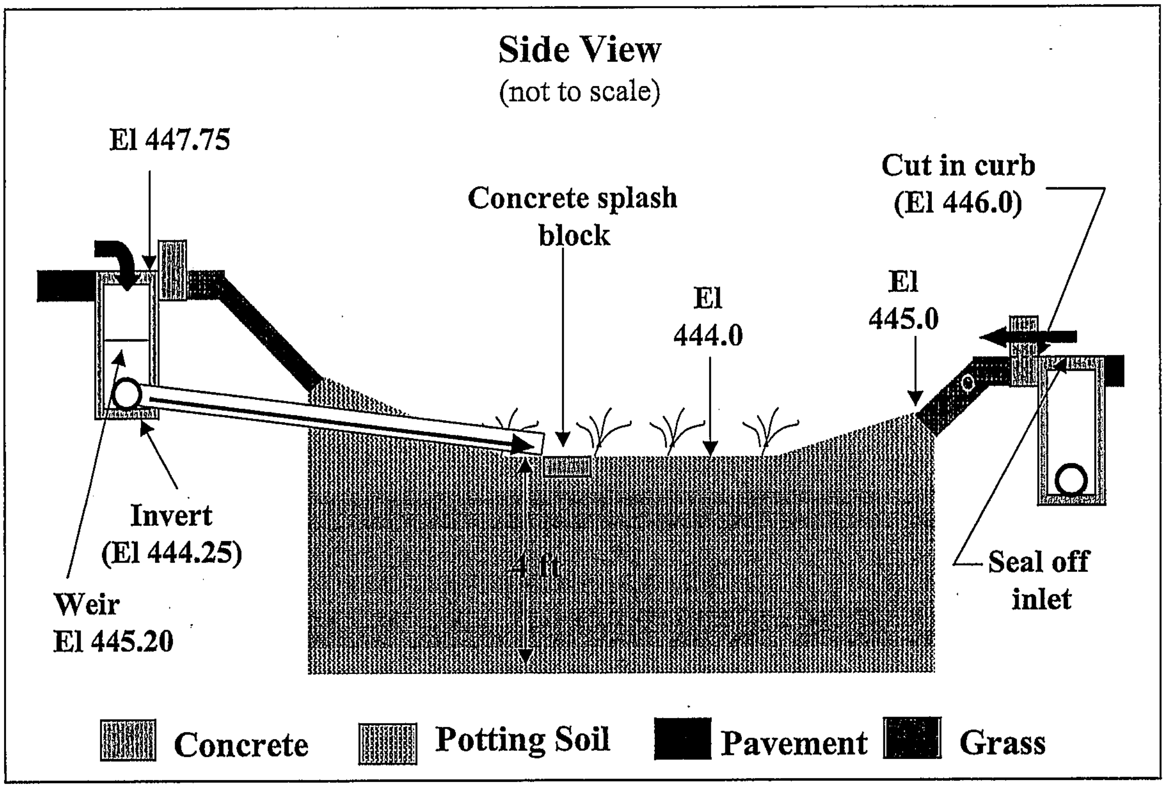

Figure 5.12: Schematic of a bioretention parking lot island (Traver, 2003).

Bioretention should not be used in areas:

- With mature trees;
- With slopes greater than 20 percent;
- With a water table within 6 feet of the land surface;
- With easily erodible soils;
- Below outfalls;
- Where concentrated flows are discharged; or
- Where excavation or cutting will occur.

To determine the appropriate design of the bioretention area with respect to the amount of runoff it receives, Prince George's County, Maryland, Department of Environmental Resources (1993), suggests a design based on a four-day maximum ponding period (appropriate for the Mid-Atlantic region). This four-day period is based on hydrologic, horticultural, and maintenance constraints such as plant tolerance of flooded conditions and mosquito-breeding concerns. Other considerations include infiltration rates for the root zone, sand layer, and in-situ material.

There is some flexibility with respect to size, shape, and placement of vegetation within the bioretention area. Other elements that should be incorporated into the design of the bioretention system include curb openings, a ponding area suitable to handle runoff from larger storms, amended planting soil that provides the desired infiltration rate, and an under-layer sand or gravel bed or underground perforated pipe that facilitates infiltration.

Regular maintenance, including soil pH testing, mulching and repairing eroded areas, inspecting vegetation, ensuring that runoff is infiltrating as designed, and checking for damage caused by large storms, will help to ensure the longevity of bioretention areas. More information about the design, operation, and maintenance of bioretention systems can be found in Coffman and Winogradoff (1999) or Prince George's County, Maryland, Department of Environmental Resources (1993).

As for the performance of bioretention areas, in one research study, simulated runoff was pumped continuously into an area of 5.3 m^2 in six bioretention cells, and effluent samples were collected from the perforated drainpipes underlying the bioretention media. All six bioretention facilities showed greater than 99 percent removal efficiency for oil and grease. Total lead removal efficiency decreased when the TSS level in the effluent increased because lead was adsorbed onto the surface of the solids. TSS removal ranged from 72 to 99 percent, and lead removal rates ranged from 80 to 100 percent. For total phosphorus, the removal efficiency was found to be highly variable, ranging from 37 to 99 percent. Nitrate-nitrogen and ammonium-nitrogen removal efficiencies ranged from 2 to 7 percent and 5 to 49 percent, respectively. Overall, the bioretention cells contributed significantly to water quality improvement (Hsieh and Davis, 2003).

The developer of Somerset Community, a typical suburban development in Prince George's County, Maryland, incorporated bioretention areas into each lot to control runoff quantity and quality. The bioretention areas eliminated the need for a wet pond, allowed the development of six extra lots, and resulted in a cost savings of more than $4,000 per lot. Somerset residents have enthusiastically accepted their bioretention areas, are actively maintaining them, and have lodged few complaints. Safety issues and mosquitoes have not been a problem (Daniels, 1995, and Curry and Wynkoop, 1995).

The Inglewood Demonstration Project in Largo, Maryland, involved retrofitting an existing parking facility with bioretention areas and comparing the pollutant removal efficiency of a bioretention cell in a laboratory setting to that of a comparable facility constructed in a parking lot. This study showed the feasibility of retrofitting an existing parking facility and demonstrated the consistency of laboratory and field pollutant removal performance. Results showed that the runoff temperature was lowered 12 degrees Celsius, lead levels were lowered 79 percent, zinc levels were lowered 78 percent, and numerous other pollutant levels were also considerably reduced. The retrofit cost $4,500 to construct, while usual methods would have cost $15,000 to $20,000 and involved fewer environmental benefits and higher maintenance costs. Also, bioretention areas offer the ancillary benefit of aesthetic enhancement. It is interesting to note that a drought occurred after the installation of the plants, and although many of the other plants in the parking lot died or experienced severe drought stress, those in the bioretention facility survived because of the retained water supply (USEPA, 2000a).

Using Landscaped Rain Gardens to Control Runoff

The city of Maplewood, Minnesota is seeking to improve drainage in its older neighborhoods through the use of rain gardens. A successful pilot project, which was implemented in 1995, was the starting point for the current citywide rain garden initiative. Rain gardens from the pilot project have prevented runoff from flowing out of the area, containing 100 percent of the flow. City officials decided to expand the project when they recognized the aesthetic and environmental benefits resulting from the pilot project rain gardens.

The city is focusing on demonstration, education, and outreach to convey the benefits of using rain gardens for runoff management, rather than requiring homeowners to participate. Although rain gardens can be a solution for people who are opposed to adding curbs and gutters to their streets, some are concerned that rain gardens may attract and breed mosquitoes. Before beginning a street improvement project for a specific neighborhood, the city holds neighborhood meetings and distributes a comprehensive educational mailing and questionnaire to homeowners. These materials contain a fact sheet that explains the purpose of rain gardens, how they are designed, how they work, their benefits, and the plants best suited for a variety of hydrologic conditions. A questionnaire is also included to ascertain existing drainage problems and to determine whether the homeowner would be willing to agree to use a rain garden.

Once a homeowner has decided that they want a rain garden, they choose the location and size. The city works with homeowners to make these types of decisions and to help them comply with restrictions on garden placement caused by existing trees, natural drainage, or the presence of gas and water mains and other utilities. Homeowners may choose from three standard rain garden sizes (12-foot by 24-foot, 10-foot by 20-foot, and 8-foot by 16-foot) and from one of six different garden themes, including an easy shrub garden, easy daylily garden, sunny garden, sunny border garden, butterflies and friends garden, Minnesota prairie garden, and shady garden.

To begin construction, the city's contractor excavates a gently sloping depression to collect the water. Rain garden depths vary depending on garden size and topography. The contractor digs a sump 42 inches wide and 3 feet deep at the deepest part of the garden to accommodate a geotextile filter fabric bag, which is filled with clean crushed rock. The sump promotes rapid infiltration to reduce the standing time of water in the rain garden. After the infiltration sump is in place, the contractor adds at least 8 inches of bedding material (typically a mixture of salvaged topsoil and clean organic compost) and covers the area with 3 to 4 inches of shredded wood mulch. Residents are provided with all necessary plants and a landscape plan at no additional cost. However, many Minnesota municipalities charge residents a street assessment to cover a percentage of the project cost.

The city's rain garden street improvement project typically costs 75 to 85 percent of a traditional curb and gutter project. Costs are kept low because most of the existing street material is recycled to use as the base aggregate. Additionally, plants are obtained at a reasonable cost and residents are responsible for the planting. Other long-term savings, which are difficult to quantify, result from the reduced demand on the city's downstream sewer infrastructure, which is not characteristic of conventional storm systems. The city may also be able to reduce the need for downstream storm sewer system upgrades and construction, including detention and treatment facilities designed to prevent pollution, erosion, and flooding problems.

More information about Maplewood's rain garden project is available from Chris Cavett, Assistant City Engineer, at 651-770-4554 or chris.cavett@ci.maplewood.mn.us (Terrene Institute, 2001).

5.3.4 Detention and Retention Practices

5.3.4.1 Detention ponds and vaults

These practices temporarily detain runoff to ensure that the postdevelopment peak discharge rate is equal to the predevelopment rate for the desired design storm (e.g. two-, 10-, or 25-year). These practices may also be used to provide temporary extended detention to protect downstream channels from erosion (e.g., 24-hour extended detention for a one-year storm).

Extended detention (ED) ponds (Figure 5.13) are an example of this type of facility. ED ponds temporarily detain a portion of urban runoff for up to 24 hours after a storm, using a fixed orifice to regulate outflow at a specified rate and allowing solids and associated pollutants time to settle out. ED ponds are normally dry between storm events and do not have any permanent standing water. These basins are typically composed of two stages: an upper stage, which remains dry except after larger storms, and a lower stage, which is designed for typical storms. Enhanced ED ponds are equipped with plunge pools or forebays near the inlet, a micropool at the outlet, and an adjustable reverse-sloped pipe as the ED control device (NVPDC, 1980; Schueler et al., 1992). Most ED ponds use a riser with an anti-vortex trash rack on top to control large floating solids.

Detention tanks and vaults are underground structures used to control peak runoff flows. They are usually constructed out of concrete (vaults) or corrugated metal pipe (tanks). Underground detention can also be achieved by retrofitting the over-capacity storm drain pipes with baffles. The baffles allow water to be stored in the pipes so it can be released at a slower rate. Pretreatment structures such as water quality inlets and sand filters can be used to treat runoff and remove trash and debris.

These systems are primarily applicable where space is limited and there are no other practical alternatives. Concrete vaults are relatively expensive and are often used to control small flows where system replacement costs are high. Corrugated metal pipe systems are less expensive and are often used to control larger volumes of runoff in parking lots, adjacent to rights-of-way, and in medians. These systems should be located where maintenance can be conducted with minimal disturbance.

Underground detention structures provide runoff quantity control but do not provide significant water quality control without modifications. Corrugated metal pipe systems can work in conjunction with infiltration to provide additional runoff treatment. This is accomplished by adding perforations to the pipe to allow it to store the water until it can be released into the soil (FHWA, no date).

5.3.4.2 Retention ponds

These practices use a permanent pool, extended detention basin, or shallow marsh to remove pollutants and can include:

- Micropool extended detention ponds;
- Wet ponds;
- Wet extended detention ponds; and
- Multiple pond systems.

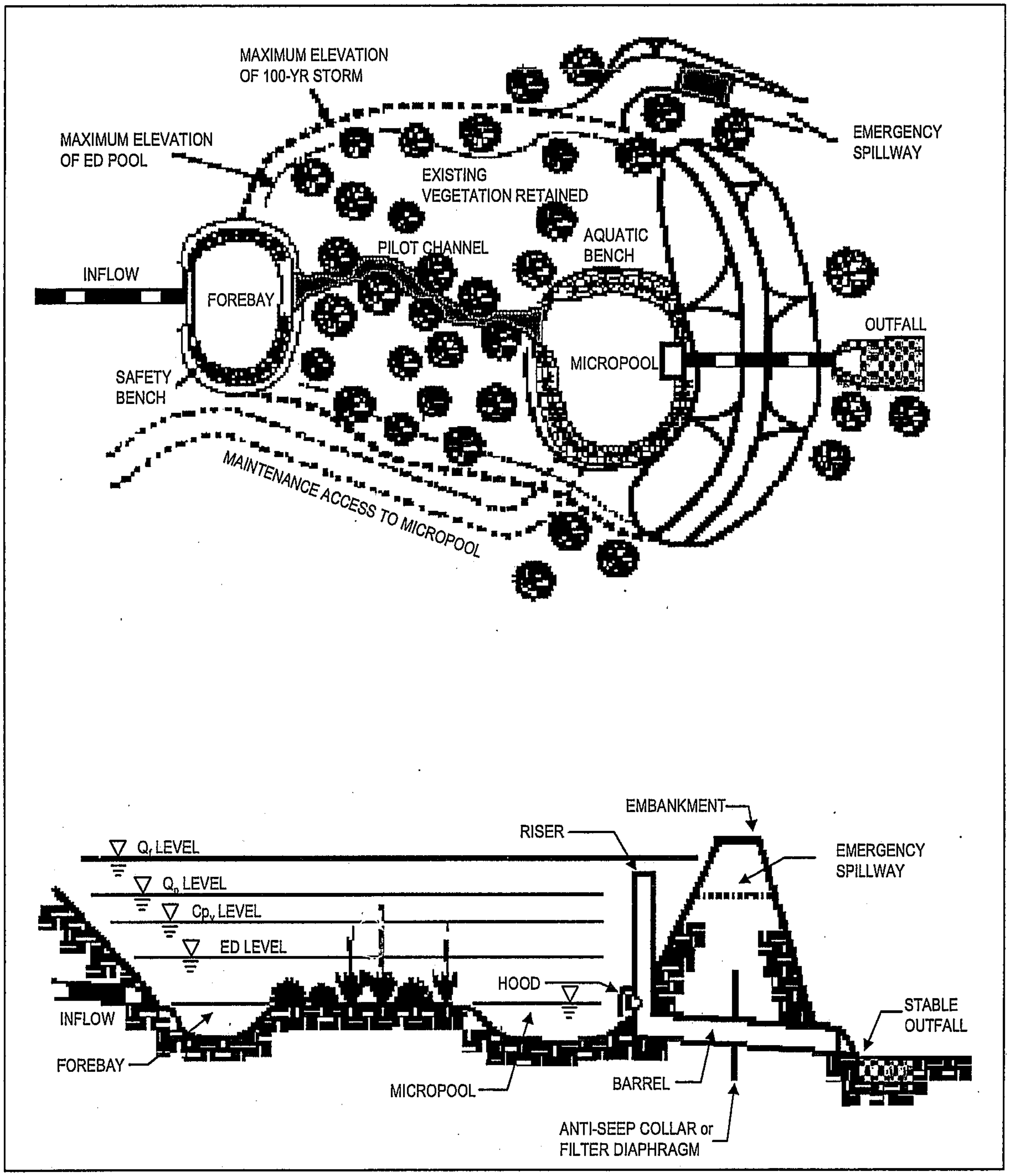

Figure 5.13: Schematic of a dry extended detention pond (MDE, 2000).

Ponds (Figure 5.14) are basins designed to maintain a permanent pool of water and temporarily store runoff (ED wet pond), which is released at a controlled rate. Ponds allow particulates to settle and can provide biological uptake of pollutants such as nitrogen or phosphorus. Enhanced designs include a forebay to trap incoming sediment where it can easily be removed. Often, a

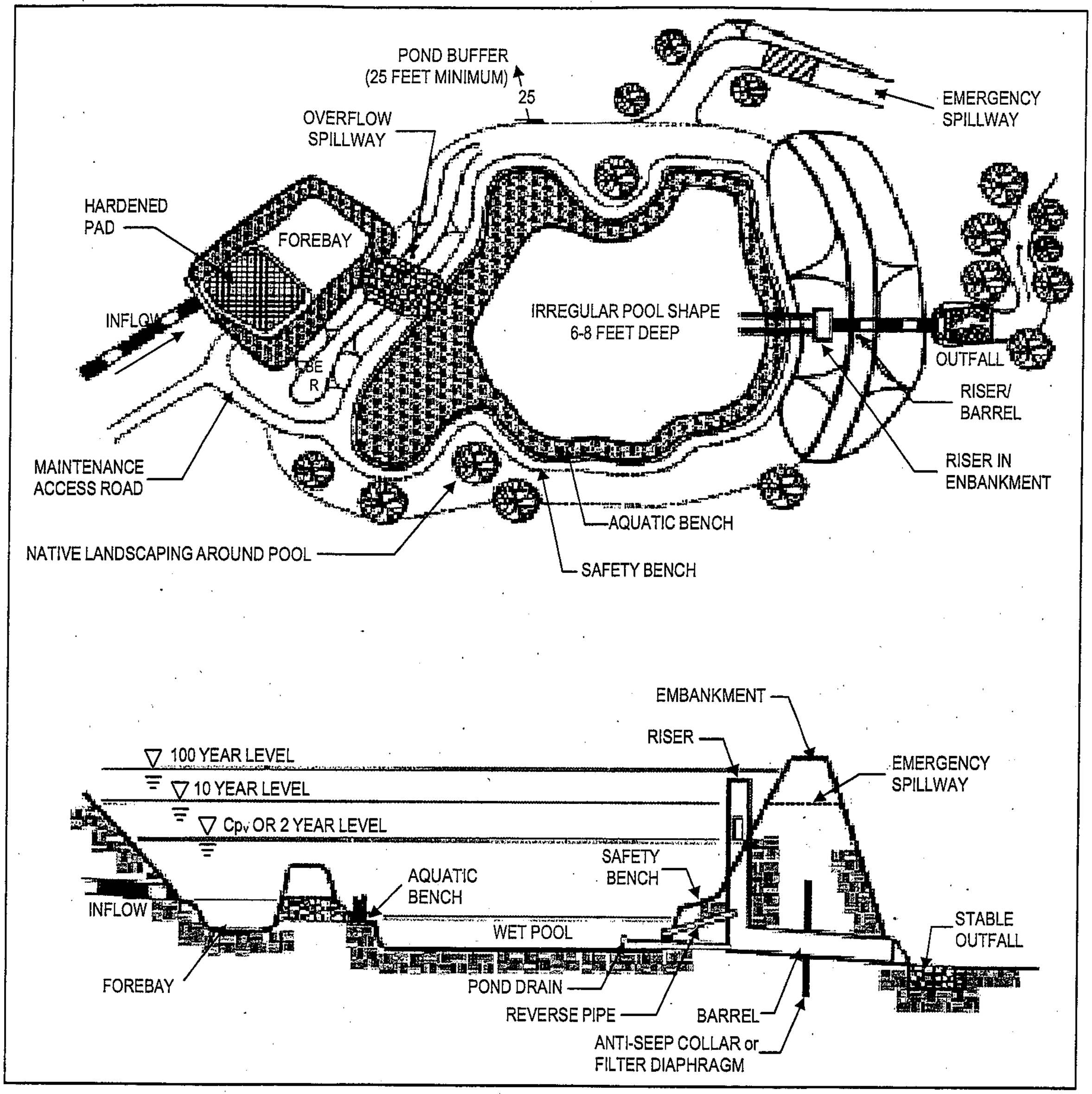

Figure 5.14: Schematic of a wet pond (MDE, 2000).

fringe wetland is installed around the perimeter of the pond to increase the habitat, aesthetic, and pollutant removal values of the facility. An outlet riser, sometimes combined with an anti-vortex trash device, is a common design modification. The design of wet ponds should account for the infiltration of ground water when the wet pond intercepts the water table. Table 5.5 presents several design considerations for ponds.

Table 5.5: Design considerations for ponds and wetlands (MDE, 2000).

Design Consideration	Ponds	Wetlands
Watershed Design Requirements		
Streams in intensely developed areas	Drainage area may limit the applicability of ponds except for pocket ponds.	Drainage area may limit the applicability of ponds except for pocket wetlands.
Cold-water streams	An offline design is recommended. Maximize shading of open pool areas.	An off-line design is recommended. Maximize shading of open pool areas.
Streams in sparsely developed areas	Require additional storage to ensure adequate downstream channel protection.	Require additional storage to ensure adequate downstream channel protection.
Aquifer protection	May require a liner depending on soil type.	May require a liner depending on soil type.
Reservoir protection	Require additional storage to ensure adequate downstream channel protection.	Require additional storage to ensure adequate downstream channel protection.
Shellfish beach located downstream	Provide moderate bacteria removal. Should be designed to prevent geese problems. Should provide permanent pools.	Provide 48-hr extended detention for maximum bacterial die-off.
Terrain Factors		
Low relief	The maximum normal pool depth should be 4 feet (dugout).	Wetlands are suitable for low-relief areas.
Karst	Require a poly or clay liner and geotechnical tests.	Require a poly or clay liner and geotechnical tests.
Mountainous	Embankment heights are restricted.	Embankment heights are restricted.
Physical Feasibility		
Soils	Depending on pond type, they may or may not require a liner or testing.	Certain soils may require a liner.
Water table	Must be at least 2 feet above water table if near a potentially contaminated "hotspot" or if underlain by an aquifer. Pocket ponds by definition are below the water table.	Must be at least 2 feet above water table if near a potentially contaminated "hotspot" or if underlain by an aquifer.
Drainage area	Minimum drainage area is 10 to 25 acres depending on type of pond. Pocket pond has a 5-acre maximum.	Minimum of 25 acres except pocket wetlands, which have a 5-acre maximum.
Site slope	Slopes should always be less than 15%	Slopes should be less than 8%.
Head	A 6- to 8-foot head is needed for all ponds except pocket ponds, which require a 4-foot head.	A 3- to 5-foot head is needed for most wetlands except pocket wetlands, which require a 2- to 3-foot head.
Ultra urban	Only pocket ponds are practical.	Pocket wetlands are sometimes practical; all others impractical.
Runoff Treatment Suitability		
Ground water recharge	No	No
Channel protection	Yes	Yes
Runoff Treatment Suitability (continued)		
Ground water recharge	No	No
Channel protection	Yes	Yes
Water quantity control	Yes	Yes
Large space requirements	Less space	More space
Community and Environmental Factors		
Maintenance	Easier	More difficult
Community acceptance	More acceptable	Less acceptable
Affordability	More affordable	Less affordable
Wildlife habitat	Yes	Yes

Used in combination with on-site and nonstructural practices, regional ponds are an important component of a runoff management program. The costs and benefits of regional, or off-site, practices compared to on-site practices should be considered as part of a comprehensive management program. For example, regional ponds can be located to treat runoff from existing development, and will result in overall net reductions on pollutant loads for the watershed (Fairfax County Environmental Coordinating Committee, 2002). Regional facilities can incorporate more advanced treatment technologies than on-site facilities (Maupin and Wagner, 2003). They can also provide community recreation and wildlife benefits, reduce peak and total flow, and be easier to maintain than dispersed controls. The City of Fairfax, Virginia, found that maintenance costs for a regional pond were about one-sixth those of on-site ponds (Fairfax County Environmental Coordinating Committee, 2002). Maintenance responsibilities and liability for regional runoff facilities belong to the municipality (Maupin and Wagner, 2003).

A study of 43 wadeable streams in Austin, Texas, showed that several indicators of stream health (ephemeroptera-plecoptera-trichoptera (EPT) richness and percent EPT abundance) were higher in streams with storm water ponds protecting 60 to 95 percent of their catchments than in streams with no storm water controls (Maxted and Scoggins, 2004). This trend was only significant in fully developed watersheds (having greater than 40 percent impervious cover). In watersheds with less than 40 percent impervious cover, storm water ponds had no significant impact on EPT richness or percent EPT abundance. The researchers attributed the lack of effects of storm water ponds to urban development in the reference watersheds and to the nature of the biological index used to gauge stream health, which was not tailored to the specific environmental conditions of the Austin area.

Research has shown that storm water ponds can increase property values. A survey in Columbia, Maryland, found that 75 percent of homeowners felt that permanent bodies of water such as storm water ponds added to real estate values. Seventy-three percent were willing to pay more for property located in a neighborhood with storm water control basins designed to enhance fish or wildlife uses (Adams et al., 1984; Tourbier and Westmacott, 1992; USEPA, 1995). Residents of a Champaign-Urbana, Illinois, neighborhood with storm water ponds stated that lots adjacent to a wet pond were worth an average of 21.9 percent more than comparable non-adjacent lots in the same subdivision. The same survey revealed that 82 percent would in the future be willing to pay a premium for a lot adjacent to a wet pond (Emmerling-DiNovo, 1995). In Alexandria, Virginia, condominiums alongside a 14-acre runoff detention pond sold for $7,500 more than comparable units not adjacent to the pond (USEPA, 1995).

Regional ponds do not, however, provide protection in contributing drainage systems, including upstream tributaries. These can experience damage from increased peak flow and flow volume. In addition, placement of regional ponds in low-lying areas may harm natural wetlands, and the ponds may create safety and liability issues. Siting ponds or other structural management practices within natural buffer areas and wetlands degrades their functions and may interrupt surface water and ground water flow when soils are disturbed for installation.

5.3.4.3 Constructed wetlands

Constructed wetlands (Figure 5.15) are engineered systems designed to treat runoff. They are typically designed to provide some of the functions of natural wetlands, e.g., wildlife habitat, in

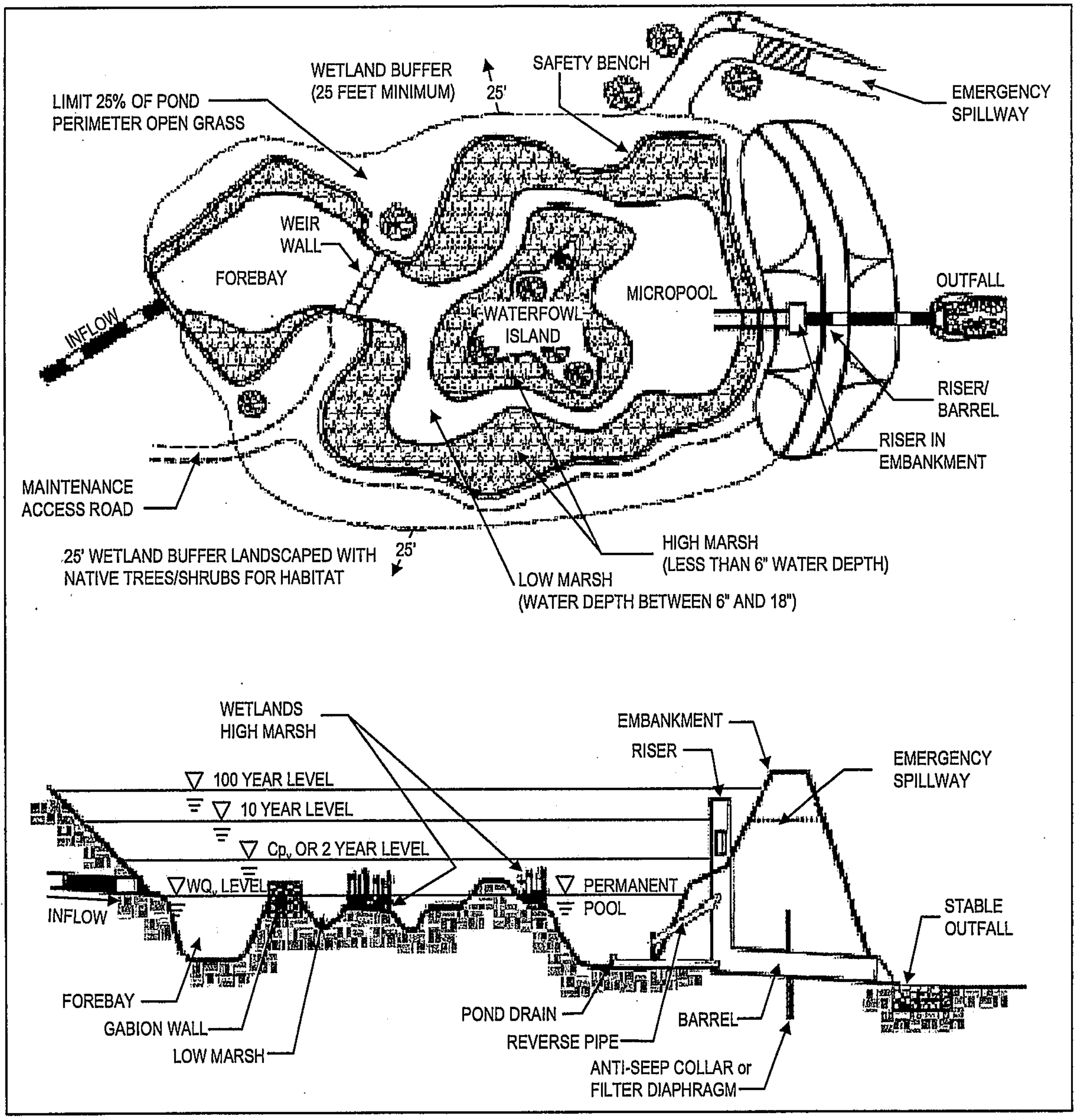

Figure 5.15: Schematic of a shallow wetland (MDE, 2000).

addition to controlling runoff volumes and pollutant loadings. There are many variations of constructed wetlands, such as shallow wetlands, extended detention wetlands, pond/wetland systems, and small isolated "pocket" wetlands. Constructed wetlands may contain some or all of the following elements: shallow vegetated areas, permanent pools, sediment forebays, transition areas, and weirs. Designs are intended to slow flow through the wetlands and provide maximum contact with wetland vegetation.

It should be noted, however, that constructed wetlands rarely replicate the functions of natural wetlands and should not be used for compensatory mitigation of natural wetlands and buffers.

Furthermore, constructed wetlands should be designed to receive periodic maintenance to ensure the wetland continues to function as designed.

Constructed wetlands are feasible at most sites and drainage areas where there is enough rainfall and/or snowmelt to maintain a permanent pool. In areas with highly permeable soils, other impermeable barriers, such as synthetic liners or clay, sometimes can be used to maintain enough water or moisture to support the wetland. Constructed wetlands should be located contiguous to existing wetlands wherever possible, unless there is concern about contaminants that may pose a threat to wildlife. Although it is technically feasible to construct a wetland on a small site (less than 1 acre), alternative control strategies should be considered when land constraints are present.

Constructed wetland systems can take several forms, including wet ponds with a wetland fringe, swale/ditch wetland depressions, and large-scale constructed wetlands used as mitigation wetlands or treatment wetlands. The choice of wetland designs depends on watershed characteristics, spatial and geomorphic constraints, runoff treatment requirements, and community and environmental factors. These considerations are outlined in Table 5.5.

In the San Diego Creek Watershed in southern California, constructed wetlands are being used as a regional runoff control technique. This approach, called the Natural Treatment System (NTS) Plan, is part of a watershed-wide management effort to meet total maximum daily load (TMDL) requirements for the San Diego Creek, which is impaired by sediment, nutrients, pathogens, heavy metals, and pesticides. The results of water quality modeling that accounted for the combined effects of the 44 planned facilities indicated that the TMDL for total nitrogen in base flows would be achieved, total phosphorus targets would be met in all but the wettest years and the fecal coliform target would be met in the dry season. While the NTS Plan is not meant to meet the TMDL for sediment, it will capture 1,900 tons annually, and the wetlands are estimated to remove 18 percent of the total zinc and 11 percent of the total copper and lead in runoff (Strecker et al., 2003).

New York City Bluebelt

The New York City Department of Environmental Protection (NYCDEP) has taken an innovative approach to solving drainage problems that have long plagued southern Staten Island. Instead of installing a conventional piped storm sewer system that would destroy the existing wetlands through drainage or filling, NYCDEP proposed to use a natural drainage system to convey, store, and filter runoff. The plan involves both preserving and restoring wetlands. In 1991, the agency began purchasing land along wetland corridors, and soon this network of property was termed the Bluebelt, because it mirrors the role a Greenbelt plays for open space areas by protecting water resources. The Bluebelt area is a total of 10,000 acres and includes 16 watersheds.

The constructed wetlands in the Bluebelt range from 0.5 to 2 acres in area and have a permanent pool that ranges from 12 to 24 inches deep. The wetlands are intended to provide water quality, flood control, and flow attenuation benefits for the region. More than 100 management practices were screened for their applicability, and in addition to constructed wetlands, meandering streams and outlet stilling basins were installed. Meandering streams convey runoff in open channels, providing a basis for the establishment and preservation of riparian areas. Outlet stilling basins mitigate the high velocities of runoff exiting conventional pipes. In the past 12 years, approximately half of the 89 planned management practices have been designed (Vokral et al, 2003).

Desert Wetlands

A constructed wetland demonstration project is being tested in the Sonoran Desert to improve the New River, which consists primarily of wastewater from Mexico and agricultural drain water from California's Imperial Valley (Fortner, 2000). Without these two sources of water, the New River would run dry. Near Imperial, California, about halfway along the New River, 68 acres of wetlands were constructed as a demonstration project. These wetlands use a series of six cells to remove sediments and other pollutants from irrigation drain water. A few miles downstream, in Brawley, California, a similar project will treat water that is diverted directly from the New River. The site for this project consists of 7 acres and three cells. The two sites are collectively referred to as the Brawley Constructed Wetlands Demonstration Project.

The project is described as one of the most challenging constructed wetlands projects in the United States and will help researchers determine the best design for treating river and agricultural drain water. Scientists are aware that it will be challenging to construct a wetland to treat a severely impaired waterbody in a desert area. They will monitor the performance of the test sites before additional wetlands are built. Once the data is obtained, the Citizens' Congressional Task Force for the New River (comprised of citizens and representatives from environmental groups, local community organizations, and state and federal agencies) will decide whether to expand the project.

Wetlands and other runoff control systems should not be sited in areas where they disrupt or significantly alter the predevelopment hydrology unless restoration objectives apply. When designing the wetland, a variety of physical characteristics should be used to promote multiple wildlife and habitat functions. For example, an irregular shape increases the perimeter of the system and provides a greater variety of microhabitats along the shoreline. Also, an irregular shoreline can extend the perimeter of a constructed wetland by 10 to 20 percent with no increase in land requirements.

Shallow-water wetlands do not contain a large volume of water per surface area as would a typical wet pond. In general, the wetland should have a shallow slope with a permanent pool in the middle. To enable growth of emergent vegetation, static water depths should not exceed 2 to 3 feet. Depths greater than 2 to 3 feet are conducive to the growth of submerged aquatic vegetation. The use of deeper water (>3 feet) in an area that is easily accessible for small children should be discouraged. No area of the pond should have a depth greater than four feet. In general, 50 percent of the pond should have depths less than one foot, 30 percent should be 1 foot to 2 feet deep, and 20 percent should be 2 to 4 feet deep. Greater depths are allowable for the inflow forebay and around the outlet structure.

The Maryland Department of the Environment (2000) requires that the first inch of runoff from the site must be controlled and released over a 24-hour period to provide water quality treatment, while peak discharge control of the two- and 10-year storms must be provided for water quantity control. Local requirements should be used when designing the treatment capacity of a constructed wetland. Other factors such as steep slopes may necessitate deeper ponds to obtain adequate runoff control.

Individual soil analyses should be done during the site design phase to determine if a clay or plastic liner is needed to maintain a wetland environment. Wetland vegetation cannot usually survive unless a base flow is available to provide a permanent pool to keep plants wet. Rapid infiltration will remove this needed pool. If a liner is needed, it should have at least 1 foot of

The Use of Wetlands to Reduce Fecal Coliform

Unusually high levels of fecal coliform have been found in an area of Laguna Niguel, California. Runoff from a neighborhood is washing into Aliso Creek and then to the Pacific Ocean. In response to a cleanup order issued by state water regulators, city officials built a series of wetlands to filter fecal coliform out of runoff. The natural water treatment system will work in combination with an existing wetland, which has already been proven successful in cleaning waters to a level acceptable for swimming.

Upon completion, water will flow through a series of four stepped ponds, spread out, and remain in the wetlands for hours or days of treatment. It is estimated that it will take a year for all vegetation to grow in and nearly two years to attain maximum removal of bacteria. When the wetlands system is complete, the existing wetland will treat 35 to 40 percent of the runoff and the new wetlands will treat 35 percent of the runoff. The city hopes that the new wetlands will work as well as the existing wetlands in reducing fecal coliform from urban runoff (Vardon, 2000).

clean fill material placed on top of it for wetland plant growth (the fill material will also reduce the potential for puncture).

An island placed in the wetland can extend the length of the flow path that runoff must travel to traverse the pond. This increased flow path enhances the pollution removal function of the constructed wetland. The highest elevation of the island should be above that reachable by storage of the first inch of runoff. Islands in wetlands may attract geese, which can be undesirable in some urban settings, but there are ways to minimize habitat for geese in a constructed wetland. Because most runoff management ponds are fairly small compared with a natural marsh system, they do not provide the long glide path preferred by geese for landing and takeoff. Planting woody vegetation or allowing areas around the pond to grow without mowing also tends to discourage goose residency.

The following are typical elements of a constructed wetland:

(1) *Sediment forebays*. It is important that sediment forebays be placed at all locations where runoff enters the wetland. A forebay is designed for vehicle access to facilitate sediment removal while preventing disturbance of substrate that could disrupt wetland functions. The forebay should constitute approximately 10 percent of the total basin volume and should have a maximum depth of 4 feet. Where there are multiple inlets to the constructed wetland, the total volume of all the forebays should be 10 percent of the basin volume, with individual inlet forebays sized with respect to the percentage of contributing flow they receive. The use of stone riprap in the forebay will reduce the velocity of flow into the wetland portion of the basin and minimize resuspension of deposited sediments. An access to the forebay should be provided for cleanout equipment. An area adjacent to the constructed wetland should be set aside for disposal of the sediments that become trapped and are removed during periodic maintenance.

The cleanout frequency of sediment forebays depends on the sediment load entering the constructed wetland. Each forebay should be inspected annually to ensure cleanout is being conducted as needed. Once the forebay has been filled to approximately 50 percent of its total volume (every 10 to 15 years), sediment should be removed, placed in an appropriate upland location, and stabilized. Costs for sediment forebay maintenance, including periodic inspection and cleaning, should be budgeted as a long-term operating expense if this practice is selected.

(2) *Diversion weir.* Diversion weirs may be needed for designs where the entire runoff volume is not directed to the constructed wetland. This diverted fraction of the runoff is often routed to collection systems or inlets. The amount of rainfall that may be diverted will vary according to local requirements and design objectives.

(3) *Outlet.* As is the case with all ponds having a normal pool of water, algae can clog outlets with small orifices that are needed for extended detention. A below-surface withdrawal structure may reduce or eliminate this problem.

(4) *Transition zone.* The maximum slope of the transition zone on wetland side slopes should be no greater than 10:1 (horizontal:vertical) and should extend at least 20 feet from the design pool of the constructed wetland. This area will be temporarily flooded whenever runoff is temporarily detained. Planting trees in the transition zone enhances nutrient uptake; the shading reduces temperature increases common in open water areas; and the trees provide habitat for wildlife. The transition zone should be mowed no more than once a year in late fall. Optimally, to promote the growth of woody vegetation, the transition area should not be mowed at all unless the pond is an embankment pond, in which case it should be mowed annually to prevent woody vegetation on the embankment.

(5) *Vegetation.* Placement of organic soils on the bottom of the pond will provide faster growth of planted or volunteer vegetation. Constructed wetlands should initially be planted with emergent plants and woody shrubs, and the wetlands should be allowed to succeed to a system dominated by woody shrubs and trees. The emergent wetland plants that are chosen should have tops that rise above the normal pool level.

It is important to consult local ecologists/plant specialists to choose suitable wetland species and to design a landscaping plan with appropriate vegetation density and spacing. Local specialists can also provide information regarding the optimal time to plant vegetation and help to design a maintenance schedule based on vegetation requirements. Native species should be used where feasible because they are well-adapted to local conditions. The USDA has a database (see http://www.plants.usda.gov/) of invasive and noxious species, which should be avoided.

The following specifications are provided as an example and apply to the Mid-Atlantic region (MDE, 2000):

- At least two aggressive species should be planted in the constructed wetland; their purpose is to rapidly spread to other unplanted areas of the wetland. In addition, at least three secondary species should be planted to increase the diversity, wildlife values, and appearance of the wetland. Ideally, plantings should include a mix of perennial and annual species.

- Plants should cover approximately 30 percent of shallow areas, with particular attention paid to areas adjacent to the shoreline. Plants should be spaced 2 to 3 feet apart, and the same species of plants should be planted in a single area to avoid interspecies competition.

– Species that are not recommended for any use in a constructed wetland are *Phragmites australis* (common reed), *Lythrum salicaria* (purple loosestrife), and *Phalaris arundinacea* (reed canary grass). Periodic inspections are important to ensure that exotic or other pest species do not dominate the plant community. In certain situations where there is an initial invasion of an aggressive, undesirable species, selective removal of the plants might be warranted, especially if the plant community that was introduced has not had time to adequately establish itself.

– Depending on site conditions, planting *Typha latifolia* (cattail) may or may not be recommended. Despite the fact that it is considered an exotic species, cattail will eventually dominate the wetland community. Additionally, cattail is an excellent plant for water treatment from a filtration and sedimentation standpoint.

– Planting will be more successful if the water level can be drawn down immediately prior to planting. This drawdown will leave the soils saturated, a condition necessary for the plants, and will improve visibility, especially when a number of people are involved in planting. The potential for damaging previously planted vegetation is reduced if the plants are clearly visible. Upon completion of planting, the outlet structure drain valve should be closed so either storm or base flow can reestablish the normal pool elevation.

– Harvesting wetland plants is only appropriate in areas such as the southern United States where plant growth is the most important mechanism for nutrient uptake. Harvesting is not needed where microbial activity is the dominant pollutant removal mechanism.

Like wet ponds, wetlands can increase adjacent property values. One study in Boulder, Colorado, found that lots located alongside a constructed wetland sold for up to a 30 percent premium over lots with no water view (USEPA, 1995). In Wichita, Kansas, a developer enhanced existing wetlands rather than filling them, and the waterfront lots sell for a premium of up to 150 percent of comparable lots (USEPA, 1995).

5.3.5 Other Practices

Other practices used to control urban runoff have not been studied as extensively as those above but have been used with varying degrees of success. They include:

- Water quality inlets;
- Hydrodynamic devices;
- "Baffle boxes;"
- Catch basin inserts;
- Vegetated filter strips;
- Street surface storage;

- On-lot storage; and
- Microbial disinfection.

In some cases, these practices are used for pretreatment or are part of an overall runoff management system, which is sometimes referred to as a "treatment train." For example, water quality inlets, catch basin inserts, and vegetated filter strips installed upslope of a wet pond or filtration practice will help remove a portion of the pollutants present in runoff before it enters the pond or filtration practice. These other practices in the treatment train improve runoff quality and can help extend the longevity of the filtration practice and wet pond.

5.3.5.1 Water quality inlets

Water quality inlets are underground retention systems designed to remove settleable solids. There are several water quality inlet designs. In their simplest form, catch basins are single-chambered urban runoff inlets in which the bottom has been lowered to provide 2 to 4 feet of additional space between the outlet pipe and the structure bottom for collection of sediment. Some water quality inlets include a second chamber with a sand filter to provide additional removal of finer suspended solids by filtration. The first chamber provides effective removal of coarse particles and helps prevent premature clogging of the filter medium.

Other water quality inlets include an oil/grit separator. Typical oil/grit separators consist of three chambers. The first chamber removes coarse material and debris; the second chamber provides separation of oil, grease, and gasoline; and the third chamber provides safety relief if blockage occurs (NVPDC, 1980). Although water quality inlets have the potential to perform effectively, they are not recommended because they are usually designed to bypass high flows, which can resuspend captured pollutants and flush them through the water quality inlet. Frequent maintenance and disposal of trapped residuals and hydrocarbons are necessary for these devices to continuously and effectively remove pollutants.

5.3.5.2 Hydrodynamic devices

A variety of engineered hydrodynamic devices, also called swirl separators or swirl concentrators, are available for removing pollutants from runoff. Swirl separators are modifications of the traditional oil-grit separator and include an internal component that creates a swirling motion as runoff flows through a cylindrical chamber. The concept behind these designs is that sediments settle out as runoff moves in this swirling path. Additional compartments or chambers, with or without pads, are sometimes present to trap oil and other floatables. Typically these devices are prefabricated and come in a range of sizes targeted at specific flow rates. At least two technologies are available. One is designed to remove suspended particles, oil, and grease during low flow conditions. The device removes particulate and floatable pollutants from runoff through settling of solids and floating of oils, greases, and litter. Higher runoff flows are diverted around the treatment unit so that scour and increased velocity do not carry the collected pollutants out of the treatment chamber. Maintenance requirements include the periodic removal of oil, greases, and sediments, typically by using a vacuum truck.

A second type of hydrodynamic device uses centrifugal motion to remove litter and debris and, potentially, larger sediment particles from runoff. This technology is designed to capture trash rather than pollutants, and therefore it is most applicable in coastal areas and areas that receive heavy trash loads such as leaf litter, plastics, and cans. Prefabricated units are currently available with capacities up to 300 cubic feet per second (cfs). The devices are constructed so that a vacuum truck can regularly remove the floatable and settleable debris collected in the treatment chamber.

Limited data are available on the performance of these devices, and independently conducted studies suggest marginal fine particle and soluble pollutant removal. Therefore, swirl separators should not be used as a stand-alone practice for new development. Also, these devices require regular maintenance. Communities may reduce maintenance costs by sharing a vactor truck. Swirl separators are best installed on highly impervious sites. These products have application as pretreatment to another runoff treatment practice and in a retrofit situation where space is limited.

5.3.5.3 Baffle boxes

Sediment control devices called "baffle boxes" have been used in Brevard County, Florida, as an "end of pipe" treatment method (England, 1996). They are concrete or fiberglass boxes, typically 10 to 15 feet long and 6 to 8 feet high, which are placed at the end of existing storm drain pipes. The box is divided into multiple chambers by weirs set at the same level as the pipe invert to minimize hydraulic losses. Trash screens are incorporated in the design to remove floating debris. Baffle boxes have been shown to have a removal efficiency of up to 90 percent for sand or sandy clay at entrance velocities of up to 6 feet per second, and 28 percent removal efficiency for fly ash at the same velocity. Baffle box designs can be modified to serve as a retrofit installation at curb or manhole inlets or beneath grates. Regular maintenance, especially removal of sediment and debris, is essential to maintain the effectiveness of this practice.

5.3.5.4 Catch basin inserts

Catch basin inserts consist of a frame that fits below the inlet grate of a catch basin and can be fitted with various trays that target specific pollutants. Typically the frame and trays are made of stainless steel, cast iron, or aluminum to resist corrosion. The trays may contain a variety of media. Often more than one tray is included in the design with the first tray filtering out sediment. Subsequent trays typically address a specific targeted pollutant, (e.g., wood fiber or other absorbent materials for oils and grease, or activated carbon for organics, fertilizers, and pesticides). The device is typically designed to accept the design flow rate of the inlet grate with bypasses as the trays become clogged with debris. The media require routine maintenance for replacement, cleaning, or regeneration. Catch basin inserts are typically used for smaller drainage areas. Usually the media need replacement on a quarterly basis.

The City of Santa Monica installs catch basin inserts that catch trash and debris in areas of high pedestrian traffic. Catch basin screens attach to the face of the curb and block trash from the storm drain, allowing debris to be easily removed by maintenance personnel or a street sweeper. Inserts that also filter hydrocarbons are installed on streets with automotive businesses. The city has found these practices to be effective when they are chosen carefully to suit site characteristics and are carefully installed and maintained (Shapiro, 2003).

5.3.5.5 Alum

Alum, which is an aluminum sulfate salt, can be added to storm water to cause fine particles to flocculate and settle out (USEPA, 2001a). It can help meet downstream pollutant concentration loads by reducing the concentrations of fine particles and soluble phosphorus. Alum can be added directly to or just before a pond or lake inlet, and booms can be used to ensure quiescent settling. When alum is injected into runoff it forms the harmless precipitates aluminum phosphate and aluminum hydroxide. These precipitates combine with heavy metals and phosphorus, causing them to be deposited into the sediments in a stable, inactive state. The collected mass of alum pollutants, precipitates, and sediments is commonly referred to as "floc." Frequent maintenance and disposal of the floc is required for continuous and effective operation.

5.3.5.6 Vegetated filter strips

Vegetated filter strips (VFSs) (Figure 5.16) are areas of land with vegetative cover that are designed to accept runoff as overland sheet flow from upstream development. Dense vegetative cover facilitates sediment attenuation and pollutant removal. Unlike grassed swales, vegetated filter strips are effective only for overland sheet flow and provide little treatment for concentrated flows. Grading and level spreaders can be used to create a uniformly sloping area that distributes the runoff evenly across the filter strip (Dillaha et al., 1989). Vegetated filter strips are often used as pretreatment for other structural practices, such as infiltration basins and infiltration trenches.

Typically, VFSs are used to treat very small drainage areas. The limiting design factor, however, is not the drainage area the practice treats but the length of flow leading to it. As runoff flows over the ground surface, it changes from sheet flow to concentrated flow. Rather than moving uniformly over the surface, the concentrated flow forms rivulets that are slightly deeper and cover less area than the sheet flow. When flow concentrates, it moves too rapidly to be effectively treated by a grassed filter strip.

VFSs should be designed on slopes between 2 and 6 percent. Steeper slopes encourage the formation of concentrated flow. Except in the case of very sandy or gravelly soil, runoff ponds on the surface on slopes flatter than 2 percent, creating potential mosquito-breeding habitat. Filter strips should not be used on soils with high clay content because they require infiltration for proper treatment. Very poor soils that cannot sustain a grass cover crop are also a limiting factor. Filter strips should be separated from the ground water by 2 to 4 feet to prevent contamination and to ensure that they do not remain wet between storms.

The design of VFSs is straightforward because they are not much more than a grassed slope. However, the following design features are critical to ensure that the filter strip provides some minimum amount of water quality treatment:

- A pea gravel diaphragm or stone drop should be used at the top of the slope. The pea gravel diaphragm (a small trench running along the top of the filter strip) serves two purposes. First, it acts as a pretreatment device, settling out sediment particles before they reach the practice. Second, it acts as a level spreader, maintaining sheet flow as runoff flows over the filter strip.

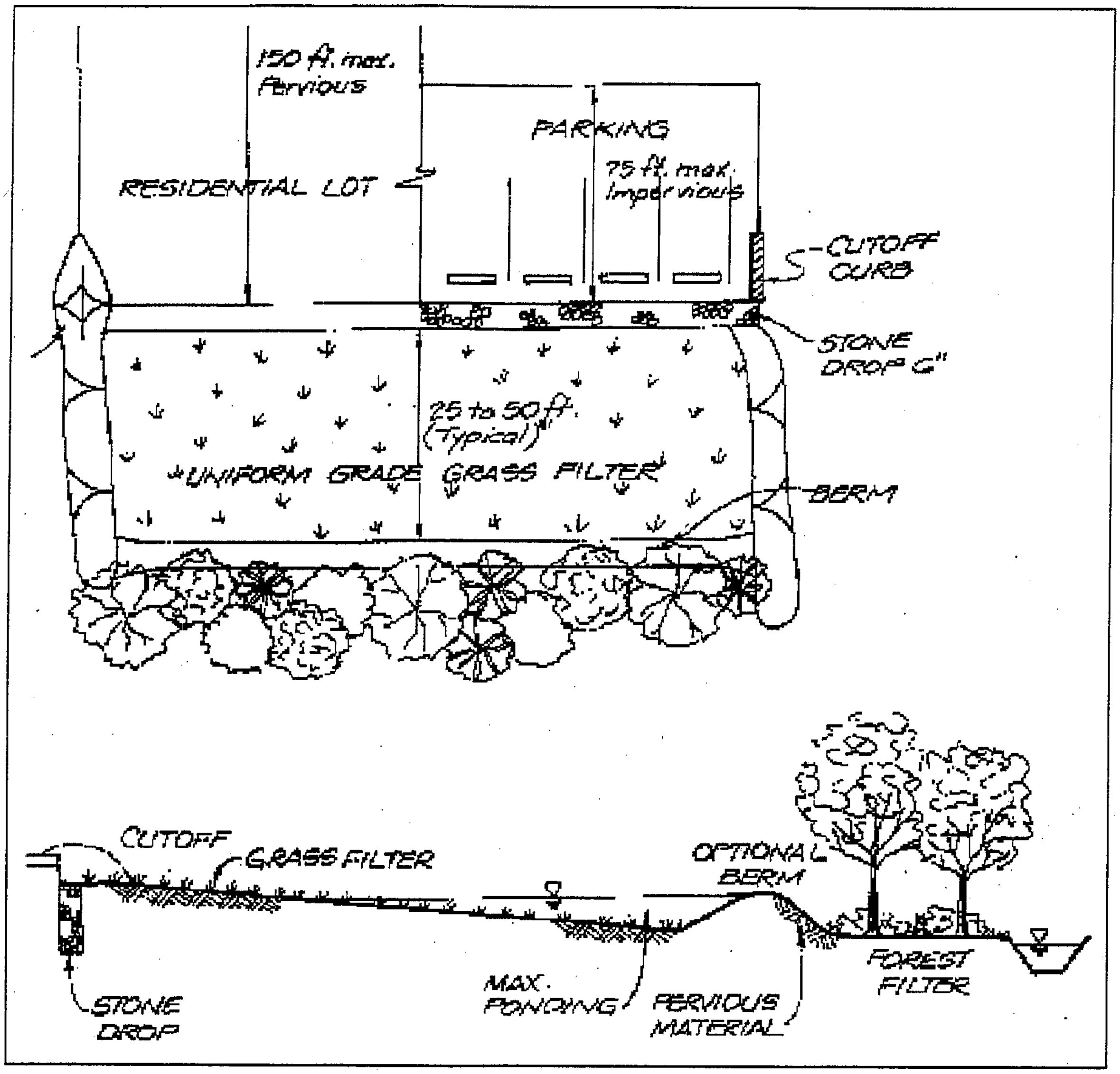

Figure 5.16: Schematic of a vegetated filter strip (Claytor and Schueler, 1996).

- The filter strip should be designed with a pervious berm of sand and gravel at the toe of the slope. This feature provides an area for shallow ponding at the bottom of the filter strip. Runoff ponds behind the berm and gradually flows through outlet pipes in the berm. The volume ponded behind the berm should be equal to the water quality volume. The water quality volume is the amount of runoff that will be treated for pollutant removal in the practice. Typical water quality volumes are the runoff from a 1-inch storm or ½-inch of runoff over the entire drainage area to the practice.

- The filter strip should have a length of at least 25 feet to provide water quality treatment.

- Vegetation must be able to withstand relatively high velocity flows and both wet and dry periods.

- The slope should have a flat top and toe to encourage sheet flow and prevent erosion.

5.3.5.7 Street surface and subsurface storage

Runoff can be temporarily stored on and below the surface of streets in urban areas, as shown in Figure 5.17, to reduce peak flows to the storm sewer system (Carr et al., 1999). Runoff can be retained on and below the street using a combination of berms, flow regulators, and below-surface storage. Berms resemble speed bumps or speed humps but are broader and gentler; they retain water in a shallow pool on the street surface upstream of the berm. In some cases, this type of surface storage is inappropriate because it can result in damage to roadways. An alternative is subsurface storage in tanks or large sewer pipes. Both above- and below-ground storage systems, when combined with flow regulators that allow only a limited amount of runoff to enter the sewer system, mitigate basement flooding, combined sewer overflows, sanitary sewer overflows, and surface flooding. These systems should be designed with public safety in mind to minimize hydroplaning and icing in cold climates.

Figure 5.17: Runoff pooling on a street surface designed for temporary storage.

Two suburban Chicago, Illinois, towns—Skokie and Wilmette—implemented street-surface storage of runoff. The Skokie system has 2,900 flow regulators, 871 berms, 10 off-street storage facilities, 83 subsurface facilities, and several new storm and combined sewers (USEPA, 2000b). Wilmette's runoff storage system is composed of essentially all street storage. These systems have been effective in preventing flooding and overflows and are less expensive than other alternatives such as sewer separation and relief sewers. More information about these studies can be found at http://www.epa.gov/ednnrmrl/publications/reports/epa600r00065/epa600r00065.htm.

5.3.5.8 On-lot storage practices

The term "on-lot storage" refers to a series of practices that are designed to contain runoff from individual lots. The purpose of most on-lot practices is to manage rooftop or parking area runoff. The primary advantage of managing runoff from rooftops and parking lots is to disconnect these impervious surfaces, reducing the effective impervious cover in a watershed.

Johnston et al. (2003) modeled the downstream hydrologic and economic impacts of on-site runoff storage based on flood risk reduction on property values and costs of storm drainage infrastructure. They found that use of reduced runoff practices provided property value benefits due to decreased flood risk of $21,600 to $36,300 per acre using countywide assessed values, or $17,540 to $29,240 per acre using U.S. Census Bureau census block median housing values. Benefits in avoided costs for storm drainage infrastructure (road culverts) totaled $247 to $836 per developed acre.

Although there are many on-lot treatment options, they can all be classified into one of three categories: (1) practices that infiltrate runoff; (2) practices that divert runoff to a pervious area; and (3) practices that store runoff for later use. The best option depends on the goals of a community, the feasibility at a specific site, and the preferences of the property owner.

Rooftop Runoff

Rooftop runoff, particularly in residential areas, generally has low pollutant concentrations compared with other urban sources (Schueler, 1994). Information on green rooftops can be found in Section 4.3.2.2. The practice most often used to infiltrate rooftop runoff is the dry well. In this design, the storm drain is directed to an underground rock-filled trench that is similar in design to an infiltration trench. French drains or Dutch drains can also be used for this purpose. In these designs, the relatively deep dry well is replaced with a long trench with a perforated pipe within the gravel bed to distribute flow throughout the length of the trench. Chamber systems, a widely marketed proprietary product, can be used in a similar manner.

Runoff can be diverted to a pervious area or to a treatment area using site grading or channels and berms. Treatment options can include grassed swales, bioretention cells, or filter strips. The bioretention design can be simplified for an on-lot application by limiting the pretreatment filter and in some cases eliminating the underdrain. Alternatively, rooftop runoff can simply be diverted to pervious lawn areas instead of discharging it directly to the street or a pipe drainage system.

Practices that store rooftop runoff, such as cisterns, chambers, and rain barrels (Figure 5.18), are the simplest designs for on-lot treatment systems. Some of these practices are available commercially and can be applied in a variety of site conditions. Cisterns and rain barrels are particularly valuable in the arid Southwest, where water is at a premium, rainfall is infrequent, and reuse for irrigation can save homeowners money.

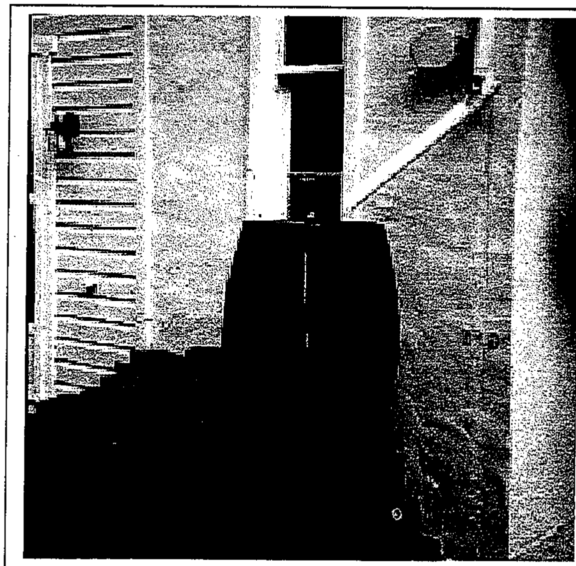

Figure 5.18: A rain barrel that collects runoff from a roof gutter downspout.

Rain barrels typically range in cost from $60 to $135. These prices do not always include the cost of additional parts needed to link the rain barrel to a downspout. These parts generally range in cost from $5 to $18, depending on the manufacturer and the design of the rain barrel (Gardener's, 2001; Jade Mountain, 2000; Midwest, 2001; Spruce Creek, 2001). If homeowners want to save money, they can build their own rain barrel, which costs approximately $15 if recycled drums are available.

Information about building a simple rain barrel is available from the Maryland Green Building Program at http://www.dnr.state.md.us/ed/rainbarrel.html (MDNR, no date). Information is also available in *How to Make a Rain Barrel*, which was published by the city of Ottawa, Ontario (no date). The manual is available by contacting the city of Ottawa toll-free at 866-261-9799, or by e-mailing info@city.ottawa.on.ca.

It is important for municipalities planning to start a rain barrel program to consider water quality issues, climate, algae and mosquito control, homeowner attitudes and willingness, and the protection of home foundations. Rain barrels can be a reliable source of water for garden and lawn watering, but if the water is intended for consumption it is crucial that the roof materials and gutter system be examined for asbestos, lead paint, and bird droppings (Sands and Chapman, 2003).

The Milwaukee Metropolitan Sewerage District (MMSD) undertook a rain barrel project in response to problems with combined sewer overflows. The project involved 40,000 single-family homes with roof areas of approximately 1,200 square feet. Two 90-gallon rain barrels were installed at each home. The MMSD found the reduction in runoff volume attributed to rain barrels to be approximately 243 million gallons. While the effort did not reduce combined sewer overflow volumes for the MMSD, it did result in savings on treatment plant costs and increased environmental awareness. The MMSD plans to continue to incorporate rain barrels into an integrated management plan that might include additional on-lot treatment practices (Sands and Chapman, 2003).

On-lot treatment practices can be applied to almost all sites with very few exceptions (e.g., very small lots or lots with no landscaping). There are currently at least two jurisdictions that offer "credits" in exchange for the application of on-site runoff management practices. In Denver, Colorado, sites designed with methods to reduce "directly connected impervious cover," including disconnection of downspout runoff from the storm drain system, are permitted to use a lower impervious area when computing the required storage of runoff management facilities (DUDFC, 1992). Similarly, new regulations for Maryland allow designers to subtract each rooftop that is disconnected from the total site impervious cover when calculating required storage in runoff management practices (MDE, 2000).

Although most residential lots can incorporate on-lot treatment, the best option for a site depends on design constraints and the preferences of the homeowner. On-lot infiltration practices have the same restrictions regarding soils as other infiltration practices. If other design practices are used, such as bioretention or grassed swales, they need to meet the siting requirements of those sites. Of all of the practices, cisterns and rain barrels have the fewest site constraints. In order for the practice to be effective, however, homeowners need to have a use for the water stored in the practice, and the design must accommodate overflow and winter freezing conditions.

Although these runoff management practices are simple compared with many others, their design needs to incorporate the same basic elements. Pretreatment is important for all of these practices to ensure that they do not become clogged with leaves or other debris. Infiltration practices may

Santa Monica Urban Runoff Program

Santa Monica's comprehensive urban runoff program combines pollution prevention and on-site practices with a runoff recycling program designed to improve water quality and harvest dry weather runoff as a resource. By protecting existing water resources, increasing infiltration on-site, and harvesting runoff for reuse, the city is maximizing the use of storm water as a resource and decreasing the demand for imported water. The city's pollution prevention program protects water quality with education, municipal housekeeping, lawn care and landscaping practices, and an ordinance that requires good housekeeping practices on construction sites. On-site practices are required by the Urban Runoff Pollution Mitigation Ordinance and include infiltration practices, porous pavement, and other low impact development techniques. The city has also installed catch basin inserts and screens to capture trash, debris, and some soluble pollutants. Finally, the Santa Monica Urban Runoff Recycling Facility (SMURRF) harvests and treats dry weather runoff and makes it available for reuse as irrigation water or for indoor toilet flushing (Shapiro, 2003).

be preceded with a settling tank or, at a minimum, a grate or filter in the downspout to trap leaves and other debris. Rain barrels and cisterns also often incorporate some sort of pretreatment, such as a mesh filter at the top of the barrel or cistern.

Both infiltration practices and storage practices should incorporate some type of bypass so runoff from larger storms flows away from the house. With rain barrels or cisterns, this bypass may be a hose set at a high level within the device that directs runoff away from both the device and the building foundation. These practices also include a hose bib set at the bottom of the device so the homeowner can use the stored water for irrigation or other uses by attaching a standard garden hose to the hose bib.

One important design requirement for on-lot infiltration practices is locating the infiltration area sufficiently far from the house (at least 10 feet) to prevent undermining of the foundation or seepage into the basement.

Infiltration practices require regular removal of sediment and debris settled in the pretreatment area, and the infiltration medium needs to be replaced when it becomes clogged. Rain barrels and cisterns require minimal maintenance, but the homeowner must ensure that the hose remains elevated during the winter to prevent freezing and cracking. In addition, the tank requires cleaning approximately once a year.

On the basis of cost per unit area treated, on-lot practices are relatively expensive compared with other runoff storage and treatment options. It is difficult to make this comparison, however, because the cost burden of on-lot practices is borne directly by homeowners. Typical costs are $100 for a rain barrel and $200 for a dry well or French drain. Often, homeowners can reduce costs by creating their own on-lot practice rather than purchasing a commercial product.

Parking Lot Runoff

Standard parking lots typically drain rapidly through curb and gutter systems to prevent flooding. This practice, however, does little to improve water quality or protect receiving waters from high flows during and after storms. Innovative designs for parking lots incorporate pervious areas for drainage, whether at the perimeter or in various islands within the lot. These pervious areas should be designed to infiltrate runoff at rates that prevent excessive ponding, which could appear unsightly or create safety issues and nuisance mosquito habitat. In cases where existing soils have poor infiltration capacity, better-drained soils should be imported or perforated under-drains installed to store infiltrated runoff underground.

The use of large-diameter underground pipes constructed of concrete, corrugated steel, or high-density polyethylene (HDPE) is becoming a more common practice for large parking areas such as shopping malls and mixed-use developments. These underground pipes and vaults as well as chamber systems can store large quantities of runoff that can be reused as needed or released at rates that will not damage natural conveyance systems.

5.3.5.9 Microbial disinfection

Other practices can be used to treat runoff for specific pollutants other than sediment. For instance, in areas where microbial pollution is an issue, runoff can be treated using ozone or ultraviolet light to prevent disease and reduce exceedances of water quality due to pathogen contamination. The City of Encinitas, California, was concerned about the number of public health warnings at its primary seaside attraction, Moonlight Beach, due to high enterococcus and coliform bacteria counts. The main source of the microbial pollution was dry weather runoff from Cottonwood Creek, which discharges at Moonlight Beach. Despite extensive evaluation of the Cottonwood Creek drainage area to identify and reduce bacterial loading, public health warnings continued to be posted. In anticipation of a total maximum daily load for bacteria under development for the region, and to reduce or eliminate the number of beach postings, the City chose to install an ultraviolet (UV) disinfection facility with partial funding from California's Clean Beach Initiative. The UV treatment facility was designed to treat 150 gallons per minute of Cottonwood Creek's dry weather flow, with 15% of the creek's flow diverted around the facility to maintain biological connectivity between upstream and downstream waters. During times of high flow (i.e., during and after storms) and high turbidity, when the system's treatment effectiveness would be reduced, the system is shut down and flow is passed through without treatment. Early monitoring results showed a significant decrease in bacterial counts downstream of the treatment facility, with a removal efficiency of more than 99.9 percent that yielded an effluent quality of 2 bacteria per 100 mL. Filters built into the system were also effective at removing suspended sediment, reducing turbidity from an average of 14.0 mg/L in the influent to 5.0 mg/L in the effluent.

5.4 Performance and Cost Information for Management Practices

Some advantages, disadvantages, and costs of specific runoff control practices described above are listed in Table 5.6. Site-specific information, regional limitations, operation and maintenance burdens, and longevity for these practices are listed in Table 5.7.

Table 5.6: Advantages and disadvantages of management practices (MDE, 2000).

Practice	Advantages	Disadvantages	Comparative Cost[a]
Runoff control ponds			
Wet pond	– Can provide peak flow control – Can serve large developments; most cost-effective for larger, more intensively developed sites – Enhances aesthetics and provides recreational benefits – Little ground water discharge – Permanent pool in wet ponds helps to prevent scour and re-suspension of sediments – Provides moderate to high removal of both particulate and soluble urban runoff pollutants	– Not economical for drainage area less than 10 acres – Potential safety hazards if not properly maintained – If not adequately maintained, can be an eyesore, breed mosquitoes, and create undesirable odors – Requires considerable space, which limits use in densely urbanized areas with expensive land and high property values – Not suitable for hydrologic soil groups "A" and "B" (USDA-NRCS classification) unless a liner is used – With possible thermal discharge and oxygen depletion, may severely impact downstream aquatic life – Hydrologic damage to stream channels and aquatic habitat is possible due to flow volume.	Moderate to high compared to conventional runoff detention
Infiltration practices			
Infiltration basin	– Provides ground water recharge – Can serve large developments – High removal capability for particulate pollutants and moderate removal for soluble pollutants – When basin works, it can replicate predevelopment hydrology more closely than other BMP options – Basins provide more habitat value than other infiltration systems	– Possible risk of contaminating ground water – Only feasible where soil is permeable and there is sufficient depth to bedrock and water table – Fairly high failure rate – If not adequately maintained, can be an eyesore, breed mosquitoes, and create undesirable odors – Regular maintenance activities cannot prevent rapid clogging of infiltration basin.	Construction cost moderate but rehabilitation cost high

Table 5.6 (continued).

Practice	Advantages	Disadvantages	Comparative Cost[a]
Infiltration trench	– Provides ground water recharge – Can serve small drainage areas – Can fit into medians, perimeters, and other unused areas of a development site – Helps replicate predevelopment hydrology, increases dry weather baseflow, and reduces bankfull flooding frequency	– Possible risk of contaminating ground water – Only feasible where soil is permeable and there is sufficient depth to bedrock and water table – Since not as visible as other BMPs, less likely to be maintained by residents – Requires significant maintenance	– Cost-effective on smaller sites – Rehabilitation costs can be considerable
Concrete grid pavement	– Can provide peak flow control – Provides ground water recharge – Provides water quality control without additional consumption of land	– Requires regular maintenance – Not suitable for areas with high traffic volume – Possible risk of contaminating ground water – Only feasible where soil is permeable, there is sufficient depth to bedrock and water table, and there are gentle slopes	Information not available
Filtering practices			
Filtration basin	– Ability to accommodate medium-size development (3–80 acres) – Flexibility to provide or not provide ground water recharge – Can provide peak volume control	– Requires pretreatment of runoff through sedimentation to prevent filter media from premature clogging	Information not available
Bioretention	– Provides ground water recharge	–	
Open channel practices			
Grassed swale	– Requires minimal land area – Can be used as part of the runoff conveyance system to provide pretreatment – Can provide sufficient runoff control to replace curb and gutter in single-family residential subdivisions and on highway medians – Economical	– Low pollutant removal rates – Leaching from culverts and fertilized lawns may actually increase the presence of trace metals and nutrients	Low compared to curb and gutter
Structural management practices that do not consistently remove 80% TSS			
Vegetated filter strip	– Low maintenance requirements – Can be used as part of the runoff conveyance system to provide pretreatment – Can effectively reduce particulate pollutant levels in areas where runoff velocity is low to moderate – Provides excellent urban wildlife habitat – Economical	– Often concentrates water, which significantly reduces effectiveness – Ability to remove soluble pollutants highly variable – Limited feasibility in highly urbanized areas where runoff velocities are high and flow is concentrated – Requires periodic repair, regrading, and sediment removal to prevent channelization	Low

Table 5.6 (continued).

Practice	Advantages	Disadvantages	Comparative Cost[a]
Water quality inlet Catch basins with sand filter	– Provide high removal efficiencies of particulates – Require minimal land area – Flexibility to retrofit existing small drainage areas – Higher removal of nutrient as compared to catch basins and oil/grit separator	– Not feasible for drainage areas greater than 5 acres – Only feasible for areas that are stabilized and highly impervious – Not effective as water quality control for intense storms	Information not available
Water quality inlet Oil/grit separator	– Captures coarse-grained sediments and some hydrocarbons – Requires minimal land area – Flexibility to retrofit existing small drainage areas and applicable to most urban areas – Shows some capacity to trap trash, debris, and other floatables – Can be adapted to all regions of the country	– Not feasible for drainage area greater than 1 acre – Minimal nutrient and organic matter removal – Not effective as water quality control for intense storms – Concern exists for the pollutant toxicity of trapped residuals – Require high maintenance	High, compared to trenches and sand filters
Extended detention dry pond with micropool	– Can provide peak flow control – Possible to provide good particulate removal – Can serve large development – Requires less capital cost and land area when compared to wet pond – Does not generally release water or anoxic water downstream – Provides excellent protection for downstream channel erosion – Can create valuable wetland and meadow habitat when properly landscaped	– Removal rates for soluble pollutants are quite low – Not economical for drainage area less than 10 acres – If not adequately maintained, can be an eyesore, breed mosquitoes, and create undesirable odors	Lowest cost alternative in size range

[a]Comparative cost information from Schueler, 1992

Table 5.7: Regional, site-specific, and maintenance considerations for management practices (USEPA, 1993; Caraco and Claytor, 1997; Schueler, in press).

Management Practice and Specifications	Cold Climate Restrictions (Caraco and Claytor, 1997)	Arid and Semi-Arid Regional Restrictions (Schueler, in press)
Infiltration basins *Size of drainage area*: Moderate to large *Site requirements:* Deep, permeable soils *Maintenance burdens*: High *Longevity:* Low	– Avoid areas with permafrost – Monitor ground water for chlorides – Do not infiltrate road/parking lot snowmelt if chlorides are a concern – Increase percolation requirements – Use 20 foot minimum setback between road subgrade and practice	– No recharge in hot-spot areas – Do not treat pervious areas – Use multiple pretreatment – Soil limitations exist in arid areas
Infiltration trenches *Size of drainage area*: Moderate *Site requirements:* Deep, permeable soils *Maintenance burdens*: High *Longevity:* Low	– Avoid areas with permafrost – Monitor ground water for chlorides – Do not infiltrate road/parking lot snowmelt if chlorides are a concern – Increase percolation requirements – Use 20-foot minimum setback between road subgrade and practice	– No recharge in hot-spot areas – Do not treat pervious areas – Use multiple pretreatment – Soil limitations exist in arid areas
Vegetated filter strips *Size of drainage area*: Small *Site requirements:* Low-density areas with low slopes *Maintenance burdens*: Low *Longevity:* Low if poorly maintained	– Small setback may be required between filter strips and roads when frost heave is a concern – Avoid areas with permafrost – Use cold- and salt-tolerant vegetation – Plowed snow can be stored in-practice	– Use drought-tolerant vegetation
Grassed swales *Size of drainage area*: Small. *Site requirements*: Low-density areas with <15% slope *Maintenance burdens*: Low *Longevity:* High if maintained	– Avoid areas with permafrost – Use cold- and salt-tolerant vegetation – Plowed snow can be stored in the practice – Increase underdrain pipe diameter and size of gravel bed – Provide ice-free culverts – Ensure soil bed is highly permeable	– Not recommended for pollutant removal in arid areas – Of limited use in semi-arid areas – Ensure adequate erosion protection of channels
Porous pavement *Size of drainage area*: Small *Site requirements*: Deep permeable soils, low slopes, and restricted traffic *Maintenance burdens*: Moderate to high *Longevity:* Low	– Only use on non-sanded surfaces – Pavement may be damaged by snow plows – Maintenance is essential	
Filtration basins and sand filters *Size of drainage area*: Widely applicable *Site requirements*: Widely applicable *Maintenance burdens*: Moderate *Longevity:* Low to moderate	– Reduced treatment effectiveness during cold season – Underground filters only effective if placed below the frost line – Peat/compost media ineffective during winter and may become impervious if frozen	– Preferred in both arid and semi-arid areas. Arid area filters require greater pretreatment
Bioretention	– Reduced treatment effectiveness during cold season – Pretreatment should be used to prevent "choking" of vegetation	

Table 5.7 (continued).

Management Practice and Specifications	Cold Climate Restrictions (Caraco and Claytor, 1997)	Arid and Semi-Arid Regional Restrictions (Schueler, in press)
Water quality inlets *Size of drainage area*: Small *Site requirements:* Impervious catchments *Maintenance burdens*: Cleaned twice a year *Longevity:* High	– Few restrictions	
Extended detention dry ponds *Size of drainage area*: Moderate to large *Site requirements:* Deep soils *Maintenance burdens*: Dry ponds have relatively high burdens *Longevity:* High	– Protect inlet/outlet pipes – Use large-diameter (> 8 in) gravel in underdrain of outfall protection – Consider seasonal operation – Provide ice storage volume – Cold-tolerant vegetation	– Preferred in arid climates and acceptable in semi-arid climates
Wet ponds *Size of drainage area*: Moderate to large *Site requirements*: Deep soils *Maintenance burdens*: Low *Longevity:* High	– Protect inlet/outlet pipes – Use large-diameter (> 8 in) gravel in underdrain of outfall protection – Consider seasonal operation – Provide ice storage volume – Cold-tolerant vegetation	– Not recommended in arid areas and of limited use in semi-arid areas
Wetlands *Size of drainage area*: Moderate to large *Site requirements:* Poorly drained soils, space may be limiting *Maintenance burdens*: Annual harvesting of vegetation *Longevity:* High	– Protect inlet/outlet pipes – Use large-diameter (> 8 in) gravel in underdrain of outfall protection – Consider seasonal operation – Provide ice storage volume – Cold-tolerant vegetation	– Not recommended in arid areas and of limited use in semi-arid areas

Table 5.8 presents pollutant removal efficiency statistics for the management practices discussed in this section. These values originate from the *National Pollutant Removal Performance Database for Stormwater BMPs* (Caraco and Winer, 2000). The database was compiled through a comprehensive literature search focusing on runoff treatment practice monitoring sites from 1990 to present. In addition, approximately 60 previously collected monitoring studies from 1977 and 1989 were included in the database. All 139 studies meet the two following criteria: (1) the researchers used automated equipment that enabled flow or time-based composite samples; and (2) they documented the method used to compute removal efficiency. With respect to the number of storms sampled, more than three-quarters of the studies were based on five or more storm samples. The sample size was not reported in the remaining studies.

Table 5.8: Effectiveness of management practices for runoff control (adapted from Caraco and Winer, 2000).

Runoff Treatment or Control Practice Category or Type	Median Pollutant Removal (Percent)							
	No. of studies	TSS	TP	OP	TN	NOx	Cu	Zn
Quality Control Pond	3	3	19	N/A	5	9	10	5
Dry Extended Detention Pond	6	61	20	N/A	31	-2	29	29
Dry Ponds	9	47	19	N/A	25	3.5	26	26
Wet Extended Detention Pond	14	80	55	69	35	63	44	69
Multiple-Pond System	1	91	76	N/A	N/A	87	N/A	N/A
Wet Pond	28	79	49	39	32	36	58	65
Wet Ponds	43	80	51	65	33	43	57	66
Shallow Marsh	20	83	43	66	26	73	33	42
Extended Detention Wetland	4	69	39	59	56	35	N/A	-74
Pond/Wetland System	10	71	56	37	19	40	58	56
Submerged Gravel Wetland	2	83	64	14	19	81	21	55
Wetlands	36	76	49	48	30	67	40	44
Organic Filter	7	88	61	30	41	-15	66	89
Perimeter Sand Filter	3	79	41	68	47	-53	25	69
Surface Sand Filter	7	87	59	N/A	31.5	-13	49	80
Vertical Sand Filter	2	58	45	21	15	-87	32	56
Bioretention	1	N/A	65	N/A	49	16	97	95
Filtering Practices[a]	18	86	59	*57*	38	-14	49	88
Infiltration Trench	3	100	42	100	42	82	N/A	N/A
Porous Pavement	3	95	65	10	83	N/A	N/A	99
Ditches[b]	9	31	-16	N/A	-9	24	14	0
Grass Channel	3	68	29	32	N/A	-25	42	45
Dry Swale	4	93	83	70	92	90	70	86
Wet Swale	2	74	28	-31	40	31	11	33
Open Channel Practices	9	81	34	*1.0*	*84*	31	51	71
Oil-Grit Separator	1	-8	-41	40	N/A	47	-11	17

Shaded rows show data for groups of practices (i.e., dry ponds include quality control ponds and dry extended detention ponds).
Numbers in italics are based on fewer than five data points.
[a] Excludes vertical sand filters
[b] Refers to open channel practices not designed for water quality.
TSS=total suspended solids, TP=total phosphorus, OP=ortho-phosphorus, TN=total nitrogen, NOx=nitrate and nitrite nitrogen, Cu=copper, Zn=zinc.

Strecker et al. (2000) identified problems with comparing different management practice effectiveness studies. They suggested that inconsistent study methods, lack of associated design information, and multiple reporting protocols make wide-scale assessments of management practices difficult. Also, differences in monitoring strategies and data evaluation methods contribute significantly to the wide range of reported management practice effectiveness.

EPA recognizes that 80 percent TSS removal efficiency cannot be achieved for each storm event and understands that TSS removal efficiency will fluctuate above and below 80 percent for individual storms. Researchers have noted that efficiency estimation is often based on pollutant loads into and out of the management practice on a storm-by-storm basis. Therefore, a multiple-study analysis or summary is based on the assumption that all storms are equal when computing average pollutant removal. Storm-by-storm comparisons are probably not effective because many storms are not large enough to displace the permanent pool volume. They recommend that effectiveness be evaluated using statistical characterizations of the inflow and outflow concentrations because if enough samples are collected, total loads into and out of the management practice can be used reliably.

Strecker et al. (2000) also analyzed the use of effluent data to measure the influence of certain design criteria on management practice efficiency. Some studies suggest that management practices can only treat runoff to a specified pollutant concentration. However, if relatively clean water enters a practice, performance data based on removal efficiency might not fully characterize whether the practice is well designed and effective. Therefore, pollutant removal efficiency, when it is expressed as percent removal, might not be an accurate representation of

Verifying the Performance of Environmental Technologies

EPA's Environmental Technology Verification (ETV) Program, which began in October 1995, was instituted to verify the performance of innovative technical solutions to problems that threaten human health and the environment. ETV was created to significantly accelerate the entrance of new environmental technologies into the domestic and international marketplaces. The program operates through public and private testing partnerships to evaluate the performance of environmental technology in all media, including air, water, soil, ecosystems, waste, pollution prevention, and monitoring. More information about the ETV Program is available at http://www.epa.gov/etv (USEPA, 2001b).

Another method for evaluating technology is the Environmental Technology Evaluation Center (EvTEC), which was established by the Civil Engineering Research Foundation (CERF) through EPA's ETV Program. EvTEC is an independent, market-based approach to technology verification and was established to accelerate the adoption of environmental technologies into practice. More information about EvTEC is available at http://www.cerf.org/evtec (CERF, 2001).

EPA and NSF International, an independent, nonprofit testing organization, have developed a testing protocol to determine the viability of runoff treatment technologies and other wet weather flow controls, including runoff, combined sewer overflow (CSO), and sanitary sewer overflow (SSO). NSF International will also test and verify high-rate separation/clarification and high-rate disinfection technologies, flow monitoring equipment, and wet weather models.

Participants in the study include vendors who want to demonstrate the effectiveness of their technologies. Results of the pilot will be useful to a variety of stakeholders including municipalities, businesses, vendors, consulting engineers, and regulatory agencies. Once verification reports have been completed, vendors may use the results in their marketing efforts. Results will be made publicly available through EPA's and NSF's Web sites at http://www.epa.gov/etv and http://www.nsf.org/business/ETV_EPA_NSF/index.asp?program=ETVEPANSF, respectively. More information about the program is available at http://www.wateronline.com/content/news/article.asp?docid={17DDF263-29B8-11D5-A770-00D0B7694F32} (Water-Online, 2001).

International Stormwater Best Management Practices Database

The American Society of Civil Engineers, in cooperation with EPA, has compiled the *International Stormwater Best Management Practices Database*, which contains performance data from more than 200 management practice studies. Information provided for the management practices includes test site location, researcher contact data, watershed characteristics, regional climate statistics, management practice design parameters, monitoring equipment types, and monitoring data such as precipitation, flow, and water quality. More information on the database's purpose, design, and documentation can be found at http://www.bmpdatabase.org/.

how well a management practice is performing. Although more research is necessary to accurately determine the effectiveness of management practices, Strecker et al. recommend that standard methods and detailed guidance on data collection be used to improve data transferability.

Table 5.9 presents information concerning the costs associated with selected structural practices. The sources of these data are publicly available articles (some are a compilation of numerous studies).

Table 5.9: Costs of selected management practices (Claytor and Schueler, 1996; Brown and Schueler, 1997).

Management Practice	Construction Costs[a]	Useful Life (years)	Total Annual Costs
Infiltration basin[b]			
Average	$0.55/ft^3$ storage	25[c]	–
Report range	$0.22–$1.31/ft^3$	–	$0.03–$0.05/ft^3$
Probable range	$0.44–$0.76/ft^3$	–	–
Infiltration trench[b]			
Average	$4.36/ft^3$ storage	10[c]	–
Report range	$0.98–$10.04/ft^3$	–	$0.03–$0.10/ft^3$
Probable range	$2.73–$8.18/ft^3$	–	–
Infiltration practices[d]			
Average	$2.99/ft^3$ storage	–	–
Report range	$2.13-4.27/ft^3$ storage	–	–
Vegetated swales[b]			
Established from seed			
Average	$7.09/linear ft	50[e]	$1.09/linear ft
Report range	$4.91–$9.27/linear ft	–	–
Established from sod			
Average	$21.82/linear ft	50[e]	$2.18/linear ft
Report range	$8.73–$54.56/linear ft	–	–
Porous pavement[b]			
Average	$1.64/ft^2$	10[f]	$0.16/ft^2$
Report range	$1.09-$2.18/ft^2$	–	–
Concrete grid pavement[b]			
Average	$1.09/ft^2$	20	$0.05/ft^2$
Report range	$1.09–$2.18/ft^2$	–	–
Filtration basins[b]			
Average (probable)	$5.46/ft^3$ storage	25[g]	–
Report range	$1.09–12.00/ft^3$	–	$0.11–$0.87/ft^3$
Probable range	$2.18–9.82/ft^3$	–	–
Bioretention practices[d]			
Average	$6.83/ft^3$ storage	–	–
Filtration practices[d]			
Average	$2.63/ft^3$ storage	–	–
Range	$2.13-6.40/ft^3$ storage	–	–
Water quality inlet[b,h]			
Average	$2,182 each	50	$164 each
Report range	$1,200–3,273 each	–	–
Probable range	–	–	–
Water quality inlet with sand filter[b,h] Average (probable)	$10,900/drainage acre	50	$764/drainage acre

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Table 5.9 (continued).

Management Practice	Construction Costs[a]	Useful Life (years)	Total Annual Costs
Oil/grit separator[b,h]			
Average	$19,640/drainage acre	50	$1,091/drainage acre
Report range	$16,370–$21,820/drainage acre	–	–
Stabilization with ground cover[b,h]			
From existing vegetation			
Average	$0	50	Natural: $109/acre
Report range	–	–	Managed: $873/acre
From seed			
Average	$436/acre	50	Natural: $131/acre
Report range	$218–$1,091/acre	–	Managed: $900/acre
From seed and mulch			
Average	$1,637/acre	50	Natural: $218/acre
Report range	$872–$3,819/acre	–	Managed: $982/acre
From sod			
Average	$12,330/acre	50	Natural: $764/acre
Report range	$4,910–$52,375/acre	–	Managed: $1,528/acre
Ext. Detention Dry Pond[b,h]			
Average	$0.55/ft^3 storage	50	–
Report range	$0.05–$3.49/ft^3	–	$0.008–$0.33/ft^3
Probable range	$0.10–$5.46/ft^3	–	–
Wet Pond and Extended			
Detention Wet Pond[b]	$0.55/ft^3 storage	50	$0.009–$0.08/ft^3
Storage vol. < 1 million ft^3	$0.05–$1.09/ft^3	–	–
Average	$0.55–$1.09/ft^3	–	–
Report range	$0.27/ft^3 storage	50	–
Probable range	$0.05–$0.55/ft^3	–	$0.009–$0.08/ft^3
Storage vol. > 1 million ft^3	$0.11–$0.55/ft^3	–	–
Average (probable)			
Report range (probable)			
Probable range			

[a]Costs updated using the Bureau of Labor Statistics Inflation Calculator.
[b]Claytor and Schueler, 1996.
[c]References indicate the useful life for infiltration basins and infiltration trenches at 25-50 and 10-15 years, respectively. Because of the high failure rate, infiltration basins are assumed to have a useful life span of 25 years and infiltration trenches are assumed to have a useful life span of 10 years.
[d]Brown and Schueler, 1997.
[e]Useful life is assumed to equal the life of the project, assumed to be 50 years.
[f]No information was available for porous pavement. It is assumed to be similar to infiltration trenches.
[g]No information was available for filtration basins. It was assumed to be similar to infiltration basins.
[h]These practices do not meet the 80 percent TSS removal, thus it is recommended that they be used with other management practices in a treatment train.

5.5 Managing Structural Controls to Reduce Mosquito-Breeding Habitat

In recent years, concern has been raised that storm water management facilities have been breeding grounds for mosquitoes (Conlon, 2002). This is a public health concern because mosquitoes are known vectors for disease-causing arboviruses such as malaria, yellow fever, dengue fever, St. Louis encephalitis, and West Nile virus, to name a few. The relationship between storm water management and mosquito breeding exists because the presence of standing and sometimes stagnant water facilitates the two aquatic stages of a mosquito's life cycle—the egg and larval stages.

Not all mosquito species are vectors for disease, but control is still warranted because, even if not a health risk, mosquitoes are considered a nuisance. Mosquito species have different habitat preferences, and two basic groups can breed in the urban environment: permanent water species and floodwater species (Metzger et al., 2002). Permanent water species would be likely to propagate in storm water management facilities that always contain water, such as wet detention ponds and constructed wetlands. Floodwater species would likely inhabit "dry" systems such as extended detention dry ponds that have fluctuating water levels.

This issue has caused a fair amount of controversy because mosquito-breeding habitats are prevalent in urban and suburban environments. Metzger et al. (2002) identified a few of the numerous manmade mosquito-breeding habitats in urban and suburban environments:

> Urban environments provide mosquitoes with a vast array of new habitats: humid and arid, above and below ground, small water-holding containers and large ponds, polluted and clean water. Aquatic habitats are found around people's homes (birdbaths, jars, flower pots, neglected pools and Jacuzzis and clogged rain gutters), in unregulated waste dumps (used tires, barrels, bottles, and cans), in parks (ponds, lakes, and streams), and in the city's own infrastructure (storm drains, sewer systems, catch basins, and culverts). Many of these sources are replenished frequently by stormwater and urban runoff (e.g., irrigation, washing cars). Adding to this, increasingly stringent urban stormwater runoff regulations have recently mandated the construction of structural practices for both volume reduction and pollution management, many of which have created additional sources of standing water. This abundance of habitats has favored mosquitoes and allowed many species to greatly expand their range and increase in number.

Although storm water management facilities are not the sole source of standing water, public concern has raised the question of how these facilities can be managed, redesigned, or otherwise modified to reduce the creation of disease vectors close to urban population centers.

The California Department of Health Services' Vector-Borne Disease Section (2002), in cooperation with the California Department of Transportation (Caltrans), undertook a study to evaluate retrofit opportunities for storm water management. Part of this study investigated the mosquito production of 37 structural management practices in southern California. Eight categories of practices were constructed and examined as part of the study: (1) biofiltration strips and swales; (2) filtration devices (Austin-type and Delaware-type sand media filters, multi-chambered treatment train sand media filters, and a proprietary canister filter); (3) extended detention basins; (4) infiltration devices (basins and trenches); (5) continuous deflective separators (CDSs); (6) an oil/water separator; (7) drain-inlet inserts; and (8) a constructed wetland (retention pond). The study consisted of comprehensive surveillance and monitoring of each practice for mosquito production, as well as follow-up monitoring after modifications had been made to reduce the potential to produce mosquitoes. Of the eight different technologies implemented by Caltrans, those that maintained permanent sources of standing water in sumps or basins (MCTT, CDS, and the retention pond) provided excellent habitat for immature mosquitoes and frequently supported large populations relative to other structural designs. In contrast, practices designed to drain rapidly (i.e., biofiltration swales and strips, Austin-type sand media filters, infiltration basins and trenches, and extended detention basins) provided less-suitable habitats and rarely harbored mosquitoes.

The project was expanded to a nationwide investigation using phone and mail surveys and site visits to 150 agencies in 28 states. Of the 72 agencies that completed a questionnaire, 86 percent reported mosquito production associated with storm water management facilities. The survey found that inadequate maintenance resulted in accumulation of trash and other constituents (e.g., sediment, vegetation, organic debris).

The Southwest Florida Water Management District conducted a study to determine the extent to which storm water management facilities were breeding mosquitoes and offer recommendations for minimizing mosquito production (Livingston, no date). After examining more than 200 management practices with both permanent pools and intermittent pools, they found that 76 percent of all practices were mosquito productive, and that 66 percent of the permanently flooded practices and 69 percent of the intermittently flooded practices bred mosquitoes. Larval density was smaller and more dispersed in wet detention systems than in intermittently flooded systems. The wet detention systems that did not breed mosquitoes shared a paucity of vegetation, abundant fish, and good aeration. The intermittently flooded dry detention pond systems that did not produce mosquitoes were those that drained or dried within 72 hours.

The Florida researchers also investigated several pesticides and found them to be between 91 and 100 percent effective at controlling existing larval infestations in intermittently flooded systems within 24 hours of treatment, although one treatment in a system with high organic content was found to be ineffective against dense larval populations. The researchers also found that sustained-release materials such as pellets were effective for up to five weeks after application, whereas short-term controls required regular application.

Regular monitoring for mosquito adults and larvae, retrofitting and maintenance of practices to reduce the likelihood for breeding, and pesticide application where needed are the three key actions for eliminating mosquito breeding in storm water facilities. The Centers for Disease Control and Prevention discussed the role of pesticides that kill adult mosquitoes (adulticides) in mosquito management and recommended that their use be incorporated into an integrated pest management program that includes surveillance, source reduction, chemical control (larvicide and adulticide), biological control, and public relations and education (Rose, 2001).

Surveillance programs track diseases in bird populations, vector-borne pathogens in mosquitoes, mosquito populations, larval habitats, mosquito traps, biting counts, and reports by the public (Rose, 2001). Control activities are initiated when threshold populations are exceeded, and predictions are made from seasonal records and weather data.

Source reduction entails eliminating or altering larval habitats. This can be achieved through public education campaigns, with outreach to both children and adults. Additionally, state and local mosquito control agencies can alter the hydrology of open water and marshy areas to reduce or prevent the proliferation of mosquito larvae. Rose (2001) suggests techniques in which mosquito-producing areas in marshes are connected by shallow ditches to deep-water habitats to allow drainage or fish access, and minimally flooding the marsh during the summer but flap-gating impounded areas to reintegrate them to the estuary for the rest of the year.

Biological control can be achieved using various predators such as dragonfly nymphs and predacious mosquitoes (Rose, 2001). Mosquito fish are the most commonly used agents for biological control because they are easily reared, although they also feed on non-target species. Other types of organisms that might be used for mosquito control include several fish types other than *Gambusia*, as well as fungi, protozoans, nematodes, and predacious copepods.

It is essential that storm water managers and public works crews who maintain storm water management facilities be educated in integrated pest management. They should be trained to identify design flaws or maintenance needs that might create mosquito-breeding habitat, and they should know the procedures for reporting and remedying the problem. Pesticide handlers should have the required training under the Federal Insecticide, Fungicide, and Rodenticide Act and all chemicals should be applied at rates recommended on the packaging. Treated areas should be monitored after application to determine the efficacy of the applications and identify where pesticide resistance might be occurring.

There are steps that a storm water manager can take to reduce the likelihood that mosquitoes will breed in storm water management facilities. From a design standpoint, most management practices other than wet retention ponds are intended to drain within 72 hours. This is a safe drainage time because mosquitoes need at least that long for their aquatic life stages. Additionally, Metzger et al. (2002) found that several design features of storm water management practices contributed to vector production, including the use of sumps, catch basins, or spreader troughs that did not drain completely; the use of loose riprap that could hold small amounts of water; pumps or motors designed to "automatically" drain water from structures; and effluent pipes with discharge orifices prone to clogging because of their small diameter.

Livingston (no date) recommends the following design considerations to minimize mosquitoes:

- Designs must be based on site characteristics to ensure that the most appropriate type of storm water management facility is selected. Vegetated dry retention systems should be designed as off-line systems. They should be used only where the soil and water table conditions will assure that the system drains or dries within 24 to 36 hours, and where the seasonal high water table is at least two feet below the bottom of the system. If on-line retention areas are used, they should be designed to be dry within three days of a 25-year, 24-hour storm.

- Dry retention systems need to be carefully constructed to avoid compacting the soil and reducing its infiltration rate. They also should have flat bottoms to avoid having areas of standing water.

- To minimize decaying organic matter, the grass or other vegetation in dry retention areas should be regularly mowed and the clippings removed and composted.

- The littoral zone of wet detention areas should be planted with aquatic macrophytes such as *Sagittaria latifolia* (duck potato), *Sagittaria lancifolia* (lance-leaf arrowhead), *Juncus effusus* (soft rush), *Pontedaria lancifolia* (pickerelweed), *Juncus roemerianus* (needle rush), *Scirpus californicus* (giant bulrush), and *Scirpus validus* (soft stem bulrush): Cattails (*Typha* spp.) should never be planted in or allowed to remain in storm water systems as they grow very profusely, creating a large quantity of decaying matter.

- Wet detention systems should be stocked with native *Gambusia* spp. minnows (mosquito fish) to foster biological predation of mosquito larvae. If needed because of site conditions, a "minnow sump" should be excavated in the deepest part of the pond to assure permanent habitat and survival during droughts.

- Sustained-release larvicides should be used whenever necessary with systems known to be mosquito productive treated before the onset of the mosquito life cycle.

- Regular inspection and maintenance of storm water systems is essential to ensure that the facility drains as designed. Such maintenance involves removing submerged vegetation and clearing sediments away from inlets, outlets, and the bottom of the pool or holding area.

5.6 Information Resources

The *Technology Review: Ultra-Urban Stormwater Treatment Technologies* (Brueske, 2000) was compiled to provide a review of "ultra-urban" storm water treatment technologies. These types of technologies are designed to remove pollutants from runoff in highly developed areas where land values are high and available space is limited. Ultra-urban technologies differ from traditional runoff treatment controls in that they are very compact and can be retrofitted into existing runoff collection systems. The document specifically analyzes four types of treatment technologies: gravity separation, swirl concentration, screening, and filtration. Technology review findings were then used to develop a design protocol for selecting and installing ultra-urban treatment technologies. This document can be downloaded in PDF format from http://depts.washington.edu/cuwrm/research/ultraurbn.pdf.

The California Department of Transportation (Caltrans) prepared two handbooks on storm water quality as an updated version of the *Construction Contractor's Guide and Specifications*. These new manuals are the *Construction Site Best Management Practices (BMPs) Manual* and the *Storm Water Pollution Prevention Plan (SWPPP) and Water Pollution Control Program (WPCP) Preparation Manual*. The two manuals provide background information on Caltrans' program to control water pollution, offer instructions for selecting and implementing construction site best management practices, and help to standardize the process for preparing and implementing the SWPPP and the WPCP. Caltrans requires contractors to prepare and implement a program to control water pollution during the construction of all projects. The manuals are available for download at http://www.dot.ca.gov/hq/construc/stormwater/manuals.htm.

The Milwaukee Metropolitan Sewerage District developed a manual entitled "Surface Water and Storm Water Rules Guidance Manual" in 2002 that is available on their Web site at http://www.mmsd.com/stormwaterweb/Startpg.htm. The document includes an extensive discussion of the principles of storm water management, descriptions of both structural and nonstructural measures to control storm water, and sizing procedures for detention basins, among other topics.

In August 1998 the Center for Watershed Protection published *Better Site Design: A Handbook for Changing Development Rules in Your Community*. The publication covers everything from basic engineering principles to "actual versus perceived" barriers to implementing better site designs. The handbook outlines 22 guidelines for better developments and provides a detailed rationale for each principle. *Better Site Design* also examines current practices in local communities, details the economic and environmental benefits of better site designs, and presents case studies from across the country. The document is available for purchase from the Center for Watershed Protection at http://www.cwp.org/.

In 2000 the Maryland Department of the Environment published the *Maryland Stormwater Design Manual*. The manual was designed to protect Maryland waters from the adverse impacts of urban runoff, to provide design guidance on the most effective structural and nonstructural management practices for development sites, and to improve the quality of management practices that are recommended by the state of Maryland. The first volume of the manual contains information on management practice siting and design on new development sites to comply with Maryland's 14 storm water performance standards. A unique feature is the use of storm water credits for rewarding innovative storm water management designs. The second volume contains detailed technical information on runoff control practices, including step-by-step design examples. Both volumes are available for download at http://www.mde.state.md.us/environment/wma/stormwatermanual.

In 1995 the Metropolitan Washington Council of Governments (MWCOG) published *Site Planning for Urban Stream Protection*, which presents a watershed approach to site planning and examines new ways to reduce pollutant loads and protect aquatic resources through nonstructural practices and improved construction site planning. The book also provides insight into the importance of imperviousness, watershed-based zoning, concentration of development, headwater streets, stream buffers, green parking lots, and other land planning topics. The document is available for purchase from MWCOG at http://www.mwcog.org/ic/95708.html.

The *Texas Nonpoint SourceBOOK* is an interactive Web tool that was designed to provide runoff management information to public works professionals and other interested parties in Texas and elsewhere. This site, which can be accessed at http://www.txnpsbook.org/, includes a beginner's guide to urban nonpoint source management issues, a discussion of water quality issues in Texas, elements of a storm water management program, information on storm water utilities, tips for assessing and selecting management practices, a comprehensive listing of links to other sites, frequently asked questions, and nonpoint source news.

In 1999 the Denver Urban Drainage and Flood Control District published the *Urban Storm Drainage Criteria Manual*. The manual was designed to provide guidance for local jurisdictions, developers, contractors, and industrial and commercial operators in selecting, designing, implementing, and maintaining management practices to improve runoff quality. The third volume of this manual is primarily targeted at developing and redeveloping residential and commercial areas. The manual is available for purchase at http://www.udfcd.org/.

In 1995 EPA published *Economic Benefits of Runoff Controls* (EPA-841-S-95-002), which contains a description of studies that document increases in property values and rental prices when properly designed runoff controls are used as visual amenities. The document is available for download from EPA's National Environmental Publications Internet Site (NEPIS) at http://www.epa.gov/ncepihom/nepishom.

EPA published the *Preliminary Data Summary of Urban Storm Water Best Management Practices* in 1999. The document summarizes existing information and data on the effectiveness of management practices to control and reduce pollutants in storm water. The report also provides a synopsis of what is currently known about the expected costs and environmental benefits of management practices, and identifies information gaps. The document is available for download in PDF format at http://www.epa.gov/ost/stormwater/usw_a.pdf.

In 1992 the Washington State Department of Ecology published its *Stormwater Management Manual for the Puget Sound Basin*. The manual is divided into five documents: Volume I: Minimum Technical Requirements; Volume II: Construction Stormwater Pollution Prevention; Volume III: Hydrologic Analysis and Flow Control Design; Volume IV: Source Control BMPs;

and Volume V: Runoff Treatment BMPs. All five volumes are available for download at http://www.ecy.wa.gov/biblio/9911.html.

The Washington State Department of Ecology's Water Quality Program has developed a Nonpoint Source Pollution home page. This Web site, accessible at http://www.ecy.wa.gov/programs/wq/nonpoint, contains nonpoint source program information, posters, resources, and references. The Department of Ecology has also made available a copy of the draft of *Instream Flows in Washington State: Past, Present, and Future*. The document is available at http://www.olympus.net/community/dungenesswc/InstreamFlowversion12.PDF.

The Metropolitan Council of St. Paul/Minneapolis developed the *Urban Small Sites Best Management Practices (BMP) Manual* to provide assistance to communities in planning for storm water management for sites of less than 5 acres located in cold climates. The document focuses on low-impact development practices that promote the restoration and preservation of natural hydrology. The manual includes information on the selection of BMPs and model storm water ordinances and contains a regulatory analysis for watershed programs. The document is available at http://www.metrocouncil.org/environment/Watershed/bmp/manual.htm.

An excellent discussion of the design of infiltration techniques in limestone/carbonate bedrock areas can be found in a new design manual developed for the Lehigh Valley Planning Commission (LVPC) by Cahill Associates. The manual, *Technical Best Management Practice Manual and Infiltration Feasibility Report: Infiltration of Stormwater in Areas Underlain by Bedrock in the Little Lehigh Creek Watershed,* is available from the LVPC at 961 Marcon Boulevard, Suite 310, Allentown, Pennsylvania, 18109, 1-888-627-2626 (toll free), lvpc@lvpc.org.

The Virginia Municipal League published an article titled "Stafford County helps pioneer low impact design movement" describing the process by which Stafford County, Virginia, incorporated low-impact design into its development codes. The article includes links to Builders for the Bay, an organization that provides assistance to local communities wishing to update their codes, as well as several other helpful resources for communities. The article can be downloaded at http://www.vml.org/VTC/VTC3908-2.html.

The American Mosquito Control Association's Web site, located at http://www.mosquito.org/, offers information about mosquitoes and their control along with links, frequently asked questions, and West Nile virus information.

American Rivers developed a report on low impact development techniques for the Great Lakes region called *Catching the Rain: A Great Lakes Resource Guide for Natural Stormwater Management.* The report includes an overview of many runoff control techniques, including pros and cons of each practice. The report can be downloaded in PDF format from the American Rivers Web site at www.americanrivers.org (visit the "Resources" link and choose to view a complete list of publications).

The Villanova University Stormwater Partnership conducts research on management practices to control urban runoff. The organization has established a "Stormwater BMP Park" with a constructed wetland, a biofiltration traffic island, and a porous concrete site. Research results and outreach materials can be found at http://www3.villanova.edu/VUSP/.

The EPA "Final Action for Effluent Guidelines and Standards for the Construction and Development Category" can be found at http://www.epa.gov/fedrgstr/. The Technical Development Document (EPA-821-B-04-001), which contains information on costs and technologies, is available from US EPA/NSCEP. P.O. Box 42419, Cincinnati, Ohio 45242-2419, (800) 490-9198 or http://www.epa.gov/waterscience/guide/construction.

EPA's *The Use of Best Managment Practices (BMPs) in Urban Watersheds* evaluates design, effectiveness, and cost considerations for storm water management practices. The document canbe downloaded in PDF format from http://www.epa.gov/ORD/NRMRL/pubs/600r04184/600r04184.pdf (cover and table of contents) and http://www.epa.gov/ORD/NRMRL/pubs/600r04184/600r04184chap1.pdf (Chapters 1–6).

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MANAGEMENT MEASURE 6
NEW AND EXISTING ON-SITE WASTEWATER TREATMENT SYSTEMS

6.1 Management Measure

Develop or maintain on-site wastewater treatment system (OWTS) permitting and installation programs that adequately protect surface water and ground water quality. Programs should include:

- A process to identify and protect sensitive areas (e.g., wellhead protection zones, nitrogen/phosphorus limited waters, shellfish habitat) and ensure that cumulative hydraulic discharges and mass pollutant loads from on-site systems do not impair surface or ground water;
- System selection, siting, design, and installation based on performance requirements, prescriptive technologies, protective setbacks, and separation distances that protect surface water and ground water resources;
- Education, training, licensing, and/or certification programs for system designers, site evaluators, permit writers, installers, inspectors, and other service providers; and
- Inspections of new on-site systems during and immediately following construction/installation to ensure that design and siting criteria are applied appropriately in the field.

Establish and implement management programs to ensure that newly permitted and existing on-site wastewater treatment systems are operated and maintained properly to prevent the impairment or degradation of surface and/or ground waters. On-site system operation and maintenance programs should include:

- System inventories and assessments of maintenance needs that provide management information regarding the types of systems in use and their location, capacity, installation date, owner, date of last inspection/service, and other data needed to support operation and maintenance oversight activities.
- Policies to ensure that on-site systems are managed, operated, and maintained to prevent degradation and impairment of surface and ground waters. These policies should include adequate authority to conduct inspections, revoke operating permits, and require pumping, repair, replacement, upgrade, or modification technologies when conditions indicate that surface and/or ground water resources might be adversely affected (e.g., eutrophication of surface waters, microbial or nitrate contamination of ground water).
- Periodic inspection and/or monitoring requirements to ensure that on-site systems are functioning properly. Inspection and monitoring programs should consider hydraulic, hydrologic, and mass pollutant loading impacts at both the site and watershed scales.
- Requirements to ensure that residuals pumped from the tank (i.e., septage) are reused or disposed of in a manner that does not present significant risks to surface waters or ground water resources.

6.2 Management Measure Description and Selection

6.2.1 Description

When properly planned, designed, installed, operated, and maintained, OWTSs (also referred to as septic systems) can effectively remove or treat contaminants such as pathogens, biochemical oxygen demand (BOD), and nutrients in human sewage. However, many on-site systems are failing because of age, inappropriate design, hydraulic/pollutant overloading, or poor maintenance (see Table 6.1). Detrimental impacts from on-site systems can occur when they are sited in sensitive ecological areas (such as wellhead protection zones, near nitrogen/phosphorus limited waters, or near beaches or shellfish habitat) or when they are installed at densities that exceed the hydraulic and hydrologic assimilative capacities of regional soils and aquifers. Pollutants of concern from on-site systems include pathogens, nitrogen compounds (e.g., nitrates), phosphorus, BOD, and other chemicals described in Table 6.2.

Table 6.1: Common causes of OWTS failure.

Type of failure	Contributing causes
Hydraulic	Excessive hydraulic loadings to undersized systems, low soil permeability, excessive ponding at the infiltrative surface, poor maintenance. Increases in water usage over a period of years can exceed the design capacity of the wastewater treatment system.
Organic	Excessive organic loading from unpumped or sludge-filled tanks results in biomat loss of permeability (biomats are discussed further in Section 6.3.1.5.2, which describes subsurface wastewater infiltration systems).
Soil depth to ground water table or bedrock	Insufficient soil depths (i.e., soil thickness between the subsurface wastewater infiltration system [SWIS] and ground water tables, impermeable strata, or bedrock is less than the recommended depth for soil texture and structure). High ground water is deleterious to pathogen removal and hydraulic performance.
System age	Systems more than 25 to 30 years old. Systems less than 25 to 30 years old experience considerably fewer hydraulic failures. Failure rates can more than triple for older systems. Regular tank pumping and use of alternating SWISs can prolong system life indefinitely.
Design failure	Inappropriate system design for the site; failure to adequately consider or characterize wastewater strength and flow (average daily and/or peak flows); failure to identify and consider restrictive soil/rock layers (e.g., fragipan) or regional geology (e.g., karst features, creviced bedrock); failure to assess landscape position.
System density	Cumulative effluent load from all systems in watershed or ground water recharge area exceeds the hydrologic capacity of the area to accept and/or properly treat effluent.

Table 6.2: Pollutants of concern for OWTSs (adapted from Tchobanoglous and Burton, 1991).

Pollutant	Reason for concern
Pathogens	Microorganisms such as parasites, bacteria, and viruses can cause communicable diseases through direct/indirect body contact or ingestion of contaminated water or shellfish. Pathogens pose a particular threat when partially treated sewage pools on ground surfaces or migrates to recreational waters. Transport distances for some pathogens in surface or ground waters can be significant.
Nitrogen	Nitrogen is a plant nutrient that can contribute to eutrophication and depletion of dissolved oxygen in surface waters, especially in estuaries and coastal embayments. Excessive nitrate-nitrogen in drinking water can cause methemoglobinemia in infants and complications for pregnant women. Livestock also can suffer health impacts from drinking water high in nitrate.
Phosphorus	Phosphorus is a plant nutrient that can contribute to eutrophication of inland fresh waters and some marine waters and eventually deplete dissolved oxygen.
Household chemicals	Chlorine, ammonia, and other cleaning compounds in high volumes may disrupt or disable biological activity in the septic tank. Wastes from hobby or craft activities (paints, solvents, etc.) and disposal of non-organic liquid wastes (old furniture polish, pesticides/herbicides, etc.) in onsite/cluster systems can have similar impacts.
Pharmaceuticals and endocrine disruptors	Disposal of large quantities of outdated antibiotics and other medicinal products in septic tank-based systems can impair or halt biological treatment processes. Disposal of products containing chemicals that disrupt endocrine system functions (e.g., regulation of metabolism, blood sugar, reproduction, embryonic development) in on-site systems might result in leaching of these chemicals into groundwater and surface waters and impair water quality and/or aquatic organisms, in some cases. Research on this issue, including toxicology, transport, and fate of potential endocrine disruptors, is ongoing (USEPA, 1998a; North Carolina Department Environment and Natural Resources, no date).

Estimates of on-site system failure rates range from 5 to 25 percent and higher in some states (USEPA, 2001b), resulting in contamination of drinking water, beaches, shellfish beds, and surface water resources. In 1996 septic systems were a contributing source of pollution for more than one-third (36 percent) of the impaired miles of ocean shoreline surveyed. The National Oceanic and Atmospheric Administration (NOAA) reported in 1995 that the discharge of partially treated sewage from malfunctioning septic systems was identified as a principal or contributing factor in 32 percent of all harvest-limited growing areas (NOAA, 1995).

In addition, ponds, lakes, and coastal embayments have been impaired by algal blooms caused in part by nutrient over-enrichment from failing OWTSs. For example, in Sarasota County, Florida, 45,000 septic systems contribute four times as much nitrogen to Sarasota Bay as the city of Sarasota's wastewater treatment plant. Septic systems are adding an estimated 1.5 million pounds of nitrogen per year to Florida's Indian River Lagoon, causing a decrease in freshwater wetlands and commercial shellfish harvests (USEPA, 2003).

States have identified OWTSs as the third most common contributor to ground water pollution and a significant threat to drinking water sources (Parsons Engineering Science, 2000). A 1999 outbreak of gastroenteritis at the Washington County (New York) Fair was linked to a failing septic system at a nearby dormitory. A failed septic system was blamed for 46 cases of hepatitis A in Racine, Missouri, in 1992, and other states have reported both health and water resource impacts from poorly functioning OWTSs (Fobbs and Skala, 1992).

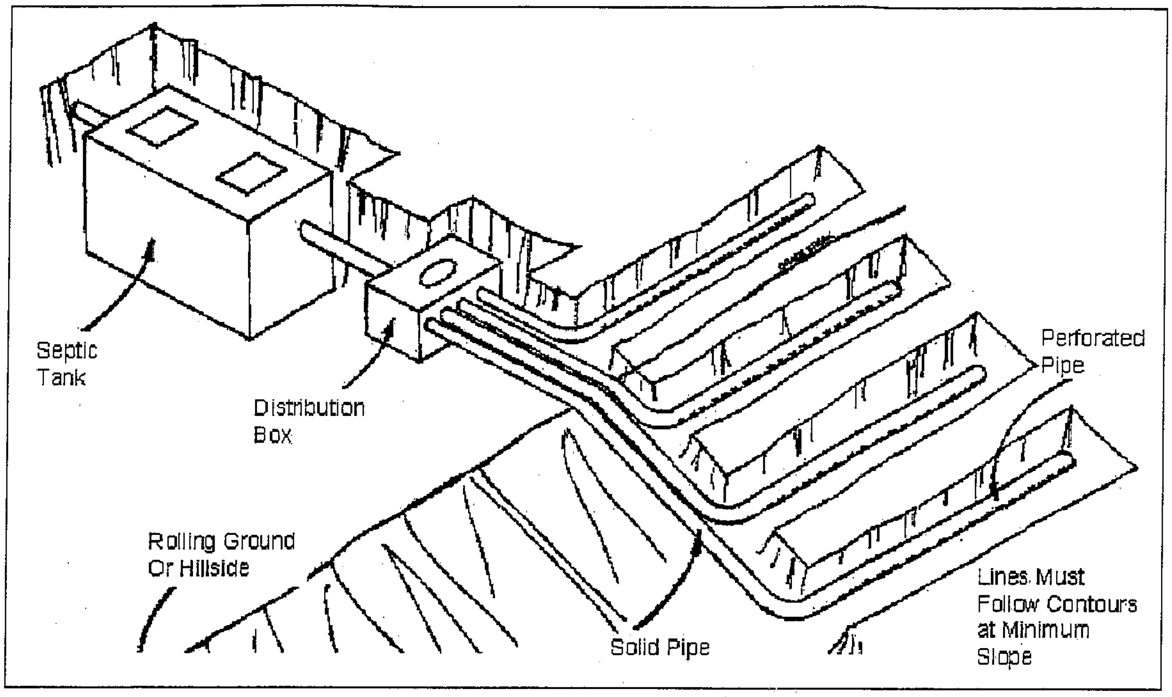

Figure 6.1: Conventional on-site wastewater treatment system.

OWTSs can generally be divided into two categories: conventional systems and alternative or innovative systems.

Conventional systems (see Figure 6.1) consist of a septic tank and a subsurface soil absorption field, commonly called a subsurface wastewater infiltration system (SWIS). Buried in the ground, septic tanks are essentially watertight, single- or multiple-chamber sedimentation and anaerobic digestion tanks. They are designed to receive and pretreat domestic wastewater, mediate peak flows, and keep settleable solids, oils, scum, and other floatable material out of the SWIS. Wastewater effluent is discharged from the tank and passes through pipes to a series of underground perforated pipes that can be wrapped in a permeable synthetic material. From there, the partially treated effluent flows onto and through the soil infiltrative surface, and finally into the SWIS infiltration medium (i.e., soil). Treatment occurs in the septic tank, on and within the biomat that forms at the soil infiltrative surface, and in the soil (or other medium); it then continues as the effluent moves through the underlying soil (biomats are discussed further in Section 6.3.1.5.2, which describes subsurface wastewater infiltration systems). Treated effluent that is not drawn into plant roots, incorporated into microbial biomass, or evaporated ultimately reaches ground waters and possibly nearby surface waters.

Alternative or innovative systems such as mound systems, fixed-film contact units, wetlands, aerobic treatment units ("package plants"), low-pressure drip applications, and cluster systems, are used in areas where conventional soil-based systems cannot provide adequate treatment of wastewater effluent. Areas that might not be suitable for conventional systems are those with nearby nutrient-sensitive waters, high densities of existing conventional systems, highly permeable or shallow soils, shallow water tables, large rocks or confining layers, and poorly drained soils. Alternative or innovative systems feature components and processes designed to promote degradation and/or treatment of wastes through biological processes, oxidation/reduction reactions, filtration, evapotranspiration, and other processes. Cluster systems can be used to collect and treat wastewater from multiple facilities at a common site (e.g., lagoon, wetland, infiltration field). Alternative, innovative, and cluster systems often require individual septic tanks for each facility served to provide primary treatment and minimize fat, oil, grease, and solids loadings to secondary treatment units. (Note: Cluster systems that serve 20 or more people may be regulated by a federal, state, and/or local Underground Injection Control Program for Class V facilities. For more information, visit EPA's Underground Injection Control Program Web site at http://www.epa.gov/safewater/uic.html.)

Many states, tribes, and municipalities use a prescriptive approach to on-site system management. Such an approach assumes that a prescribed system design will adequately protect public health and water resources when installed at sites meeting established minimum requirements. Site evaluations are usually based on empirical approaches such as percolation tests and setback/separation distance requirements.

These evaluations do not typically consider regional hydrology or the density and cumulative discharge of existing and planned treatment systems. They do not consider the overall assimilative capacity of regional soils and hydrology and do not assess complex relationships among soil characteristics, site conditions, wastewater composition, biological mechanisms, and regional climate (Otis and Anderson, 1994). A prescriptive approach is often restrictive and arbitrary and can be underprotective or overprotective of public health and water quality.

A performance-based on-site system management approach does not require specifications for treatment methods or processes, but rather establishes treatment performance requirements for protecting human health and water resources. For example, this approach requires additional nitrogen removal in designated nutrient-sensitive areas without specifying the type of technology to be used (Code of Massachusetts Regulations, 1995). A report issued by the Maryland Department of the Environment and Maryland Office of Planning (2000) recommends installation of systems with enhanced nitrogen removal capabilities in designated "areas of special concern" to reduce nutrient loadings to the Chesapeake Bay and other sensitive waters.

Under a performance-based approach, officials are free to consider the application of alternative and innovative on-site systems in addition to conventional systems. Systems are planned, designed, sited, and installed to achieve specified performance requirements within the context of regional and individual site conditions, rather than requiring site conditions to conform to the soils, slopes, and other needs of a restricted set of prescribed technologies. Performance-based on-site programs also include rigorous and ongoing system management, such as periodic inspections and required maintenance. Such a management approach can result in fewer system failures and greater protection of public health, surface waters, and ground water.

EPA issued *EPA Voluntary National Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems* (USEPA, 2003), which recommends management measures for on-site systems based on the administrative and managerial capacity of management entities, the complexity of technologies used, and the value and proximity of resources to be protected. The guidance contains tools and directions to assist states and communities in developing management programs based on local needs and resources, as well as risks to human health and water resources. Activities include planning, design, site evaluation, inspections, monitoring, funding, and other functions. The guidelines note the shortcomings of on-site programs that: (1) do not have a planning element that considers regional hydrology and system densities and discharges; and (2) do not have operation and maintenance requirements that ensure monitoring, periodic septic tank pumping, system repair, and upgrades when necessary. Many existing OWTS regulatory programs fail to consider the ability of regional soils to assimilate pollutants from dozens or hundreds of treatment systems in an area and often leave operation and maintenance of these systems to uninformed and untrained homeowners.

In *EPA Voluntary National Guidelines for Management of Onsite and Clustered(Decentralized) Wastewater Treatment Systems*, EPA recognizes the benefits of both conventional and alternative systems and emphasizes the importance of proper planning, site evaluation, system design, installation, inspection, operation, monitoring, and maintenance. On-site systems, like sewage treatment plants that serve urban areas, require periodic attention and regular servicing to ensure that treatment levels meet established performance requirements. Management programs must comply with performance requirements by ensuring sludge is pumped from tanks periodically, failed or failing systems are detected promptly and repaired or replaced, and undersized or underperforming systems are upgraded.

6.2.2 Management Measure Selection

This management measure was selected to ensure that new and existing on-site wastewater treatment systems function properly. If these systems fail, wastewater can pool on ground surfaces or migrate to aquifers or surface waters and cause significant public health or environmental problems (e.g., disease outbreaks, eutrophication, loss of dissolved oxygen). This management measure supports a performance-based approach to system management and is consistent with the *EPA Voluntary National Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems* (USEPA, 2003) and the *Onsite Wastewater Treatment System Manual* (USEPA, 2002a).

6.3 Management Practices

6.3.1 Permitting and Installation Programs

EPA believes that on-site system permitting and installation programs that protect surface and ground waters are necessary to decrease or eliminate risks to human health and sensitive ecological resources. Approaches that match the treatment capabilities of various on-site technologies to the conditions and sensitivity of the receiving environment (ground water or surface water) are preferred. EPA recognizes that, due to a lack of staff expertise, funding, assessment data, regulatory infrastructure, public support, and other resources, not all on-site regulatory agencies or management programs will have the ability to implement performance-based approaches.

Therefore, alternative approaches, which include prescriptive standards that provide appropriate levels of protection for human health and water resources, are included among the acceptable management practices summarized in this section. These standards include prescribed treatment technologies, minimum requirements (e.g., soils, slopes) for proposed installation sites, mandatory setback and separation distances, and specific system component requirements (e.g., septic tank screens, grease traps). They will be considered acceptable management practices if they provide reasonable assurances of protecting public health and water resources when applied under the specific site conditions.

Elements supporting this Management Practice are listed below and correspond with the management measures listed in Section 6.1.

6.3.1.1 Planning activities

Comprehensive planning can provide valuable information and support for on-site system placement and management. Integrating planning with regulatory programs can provide a basis for ensuring the performance of existing systems and permitting future installations. Planning involves the examination of many variables:

- A wide range of environmental characteristics (e.g., ground water, topography, soils, climate, sensitive ecological resources);
- The locations and types of facilities that could be part of an overall wastewater management plan;
- The organizational and institutional structures that exist or may need to be created; and
- Financial support for their development and implementation.

At a minimum, planning should identify areas where:

- Installation of conventional systems can be allowed at specified densities;
- Alternative systems could be required; and
- On-site systems could be permitted only under strict design and performance requirements and assurances for long-term monitoring and maintenance.

6.3.1.1.1 *Comprehensive planning*

Comprehensive planning provides one of the best vehicles for ensuring that on-site management issues are considered under future growth and development scenarios. Comprehensive planning and zoning are closely related and are usually integrated. Comprehensive planning sets overall guidance and policies; zoning provides the detailed regulatory framework for implementation. Comprehensive planning that addresses environmental protection while providing adequate public services such as wastewater treatment can be administered through zoning regulations that:

- Specify prescriptive or performance requirements for individual or clustered systems installed in unsewered areas, preferably by watershed, subwatershed, or ground water recharge area;
- Limit, manage, or prevent development on sensitive natural resource lands or in designated critical areas (e.g., in wellhead protection zones or shellfish habitat runoff catchments, or near nutrient-sensitive waters and wetlands);
- Encourage development within urban growth areas serviced by sewer systems, if adequate capacity exists; and
- Consider factors such as system densities, hydraulic and pollutant output, proximity to water bodies, soil and hydrogeological conditions, water quality, and cumulative loadings from all systems, including future systems, in planning and zoning decisions. Large numbers of soil-based on-site systems discharging to a confined area (e.g., high-density subdivisions) can overwhelm the capacity of soils to assimilate and treat wastewater pollutants of concern, such as nutrients and pathogens.

It should be noted, however, that it is not necessary for the on-site regulatory agency or management entity to oversee or administer the planning program. In many areas, local or regional planning offices collect and store the types of information needed for on-site system management. Some of these offices have the ability to generate geographic information system (GIS) maps that can incorporate water resource, soil, topographic, and other information that provides screening-level site criteria for proposed installation of on-site systems. Coordination with planning offices to designate ecologically sensitive areas and those approved for future on-site system installations can significantly improve the management capabilities of the on-site regulatory agency or management program and improve watershed protection.

6.3.1.1.2 *Wastewater treatment continuum concept*

Decision-makers responsible for approving wastewater collection and treatment services for existing or new facilities often require information and guidance on the various options available. Protection of public health and valued water resources and cost are the primary decision-making criteria in most cases. Both centralized sewer service and decentralized/on-site systems protect public health and water resources, though treatment levels and cost may vary depending on technology, operational factors, system maintenance, and site-specific conditions (e.g., combined sewer overflows, bypasses, and nutrient removal requirements for centralized systems; and geology, soils, climate, and other factors for decentralized/on-site systems).

A number of wastewater treatment and collection options exist along the continuum between individual on-site systems and centralized sewer service. The following options are suggested for decision-makers seeking to improve collection and treatment in existing areas or to provide these services to new development (Venhuizen, 2000):

- Current practice, employing conventional septic tank/soil absorption field systems within the confines of each residential or facility lot;

– Alternative on-site systems for each lot. Examples include sand filters, aerobic treatment units, vegetated submerged wetlands, and dispersal in shallow, pressure-dosed subsurface wastewater infiltration systems;

– Small-diameter collection/treatment facilities using septic tank effluent drains (STEDs) or other shallow, low-cost collection systems to pump or route the flow from each lot to a common site for final treatment and dispersal or discharge; or

– Centralized sewage collection and treatment with the option of either conventional or alternative treatment facilities at one centralized plant.

Each of these strategies should include oversight and management programs to ensure that collection and treatment equipment and processes continually meet performance requirements. The responsible management entity (RME) should be charged with keeping collection and treatment systems working. The RME should have sufficient authority to enforce programmatic and other requirements, pay for operational and other costs, and take necessary actions in the event of performance failure or emergencies.

Developing operation, maintenance, and management strategies for decentralized/on-site systems in a manner similar to those in existence for centralized systems—or incorporating on-site treatment options into the centralized system strategy—can help to ensure that public health and water resources are protected effectively and efficiently.

6.3.1.1.3 *Centralized sewage treatment*

As development activity increases the density of OWTS-served housing, commercial establishments, and other facilities in a region, it is sometimes cost-effective to extend service lines from centralized sewage treatment facilities (i.e., publicly owned treatment works or POTW) for wastewater collection and treatment at a central plant. Small towns in the past have typically only considered connections to a regional POTW or the construction of a treatment facility. Factors to consider other than costs when deciding whether it is beneficial to use decentralized/onsite systems, construct a new treatment plant, or extend service lines of a nearby system include the following:

– Age and operational history of existing OWTSs;

– The RME's capacity and authority to properly manage OWTSs;

– Future housing and other development trends based on land use planning information;

– Proximity and capacity of existing POTW service lines and treatment facilities;

– Potential for revision to an existing NPDES discharge permit;

– Suitable financing, land area, and site conditions for construction of POTWs or collection lines; and

– Hydrological impacts and catastrophic risk assessment due to failure of collection systems and POTWs.

6.3.1.2 System selection, site evaluation, design, and installation

On-site systems often fail because of improper design and inadequate site evaluation and/or installation. Some states require higher levels of treatment near wellhead recharge zones, nutrient-sensitive waters, shellfish habitat, or other areas of special concern. On-site wastewater treatment systems discharging pathogens that can reach wells or shellfish habitat areas, and those that discharge significant inputs of nitrogen or phosphorus to nutrient-sensitive waters, should be high-priority candidates for upgrade or replacement (Commonwealth Biomonitoring, 2001). A committee advising the Maryland Department of the Environment recommended in 2000 that legislation be adopted requiring county water and sewer agencies to designate areas of special concern to address elevated nitrogen inputs from existing and new on-site systems (Maryland Department of the Environment, 2000). State income tax credits of up to $1,100 per year for three years were suggested to assist homeowners with increased system costs. Existing systems would only require nitrate removal in these areas when system replacement was required.

6.3.1.2.1 *Performance-based programs*

Performance requirements for individual or clustered on-site treatment systems are most often based on assurances that system discharges will not cause violations of surface water quality standards or drinking water standards. A performance-based program includes the following components:

- Performance goals;
- Performance criteria;
- Performance requirements; and
- Performance monitoring.

(a) *Performance goals*. Performance goals define the larger issues that are important to consider in on-site system siting, selection, design, and management. A properly functioning on-site system should be able to meet two basic performance goals: protect public health and protect water resources.

An example of a performance goal might be to protect the surface water from nutrient enrichment in environmentally sensitive areas such as lakes or estuaries. Detailed planning, design, installation, and management programs can help prevent placement of inappropriate systems in areas with unsuitable soils, on sites adjacent to valued and sensitive surface water bodies, and at densities that exceed regional hydrologic and pollutant assimilative capacities. Such an approach can help control or minimize pollutant loadings and associated impacts on surface and ground waters.

Promoting System Upgrades Through Innovative Financing

The Code of Massachusetts Regulations allows a state tax credit of up to 40 percent of the cost of a new on-site system or system repairs. The credit is capped at $1,500 per year and $6,000 total and is limited to homeowners living in the residence served by the repaired or replaced on-site system (Code of Massachusetts Regulations, 2001).

(b) *Performance criteria.* Performance criteria are measurable indicators that identify the pollutants of concern for a particular area so that benchmarks or performance requirements can be established to reduce further inputs of those pollutants. Performance criteria are used to quantify progress in achieving performance requirements for specific pollutants. Some examples of site-scale performance criteria include effluent concentration limits for nitrate, biochemical oxygen demand (BOD), fecal coliform bacteria, and overall flow. Watershed-scale criteria might include total hydraulic input to a ground water recharge zone from on-site systems, and total nitrogen load or total phosphorus load to ground water or surface waters.

(c) *Performance requirements.* Performance requirements are criteria-based limits that define acceptable environmental impacts and public health risks associated with on-site systems. Performance requirements are based on the type of water body that ultimately receives treated wastewater effluent (ground water or surface water) and the present or projected uses of that water body (e.g., drinking water source, shellfish habitat, contact recreation). Examples of a performance requirement might be that on-site systems in nitrogen-sensitive areas must not discharge more than 5 pounds of nitrogen per year, or that nitrate concentrations in OWTS effluent cannot be greater than 15–20 milligrams per liter (mg/L).

Resource protection performance requirements are based on the assumption that any given resource has a threshold (carrying or assimilative capacity) beyond which it cannot function and may deteriorate. Nitrogen requirements are more likely to be appropriate near marine waters because this nutrient is usually the limiting factor for algal growth in coastal areas. In ground waters, nitrogen can degrade drinking water resources as well. The Commonwealth of Massachusetts has designated certain areas, such as wellhead protection areas, areas in public water supply watersheds, and nitrogen-sensitive coastal embayments or other nitrogen-sensitive water bodies, as "Nitrogen-Sensitive Areas" (Code of Massachusetts Regulations, 1995) and has issued requirements to ensure their protection. Environmentally sensitive areas might include nitrogen-limited coastal waters, phosphorus-limited inland waters, shellfish habitat, and ground water used as drinking water. Typical performance criteria and examples of corresponding performance requirements are listed below:

- Fecal coliform bacteria as an indicator of the possible presence of pathogens (e.g., less than 200 colony-forming units per 100 milliliters [cfu/100 ml]) for support of primary contact recreation or 14 cfu/100 ml in shellfish waters
- Nitrogen in the form of nitrate in potable ground water (e.g., less than 10 mg/L) and as total nitrogen in nitrogen-limited coastal waters to prevent or reduce enrichment
- Phosphorus concentration in surface waters where phosphorus is the limiting element for algal growth (e.g., less than 0.025 mg/L to support warm water aquatic habitat)
- BOD for surface waters requiring high levels of dissolved oxygen for propagation of fish and shellfish (e.g., 5–10 parts per million of 5-day BOD after tertiary treatment to support warm water aquatic habitat)
- Nuisance factors (e.g., no objectionable odors emanating from the septic tank or infiltration field area, no sewage surfacing to minimize risk of human contact)

(d) *Performance monitoring*. Performance monitoring tracks progress in achieving performance requirements. Typical approaches involve measuring or assessing performance criteria at some specified point of compliance (e.g., a designated performance boundary). For example, if waters of a commercial shellfish habitat in a coastal bay are experiencing elevated bacterial contamination, a fecal coliform bacteria performance requirement for on-site systems in the area might be established at the property line or shoreline of the lot. A variety of monitoring programs have been developed to assess the performance of on-site systems. Approaches include measurement of chemical parameters (e.g., nitrogen, phosphorus, BOD, nitrate) in effluent or receiving waters; analysis of fecal coliform/fecal streptococcus ratios; and a variety of new, experimental, analytical approaches using molecular, chemical, or biochemical methods (e.g., ribotyping, antibiotic resistance analysis, randomly amplified polymorphic DNA, pulse field gel electrophoresis, caffeine tracking) (Hagedorn, 2000). Validation and cost issues prevent widespread use of the newer methodologies at the present time, but research in the field shows significant promise.

The Critical Point Monitoring (CPM) approach being developed in Washington State provides a systematic approach to choosing critical locations to monitor specific water quality parameters (Eliasson et al., 2001). The program is most suitable for responsible management entities operating comprehensive management programs. CPM provides an appropriate framework for monitoring treatment train components (i.e., septic tank, infiltration field, sand/media filters, aerobic treatment units), though it should be recognized that evaluations of overall system effectiveness—and compliance with performance requirements—should be based on monitoring at designated performance boundaries.

Tracer dye tests, analysis of *E. coli* concentrations in receiving waters, and system inspections are the most widely used methods for monitoring on-site system performance at present. The first only provides indirect hydrologic information, while the latter two offer direct utility to assess whether performance goals are being achieved. For the purpose of watershed-scale monitoring and modeling, the use of output criteria derived from typical performance ranges of on-site system types used in the area is a common practice. Models can be useful tools to predict potential ground water impacts if they are based on site- or regional-specific characteristics and are calibrated to achieve the best estimates of actual field results. They are rarely accurate under all conditions, however, and must be supplemented with actual field monitoring results when available.

6.3.1.2.2 *Modeling system performance and impacts*

There have been relatively few attempts at developing modeling tools to predict and simulate nutrient fate and transport mechanisms from on-site system effluent (Tetra Tech, 2000; Bicki and Brown, 1991; Harmesen et al., 1991). Most of the work has focused on identifying nitrate loading to ground water for the purpose of planning for drinking water protection. Computer models require a considerable amount of site-specific information regarding wastewater characteristics, discharge volumes, soils, topography, underlying geology, ground water, and climate, but they can be useful tools for assessing the long-term impacts of OWTSs in an area and developing strategies to mitigate potential problems.

The State of Florida developed a computerized model to assess ground water contamination potential in selected hydrogeologic regions as a tool to guide development of subdivision regulations (Florida HRS, 1993). The model incorporated features of the state's varied surficial hydrology and soil regimes and provided estimations of the transport and fate of nitrogen compounds. The Florida model uses a steady-state, one-dimensional flow field with three-dimensional dispersion and assumes retardation and first-order decay rates to be zero. Nitrate contaminant plumes generated by the model show a variety of dispersion and transport scenarios and confirm that increasing lot size from four homes per acre to two homes per acre (and even fewer in areas of high porosity) reduce nitrate concentration and migration in ground water by approximately 50 percent (from 10 mg/L to 5 mg/L 700 feet downgradient of the subdivision under study). The results suggest that concerns over nitrate contamination of ground waters from large, densely developed subdivisions with OWTSs are not unfounded. They support recommendations to monitor ground water nitrate concentrations below and downgradient of large subdivisions with home densities greater than four units per acre.

Another model developed for the Indian River Lagoon National Estuary Program found that nitrogen inputs linked to on-site systems constituted 12 percent of the total nitrogen load into the lagoon, an amount nearly equal to the load from cattle. The loading model provides a mechanism for calculating total nitrogen inputs into the aquatic system, and it attempts to predict the nitrogen concentrations in ground water based on hydrological parameters (University of Massachusetts, 2000). Efforts to calibrate the ground water prediction capabilities of the model are ongoing.

6.3.1.2.3 *Applying system siting criteria*

Conventional and many alternative on-site systems include a SWIS, which requires a certain minimum area of soil, sand, or other treatment media to effectively remove pathogens and other pollutants. Under a prescriptive approach, setbacks from wells, surface waters, building foundations, and property boundaries are minimum requirements necessary to eliminate or reduce threats to public health and the environment. Setbacks are used only rarely but can be established based on soil type, slope, characteristics of the water table (as defined by the implementing agency), sensitivity of aquatic resources, and type of on-site system. Under a prescriptive program, setback guidelines also should be established for both conventional and alternative on-site systems. Recommendations for horizontal separation distances are based on the degree of pre-soil application treatment achieved, as well as site-specific factors such as climate, topography, soil permeability, ground water gradient, ground water flow, and geology. The management entity should adopt measures that restrict the placement of wastewater treatment systems in inappropriate soils, in proximity to valuable surface waters, and at densities too high for soils to treat pollutants sufficiently. One example is the lack of available concentrations of certain metals that retard phosphorus movement to nearby surface waters.

Separation and setbacks can also be used under the performance-based approach. Under this approach, setback or separation distances should be based upon research or field data that demonstrate pollutant removals needed to meet performance requirements given the specific site conditions and treatment technology applied. Pretreatment systems that discharge effluent containing concentrations of bacteria, nitrogen, and phosphorus below requirements established to protect water quality can be sited closer to water resources if impact analyses determine that contamination risk is unlikely.

6.3.1.2.4 *Site evaluations that assess suitability for specific technologies*

States vary greatly in their approach to evaluating site suitability; such approaches range from no specific requirements to very detailed evaluations that require qualified soil scientists and hydrogeologists (NSFC, 1995). A performance-based approach to site evaluation may involve one or more of three evaluation approaches:

1. *Soil-based.* Sites are characterized by conducting a soil profile analysis, usually through the use of soil maps, field data, and inspection of the soil profile in a backhoe pit. Many states now require a soil profile analysis to determine site suitability for conventional systems.

   The soil-based approach focuses on site-specific observation of soil properties that significantly affect the performance of soil-based on-site systems. The soil-based approach has two major advantages: (1) direct observation of soil properties provides a considerable amount of quantitative and qualitative information that can be used to select or modify on-site system design; and (2) site evaluations for individual systems can sometimes be completed in a single visit. The major disadvantage of this approach is that it provides little quantitative information on hydrologic properties and characteristics of the region and sub-watershed. The risk of inadequate hydrogeologic characterization increases when on-site system densities increase.

   Soil assessments are best conducted by observing the soil profile on the wall of a backhoe pit that is 48 to 72 inches deep. Soil layers should be characterized to a depth of at least 3 to 5 feet below the proposed excavation of the effluent absorption field, especially in highly porous soils. Characterizing the soil profile in a backhoe pit is best accomplished using natural lighting because soil texture, structure, color, mottling, and iron or manganese concretions can be observed, assessed, and described more accurately. Hand augers tend to disturb and compress the soil and disguise soil layers, making it difficult to observe structure and other features. Pits should be excavated at the perimeter of the soil absorption field rather than in the middle of it because settling might cause problems with distribution piping and absorption trench stability, and the disturbance could modify subsequent soil system performance.

2. *Hydrogeologic-based.* Surface water and ground water hydrology and the geology of the management area are characterized to determine treatment technology selection and maximum system densities. Zones can be created to establish minimum lot sizes, maximum discharge rates per acre, or minimum treatment efficiencies (e.g., effluent nitrogen concentrations). Percolation rate tests, which have been used extensively in the past to characterize wastewater dispersion in the soil, do not predict treatment effectiveness or ensure future hydraulic performance.

   Hydrogeologic-based evaluations originated with the development of the percolation test in the 1920s. Although the percolation test is simple to conduct and can provide some information on relative infiltration rates, it does not necessarily provide design information because of its inability to discern what controls the rate of water loss from the hole. Also, the test cannot accurately predict infiltration rates at equilibrium operation or in downgradient zones through which the effluent will migrate.

Hydrogeologic characterization can also include testing for hydraulic conductivity, porosity, and permeability, usually requiring multiple extended site visits. Cluster and small community on-site systems (> 2000 gpd) require more extensive hydrogeologic characterization. Multifactor approaches for site evaluation use information regarding soils, hydrogeology, mineralogy, cation exchange, and possibly other information such as regional effluent loading models.

3. *Multifactor-based.* A variety of factors (e.g., soils, climate, ground water conditions, slopes, OWTS densities, proximity to and status of water resources) in the management area are characterized to establish zones reflecting likely treatment effectiveness and the potential for public health and environmental impacts. Conventional systems are permitted in nonsensitive zones that meet minimum soil, separation/setback, and other prescriptive requirements. Alternative systems should be required for sensitive sites that cannot support conventional SWIS-based applications. Sites within sensitive zones can be required to meet performance standards and to be closely managed for continued compliance.

Regardless of approach, the objective of the site investigation is to evaluate the wastewater treatment and dispersal capabilities of the site and surrounding area. The site evaluation systematically gathers information that is used to narrow the range of OWTS design options to the one that best accomplishes the overall performance goals of protecting human health and the environment. The evaluation should begin with a consideration of both regional hydrology and the density and discharge of existing OWTSs in the area. Regional planning programs, where they exist, can provide a significant amount of information during this stage of the process. Other reconnaissance activities prior to the actual site visit should include researching the following: soil surveys; geology, topography, and surface water and ground water resources; OWTS installations in the vicinity and their operating record; well locations and hydrogeological records in the area; and maps showing utility lines and other features that might have an impact on design and placement of the system.

Landscape position, location of treatment unit components, slopes, trees, and other features (e.g., drainages, fences, pipelines, electric lines) should be noted on a site plan that is filed with permit documents. The soil analysis should include identification of the major horizons and their structure, texture, color, mottles and concretions, as well as other notable features (e.g., rocks, organic matter, wetness). If percolation tests are used, they should be conducted in strict accordance with established procedures and should always be accompanied by a detailed investigation of the soil profile and regional conditions. Permitting of OWTSs on the basis of percolation tests alone is not recommended.

Table 6.3 presents a list of site features that might require evaluation prior to selecting the system design and installation site. The site evaluation process typically differs for individual OWTSs and larger-scale cluster or small community systems; i.e., data on every feature on the checklist does not have to be collected for every individual home site. Site assessments should be performed to determine the soil infiltration rate, expected soil pollutant removal capacity, acceptable hydraulic loading rate, and required depth to the water table, at a minimum, prior to design and application for a construction permit for on-site systems. A simple individual home site evaluation can be accomplished in a single site visit when a soil-based approach is used.

Three American Society for Testing and Materials (ASTM) practices covering surface characterization (ASTM, 1995), subsurface soil characterization (ASTM, 1996b), and preliminary sizing and delineation of subsurface soil absorption or constructed filter field areas (ASTM, 1996a) give specific guidance on how this can be accomplished (http://www.astm.org/). Surface and some subsurface characterization practices are shown in Table 6.4. The ASTM standard practice for characterizing subsurface conditions through test pit inspection is summarized in Table 6.5. These practices can be specified when hiring contractors and consultants.

Table 6.3: Site features that should be evaluated before OWTS design and installation.

Type	Site Feature
Surface Features	Location of property boundaries, location of existing and/or proposed structures, location of surface water features (landscape position and land form, including intermittent and perennial drainage ways, irrigation ditches, streams, swales, depressions, water bodies, and wetlands), topography (use local regulatory suitability criteria or Natural Resources Conservation Service [NRCS] soil survey classes), location of water supply sources (well, public water supply reservoir), location of buried anthropogenic features (water lines, utility lines, etc.), location of disturbed soil (cut and fill), other significant features (large trees, bedrock at the surface, etc.)
Soil Features	Major soil horizons, texture and structure of each horizon, color, mottles, other relevant features of each horizon (rupture resistance, penetration resistance, wetness, pore characteristics, presence of roots), depth to bedrock, depth to low permeability (i.e., restrictive) soil horizons (fragipan, caliche, duripan, etc.), depth and thickness of strong textural contrasts. Phosphorus (P) Index when P retention is needed.
Hydrogeologic Features	Depth to seasonal high water table and shallow ground water tables, potentiometric surface, ground water flow direction and gradient, percolation test results, saturated hydraulic conductivity (estimated, field, and laboratory), ground water time of travel to points of interest, unsaturated hydraulic conductivity relationships, other water budget parameters (precipitation, potential evapotranspiration, etc.)

Table 6.4: Practices to characterize surface and subsurface features of proposed OWTS sites (ASTM, 1995, 1996b).

Description of activity	Information from research
Preliminary Documentation	– Site survey map – Soil survey, U.S. Geological Survey (USGS) topographic map – Aerial photos, wetland maps – Natural resource inventories – Applicable regulations and/or setbacks – Hydraulic loading rates – Criteria for alternative OWTSs – Size of house or facility – Loading rates, discharge types – Planned location of water well
Scheduling	– Planned construction schedule – Date and time for meeting
Description of Activity	– Information from field study
Identification of Unsuitable Areas	– Water supply separation distances – Regulatory buffer zones and setbacks – Limiting physiographic features

Table 6.4 (continued).

Description of activity	Information from research
Subsurface Investigations	– Ground water depth from pit or auger – Soil profile from backhoe pit – Percolation tests
Identification of Recommended OWTS Site	– Integration of all collected data – Identification of preferred areas – Assessment of gravity-based flow – Final selection of OWTS site

Table 6.5: Practices to characterize subsurface conditions through test pit inspection (ASTM, 1996a).

Description of activity	Process steps	Information to be collected
Select backhoe pit site(s) near but not in proposed drainfield	Orient pit so that sunlight illuminates vertical face of pit	Proposed location of soil absorption field
Excavate pit to depth required by regulations	Pit excavation	Required ground water separation distance, soil profile depth
Enter test pit	– Take safety precautions – Beware of cave-ins – Select area of pit wall to examine	Safe depths for unbraced pit walls
Expose natural soil structure	Use soil knife, blade, screwdriver, or other tool to pick at area 0.5 m wide along full height of pit wall	Soil structural type (e.g., prismatic, columnar, angular blocky, subangular blocky, platy, granular)
Describe soil horizons	– Note master soil horizon layers – Describe features of each horizon	List soil horizon features: – Depth of horizon and thickness – Moisture content – Color (i.e., hue, value, chroma) – Volumetric percentage of rock – Size, shape, type of rock found – Texture of <2mm fraction of horizon – Presence or absence of mottles and other redoximorphic features – Soil structure by grade – Level of cementation – Presence or absence of carbonates – Soil penetration resistance – Abundance, size, and distribution of roots
Determine lateral changes in soil profile	Use hand auger and/or compare to profile of second pit	Determine changes, if any, in soil profile across proposed site
Interpret results	Identify limiting depths	– Check vertical separation distances – Identify mottled layers and concretions – Determine depth to saturation – Measure depth to confining layer
Issue site report	Log all data onto survey form	Develop system type, site location, and installation recommendations

Several systems have been developed to perform source water vulnerability assessments and to map locations where site conditions might preclude the use of conventional on-site systems. A system such as the DRASTIC methodology (Aller et al., 1987) can be used to map areas where aquifers might be vulnerable to pollution from on-site systems. DRASTIC considers soil permeability, depth to ground water, and aquifer characteristics. Florida adapted the DRASTIC approach to produce digital maps showing potential areas where ground water threats might increase (http://www.dep.state.fl.us/gis/datadir.asp). The U.S. Department of Agriculture (USDA) developed soil maps that contain detailed information on regional soils, including suitability for conventional on-site systems, and is updating these maps in some areas. The USDA National Soils Survey Center (http://ssldata.nrcs.usda.gov/) provides county-level soil information nationwide.

States are implementing GIS-based programs for identifying and mapping critical water supplies and aquifer protection areas. Some states have established zones that define effluent quantity and quality and system options available to meet those requirements. Computer simulation models have also been developed that assess the impact from locating on-site systems at various densities within a watershed. For example, the Buzzards Bay Project of the National Estuary Program provides an online nitrogen input modeling spreadsheet that can be adapted for local use by entering appropriate information for land use, nitrogen loading rates, watershed size, projected build-out, and other parameters (http://www.buzzardsbay.org/nitrmang/bbploadcalc.xls).

6.3.1.3 Education, training, licensing, and/or certification programs

In the past, a few states established training programs for site evaluators and adopted more-stringent codes for system design, setback distances, and general site requirements (Kreissl, 1982). If a site were declared unsuitable by these evaluators under the code prescriptions, some of these states would allow professional engineers to propose system designs that could overcome site limitations. Many jurisdictions (regulatory agencies) have begun to favor employing trained, experienced, professional staff who can make judgments and decisions on system design and siting in an efficient, effective manner. This practice must be differentiated from programs that use compliance enforcement staff to design systems. Such approaches are not recommended due to potential conflicts of interest resulting from design and compliance determinations by the same entity.

Most states have minimum requirements (e.g., college coursework, state-sponsored training) for oversight agency staff (e.g., health department permitting personnel), but some states have more stringent competency requirements.

In many states, system installers must be certified (see Table 6.6). Florida requires installers to meet certain minimum requirements, demonstrate experience, provide references, pass an examination, and complete six hours of approved classroom instruction annually to retain their certification. Minnesota has had a certification program for installers, designers, pumpers, and inspectors since the early 1970s; the program became mandatory for all service providers in 1994. Maine instituted a licensing program for site evaluators in 1974 and saw system failure rates drop to insignificant levels (Kreissl, 1982). Site evaluators in Maine must now be licensed professional geologists, soil scientists, or engineers with at least one year of relevant field experience. They must also pass a written examination and a field practices test (Maine Department of Health Services, 1996).

Requirements for site evaluators, system designers, installers, inspectors, and maintenance service providers vary widely among the states. Some states have few, if any, requirements for service personnel, whereas other states require professional certification and ongoing training for most service providers (see Table 6.6). In addition, some states issue permits or grant exemptions that allow homeowners to design and install on-site treatment systems at their primary residence.

Table 6.6: Survey of state certification and licensing programs for onsite wastewater service providers (Noah, 2000).

State	Contractors	Installers	Inspectors	Pumpers	Designers	Engineers	Geologists	Operators
AL	Y	Y	Y	Y	N	Y	Y	Y
AK	Y	Y	NA	NA	NA	Y	NA	NA
AZ	Y	Y	NA	Y	NA	Y	Y	NA
AR	N	Y	N	Y	Y	N	N	N
CA	N	N	N	N	N	N	N	N
CO	N	N	N	N	N	Y	N	Y
CT	NA	Y	Y	Y	NA	Y	NA	NA
DE	Y	Y	N	Y	Y	Y	N	Y
FL	Y	Y	Y	Y	Y	Y	Y	Y
GA	Y	Y	Y	Y	N	N	N	N
HI	N	N	N	N	N	Y	N	Y
ID	N	Y	Y	Y	N	N	N	N
IL	Y	Y	NA	Y	NA	NA	NA	NA
IN	N	N	N	N	N	N	N	N
IA	N	N	N	Y	N	N	N	N
KS	NA	NA	NA	NA	NA	Y	Y	Y
KY	Y	Y	Y	Y	N	N	N	N
LA	NA	Y	NA	NA	NA	NA	NA	NA
ME	N	Y	Y	N	Y	Y	Y	N
MD	N	Y	Y	N	N	N	N	N
MA	Y	Y	Y	Y	Y	Y	N	Y
MI	N	N	N	N	N	N	N	N
MN	NA	Y	Y	Y	Y	NA	NA	Y
MS	NA	Y	Y	Y	NA	NA	NA	NA
MO	Y	N	N	Y	N	Y	N	N
MT	N	N	N	N	N	N	N	N
NE	N	N	N	N	N	N	N	N
NV	NA	NA	NA	NA	NA	NA	NA	NA
NH	N	Y	N	N	Y	Y	N	Y
NJ	N	N	N	N	N	N	N	N
NM	Y	Y	N	N	N	N	N	N
NY	N	N	N	Y	N	N	N	N
NC	N	N	Y	N	N	N	N	Y
ND	Y	Y	Y	N	N	N	N	N
OH	N	N	N	N	N	N	N	N
OK	Y	Y	N	Y	Y	N	N	Y
OR	Y	Y	Y	Y	Y	Y	Y	Y
PA	N	N	Y	N	N	Y	Y	N
RI	Y	Y	Y	N	Y	Y	N	Y

Table 6.6 (continued).

State	Contractors	Installers	Inspectors	Pumpers	Designers	Engineers	Geologists	Operators
SC	Y	Y	NA	Y	NA	NA	NA	NA
SD	N	Y	N	N	N	N	N	N
TN	N	Y	N	Y	N	Y	Y	Y
TY	N	Y	Y	Y	N	N	N	Y
UT	N	N	N	N	N	N	N	N
VT	N	N	N	N	Y	N	N	Y
VA	N	N	N	N	N	Y	Y	Y
WA	N	N	Y	N	Y	N	N	N
WV	N	N	N	Y	N	N	N	N
WI	N	Y	Y	Y	Y	Y	Y	N
WY	N	N	N	N	Y	Y	Y	N

Y = yes; N = no; NA = not available.

NSF Onsite Wastewater Inspector Accreditation Program

NSF International has developed an accreditation program to verify the proficiency of persons performing inspections on existing on-site wastewater treatment systems (NSF International, 2000). The accreditation program includes written and field tests and provides credit for continuing education. Inspectors who pass the tests and receive accreditation are listed on the NSF International Web site and in the NSF Listing Book, which is circulated among industry, government, and other groups.

The accreditation process includes four components. A written examination, conducted at designated locations around the country, covers a broad range of topics relating to system inspections, including equipment, evaluation procedures, trouble-shooting, and the NSF International Certification Policies. The field examination includes an evaluation of an existing on-site wastewater treatment system. An ethics statement, required as part of the accreditation, includes a pledge by the applicant to maintain a high level of honesty and integrity in the performance of evaluation activities. Finally, the continuing education component requires requalification every 5 years through retesting or earning requalification credits through training or other activities.

To pass the written examination, applicants must answer correctly at least 75 of the 100 multiple choice questions and score at least 70 percent on the field evaluation. A 30-day wait is required for retesting if the applicant fails either the written or field examination.

These code provisions, which are linked to outdated farmstead or homestead exemptions, should require some demonstration of competency on the part of the prospective homeowner designer or installer. For example, Alaska allows homeowners to design and install systems at their residence if they complete an approved training course and comply with state design, construction, and siting requirements. Approval is granted after the homeowner submits an infiltration field size estimate based on a professional analysis (i.e., by an engineer or a laboratory) of soils at the proposed site (Alaska Administrative Code, 1999). Another approach could include providing technical assistance for system design and close oversight of installation to ensure that homeowner-installed systems meet performance requirements.

On-site programs should establish minimum criteria for all service providers to ensure protection of public health and water resources. The Maine program requires that site evaluators be licensed and that designers of systems treating more than 2,000 gallons per day or systems with unusual wastewater characteristics be registered professional engineers. Prerequisites for applying for a license and taking the certification examination are either a degree in engineering, soils, geology, or a similar field plus one year of experience, or a high school diploma or equivalent and four years of experience (Maine Department of Human Services, 1996).

Some jurisdictions opt to secure planning, operation, maintenance, and inspection services by partnering with other agencies or contracting with private entities to perform these functions. For example, the Massachusetts communities of Yarmouth and Dennis contract with an engineering firm to conduct system inspections (Shephard, 1996). Many management agencies in highly developed areas depend on regional planning or environmental agencies for guidance on the hydraulic and pollutant assimilation capacity of water resources in areas proposed for development. When on-site management functions are performed by outside entities, it is important to establish clear, consistent, and reasonable program requirements, administrative processes, and communication procedures.

6.3.1.4 Inspection of new on-site wastewater treatment systems

Verifying that systems are constructed and installed as designed helps to ensure that they will perform as intended. A construction management program that includes multiple field inspections will ensure that system design and specifications are followed during the construction process. If a system is not constructed and installed properly, the chances of failure increase. For example, if the natural soil structure is not preserved during the installation process (i.e., if equipment compacts or smears infiltration field soils) the infiltration field can be significantly impaired. Most failures of conventional on-site system soil absorption fields have been attributed to hydraulic overloading (USEPA, 1993a). These failures can be exacerbated by poor design and installation practices. Effective on-site system management programs ensure proper system construction and installation through construction permitting, inspections during construction, and designer/installer certification programs.

Design and plan reviews before construction begins help to acquaint the installer with site conditions as characterized by the site evaluator and the proposed system design. During this review, details of the construction schedule, inspections, and final permit issuance can be discussed and agreed upon. In general, construction should conform to the approved plan and use appropriate methods, materials, and equipment. Typical regulatory mechanisms to ensure proper installation are reviews of site evaluation procedures and findings, and inspections of systems during and after installation. The review and inspection process should include:

- Preconstruction meeting of the owner, designer, regulator, and contractor;

- Inspection after delivery of components;

- Inspections during and after construction (e.g., during excavation and installation of components, and after backfilling); and

- Issuance of a permit to operate the system as designed and built.

During the construction process, inspections should verify compliance with approved construction documents and procedures. If there are not enough management program personnel to conduct these inspections, a trained/certified inspector should be assigned to oversee installation and certify that it has been conducted and recorded properly. The construction process for soil-based systems must be flexible, as construction during wet weather may compact, smear, or otherwise alter soil structure.

6.3.1.5 Installation of conventional or alternative systems

As noted previously, selection of an on-site system should consider climate, regional hydrology, site slopes, soil, ground water characteristics, and the quality requirements of the water(s) receiving on-site system effluent. Design, operation, and maintenance information for on-site systems can be found in the *Design Manual: Onsite Wastewater Treatment and Disposal Systems* (USEPA, 1980), the *Onsite Wastewater Treatment System Manual* (USEPA, 2002a) and the *Draft Onsite Wastewater System Management Handbook* (USEPA, 2002b). Table 6.7 summarizes the different treatment technologies used to remove various pollutants of concern.

A conventional on-site system consists of a septic tank, as shown in Figure 6.2, and a SWIS. Septic tanks perform the following four important functions:

1. Removal of settleable and floatable solids, oils, and grease from raw wastewater;
2. Storage of the removed solids;

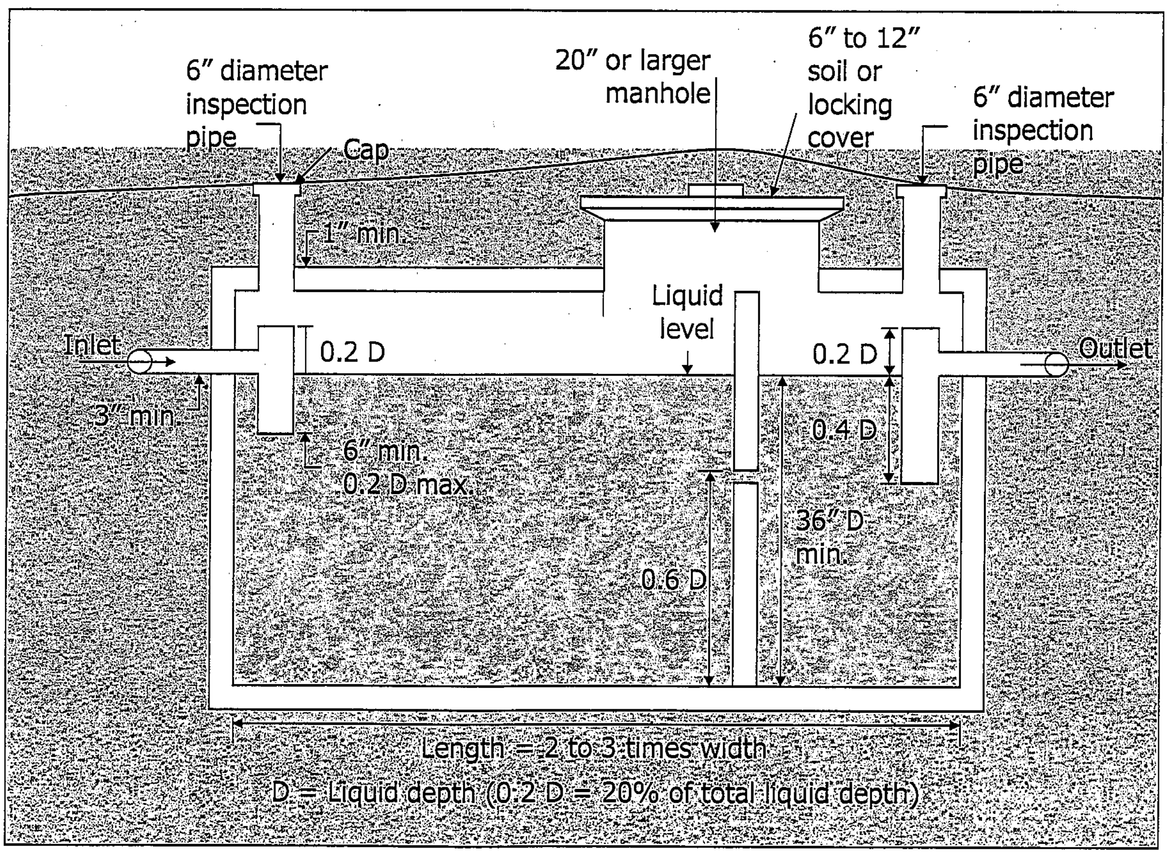

Figure 6.2: Septic tank detail (University of Missouri Extension Service, 1997).

3. Partial anaerobic digestion (liquefaction) of settled organic matter; and
4. Flow attenuation.

Table 6.7: Treatment technologies for OWTSs.

Treatment objective	Treatment process	Treatment methods
Suspended solids removal	Sedimentation	Septic tank Free water surface constructed wetland Vegetated submerged bed Lagoons Septic tank effluent screens
	Filtration	Packed bed media filters[a] Mechanical disc filters Soil infiltration
Soluble carbonaceous BOD and ammonia removal	Activated sludge	Extended aeration Fixed film activated sludge Sequencing batch reactors
	Fixed film aerobic bio-reactor	Soil infiltration Packed bed media filters[a] Trickling filter Fixed film activated sludge Rotating biological contactors
	Lagoons/wetlands	Free water surface constructed wetland
Nitrogen removal	Biological nitrification/ denitrification	Activated sludge (nitrification only) Sequencing batch reactor (only if designed with certain operating modes) Fixed film bio-reactor (nitrification only) Recirculating media filter Fixed film activated sludge (nitrification only) Anaerobic upflow filter (denitrification only) Anaerobic submerged media reactor (denitrification) Submerged vegetated bed (denitrification) Free water surface constructed wetland
	Ion exchange	Cation exchange (ammonium) Anion exchange (nitrate)
Phosphorus removal	Adsorption	Soil infiltration Iron-rich packed bed media filter Sequencing batch reactor (only if designed with certain operating modes)
Pathogen removal (bacteria, viruses, and parasites)	Filtration/predation/inactivation	Soil infiltration Packed bed media filters[a]
	Disinfection	Hypochlorite feed Ultraviolet light
Grease removal	Flotation/adsorption	Grease trap Septic tank Mechanical skimmer
	Aerobic biological treatment[b]	All types

[a] Including dosed systems; granular [sand, gravel, glass], peat, textile, foam.
[b] Incidental removal will occur, although overloading is possible.

Removal of total suspended solids (TSS) is usually 70 to 85 percent for well-designed septic tanks. Other pollutant removal rates are affected by the characteristics of the wastewater. Typically, reduction of BOD is 40 to 60 percent. Nitrogen and phosphorus removals are approximately 10 to 20 percent, while fecal coliforms are reduced by approximately 1 log (USEPA 2002a). The conventional system accepts both graywater (wastewater from showers, sinks, and laundry) and blackwater (wastewater from toilets). Depending on climate, diet, and other factors, the tank will need to be pumped every 3 to 5 years, since the pumping interval depends on the rate of accumulation of sludge, oils, and grease. Periodic visual inspection or remote sensing of the depth of those accumulations is possibly the most efficient way to determine pumping intervals.

A gravity-flow SWIS is the most commonly used treatment and discharge method for OWTS septic tank effluent. Soil absorption systems usually consist of covered excavations filled with porous media and perforated pipes or plastic leaching chambers with a distribution system for introducing and dispersing wastewater throughout. SWISs work well at sites with moderately permeable soils and sufficient vertical depth to ground water (i.e., the seasonally high water table), bedrock, or other limiting layer. The most common types of hydraulic failure of these systems are clogging of the infiltrative surface, insufficient separation distance to the water table, insufficient percolation capacity of the soil, and hydraulic overloading. Trenches and leaching chambers are the most widely used designs for both individual residences and commercial establishments. Uniform distribution and dosing via siphons or pressurized distribution are the best methods of pollutant removal because they distribute the wastewater load widely and uniformly across a large surface and sidewall area.

6.3.1.5.1 *Pollutant removal processes for conventional systems*

Nitrogen in domestic wastewater can be removed through effective linking of aerobic and anaerobic biochemical transformation processes, but in general, most conventional septic systems are not considered effective in removing nitrogen without additional treatment in the soil. Septic tanks remove approximately 30 percent of the nitrogen in raw domestic wastewater (University of Wisconsin, 1978). Percolation through 3 to 5 feet of soil can remove 0 to 20 percent of the total nitrogen in septic tank effluent (Siegrist, 2001). Additional nitrogen removal is possible under optimum soil and denitrification (e.g., anaerobic and carbon-rich) conditions. Factors that favor denitrification in soil absorption fields include fine-grained soils such as silts and clays, layered soils that feature alternating fine-grained and coarse-grained layers, and organic matter or sulfur compounds in the infiltrative medium. Placing the soil absorption field high in the soil profile where organic matter is more likely to exist, and dosing effluent to achieve alternating wet/dry (anaerobic/aerobic) cycles, can aid denitrification and reduce nitrate leaching. Maine's Coastal Nonpoint Source Control Program and Division of Health Engineering favor shallow leach field installations to take advantage of the treatment potential in the upper soil horizon. Monitoring of shallow SWISs in Maine found total nitrogen reductions of 41 to 91 percent (Leyden, 1999).

In those areas where nitrogen is a problem pollutant, existing systems may be retrofitted to improve nitrogen removal, and new systems should include treatment components that are capable of removing nitrogen. Retrofitting upon failure of systems in these areas is recommended. Also, it is important to consider the density and overall discharge of on-site treatment systems. As the density of residences increases, lot sizes decrease and nitrogen impacts on surface and ground waters intensify. Lots of 1/2 acre to 5 acres are generally the minimal requirement of prescriptive codes for siting conventional on-site systems. The Code of Massachusetts Regulations identifies certain wellhead protection areas, public water supply recharge zones, and coastal embayments as nitrogen-sensitive areas and requires treatment systems in those areas to meet nitrogen loading limitations. For example, recirculating sand filters or equivalent technologies must be employed to limit total nitrogen (nitrogen as nitrate, nitrite, or ammonia) concentrations in effluent to no more than 25 mg/L and to remove a minimum of 40 percent of the influent nitrogen load. All systems in nitrogen-sensitive areas must discharge no more than 440 gallons of design flow per day per acre unless system effluent meets a nitrate standard of 10 mg/L or other nitrogen removal technologies or attenuation strategies are used (Code of Massachusetts Regulations, 1995). Any zone requiring such systems should have a management entity to assure sustained performance by these systems.

One of the most effective nitrogen removal methods is the recirculating sand filter (Table 6.8), which has been shown to remove approximately 50 percent of the total nitrogen from residual wastewater (USEPA, 1993b and 2002a). Other innovative and alternative systems have been developed to address site constraints and to provide improved on-site treatment and dispersal of wastewater. Many of these systems use advanced nutrient removal processes to enhance the ability of on-site systems to protect surface and ground water quality. Such systems include recirculating sand (nitrogen removal) and anaerobic upflow filters (denitrification), intermittent sand filters (nitrification), and subsurface-flow constructed wetlands (denitrification). The subsurface flow constructed wetland (i.e., vegetated submerged beds) and anaerobic upflow filters require nitrification of septic tank effluent before it enters the treatment process. Nitrification technologies include trickling filters with highly permeable plastic media, single-pass media filters, aerated sequencing batch reactors, activated sludge treatment systems, and filtration systems that use peat or other materials in place of sand. Table 6.8 presents an estimated performance summary for a variety of treatment technologies.

Another primary nutrient, phosphorus, is often the limiting factor for algal growth and eutrophication in freshwater systems. Because other nutrients necessary for the growth of algae and other aquatic plants are usually present in inland waters, low concentrations of phosphorus can lead to a direct increase in growth. Studies have shown that lakes with phosphorus concentrations as low as 20 to 30 parts per billion can become highly productive or eutrophic. Conventional OWTSs (septic tanks/SWISs) remove only 15 to 30 percent of the phosphorus in raw wastewater. Favorable phosphorus removal conditions exist for SWISs in most soils of the United States, but some phosphorus loading problems might be encountered in areas with older systems, highly permeable soils (e.g., sands), mineral-poor soils, nearby surface waters, and high system densities. Some technologies can enhance phosphorus removal (e.g., sand filters with high iron-content sand, sequencing batch reactors operated in certain modes).

Table 6.8: Wastewater constituents of concern and representative estimates of concentrations in the effluent of various treatment units (adapted from Siegrist et al., 2000).

Constituents of concern	Direct or indirect measures	Tank-based treatment unit effluent concentrations: Domestic STE[a]	Domestic STE with N-removal recycle[b]	Aerobic unit effluent	Recirculating sand filter effluent[c]	Recirculating foam or textile filter effluent[c]	SWIS percolate into ground water at 3- to 5-ft depth (% removal)
Oxygen demand	BOD_5 (mg/L)	140-200	80-120	5-50	2-15	5-15	>90
Particulate solids	TSS (mg/L)	50-100	50-80	5-100	5-20	5-10	>90
Nitrogen	Total N (mg N/L)	40-100	10-30	25-60	10-50	30-60	10-20
Phosphorus[d]	Total P (mg P/L)	5-15	5-15	4-10	3-9	4-10	0-100
Bacteria (e.g., *Clostridium perfringens, Salmonella, Shigella*)	Fecal coliform (organisms per 100 mL)	10^6-10^8	10^6-10^8	10^3-10^6	10^1-10^3	10^1-10^3	>99.99
Virus[e] (e.g., hepatitis, polio, echo, coxsackie, coliphage)	Specific virus (pfu/mL)	0-10^5	0-10^4	0-10^4	0-10^3	0-10^3	>99.9
Organic chemicals (e.g., solvents, petro-chemicals, pesticides)	Specific organics or totals (µg/L)	0 to trace	0 to trace	0 to trace	0 to trace	0 to trace	>99
Heavy metals (e.g., Pb, Cu, Ag, Hg)	Individual metals (µg/L)	0 to trace	0 to trace	0 to trace	0 to trace	0 to trace	>99

[a] Septic tank effluent (STE) concentrations given are for domestic wastewater. However, restaurant STE is markedly higher, particularly in BOD_5, COD, and suspended solids, while concentrations in graywater STE are noticeably lower in total nitrogen.
[b] N-removal accomplished by recycling STE through a packed bed for nitrification with discharge into the influent end of the septic tank for denitrification.
[c] Operated in recirculating mode.
[d] P-removal by adsorption or precipitation is highly dependent on media capacity, P loading, and system operation.
[e] Episodically present at high levels.

6.3.1.5.2 *Septic tanks*

Septic tanks are designed to retain a minimum 24- to 48-hour wastewater flow and are usually the first component in OWTSs. Additional treatment components (e.g., soil absorption field, sand/media filter) are necessary because the quality of septic tank effluent is not adequate for direct discharge. The septic tank should be watertight for two reasons: (1) infiltration into the tank can cause hydraulic overloading of treatment and/or dispersal components; and (2) leaks can cause discharge of scum and sludge to subsequent processes and increase potential for surface and ground water contamination. Many states and counties require tanks to be watertight. For example, Suffolk County, New York, regulations state that "all joints shall be sealed so that the tank is watertight and certified as to watertightness after installation. Tanks that are cast in place must be certified by a licensed professional engineer and, as a minimum, have the floor and walls monolithically poured." Oregon septic tank standards stipulate that tanks are to be tested by filling them with water to a level 2 inches above the point of riser connection to the top of the tank. Leakage of no more than 1 gallon during a 24-hour period must be demonstrated. Because of leakage concerns, cast concrete and polyethylene tanks are preferred over those constructed of metal, redwood, concrete block, brick, or other materials, unless equipped with a watertight liner.

Septic tanks should be fitted with a regularly serviced effluent screen, commonly called a filter, at the outlet pipe. Several states and localities (e.g., Connecticut, Georgia, Florida, Alabama, North Carolina, Contra Costa County, California) now require septic tank screens to help protect the integrity of the SWIS for long-term performance (Schaub, 2000; Stuart, 2000). Screens not only prevent the discharge of neutrally buoyant solids and reduce TSS during tank upsets, but also provide an early warning sign that an inspection is needed, since they will clog and cause plumbing fixtures to drain poorly as they screen solids attempting to exit the tank through the outlet pipe.

Because septic tanks need to be serviced, the top of a septic tank riser should extend above the ground surface. Older installations can be difficult to locate when these features are not provided. Both septic tanks and SWISs are usually required to be at least 50 to 100 feet from any surface water body, but this setback might not be adequate in some cases (e.g., high-porosity soils, high water tables). Septic tanks should be inspected and pumped every 3-5 years.

6.3.1.5.3 *Subsurface wastewater infiltration systems*

Infiltration trenches containing perforated pipe and stone are the most widely used method for treating and dispersing septic tank effluent, though other septic tank effluent infiltration approaches (plastic open-bottomed leaching chambers, perforated pipes encased in net-wrapped foam pellets, and alternate media such as tire chips) have been used successfully. SWIS trenches are typically about 2 to 4 feet deep and about 2 to 3 feet wide. Soils, surface water drainage, and the slope of the land influence the location of the tank and field (Dickey et al., 1996). For example, septic systems are usually required to be located downslope from all wells, although ground water might not always follow this gradient. Trenches typically range in length from 45 to 100 feet.

Infiltration occurs through the bottom and sides of the trench. Gravelly soils promote rapid movement of wastewater contaminants, and poor-permeability soils (clays, etc.) require very large SWISs to accept the entire wastewater volume. Shallow trenches are generally preferred to deeper trenches because the upper soil horizons are usually more permeable and greater aeration and evapotranspiration can occur. A reserve area for future repairs or additions to the drainage field is often required by state code.

Septic tank effluent can be distributed to soil absorption system components by gravity, dosing, or uniform application. Dosing refers to periodically (e.g., 4 to 24 times per day) releasing effluent to the SWIS using a pump or siphon after a predetermined quantity has accumulated. Similarly, uniform application stores the effluent for a short time, after which it is pumped through smaller-diameter perforated pipes throughout the entire trench length to achieve uniform distribution. Distribution boxes have long been a source of poor performance in gravity-dosed systems, and they must be inspected frequently after initial installation because uneven settling causes uneven distribution of effluent. Ports with cam-type levelers can be adjusted to compensate for settling where regular inspection is required. Distribution boxes that do not have access ports or are not inspected or maintained are not recommended.

Uniform application can result in the least amount of infiltrative surface clogging and greatest treatment efficiency. Maintenance of trenches and beds is minimal, particularly if the tank is pumped regularly. Alternating SWIS systems are especially effective because they allow the use of one or more leaching systems while others rest for six months to a year to restore their effectiveness.

Most SWISs are designed to oxidize carbonaceous organics and convert the ammonium in septic tank effluent to nitrate by providing an aerobic environment. Nitrogen removal capabilities of SWISs are minimal and depend in part on temperature. Nitrate is water-soluble and travels freely to ground water. Elevated nitrate concentrations in ground water used as drinking water can cause the childhood illness methemoglobinemia (blue baby syndrome), can cause problems during pregnancy, and can present a risk to poultry livestock. In soils with no denitrifying capability, nitrate can travel with the ground water to nearby surface waters. Nitrogen loadings in coastal areas can cause eutrophication and related problems (e.g., low dissolved oxygen) that impair the life functions of desirable aquatic biota.

Some clogging of infiltrative surface pores from biomass and slimes produced by natural wastewater decomposition processes occurs under normal conditions. In coarser soils, this "biomat" improves treatment performance. Research conducted in Marion County, Florida, found that the predominant cause of hydraulic failure in systems less than five years old was hydraulic overload. After 15 years of service, root clogging was the cause of hydraulic failure in most cases. In general, SWISs located high in the soil profile provide access to both carbon (from organic matter) and oxygen (diffusion from ground surface), two elements needed for biochemical wastewater decomposition processes. Shallow placement also maximizes vertical separation between the infiltrative surface and ground water.

The vertical distance between the soil infiltration system and ground water is an important consideration. If seepage from the SWIS reaches the ground water in an area where unsaturated soil depth is inadequate, it could contaminate drinking water supplies. Furthermore, during wet seasons, ground water might rise into the SWIS, causing sewage to move upward toward the ground surface. This is especially important to consider in areas with a high water table (Lockwood, 1997) or in areas with poor permeability. Dickey et al. (1996) recommend that SWISs be placed at least 4 feet above the ground water table during the wettest season. The type of soil also influences the potential for ground water contamination. If sewage is applied to coarse soils, for example, the potential for contamination may be higher (Dickey et al., 1996). Clays that crack when dry or contain other types of macropores can also have a high contamination potential.

Installation of a conventional septic tank with a SWIS typically costs between $3,000 and $5,000 per home, but costs vary widely based on site-specific physical and regulatory limitations.

6.3.1.5.4 *Leaching chambers*

Molded plastic leaching chambers (see Figure 6.3) have been used in lieu of trench-based perforated pipe and aggregate infiltration systems to distribute septic tank effluent to the soil for final treatment. A typical leaching chamber infiltration system consists of interconnected arch-shaped bottomless chamber segments, installed below grade in level beds that comprise the drain field network. Aggregate is not needed, although porous media (e.g., gravel) is often used to fill in around the exterior of the vented chamber sidewalls to accommodate delivery of effluent through the sidewalls when ponding in the chambers occurs. Sizing of the network is based on wastewater characteristics, flows, and site conditions (soils, depth to groundwater/bedrock, etc.).

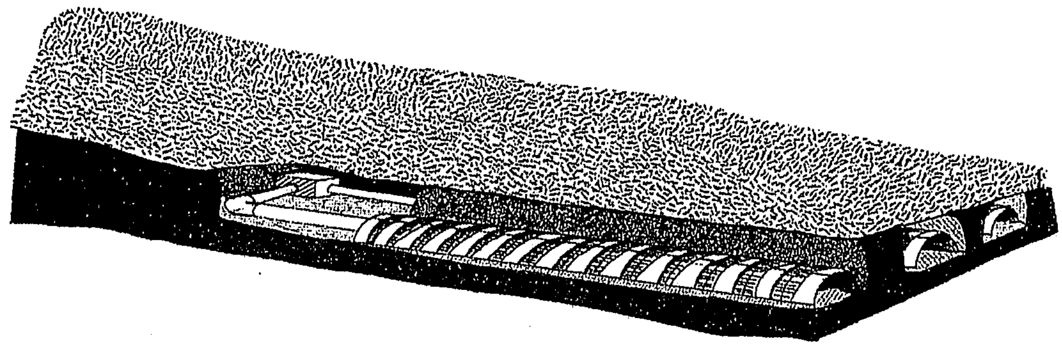

Figure 6.3: Leaching chamber subsurface wastewater infiltration system (Hoover et al., 1996).

Chamber systems have increased in use due to their performance, cost, light weight, and ease of installation.

6.3.1.5.5 *Alternative systems*

Several states have adopted provisions for the use of alternative and innovative technologies. Massachusetts has adopted a provision of its state environmental code that allows "approval of innovative (dispersal) systems if it can be demonstrated that their impact on the environment and hazard to public health is not greater than that of other approved systems" (Code of Massachusetts Regulations, 1995). Commonly referred to as Title 5, this legislation requires evaluation of pollutant loadings as well as management requirements prior to approval of alternative systems (Venhuizen, 1992).

The State of Maryland's regulations assert that the Maryland Department of the Environment (MDE) and the approving authority "shall consider all possible methods for correcting existing system failures and providing facilities for homes that lack indoor plumbing and, based on a case-by-case evaluation, provide the best technical guidance in attempting to resolve existing pollution or public health problems" (Code of Maryland Regulations, 2001). Alternative technology (with appropriate management) can be used for new construction on existing lots of record where site limitations prevent the use of conventional on-site systems. State regulations require that the local health unit and MDE monitor these systems for not less than two years.

More information on the alternative technologies described below is available from the National Small Flows Clearinghouse Environmental Technology Initiative (http://www.nesc.wvu.edu/nsfc/nsfc_ETI.htm) and EPA (http://www.epa.gov/owm/decent/treat.htm). An extensive list of links to public and private sector OWTS resources can be found at http://centreforwaterresourcesstudies.dal.ca/cwrs/onsite/info.htm. For information on loading rates, design, and performance capabilities for conventional and alternative treatment systems, refer to the *Onsite Wastewater Treatment System Manaual* (USEPA, 2002a). Table 6.9 provides a summary of capital and maintenance cost data for selected OWTS technologies.

Table 6.9: Summary of estimated capital and operation and maintenance costs for OWTSs (adapted from Hoover, 1997).

System Type	Costs (dollars)					
	Total materials & installation	Present value of total O&M[1]	Total over life of system	Amortized monthly materials & installation	Average monthly present value of O&M[1]	Average monthly over the life of the system
Septic Tank and Gravity Distribution						
Alone	2,504	6,845	9,349	20	19	39
With chambers	3,336	7,032	10,368	27	20	46
With styrene foam	2,846	6,920	9,767	23	19	42
With large diameter pipes	3,816	7,156	10,971	31	20	51
With pressure manifold	4,774	7,707	12,482	38	21	60
With pressure manifold and chambers	5,593	7,889	13,482	45	22	67
With pressure manifold and styrene foam	5,103	7,777	12,881	41	22	63
With pressure manifold large-diameter pipes	6,073	8,013	14,085	49	22	71
With sand filter pretreatment	7,296	12,069	19,364	59	34	92
With peat filter pretreatment	11,808	12,604	24,412	95	35	150
With recirculating sand filter pretreatment	6,226	12,059	18,285	50	33	84
With wetland cell	5,574	23,231	28,805	45	65	109
With 18" fill mound	4,507	6,850	11,357	36	19	55
With 18" fill mound and chambers	5,326	7,032	12,357	43	20	62
Septic Tank and LPP Distribution						
Alone	4,523	12,319	16,843	36	34	71
With sand filter pretreatment	10,223	13,338	23,561	82	37	119
With recirc. Sand filter pretreatment	8,232	13,007	21,239	66	36	102
In at-grade system	4,590	12,345	16,935	37	34	71
Septic Tank and Drip Distribution						
Alone	11,163	13,082	24,245	90	36	126
With sand filter pretreatment	15,994	14,101	30,095	129	39	168
With recirculating sand filter pretreatment	14,872	14,094	28,966	120	39	159
With sand filter pretreatment and chlorine disinfection	16,408	21,244	37,652	132	59	191
With recirculating sand filter pretreatment and chlorine disinfection	15,285	21,237	36,522	123	59	182
with sand filter pretreatment and UV disinfection	17,867	21,655	39,522	144	60	204
With recirculating sand filter pretreatment and UV disinfection	16,744	21,757	38,501	135	60	195
Septic Tank and Gravity Distribution						
Alone	2,504	6,845	9,349	20	19	39
With chambers	3,336	7,032	10,368	27	20	46
Septic Tank and Spray Irrigation						
With sand filter pretreatment and chlorine disinfection	11,890	20,670	32,580	96	57	153
With recirculating sand filter pretreatment and chlorination	10,768	20,663	31,431	87	57	144
With sand filter pretreatment and UV	13,349	21,190	34,539	107	59	166
With recirculating sand filter pretreatment and UV	12,227	21,183	33,410	98	59	157
Denitrification System Black Water and Gray Water Separation						
With gravity distribution	9,963	13,508	23,471	80	38	118
With LPP distribution	12,565	15,070	27,635	101	42	143

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Table 6.9 (continued).

System Type	Costs (dollars)					
	Total materials & installation	Present value of total O&M[1]	Total over life of system	Amortized monthly materials & installation	Average monthly present value of O&M[1]	Average monthly over the life of the system
Other Types						
Aerobic treatment unit and gravity distribution	8,037	36,406	44,443	65	101	166
Septic tank and pressure-dosed sand mound system	4,863	12,407	17,269	39	34	74
Septic tank filter or screen (installation or retrofit into existing tank only)	200-400	938	1,250	1	<1	<1

Note: These numbers could be considered in the low to moderate range and may vary in other regions because of differences in material and labor costs.
[1] O&M = Operation and Maintenance

Regardless of the type of soil, sand, or other medium used for the absorption field, some sort of minimal maintenance is often required. It is important to restrict the operation of heavy equipment within the area proposed for soil absorption fields to prevent compaction of the soil structure and system clogging. Vehicles or other heavy equipment should not be operated over previously installed absorption fields or filters for the same reason. Concrete tanks are often capable of withstanding heavy loads, but operation of vehicles or other heavy equipment directly above them can cause settling or structural failure that can affect tank performance. Finally, because of the clogging effect of roots, vegetation above absorption fields and filter media should be restricted to types with short root structures. Trees or shrubbery should be immediately removed from absorption fields or filter medium installations.

6.3.1.5.6 *Elevated systems*

Mound systems are alternative soil absorption systems typically used at sites where insufficient ground water separation distances or slow-permeability soil conditions exist (see Figure 6.4). Mound systems are usually designed so that the effluent from the septic tank flows to a dosing tank and is then pumped to the top of the mound, which is constructed above the natural soil surface. The mound consists of a layer of suitable sand fill, an absorption bed filled with aggregate within the sand fill, and a covering layer of topsoil. The topsoil layer should be at least 6 inches deep and serves as a growth medium for vegetation. Converse and Tyler (2000) advise that mounds not be built on grades steeper than 25 percent.

At-grade systems are similar to mound systems, but the absorption bed is built directly on the ground surface, with aggregate placed on tilled soil instead of on top of raised sand. At-grade systems are typically designed for sites unsuitable for subsurface systems, but with less-restrictive conditions than sites where mounds would be needed (Converse and Tyler, 2000).

Pollutant removal effectiveness and operation and maintenance are similar to those of conventional systems with pressurized distribution. A mound system is more expensive to install than a typical soil absorption trench system. The cost of a complete mound system, including a septic tank, is typically $7,000 to $12,000 installed. Operation and maintenance include septic tank pumping every 3 to 5 years; annual or semiannual inspection of the pump, float switches, tank, and dosing chamber; and maintenance of vegetative cover (i.e., grass) to prevent erosion.

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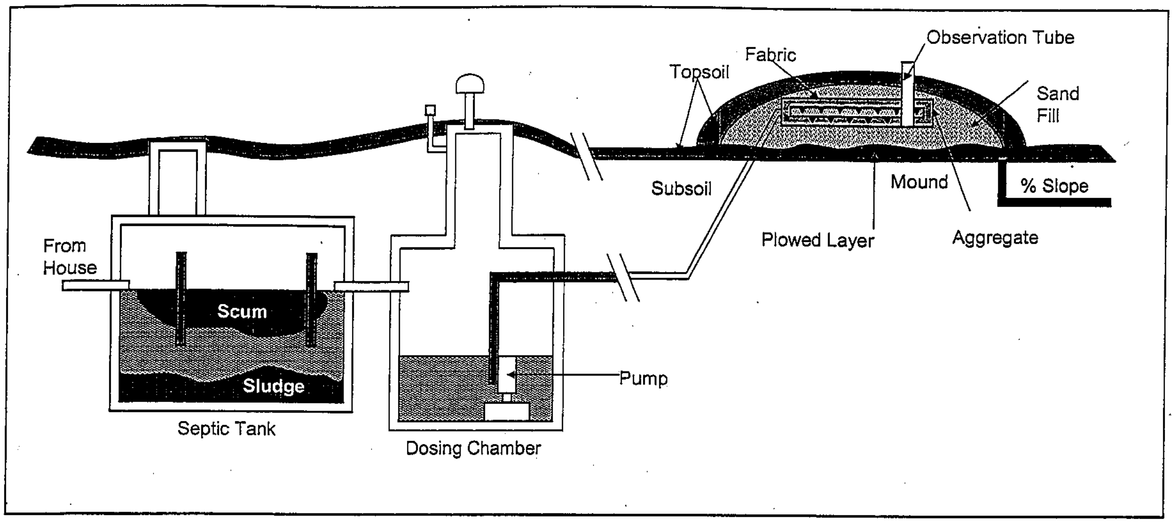

Figure 6.4: Schematic of a typical mound system (Ohio State University, no date).

6.3.1.5.7 *Intermittent sand/media filters*

An intermittent filter system receives and treats effluent from the septic tank via sand or other media (e.g., peat or composite materials) before it is discharged to the soil absorption field. Periodic, uniform dosing of septic tank effluent is distributed to the surface of the sand/media filter. The filter consists of a bed (either open or buried) of granular, synthetic, or organic material from 24 to 36 inches deep. Microorganisms living and growing on the filter medium consume nutrients and other wastes and facilitate aerobic decomposition of organic matter in the wastewater. The treatment medium is underlain by leveled rock or gravel and collector drains. Siphon or pressure distribution of septic tank effluent is used to dose wastewater to the surface of the media. Free access filters (media exposed to the atmosphere) should be covered with removable covers to prevent operation and maintenance problems (such as those caused by dust and rain), and should include insulation in cold and wet regions.

Intermittent media filters might become clogged as the pore space between the grains of the medium begins to fill with excessive amounts of inert biological materials. Resting the filter for several months in warm weather will restore hydraulic conductivity (Tyler et al., 1985). Free access filters should be checked every three to four months to prevent surface problems. Periodic raking is recommended to remove leaves and other debris where the system is not covered.

Intermittent sand filters typically produce high-quality effluents with BOD_5 and suspended solids concentrations below 10 mg/L (Tchobanoglous and Burton, 1991). Nitrogen compounds are almost completely nitrified if the filter remains aerobic, although nitrification rates might fall during cold weather. Total nitrogen removal rates average 15 to 35 percent (USEPA, 2002a). Installation cost ranges from $5,000 to $10,000. Systems that use peat or other organic media in place of the soil/sand filter media have been installed in several areas of the country to serve single- and multiple-family residences. This technology has shown excellent results in many applications but is still under study and considered a provisional application subject to monitoring in most jurisdictions.

Sand Filter System, Washington Island, Wisconsin

Washington Island, Wisconsin, covers a 36-square-mile area. Its geology consists of shallow soils and fissured, cavernous carbonate bedrock. Sinkholes are not uncommon and the threat of ground water contamination is real. Conventional systems serve older developments on the island, but the potential for ground water contamination from pathogens and nitrate spurred interest in alternative technologies. As part of a demonstration project, recirculating sand filters were installed and evaluated for 2 years. The demonstration project showed that total nitrogen could be reduced by 60 to 90 percent. Water quality was also improved by inserting an anaerobic upflow filter between the septic tank and the sand filter dosing tank.

Operation and maintenance include monitoring influent and effluent, inspecting the dosing equipment, maintaining the filtration medium surface (i.e., raking and replacing as needed), checking the discharge orifices for buildup or blockage, and flushing the distribution manifold annually. Costs for operation and maintenance of these systems include three or four visits per year ($100 to $150/year), in addition to septic tank maintenance.

6.3.1.5.8 *Recirculating sand/media filters*

A recirculating sand/media filter is a modified intermittent filter that recirculates the effluent from the filter through the septic tank and/or the recirculation tank before it is discharged to the wastewater infiltration system. The addition of the recirculation loop in the system enhances pollutant removal effectiveness by providing a denitrification step (i.e., in the septic or recirculating tank) in the treatment process. Nitrogen is both nitrified (in the media filter) and denitrified in these systems, resulting in 40 to50 percent or more (if enhanced) nitrogen removal. Recirculation rates of 3:1 or higher are generally recommended. Recirculating media filters can be used in new, on-site systems or applied to retrofits of failing conventional systems (Bruen and Piluk, 1994), particularly at sites with nitrogen concerns. Recirculating media filter effluent might also be appropriate for soil absorption systems with low-permeability soils.

BOD and suspended solid concentrations in the effluent are typically less than 10 mg/L (Roy and Dube, 1994; Bruen and Piluk, 1994; Loudon, 1996). Recirculating sand filters typically cost $8,000 to $11,000.

Operation and maintenance include monitoring effluent; inspecting the dosing equipment; maintaining the filtration surface (i.e., raking as needed); checking the discharge orifices for buildup and blockage; and flushing the distribution manifold annually in addition to septic tank maintenance.

6.3.1.5.9 *Anaerobic upflow filters*

An anaerobic upflow filter (AUF), which may resemble a septic tank filled with gravel, is designed so that the effluent flows up through the bottom of the AUF filter media (e.g., ⅜-inch gravel). Anaerobic bacteria that convert nitrate in the influent to nitrogen gas grow on the surfaces of the filter medium. Septic tank effluent is gravity-dosed or pumped (depending on site conditions) to the bottom of the AUF and up through the filter to the top, where a collection pipe transports it to a dosing chamber and/or SWIS for final discharge. A nitrogen-removal system may include a septic tank, a sand filter, an AUF, and a soil absorption field. AUFs are relatively small (e.g., 4 feet deep and 6 feet in diameter) (Boyle, 1995) and sized to allow retention times of 24 to 48 hours.

Nutrient Export from Conventional vs. Open Space Development in Maryland

Zielinski et al. (2000) undertook a study to compare nutrient export from several conventional development projects and the same projects designed using alternative open space strategies (see Management Measure 4 for a discussion of conventional and alternative development scenarios). One site was a low-density residential subdivision in Maryland. In the conventional design, each lot had an on-site private septic system and the neighborhood had a septic reserve field of approximately 10,000 square feet. When the site was redesigned to preserve open space, the individual septic systems were replaced with shared septic systems that used more advanced recirculating sand filter technology with better nutrient removal capacity and lower construction and installation costs. When the two development scenarios were modeled to determine relative rates of nutrient export, the redesigned septic system showed a substantial decrease in nutrient output. However, despite the use of more advanced technology, septic systems remained the predominant source of exported nutrients.

Total nitrogen concentrations from AUFs treating fully nitrified influent can range from less than 3 to 23 mg/L or higher, with removal efficiencies of approximately 60 to 70 percent. Boyle (1995) reported average total nitrogen concentrations below 15 mg/L in a recirculating sand filter-anaerobic upflow filter system. The cost of the filter varies by manufacturer and is approximately $1,000 to $1,500. Operation and maintenance tasks are minimal, especially if the filter medium consists of large gravel (i.e., > 1 inch). Sand-sized media will clog and should not be considered. Inspection of wastewater levels in the septic tank and AUF filter tank, as well as periodic inspection of pumps, float switches, discharge orifices, and other components, should be conducted to ensure continuous performance.

6.3.1.5.10 *Cluster systems*

For the purposes of this guidance, a cluster system is defined as a collection of individual on-site systems that provide primary treatment in septic tanks at each site. Septic tank effluent is collected and routed to another site for further treatment. Other designs in which primary treatment occurs at the treatment site instead of the septic tank are also possible. Collection and movement of effluent to the final treatment site can be accomplished by gravity flow or pumps.

Additional treatment for cluster systems may involve the use of conventional SWISs, sand filters, AUFs, constructed wetlands, aerobic lagoons, or aerobic treatment. The use of cluster systems can be advantageous in the case of inadequate soil, groundwater, or space at individual homes, or when better soil at is available at another location in the development.

6.3.1.5.11 *Constructed wetlands*

Constructed wetlands have traditionally been used for polishing effluent that has already had some degree of treatment. Vegetated submerged beds (VSBs), also known as submerged constructed wetlands, subsurface flow constructed wetlands, or plant rock filters (see Figure 6.5), are designed primarily to reduce concentrations of BOD and suspended solids in wastewater effluent from the septic tank. VSBs consist of horizontal flow gravel filters with wetland-type vegetation (e.g., cattails, canna lilies) and are usually underlain with an impermeable liner (e.g., plastic sheeting). The vegetation has a minimal role in treatment in this application. Residential vegetated submerged beds are normally followed by subsurface infiltration trenches or chambers.

The performance of constructed wetlands is not significantly degraded in colder climates during winter months because removal is by physical and chemical processes. Recent tests that

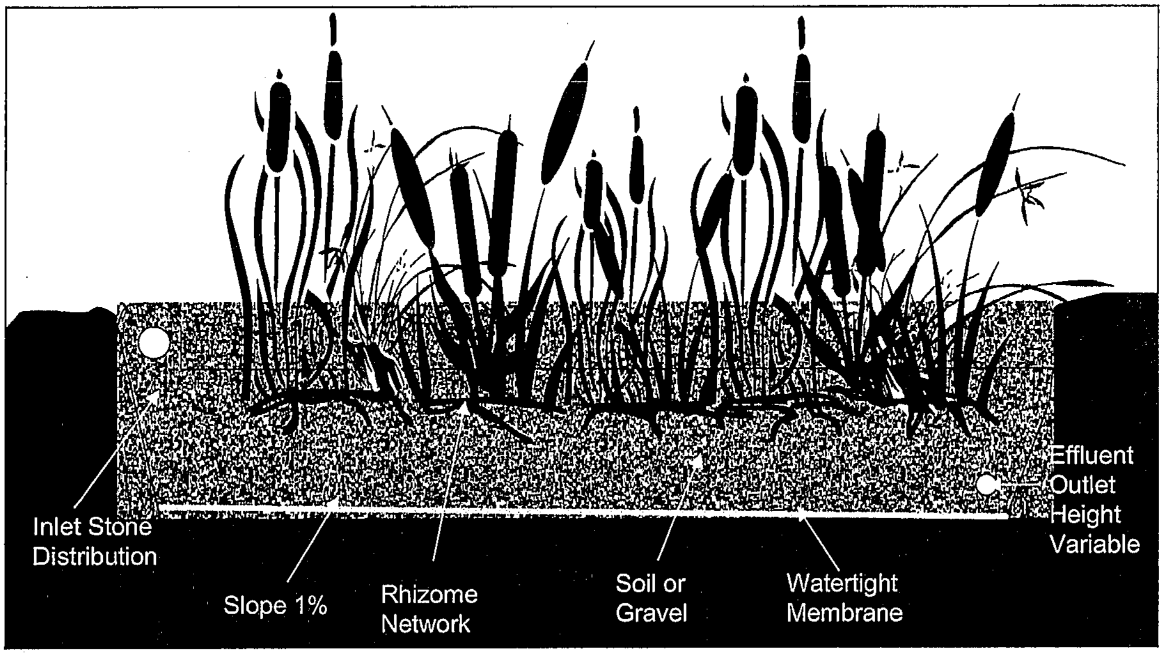

Figure 6.5: Components of a vegetated submerged bed.

incorporated a submerged aeration line in the wetland cell have shown promise in facilitating nitrification/denitrification (Wallace, 2000).

Constructed wetlands are configured as free-water surface wetlands, which can facilitate aerobic treatment processes, or subsurface flow wetlands, which are generally anaerobic. Removal rates for fecal coliform, BOD, and suspended solids can be as high as 90 percent for a gravel-based VSB (White and Shirk, 1998). However, removal of nitrogen and phosphorus compounds (e.g., ammonium, nitrate, SRP) is typically much less. Nitrogen removal can be enhanced through designs that accommodate nitrification-denitrification processes—i.e., aerobic treatment followed by anaerobic treatment zones—but significant phosphorus removal is much more difficult to achieve (USEPA, 2001a). Estimated costs for VSBs range from approximately $10,000 to $20,000 for a system serving a typical residence. Maintenance tasks include removing dead vegetation; inspecting and cleaning the inlet and outlets; inspecting wastewater levels in the tank and filter bed; and ensuring wastewater levels do not rise above the filter medium.

6.3.1.5.12 *Sequencing batch reactors*

A sequencing batch reactor (SBR) is a modified cyclically aerated and decanted activated sludge treatment system. The SBR carries out aeration, sedimentation, and clarification via timed cycles in the same tank. Continuously fed SBRs are compartmented to reduce short-circuiting. SBRs remove BOD and TSS from wastewater. Modification to the operational mode can enhance removal of phosphorus and nitrogen. Development of reliable and versatile control systems has been a major factor in the increased use of SBRs during recent years. However, repair and replacement costs and operator knowledge requirements should be considered in decisions regarding this technology.

SBRs can be used for new developments or connected to existing septic systems and can be designed to collect effluent from multiple septic tanks for treatment at a common site. SBRs can be sited in relatively small areas of only a few hundred square feet. SBR costs, operation, and maintenance requirements are greater than those of conventional on-site systems. SBRs can be suitable alternatives for sites where high-density development and/or unsuitable soils preclude adequate treatment of effluent by conventional systems.

With appropriate design and operation, SBR plants have been reported to produce high-quality effluents with very good removal rates for BOD and TSS. Typical ranges of $CBOD_5$ (carbonaceous 5-day BOD) are from 5 to 15 mg/L, while TSS levels can range from 10 to 30 mg/L in well-operated systems. Fecal coliform removal of 1 to 2 logs can be expected (USEPA, 2002b). By using an anaerobic-aerobic operating mode, significant nitrogen and phosphorus removals are also possible.

6.3.1.5.13 *Aerobic treatment units*

Packaged aerobic treatment units have been used for residential on-site use for nearly 40 years. Treatment unit storage volumes can provide a hydraulic retention time of several days based on typical household flows. These systems require regular supervision, operation, and maintenance to be effective. Since maintenance has been a particular problem with these units, requiring a perpetual maintenance contract at the time of permitting is strongly recommended. Packaged aerobic treatment units generally include pretreatment by settling (usually in a septic tank) to remove fats, oils, grease, and solids. Effluent is usually discharged to a SWIS. When additional treatment (e.g., filtration, disinfection, etc.) is provided, discharge to surface waters may be possible if a Clean Water Act Section 402 (National Pollutant Discharge Elimination System) permit is obtained. Power requirements can be significant for certain types of package plants. Mixed liquor solids must be disposed of regularly, so the system should be inspected at least every three months.

Extended aeration units can achieve BOD concentrations ranging from 30 to 50 mg/L and suspended solids concentrations ranging from 40 to 60 mg/L in well-operating systems, often reflecting 75 to 95 percent removal efficiency (Kellam et al., 1993; Ayres and Associates, 1991; Tchobanoglous and Burton, 1991). Installing a sand filter or other polishing unit to treat wastewater after an extended aeration unit can improve BOD and suspended solids removal performance, although nitrate levels might increase as a result (Kellam et al., 1993). Costs typically range from $3,000 to $6,000 for an installed unit, with maintenance costs of $200 to $300 per year.

6.3.1.5.14 *Fixed film systems*

Fixed film systems feature media (e.g. plastic disks, pellets, gravel, tire chips, fabric media, foam pellets) with large amounts of surface area where microorganisms that digest wastes become attached and grow. Colonies of bacteria and other organisms develop into a biologically active slime layer that is sustained by nutrients and other constituents in the effluent. As wastewater flows over the media, colonies of microorganisms extract soluble organic matter and nutrients as a source of carbon and energy. Oxygen, which is required by these microorganisms, can be supplied by natural ventilation or by mechanical or diffused aeration within the wastewater.

Fixed film systems include trickling filters (where the wastewater flows down through a bed of gravel, carbon-based, or composite media such as tire pellets, fabric strips, foam pellets, etc.) and rotating biological contactors (rotating plastic discs colonized by wastewater flora/fauna partially submerged in the wastewater). These systems require pretreatment of sewage in a septic tank. Final effluent can be discharged to a SWIS or reused. Disinfection is necessary if effluent may come into contact with humans or disease vectors. Both systems can achieve TSS concentrations of 60 to 80 mg/L and BOD levels of 80 to 90 mg/L. Maintenance includes periodic inspection of wastewater levels in the septic tank; inspection of pump switches and discharge orifices; and cleaning or replacement of the growth medium at regular intervals, or more frequently if clogging develops.

6.3.1.5.15 *Pressure distribution systems*

Low-pressure effluent distribution into the soil using technologies developed by the drip irrigation industry offers significant treatment performance improvements. Pumping effluent to the dispersal field typically creates a large flow surge that distributes effluent uniformly throughout the dispersal field. This minimizes localized overloading and the consequent potential for eventual failure (Venhuizen, 1995). Pressure systems are placed very high in the soil profile and use periodic dosing to distribute effluent to the soil matrix. Pressure distribution trenches are typically shallow and narrow, providing ease of installation and maximum carbon availability for treatment processes. Reaeration of the infiltrative surface and drying of the biomat between doses reduce potential clogging threats and help to ensure nitrification of ammonia in the septic tank effluent. Drip irrigation distribution lines are typically installed with a vibratory plow at shallower depths (i.e., 8-12 inches below surface grade) and should be preceded with pretreatment by a septic tank and fixed film filter to prevent clogging of emitters (USEPA, 2002a).

6.3.1.5.16 *Evapotranspiration*

Evapotranspiration (ET) systems are designed to remove wastewater through evaporation and transpiration; they are used mostly in dry climates (e.g., Arizona, New Mexico). They have been used in wetter climates where ET potential is sufficiently high in certain months. Seepage from an ET system can be reduced or eliminated by using a plastic, PVC, or clay liner, but leaving the system unlined allows both percolation and evapotranspiration to occur. Wastewater is applied below the surface to the sand medium of the ET system. Water moves to the soil surface by capillary action for use by plants or is evaporated to the atmosphere. Performance strongly depends on climate, available surface area, and physical properties of the sand. Properly operating ET systems must evaporate or transpire more water than is applied as waste or collected during precipitation. More than 5,000 ET systems are in use in the United States. The cost of installation ranges from $10,000 to $15,000, but operation and maintenance costs are generally quite low.

6.3.1.5.17 *Spray irrigation*

Spray irrigation is commonly used to discharge septic tank effluent as irrigation water to hayfields or other vegetated areas not used to produce food crops. Spray irrigation can effectively dispose of effluent from OWTSs. However, strict controls on human contact with discharges that might contain pathogens are required. Design of spray irrigation systems must consider soil permeability, slopes, climate, and the water and nutrient needs of vegetation growing on the spray field. Additional treatment and disinfection of spray irrigation water is necessary if human contact with the spray field or wet vegetation is likely. Successful applications have been installed in shallow soils in the Northeast. It is recommended that effluent be treated prior to spraying to remove most BOD for odor-prevention. Spray devices should not be activated during wet weather, freezing temperatures, or saturated soil conditions. Because large buffer areas around the spray sites are usually required, extensive land is required, limiting this option to very large lots.

6.3.1.5.18 *Disinfection devices*

In some areas (e.g., source water protection areas and sites near recreational lakes, and coastal beaches), pathogen contamination from on-site systems is a major concern. Disinfection devices can be used in conjunction with the technologies summarized above to treat effluent for pathogens before it is discharged. The three most common methods of disinfection in the United States are chlorination, ozonation, and ultraviolet (UV) disinfection (NSFC, 1998).

Installation of these devices in an on-site system increases its cost and adds to operation and maintenance requirements. Single-home chlorinators in non-dosed conventional OWTSs have a poor track record when applied without management oversight. These units can greatly overdose or not dose at all if proper operation and maintenance are not performed. Chlorine is a powerful biocide and can have significant impacts on aquatic biota at concentrations well below 1 mg/L. Some states (e.g., Maryland) have additional requirements for maximum chlorine concentrations in effluent or prohibit the use of halogen (i.e., chlorine and iodine) processes. UV units generally require controlled dosing of a high-quality influent (BOD of 30 mg/L and TSS of 30 mg/L or better) for consistent performance. Maintenance includes periodically cleaning UV tube surfaces to maintain integrity and inspecting the contact chamber to ensure that solids have not accumulated. Annual replacement of UV bulbs is suggested. UV units cost $1,000 to $2,000 (installed) or about the same as tablet chlorinator units. Operation and maintenance costs for UV are about $150 to $200, similar to the chlorinator.

6.3.1.5.19 *Water separation systems*

A water separation system separates graywater from sinks, tubs, and appliances from toilet blackwater. The graywater is treated by using a somewhat smaller conventional OWTS or a SWIS. The blackwater can be treated in another OWTS or stored in a holding tank and periodically hauled off site for treatment or disposal. For extreme situations or for seasonal residents, some form of separation of toilet wastes from bath and kitchen wastes can be helpful. Most nitrogen discharges in residential wastewater come from human wastes, and they also provide almost half of phosphorus, TSS, and BOD. Use of holding tanks can be very expensive owing to the cost of $0.10 to $0.20 per gallon for pumping and hauling.

6.3.1.5.20 *Vaults or holding tanks*

Vaults or holding tanks are used to contain wastewater in emergencies or other temporary situations and to hold wastewater from a blackwater system. These systems require frequent pumping, which can be expensive if the total wastewater flow is contained.

6.3.2 Operation and Maintenance Programs

This chapter discusses two broad functions that have an impact upon on-site wastewater treatment systems: regulatory oversight and management. In the following discussion, oversight refers to the regulatory and enforcement functions (e.g., issuing permits, compelling compliance with local or state codes) typically performed by the regulatory authority (i.e., state health departments and their agents, which are usually local health departments). The term management includes other functions and services that may or may not fall under the direction of the regulatory authority, such as long-term planning, ensuring that septic tanks are pumped regularly, conducting periodic system inspections, arranging for financial assistance for installations/repairs, and other activities.

Management services may be provided by a management entity separate from the regulatory authority, such as a sanitation district, contracted firm, or homeowners' association. It is important to recognize that while the enforcement of codes and regulations (i.e., by the regulatory authority) provides a very basic level of protection for public health and environmental resources, the execution of management tasks (e.g., planning, monitoring, operation, maintenance, inspection) by a designated management entity helps to ensure that long-term system use meets established performance requirements.

Implementation of the various management program elements will undoubtedly be subject to the authority of the regulatory agency or agencies, but may be accomplished by another management entity, such as a public or private utility, regional planning agency, or water monitoring council. Some management program elements may require special arrangements or agreements if they are to be performed by a separate management entity. For example, where state codes require the regulatory authority to oversee system design and permitting, a formal agreement would likely be required if an outside management entity assumed those duties. The exact nature of the relationship between the regulatory authority and any management entities servicing a particular jurisdiction will vary considerably and depend upon the capacity of the regulatory authority, state and local codes, and the ability of management entities to provide designated services in an acceptable manner.

According to the U.S. Census Bureau (1997b), approximately 25 percent of the estimated 112 million occupied homes in the United States are served by on-site systems, a proportion that has changed little since 1970. Distribution and density of homes with OWTSs varies widely by state, with a high of about 55 percent in Vermont and a low of around 9.8 percent in California. New England states have the highest proportion of OWTS-served homes: New Hampshire and Maine both report that about half of all homes are served by on-site systems. More than a third of homes in the southeastern states depend on OWTSs, including approximately 48.5 percent in North Carolina and about 40 percent in both Kentucky and South Carolina.

More than half of the nearly 26 million homes with on-site treatment systems are more than 30 years old (U.S. Census Bureau, 1997a, 1999) and a significant number report problems. A survey conducted by the U.S. Census Bureau (1997a) estimated that 403,000 homes experienced septic system breakdowns within a three-month period during 1997, with 31,000 reports of four or more breakdowns at the same home. Typical reported malfunction rates average between 1 and 5 percent annually, with reported failure rates in a study conducted in the State of Washington ranging between 2.6 percent and 6.1 percent (USEPA, 1993b). It has been estimated that in some areas of Connecticut, 4 percent of on-site systems fail each year. The failure rate might be high because many on-site systems are approved in areas with unsuitable soil conditions.

Reported failure rates may underestimate true failure rates because they typically consider only plumbing backup and sewage surfacing, and not ground water or surface water contamination. Parsons Engineering Science (2000) reported that dye testing conducted for the Rouge River National Wet Weather Demonstration Project found failure rates (defined as short-duration appearance of dye in receiving waters) of 39 to 72 percent. Nelson et al. (1999) reported that estimates of partial and total system failure rates in some states range as high as 50 percent and more in some cases, but definitions of failure were highly variable and included all systems that were not designed according to the states revised codes.

Besides design, installation, and maintenance problems, regional hydraulic overloading (i.e., hundreds or thousands of densely sited systems discharging into a single ground water aquifer or subwatershed) can cause OWTSs to fail to meet requirements for protection of public health and water quality. Other factors include lack of maintenance and system age. In some areas, on-site systems are installed at a density that exceeds the capacity of the local soil to assimilate hydraulic and pollutant discharge loads. In addition, the design life of many OWTSs built between 1960 and 1980 has been exceeded. System owners are not likely to repair or replace aging OWTSs unless sewage backup, septage pooling on lawns, or targeted monitoring and failure documentation occurs. Approaches for reducing operation and maintenance failures through development of management activities and systems are outlined below.

The following sections describe recommended management measures that promote the protection of public health and water resources from risks linked to on-site systems. More information on OWTS management measures and system technologies, as well as case studies from across the nation, are available from EPA at http://cfpub.epa.gov/owm/septic/home.cfm and from the National Small Flows Clearinghouse at http://www.nesc.wvu.edu/nsfc/nsfc_index.htm. A model framework for management programs and other information on OWTS issues is posted by the National On-Site Wastewater Recycling Association at http://www.nowra.org/.

6.3.2.1 Development of system inventories and assessment of maintenance needs

System inventories are critical elements of an effective on-site/decentralized system management program. An inventory is essential to both long- and short-term planning. Knowledge of factors such as system location, type, age, maintenance schedule, and potentially affected water resources is necessary to predict watershed and site-specific pollutant loadings. This knowledge is also needed to achieve a community's public health, environmental, and fiscal goals.

Inventories can also give owners information regarding the proper operation and maintenance of their systems. A typical inventory will contain information such as: owner name, contact information, system type, location, installation date, design capacity, and last date of service.

Clermont County, Ohio, developed an OWTS owner database by cross-referencing water line and sewer service customers (Caudill, 1998). Because most people in the county were public water line customers, subtracting those who were also connected to the public sewer system yielded a database of nearly all the OWTS users. Contact information from the database was used to mass-mail information on system operation and maintenance and the county's new inspection program to 70 percent of the target audience. Other approaches used in the Clermont County outreach program were advisory groups, homeowner education meetings, news releases and interview programs, meetings with real estate agents, presentations at Farm Bureau meetings, displays at public events, and targeted publications.

System inventories are essential elements for management programs, and most jurisdictions maintain databases of new systems through their permitting programs. However, older systems (e.g., those installed prior to 1970) are often not included in those data files. Some on-site management programs or other entities conduct inventories of older systems when they are included in a special study area. For example, Cass County and Crow Wing County, Minnesota, have developed projects to inventory and inspect systems at more than 2,000 properties near lakes in the north-central part of the state (J. Sumption, Deputy Director of Cass County, Minnesota, Environmental Services, 2000). The project inventoried but did not inspect systems that were less than five years old unless a complaint or other report indicated possible problems. Costs for inventorying and inspecting 234 systems in one lake watershed totaled $9,000, or nearly $40 per site (J. Sumption, Deputy Director of Cass County, Minnesota, Environmental Services, 2000).

In some cases, data necessary for on-site system management may be held and administered by other agencies. For example, land and water resource characterization data are often collected, stored, and analyzed by environmental or planning agencies. Developing data-sharing policies with other entities through cooperative agreements can help all organizations involved with health and environmental issues improve their efficiency and overall program performance. The RME should ensure that data on existing systems are available to health and water resource organizations (usually regulatory authorities) so that their activities and analyses reflect this important aspect of public health and environmental protection.

Education for system owners is an important component of the outreach for management programs that rely on homeowners for system operation and maintenance. Educational initiatives are most effective when they result in understanding of the relationship between ground water and surface water, and how septic system siting, design, installation, operation, and maintenance can affect those resources and public health. Surveys show that many people have their septic tank pumped only after the system fails. Property owners who are educated in proper system operation and maintenance practices, and who understand the consequences of system failure, are more likely to take actions to ensure that their systems function properly. Typical public outreach and education program topics for homeowners in the present system of prescriptive and conventional on-site systems include:

- How an on-site wastewater treatment system works;
- System siting and design considerations;
- How on-site systems can affect health, ground water, and surface water;
- The importance of water conservation in minimizing hydraulic failures;
- Practices to reduce mass pollutant loadings and toxic inputs to the system;
- Typical operation and maintenance practices, procedures, and timetables;
- How delaying septic tank pumpout can cause solids to clog infiltration systems; and
- Costs of repairs, upgrades, or replacement of system components.

Inventories of existing systems can be developed by consulting wastewater treatment plant service area maps, identifying areas not served by POTWs, and working with public and private utilities (drinking water, electricity, and septage pumpers and haulers) to develop a database of system owners and contact information.

A variety of commercially available software exists for managing system inventory and other information. Electronic databases can make collecting, retrieving, using, and integrating data fairly easy after the initial implementation (data entry) and learning curve have been overcome. For example, if system locations are described in terms of specific latitude and longitude coordinates, a data layer for existing on-site systems can be created and overlaid on geographic information system (GIS) topographical maps. Adding information on on-site wastewater hydraulic output, estimated mass pollutant loads, and transport times expected for specified hydrogeomorphological conditions can help managers understand how water resources become contaminated. This can also help target remediation and prioritization actions to sources primarily responsible. Models can also be constructed to predict impacts from proposed development and suggest guidance on performance requirements for on-site systems in proposed development areas.

6.3.2.2 Management, operation, and maintenance policies

There are three basic approaches for developing and implementing a management program (see below). In addition, EPA has issued the *EPA Voluntary National Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems* (USEPA 2003). See http://cfpub.epa.gov/owm/septic/home.cfm for management guidelines, technology fact sheets, links, and other information). The guidelines describe five progressive tiers of management in the form of model programs that can be tailored by local communities to meet their public health and water resource protection needs (Table 6.10). Appropriate adoption of these guidelines based on level of risk and value of resources affected by on-site systems is strongly recommended. Table 6.11 shows an example matrix of different on-site system management program elements and functional responsibilities.

Table 6.10: Guidelines for OWTS management programs under a tiered approach (adapted from USEPA, 2002a).

Program type	Program objectives	Basic management program elements
System inventory and awareness of operation and maintenance needs	– Owner awareness of permitting program, installation, and operation and maintenance needs – Compliance with codes and regulations	– Only conventional systems allowed – Prescriptive design and site requirements – Owner education to promote operation and maintenance – Complaint inspections and investigations – Point-of-sale inspections
Management through maintenance contracts	– Maintain prescriptive program for sites that meet siting criteria – Permit proven alternative systems on sites not meeting criteria	– Prescriptive design/site requirements – Measurable operation and maintenance requirements – Allowances for approved alternatives – Operation and maintenance contracts for alternative systems – Inspections, owner education
Operating permits	– System design based on site conditions and performance requirements – System performance verified through permit renewal inspections	– Wide variety of designs allowed – Performance governs acceptability – Compliance monitoring essential – Property sale or change of use triggers compliance assurance inspection
Management entity operation and maintenance	Public or private entity assumes operation and maintenance responsibilities for all systems in management area	– Performance governs acceptability – Operating permits ensure compliance – All systems are inspected regularly – Monthly/yearly fees support program – Owner relieved of operation and maintenance responsibility
Management entity ownership	– Public or private entity owns and operates all systems in management area – Similar to centralized sewage treatment service approach	– Performance governs acceptability – Operating permits ensure compliance – All systems are inspected regularly – Monthly/yearly fees support program – Management entity responsible for operation and maintenance – Management entity finances installation, repairs

Table 6.11: Program elements and functional responsibilities example matrix.

Program Element	Responsible Party							Comments
Planning								
Stakeholder involvement process								
Watershed assessments								
Sensitive area and critical area designations								
Performance Requirements								
Health and environmental goals								
General requirements								
Requirements for sensitive and critical areas								
Site Evaluation								
Wastewater characterization procedures								
Site suitability analysis								
Design								
Prescriptive or performance criteria								
Design review and approval process								
Construction								
Permitting requirements and process								
Construction and/or installation oversight								
Operation and Maintenance								
Owner/operator requirements								
Performance certification approaches								
Residuals Management								
Residuals removal/disposal requirements								
Tracking and reporting system								
Certification and Licensing								
Staff and service providers covered								
Certification/licensing requirements								
Education and Training								
System owner/operator education								
Requirements for staff and service providers								
Provision of training programs								
Inspections and Monitoring								
Routine (point-of-sale) and emergency inspections								
Targeted surface water and ground water monitoring								
Corrective Actions								
Compliance schedules and enforcement program								
Repair, upgrade, or replacement oversight								
Record Keeping and Reporting								
Existing and new systems inventory								
Tracking system for permits/inspection/maintenance								
Financial/administrative/program management								
Financial Assistance								
Funding source development								
Administration/management funding								
Installation and operation and maintenance assistance								

● State Health Department
■ State Water Agency
▲ District/County/Local Health Department
✪ County or Local Government Office
▼ Local/Regional Planning Office
◆ Utility District
✱ System Owner
✦ Private Contractor

6.3.2.2.1 *Voluntary Management*

An effective voluntary program develops recommended guidelines and educational materials and distributes this information to the homeowner or system operator. Voluntary management programs are highly dependent on comprehensive, easy-to-understand educational materials and an aggressive outreach program that includes distribution of the materials, training workshops, and site visits to provide individual assistance.

In 1997 the University of Minnesota Cooperative Extension Service published a guide for homeowners that incorporates important elements of an on-site training program. The guide is available online at http://www.extension.umn.edu/distribution/naturalresources/DD6583.html. Another equally useful guide can be found on the North Carolina Cooperative Extension Web site at http://ces.soil.ncsu.edu/soilscience/publications/Soilfacts/AG-439-22.

6.3.2.2.2 *Regulatory Management*

Under this approach, the regulatory authority—typically a district or local health department—oversees and enforces an on-site program of system design, permitting, installation, operation, and maintenance authorized under state and local codes. The codes may require routine inspections by the health officer either on an annual basis or at the time of property transfer, as is

On-site System Operating Permits in St. Louis County, Minnesota

St. Louis County, located in the northeastern region of Minnesota, extends from the southwestern tip of Lake Superior north to the Canadian border. The physical characteristics of the region are poorly suited for application of traditional on-site treatment systems. Many of the soils are very slowly permeable lacustrine clays, shallow to bedrock, and often near saturation. The existing state code restricts on-site systems to sites with permeable soils of sufficient unsaturated depths to maintain a 3-foot separation distance to the saturated zone. The county has adopted performance requirements that can be followed in lieu of the prescriptive requirements where less than 3 feet of unsaturated, permeable soils exist. In such cases the county requires the owner to continuously demonstrate and certify that the system is meeting performance requirements. This is achieved through the issuance of renewable operating permits for all alternative treatment systems. The operating permit is based on evaluation of system performance rather than design prescription and includes the following:

- System (technology) description.
- Description of environmental conditions.
- Site evaluation documentation.
- Performance requirements.
- System design, construction plan, specifications, and construction drawings.
- Maintenance requirements.
- Monitoring requirements (frequency, protocol, and reporting).
- Contingency plan to be implemented if the system fails to perform to requirements.
- Enforcement and penalty provisions.

The permit is issued for a limited term, typically 5 years. Renewal requires that the owner document that the permit requirements have been met. If documentation is not provided, a temporary permit is issued with a compliance schedule. If the compliance schedule is not met, the county has the option of reissuing the temporary permit and/or assessing penalties. The permit program is self-supporting through permit fees.

the case in Washtenaw County, Michigan (Washtenaw County, 1999), the Code of Massachusetts Regulations, and other state and local statutes. Financial incentives and disincentives usually aid compliance; these can vary from small fines for poor system maintenance to mandatory repairs if the wastewater treatment system is not functioning properly. Inspection fees can cover program costs. Some jurisdictions (e.g., Florida) issue renewable operating permits and/or ground water discharge permits to manage system operation and maintenance. These permits may require homeowners either to have a contract with an authorized inspection and maintenance contractor or to demonstrate that periodic inspection and maintenance procedures have been performed (Florida Statutes, 2001). Permits or inspection requirements for alternative systems, especially those with mechanical components, are recommended.

6.3.2.2.3 *Direct management*

Another option for managing and maintaining on-site systems is a management entity, typically a wastewater utility or district. From a regulatory standpoint, an OWTS management program can save both time and money by allowing a management entity to execute various management program tasks. Incorporating on-site systems into a local or regional wastewater management district, with the district responsible for system operation and maintenance, is a means to ensure that small wastewater systems in a designated area function properly and do not threaten ground water or surface water. State legislation to create wastewater management districts is sometimes required. Enabling legislation for special districts allows district personnel to enter private properties within the district for the purpose of inspecting, repairing, upgrading, or replacing on-site systems. Taxpayers in the proposed district often must vote to create the special district.

The regulatory authority also may decide to perform these tasks and assume overall responsibility for managing the on-site systems in its jurisdiction. Health departments can serve as the management entity under some of the approaches outlined above because they often have considerable permitting, installation, and inspection authority. Regardless of the approach, system users usually pay an annual fee that is applied to operation, maintenance, and management costs. Texas law authorizes local governments to petition the Texas Natural Resource Conservation Commission to assume management authority for on-site systems (Texas

On-Site Sewage Management Ordinance, Chippewa County, Michigan

Chippewa County is located on Michigan's Upper Peninsula, along the shores of Lake Superior. Over the past 10 years, the number of requests for OWTS permits has tripled. The high demand for property in the county, as well as its increased value as a tourist destination, has dramatically increased the county's population. Many of the properties to be developed are located in environmentally sensitive areas, including fractured bedrock and limestone, which puts the county's ground water at high risk of contamination from faulty septic systems.

The county's Environmental Health Department amended the existing sanitary codes to allow the installation of alternative on-site systems for lakeshore areas. County officials worked with a Michigan State University professor to educate the citizens and local officials of Chippewa County about the values of these alternative systems. Some of these alternative systems include recirculating systems, single-pass filter systems, sewage waste lagoons, and mound systems. In the end, both the public and the local government supported the new codes, and no new bacterial contamination has been found since the codes were passed.

Administrative Code, 1997). Procedures that can be used to apply the wastewater management district concept to a specific problem area include:

- Researching relevant legal and regulatory issues;
- Conducting a thorough site investigation;
- Identifying the specific geographic area to be included within the wastewater management district;
- Selecting the performance standards to be met and the means of attaining them;
- Preparing accurate cost estimates;
- Receiving approval from ratepayers within the proposed district for the creation of the management district;
- Preparing and adopting regulations, as needed, to establish the wastewater management district; and
- Adopting a management strategy (including operational, administrative, and financial processes).

Resources are available to help management entities explore the concept of an onsite wastewater management district. For example, the City of Austin, Texas, provides online resources related to its study of management district establishment (see http://www.ci.austin.tx.us/wri/altern.htm)

6.3.2.3 Inspection and monitoring programs

Inspection and monitoring programs are recommended to assess current and likely (future) on-site wastewater impacts. A means of inventorying existing and new systems, conducting inspections, providing monitoring data, or responding to treatment failures should be developed. As noted above, information on new systems (system owner, contact information, system type, location, design life and capacity, recommended service schedule) should be collected by the OWTS regulatory agency at the time of permitting and installation. Telephone, door-to-door, or mail surveys can be helpful to gather information on system type, tank capacity, installation date, last date of service (e.g., pumping, repair), problem incidents, and other relevant information. A number of private firms marketing new treatment technology packages (e.g., fixed film reactors, sand/media filters, aeration units) include remote monitoring services as part of the system package. For example, some companies install controls that continuously upload key system data (e.g., flow rates, pump cycles) to dedicated Web sites. Management staff can monitor the performance of multiple systems by accessing these Web sites, allowing detection of problems before massive failures occur. The per-unit cost of remote monitoring, which is required under the system installation contract, can range from $25 to $50 or more, depending on the type of unit and maintenance needs. The extra expense for necessary equipment is typically less than 10 percent of the cost of the packaged system.

6.3.2.3.1 *System inspections*

On-site system operation and performance inspections should check for the following (USEPA, 2002a):

- Evidence of vehicles being driven over the septic tank or reserve field;
- Installation of pavement, driveways, or structures over the septic tank or reserve field;
- Wet areas or poor drainage in or around the infiltration field;
- Slow flushing or gurgling of water in plumbing fixtures;
- Leaking toilets or addition of significant wastewater-generating fixtures such as water softeners;
- Additions to the house or building after system installation;
- Surface drainage patterns in the area of the tank and infiltration field;
- Broken or open tank access covers or doors; and
- Sludge or scum buildup in the septic tank; clogging of tank filters (if present).

More-detailed inspections of the system are recommended if there is evidence of a problem and should include the following:

- Pump and inspect the tank for structural deficiencies.
- Inspect the pumping components of the system.
- Test the system by filling the tank and observing the water level rise and fall.
- Inspect the baffles, valves, or other key appurtenances.
- Check all piping from the fixtures to the tank.
- Inspect runoff pathways of water from roofs, driveways, and other sources.
- Uncover distribution boxes (if used), and check flow distribution.
- Check for plumbing fixture leaks.

Inspections can be conducted in several ways (USEPA, 1993b). Homeowners can serve as monitors if they are educated and trained on how to inspect their own systems; however, this approach has not been effective in most cases. Brochures are often made available to instruct individuals on how to monitor their systems and the steps to take if they determine that their on-site system is not functioning properly. It should be noted, however, that homeowners rarely inspect their own systems, even with training. Trained inspectors are the best means for identifying failing systems.

Inspections can be conducted at the time of property transfer (point-of-sale inspections). Massachusetts has a rule that has required regular inspections since 1995. Colorado mandates inspections at the time of transfer, although its inspection requirements are less stringent than those of other states. Inspections are discussed further in *EPA Voluntary National Guidelines for*

Comprehensive Monitoring and Inspection Program in Nags Head

The town of Nags Head has implemented a program to identify and address on-site system impacts in that North Carolina Outer Banks community. The town's Septic Health Initiative Program secured competitive bids for tank pumping and inspection and will reimburse full inspection costs (about $65) and provide a $30 rebate on the next water bill if the system owner has the tank pumped. Monitoring consists of a series of ground water well and surface sites that are tested for fecal coliform, ammonia, dissolved oxygen, nitrate, pH, salinity, phosphorus, specific conductance, and turbidity. An education program complements the effort by circulating information on treatment processes, operation, and maintenance (Krafft, 2001).

Management of Onsite/Decentralized Wastewater Treatment Systems (http://cfpub.epa.gov/owm/septic/home.cfm).

Inspection programs operated by OWTS management agencies, special districts, and utilities can be the most effective in terms of cost and results. The State of Arizona requires routine operation and maintenance inspections for alternative on-site systems and pre-sale inspections (NSFC, 1995). Massachusetts requires inspections by a certified individual at the time of property transfer. Minnesota requires property transfers to be accompanied by certification that the on-site system is performing in a satisfactory manner. More than half of all Minnesota counties and most lending entities require inspections because of market-driven desires to ensure that on-site systems are operating properly at the time of property sale (Prager, 2000). Massachusetts also requires that systems with a design flow of 10,000 gal/day or more be inspected every three years, and shared facilities must be inspected annually (Massachusetts Department of Environmental Protection, 1996). Some counties (e.g., Washtenaw County, Michigan) with mandatory property transfer inspection programs require inspectors to be certified. New Hampshire requires an assessment and an on-site system inspection by a permitted designer prior to the sale of any developed waterfront property (New Hampshire Code of Administrative Rules, 2001).

States and localities can also indirectly assess whether on-site systems are failing through surface water and ground water monitoring. If indicator pollutants (e.g., fecal coliform as an indicator of potential pathogen contamination) are found, nearby on-site systems should be inspected to determine if they are a contributing or primary source of the contaminants. For example, residents living along the shore of Ten Mile Lake in Minnesota support a lake association that conducts regular fecal coliform monitoring below lakefront homes. High coliform concentrations prompt system inspections and involvement of property owners in remediation discussions. Owners who repair their system or install a new one are added to the OWTS "honor roll," which is published in the association's monthly newsletter.

Health department personnel and/or system inspectors often use tracer dye to observe effluent movement (USEPA, 1991). Many local agencies use non-toxic tracer dye to determine wastewater migration into nearby wells or surface waters. Tracer dye, which is typically flushed down the toilet, is often used to demonstrate to system owners that effluent is migrating rapidly into nearby surface waters or ground water. Rapid movement of effluent, that is, 20 to 30 feet in less than 30 minutes, may indicate that subsurface infiltration and treatment of wastewater have been short-circuited. Other confirmatory tests should be employed to verify this fact.

Galveston Bay Project Targets "Hot Spots"

In support of the Galveston Bay Estuary Program, the Galveston county health department conducted an intensive survey of on-site systems in the Dickinson Bayou watershed to identify failed systems and improve homeowner operation of existing systems. During the first part of the project, 36 of 90 (40 percent) systems inspected exhibited some degree of failure and were likely contributing to significant fecal coliform water quality violations in the bayou (Galveston County Health District, 1998).

A variety of online resources are available for agencies seeking information on the operation, maintenance, or inspection of on-site systems. The Rhode Island Department of Environmental Management published the *Septic System Checkup* inspection guide in 2000 and posted an online version at http://www.dem.ri.gov/pubs/regs/regs/water/isdsbook.pdf. A general operation and maintenance manual entitled *The Septic System Owner's Guide* is available online from the University of Minnesota Extension Service at http://www.extension.umn.edu/distribution/naturalresources/DD6583.html. For links to other online resources, visit the links page maintained by the Consortium of Institutes for Decentralized Wastewater Treatment at http://www.onsiteconsortium.org/links.cfm. The Wayne County, Ohio, Health District also has an extensive list of links on its Web site (http://wchd.neobright.net/wc_wastewater_tx2.html).

6.3.2.3.2 *Improving system effectiveness through water conservation and pollutant reduction*
In addition to structural methods to remove nitrogen and other pollutants from wastewater, management practices that reduce wastewater flow and/or pollutants are effective. Reducing the overall hydraulic load by installing water-saving devices and adopting water conservation practices can increase the residence times for wastewater pretreatment and, most importantly, reduce the amount of wastewater that must be infiltrated into the soil. Jarrett et al. (1985) stated that 75 percent of soil absorption field failures could be attributed to hydraulic overloading. Several practices are available to retrofit these failing systems so that they operate properly. Eliminating the use of garbage disposals (pollutant reduction), installing low-volume plumbing fixtures (flow reduction), and adopting water conservation practices (flow reduction) are usually the most cost-effective approaches for reducing pollutant and hydraulic loads to the field.

Reduced loading of organics and chemicals can extend the useful life of the on-site system and improve treatment effectiveness. Mass pollutant loads in the OWTS can be significantly decreased by avoiding detergents that contain phosphates, cleaning food debris and grease from dishes before washing, removing or not using in-sink garbage disposal units, and eliminating the disposal of sanitary napkins and disposable diapers in toilets. Inputs of discarded antibiotics, dialysis unit discharges, and toxic cleaners and other chemicals can cause treatment process upsets and may impact public health if they reach the ground water. These problems can be addressed through homeowner education and better disposal practices. See Management Measure 9 (Pollution Prevention) for more information about proper disposal practices.

Reducing hydraulic loads can achieve significant reductions in OWTS failure rates. In 1992 Congress adopted the Energy Policy Act, which established national standards governing water use and energy conservation for showers, kitchen sinks, basins, and toilets (see Table 6.12). Several states have implemented specific water conservation practices (USEPA, 1998b). If low-flow plumbing fixtures are used, it is important that on-site system design not be modified to decrease the required septic tank size. The use of smaller septic tanks could negate the advantages of using low-flow plumbing fixtures by increasing organic loading rates to the soil infiltrative surface.

Table 6.12: Comparison of current and federally mandated flow rates and flush volumes (USEPA, 1998b).

Fixture	Current Practice	Energy Policy Act of October 1992	Potential reduction in water used (%)
Kitchen Sink	3.0 gpm	2.5 gpm	17
Lavatory	3.0 gpm	2.5 gpm	17
Shower	3.5 gpm	2.5 gpm	29
Tub	6.0 gpm	4.0 gpm	33
Water closet (tank)	3.5 gal	1.6 gal	54
Water closet (valve)	3.5 gal	1.6 gal	54
Urinal	3.0 gal	1.5 gal	50

Eliminating the use of garbage disposals can significantly reduce the loading of suspended solids and BOD to OWTSs (Table 6.13) unless OWTSs are designed for their use. Eliminating garbage disposals can decrease the buildup of solids in the septic tank and reduce the frequency of pumping required. A number of states have regulations prohibiting the installation of garbage disposals where on-site systems are used. New OWTSs can be designed to accommodate garbage disposals and the associated increase in organic and solids loadings to wastewater by increasing tank volume or pumping frequency (USEPA, 2001c).

Table 6.13: Residential wastewater pollutant contributions by source (adapted from USEPA, 1992b).

Parameter		Garbage disposal (gpcd)	Toilet (gpcd)	Bathing, sinks, appliances (gpcd)	Approximate total (gpcd)
BOD_5	Mean	18.0	16.7	28.5	63.2
	Range	10.9–30.9	6.9–23.6	24.5–38.8	–
	% of total	(28%)	(26%)	(45%)	(100%)
TSS	Mean	26.5	27.0	17.2	70.7
	Range	15.8–43.6	12.5–36.5	10.8–22.6	–
	% of total	(37%)	(38%)	(24%)	(100%)
Nitrogen	Mean	0.6	8.7	1.9	11.2
	Range	0.2–0.9	4.1–16.8	1.1–2.0	–
	% of total	(5%)	(78%)	(17%)	(100%)
Phosphorus	Mean	0.1	1.6	1.0	2.7
	Range	–	–	–	–
	% of total	(4%)	(59%)	(37%)	(100%)

6.3.2.4 Management of residuals to ensure that they do not present significant risks to human health or water resources

On-site systems are not maintenance-free systems. Huang (1983) stated that half of on-site system failures are due to poor operation and maintenance. Most residential septic tanks are designed for approximately 72- to 96-hour retention of wastewater to allow for the removal of solids, greases, and fats. Some of the solids retained in the tank decompose naturally by bacterial and chemical action. As sludge accumulates on the bottom of the tank, however, the decrease in tank volume available for storing settleable solids and raw wastewater results in less contact time. When sludge or scum levels get too near the outlet entrance level, solids can move directly to the soil absorption system and cause clogging (Mancl and Magette, 1991). Septic tank effluent screens can provide some protection from neutrally buoyant solids and during tank upsets, but periodic removal of solids from the tank is necessary to protect the soil absorption system. Most tanks should be pumped out every three to five years in lieu of a regular inspection program. If a septic system is not pumped out regularly, failure will not occur immediately; however, continued neglect will cause the SWIS to fail because it is no longer protected from greases, oils, and solids. Failure may require replacement, often at considerable expense.

Responsibility for ensuring proper operation and maintenance is most often left to homeowners. Homeowners generally are not properly trained or informed on how to take care of their systems, and many do not care to do so. On-site system regulatory authorities and management entities have recognized the need for more comprehensive management programs and have developed educational and other programs to help owners understand their responsibility for system management. Some regulatory authorities have opted for a more proactive approach and have developed inspection programs, renewable permits, and financial incentives (e.g., low-interest loans, grants) for installing, upgrading, or repairing underperforming systems. More than 100 OWTS management programs that provide operational oversight beyond initial permitting are now operating across the country (Knowles, G., Coordinator, National Onsite Demonstration Program (NODP) Phase IV, personal communication, 2000; see also http://www.nodp.wvu.edu/).

The primary objective of a residuals management program is to establish procedures and rules for handling and disposing of accumulated sludge and wastewater removed from tanks (i.e., septage, also called biosolids) in an affordable manner that protects public health and ecological resources. When planning a program, it is important to have a thorough knowledge of legal and regulatory requirements regarding handling and disposal. In general, state and local septage management programs that incorporate land application or disposal to landfills must comply with Subpart C of 40 CFR (U.S. Code of Federal Regulations) Part 503. Detailed guidance for identifying, selecting, developing, and operating reuse or disposal sites for septage can be found in the two process design manuals: *Land Application of Sewage Sludge and Domestic Septage* and *Surface Disposal of Sewage Sludge and Domestic Septage* (USEPA, 1995 a and b), which are posted on the Internet at http://www.epa.gov/ORD/WebPubs/sludge.pdf. Additional information can be found in *Domestic Septage Regulatory Guidance* (USEPA, 1993a).

States and municipalities typically establish additional public health and environmental protection regulations for residuals handling, transport, treatment, and reuse or disposal. In addition to regulations, practical limitations such as land availability, site conditions, buffer zone requirements, hauling distances, fuel costs, and labor costs play a major role in evaluating septage reuse or disposal options. These options generally fall into three basic categories: land application; treatment at a wastewater treatment plant; or treatment at a special septage treatment facility. Initial steps in the residuals reuse or disposal decision-making process include characterizing the quality and quantity of the septage to be produced annually and determining potential adverse impacts associated with various reuse or disposal scenarios. In general, program officials strive to minimize the exposure of humans, animals, ground water, and surface water to potentially toxic or hazardous chemicals and pathogenic organisms found in septage.

Other key aspects of residuals management programs are tracking or manifest systems that identify septage sources, pumpers, transport equipment, final destination, and treatment, along with procedures such as vector control, wet weather runoff, and access to disposal sites for controlling human exposure to residuals.

6.4 Information Resources

The *Onsite Wastewater Treatment System Manual* (EPA, 2002a) is an update to EPA's 1980 manual entitled *Design Manual: Onsite Wastewater Treatment and Disposal Systems*. This comprehensive reference manual is designed to provide state and local governments with guidance on the planning, design, and oversight of onsite systems. This manual will also be useful for onsite wastewater professionals, developers, land planners, and academics. It is available in PDF format from http://www.epa.gov/ORD/NRMRL/Pubs/625R00008/625R00008.htm.

EPA Voluntary National Guidelines for Management of Onsite/Decentralized Wastewater Treatment Systems is a set of recommended practices needed to raise the level of performance of on-site/decentralized wastewater systems through improved management programs. Five model programs are presented as a progressive series: (1) system inventory and awareness of maintenance needs; (2) management through maintenance contracts; (3) management through operating permits; (4) operation and maintenance by a public or private management entity; and (5) ownership and management by a public or private management entity. Each of these model programs includes a set of recommended approaches for planning, siting, design, performance, installation, operation, maintenance, and monitoring of wastewater systems. The guidelines can be obtained at EPA's Office of Wastewater Management Web site at http://cfpub.epa.gov/owm/septic/home.cfm.

Funded by the U.S. Environmental Protection Agency, the National Small Flows Clearinghouse (NSFC) helps small communities and individuals find affordable wastewater treatment options to protect public health and the environment. The NSFC Web site, which can be accessed at http://www.nesc.wvu.edu/nsfc/nsfc_index.htm, offers news, publications, databases, discussion groups, information about innovative and alternative wastewater technology projects (through EPA's Environmental Technology Initiative project), and links related to small wastewater systems.

The ASTM International Web site (http://www.astm.com/) offers guides to standard practices and technical publications on environmental assessment and waste management practices that can be useful for siting, designing, and installing OWTSs.

The American Society of Agricultural Engineers (ASAE) offers several proceedings from conferences focusing on on-site wastewater treatment at its publications page (http://www.asabe.org/pubs/PubCat02/waste.html). ASAE also has a searchable library of technical articles (http://asae.frymulti.com/), many of which pertain to OWTSs.

The National Onsite Wastewater Recycling Association (NOWRA) Web site, which can be accessed at http://www.nowra.org/, offers a calendar of events related to OWTSs, contact information for state and local OWTS organizations, links to OWTS-related businesses and organizations, the *Onsite Insight* newsletter, technical guidance for owners and operators of OWTSs, a bookstore with conference proceedings available for purchase, and the *Model Framework for Unsewered Wastewater Infrastructure*, which is a guide for establishing future national policy for onsite systems.

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MANAGEMENT MEASURE 7
BRIDGES AND HIGHWAYS

7.1 Management Measure

Plan, design, operate, and maintain highways and bridges to:

- Protect sensitive ecosystems, including wetlands and estuaries, by minimizing road- and bridge-related impacts and water crossings, and by establishing protective measures including setbacks during construction;
- Reduce the runoff of pollutants through the use and proper maintenance of structural controls;
- Reduce the generation of pollutants from maintenance operations by minimizing the use of pesticides, herbicides, fertilizers, and deicing salts and chemicals; and
- Reduce the generation and runoff of pollutants during highway and bridge repair operations by decreasing the use of hazardous materials and incorporating practices to prevent spillage into sensitive areas.

7.2 Management Measure Description and Selection

7.2.1 Description

Motor vehicles generate runoff pollutants through emission and deposition of automobile exhaust and through discharges of both fluids and solid particles while traveling and braking. In a study of traffic-generated particulates in Cincinnati (where the average daily traffic load is 150,000 vehicles), Sansalone and Buchberger (1997) found that of the 13,500 mg of particulates per square meter of road surface generated per day, 44 to 49 percent originated from pavement wear, 28 to 31 percent from tire wear, and 15 percent from engine and brake pad wear. The study also found that 6 percent of particulates were deposited from settleable exhaust and 3 percent from atmospheric deposition.

A study by Shepp (1996) examined generation of petroleum hydrocarbons in urban runoff from four land uses: all-day parking lots, streets, gas stations, and convenience stores. Shepp found that convenience stores had the highest hydrocarbon concentration (see Figure 7.1). Evaluation of the land uses and their respective catchment areas suggested that the degree of automotive exposure (a combination of duration of exposure to vehicles with engines running and volume of traffic) is the primary factor in the generation of petroleum hydrocarbons in runoff from automotive-intensive land uses.

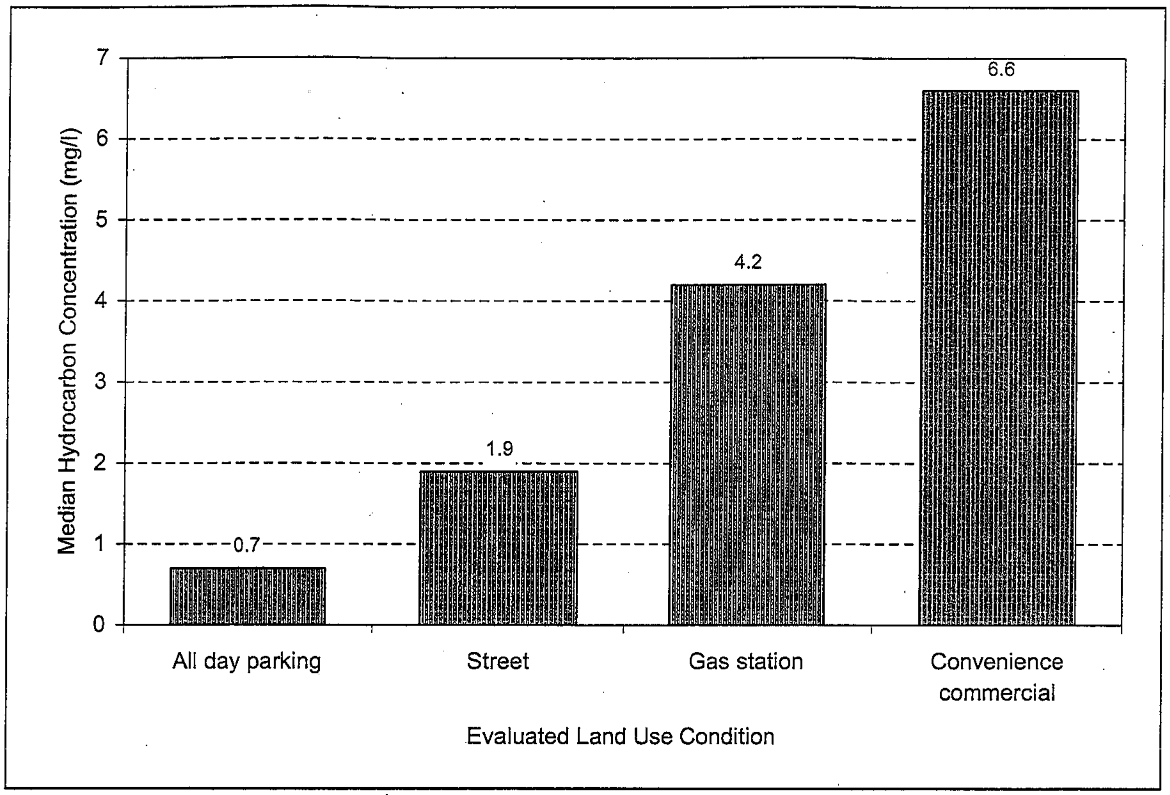

Figure 7.1: Median hydrocarbon concentrations by land use (Shepp, 1996).

The National Water Quality Assessment Program (NAWQA) of the U.S. Geological Survey (USGS) recently conducted studies on water pollution related to sprawl-induced traffic. These studies show a consistently positive correlation between increases in vehicular traffic associated with urban sprawl and the buildup of polycyclic aromatic hydrocarbons (PAHs) in 10 lakes and reservoirs in six metropolitan areas across the country. PAH sources related to motor vehicle use include tire wear, roadway wear, exhaust and soot, and crankcase oil releases (Van Metre et al., 2000). A study in Austin, Texas, demonstrated that elevated levels of PAHs found in Barton Springs sediments, although not toxic on their own, yielded 100 percent mortality in test invertebrates (amphipods, *Hyalella azteca*), when the organisms were exposed to UV radiation (Hayward et al., 2002). Mahler and Van Metre (2004) identified abrasion of coal tar emulsion sealants on parking lots as contributing significant amounts of PAHs to local water bodies and speculated that they could be the dominant source of PAHs in some urban watersheds. The U.S. Fish and Wildlife Service (USFWS) found that 50 to 68 percent of brown bullhead catfish collected from the Anacostia River in Washington, DC, had liver tumors and 13 to 23 percent had skin tumors (Reel, 2004). The USFWS attributed these tumors to DNA changes linked to PAHs from vehicle emissions and runoff.

Roads tend to accumulate particulate matter from roadsides, salting and sanding, dirty cars, brake pad dust, aerial deposition, and surface deterioration. Sansalone and Tribouillard (1999) and Sansalone et al. (1998) measured the deposition and size distribution of particles deposited on highways. They found that accumulation of particulate matter was significantly greater along the downslope of the highway than along the upslope and that particle size distributions (PSDs) along the downslope were consistently coarser across the entire size gradation than the upslope and pavement PSDs (Sansalone and Tribouillard, 1999). Solids in the 2 to 8 μm range generated the largest counts and were rapidly washed from the pavement in a "first flush" effect (Sansalone et al., 1998). Lateral pavement sheet flow rate and duration controlled the yield and size of transported solids; particle transport was mass-limited during extended, high-intensity events, but was flow-limited during intermittent, low-intensity events with high traffic (Sansalone et al., 1998).

These particles, when transported in runoff to receiving waters, contribute to high levels of total suspended solids and turbidity and act as carriers for pollutants that adhere to their surfaces. Because of this adsorption phenomenon, surface area can be an important determinant in pollutant loading from highways. A relationship exists between particle size and surface area. Sansalone et al. (1998) found that particles 425 μm to 850 μm in size contributed the greatest total surface area. Sansalone and Tribouillard (1999) found that total surface area decreased with decreasing particle size. Particle-specific surface area, however, increased with decreasing particle size (Sansalone and Tribouillard, 1999; Sansalone et al., 1998), but measured values deviated from the monotonic pattern expected for spherical particles (Sansalone et al., 1998).

Because total surface area is predominantly associated with the coarser fraction, heavy metal mass (adhered to particle surfaces) is also strongly associated with this fraction (Cristina et al., 2000). Cumulative analyses for lead, copper, cadmium, and zinc in snow residuals indicated that more than 50 percent of these heavy metals (by mass) was associated with particles greater than 250 μm, and more than 80 percent was associated with particles greater than 50 μm (Sansalone and Glenn, unpublished).

Heavy metals such as lead, iron, and aluminum are typically particulate-bound in urban runoff (Sansalone and Buchberger, 1997). Sansalone and Glenn (2000), however, found that lead was predominantly dissolved in highway runoff, a phenomenon they attributed to low urban rainfall pH and alkalinity and relatively short pavement residence times. Other metals predominantly found in the dissolved phase in highway runoff were zinc, cadmium, and copper (Sansalone and Buchberger, 1997; Sansalone and Glenn, 2000).

The California Department of Transportation (Caltrans) conducted a study of highway runoff quality from 1999 to 2000 at 100 locations throughout the state. Caltrans found a positive correlation between the concentration of most pollutants and traffic volume. In addition, more than 30 percent of the total arsenic, cadmium, chromium, copper, nickel, silver, and zinc were found in the dissolved state (Kayhanian et al., 2001).

The partitioning of heavy metals between the particulate-bound and dissolved fractions raises important questions for watershed managers regarding storm water treatment. It was previously thought that metals were associated with particulates and that removing sediment and reducing turbidity would address these pollutants. However, new research indicates that event mean concentrations of dissolved zinc, cadmium, and copper can exceed surface water quality discharge standards and can exhibit a "first flush" effect that cannot be mitigated by settling. In addition, the dissolved nature of these metals makes them highly mobile and bioavailable.

Other pollutants found in highway runoff, along with their likely sources, are shown in Table 7.1. Although runoff characteristics tend to be site-specific, a number of studies have been performed to compile typical concentrations of highway pollutants from a range of different locations from Northhampton, England, to Durham, North Carolina. Table 7.2 shows the range of values for highway contaminants presented by Newberry and Yonge (1996). These concentration levels vary significantly among the different locations. Suspended solids, for example, had concentration levels ranging from 45 mg/L to 798 mg/L; ranges for other parameters were even greater. For some pollutants, such as solids, heavy metals, and organics, concentration levels have been found to correlate with traffic volume.

Table 7.1: Primary sources of highway runoff pollutants (Adapted from NCHRP, 1999).

Pollutants	Primary Source
Particulates	Pavement wear and vehicle maintenance
Lead, cadmium, copper	Tire wear, lubricating oil and grease, bearing wear
Nitrogen, phosphorus	Roadside fertilizer application
Chromium, copper, nickel, cadmium	Metal plating, moving engine parts, brake lining wear
Chloride, sulfates	Deicing salts
PCBs, pesticides	PCB catalyst in synthetic tires, spraying highway rights-of-way
Cyanide	Anti-cake compound used to keep deicing salt granular
Petroleum, ethylene glycol	Spills and leaks of motor lubricants, antifreeze, hydraulic fluids

Table 7.2: Range of average values for runoff contaminant concentration for selected highway contaminants (Newberry and Yonge, 1996).

Contaminant	Concentration (mg/L)	Load (kg/ha/yr)	Load (kg/ha/event)
Suspended solids	45–798	314–11,862	84–107.6
Lead	0.073–1.78	0.08–21.2	0.008–0.22
Phosphorus	0.073–1.78	0.6–8.23	—
Biological oxygen demand	0.113–0.998	30.6–164	0.98
Polycyclic aromatic hydrocarbons	12.7–37	0.005–0.018	—

Runoff from the construction, operation, and maintenance of highways and bridges can adversely affect vegetation, surface waters, and wetlands with a variety of pollutants, including sediments, heavy metals, hydrocarbons, and toxic substances. Runoff issues associated with construction of highways and bridges are addressed in Management Measure 8—Construction Site Erosion, Sediment, and Chemical Control. Although the runoff constituents and concentration levels vary with highway type and location, the sources of highway runoff pollutants fall into three basic categories: vehicle traffic, snowmelt and ice-melt containing deicing chemicals, and chemicals used to manage roadside vegetation.

The specific impacts of highway and bridge runoff on aquatic ecosystems are both site-specific and runoff event-specific. In general, highway pollutants can affect water quality through either acute toxicity or gradual accumulation. Potential adverse environmental effects associated with specific constituents include the following:

- *Suspended solids* increase turbidity, transport other pollutants adhered to particle surfaces, and reduce runoff storage capacity in ponds and lakes.

- *Heavy metals* are toxic to many aquatic organisms and can bioaccumulate in fish tissues, thus posing potential health risks to humans.

- *Nutrients* degrade water quality by stimulating the growth of algae and aquatic weeds. Rapid increases in these populations can then deplete oxygen levels to the extent that fish and other aerobic organisms die off.

- *Biochemical oxygen demand (BOD)* reduces dissolved oxygen levels as a result of the biological processes that break down organic constituents in runoff.

- *PAHs* include compounds such as benzo(a)pyrene that are found in petroleum products and are carcinogenic. These compounds can pose risks to human health if drinking water or fish become contaminated with them. PAHs in streams and lakes usually do not pose a health risk for people because they tend to adhere to sediment particles rather than dissolve in water. As a result, the risk of drinking water degradation is low (Van Metre et al., 2000). Aquatic invertebrates were impacted in the previously identified study from Austin, Texas (Hayward et al., 2002).

Paved roadways often generate higher loads of metals and toxicants than other nonpoint source pollutants[1]. Nutrient loadings from highways tend to be of concern when they are located upstream of a reservoir or estuary.

Winter maintenance activities to prevent ice and snow buildup on highways can also be significant contributors to loadings of particulates, salts, and various other chemicals. Salts in particular can harm both vegetation and aquatic ecosystems. Other highway maintenance activities, including roadside vegetation management, can also contribute herbicides, pesticides, and nutrients to runoff pollutant loads.

In several studies, Sansalone and Glenn (2002a, 2002b, and unpublished) examined the characteristics of snowbanks and snowmelt. Table 7.3 summarizes their findings for several pollutants and physical characteristics. From their research, they concluded the following:

- Traffic and winter maintenance practices generate significant levels of inorganic and organic constituents, many of which become predominantly particulate-bound in the snowbank with increasing residence time.

- The accretion of traffic-generated constituents in urban highway snow is relatively rapid within the first 12 hours of the snowbank's exposure to traffic.

A research team at Oregon State University, under the National Cooperative Highway Research Program (NCHRP, 2000) identified potentially mobile constituents from highway construction and repair materials and measured their potential impact on surface and ground waters. The

[1] Several recent studies cited by the Federal Highway Administration (FHWA) indicate that few significant environmental impacts have been associated with roads with an average daily traffic volume of less than 30,000 vehicles (USDOT, 1996).

materials tested were conventional, recycled, and waste materials; and excluded constituents originating from construction processes, vehicle operation, maintenance operations, and atmospheric deposition. The research team established laboratory methods to realistically simulate the leaching of constituents from construction and repair materials in typical highway environments. They also established methods to evaluate the removal, reduction, and retardation of leached constituents by environmental processes in the highway right-of-way. The team produced extensive data sets of laboratory test results for highway construction and repair materials, and they expressed the results as aquatic toxicity and chemical concentrations. They then developed a software program called IMPACT, which estimates the fate and transport of leachates surrounding the highway right-of-way. IMPACT contains an extensive, readily accessible database of laboratory test results for materials ranging from common construction and repair products to waste and recycled materials proposed for use in highway construction.

Table 7.3: Results of three studies that analyzed chemical and physical parameters of snowmelt (Sansalone and Glenn, 2002a, 2002b, and unpublished).

Parameter	Result
Bulk density	Bulk densities increased as TSS accumulation continued and the snow matrix began to melt or evaporate.
Particle size distribution and bulk density	For all sites, particle sizes ranged from 10,000 µm to less than 25 µm, with a mean bulk density of 1,225 µm.
Specific gravity	Specific gravity of residual solids ranged from 2.5 to 3.2 g/cm^3 across the gradations; the lower specific gravity was associated with particles less than 100 µm.
Chloride and conductivity	Conductivity and chloride concentrations increased rapidly at first because of initial deicing salt applications at each site. Strong correlations indicated that conductivity trends were mainly a function of chloride trends.
Hardness	Hardness increased rapidly to nearly 100 mg/L during initial snow accumulation and remained relatively constant (100–300 mg/L) for most of the study. This increase is likely a result of liquid $CaCl_2$ mixed with rock salt and $CaCO_3$ as part of the TSS captured by the snow matrix.
COD	Temporal trends toward increasing total chemical oxygen demand (COD) exerted by roadway snow are similar to trends in TSS, with COD values of 100,000 mg/L.
TDS and TSS	Although accretion of total dissolved solids (TDS) was initially rapid with a decrease late in the event, total suspended solids (TSS) accretion demonstrated a more gradual increasing trend for the duration of roadway snow, approaching 100,000 mg/L.
Cyanide	Applications of 216,000 kg of rock salt containing cyanide as an anti-caking agent resulted in a discharge of approximately 6 kg of cyanide along the interstate.
Metals	Concentrations for lead, copper, cadmium, zinc, and cyanide were orders of magnitude higher than those of the control site and exceeded storm water runoff concentrations by 1 to 2 orders of magnitude.

Note: TSS = total suspended solids, TDS = total dissolved solids, COD = chemical oxygen demand, $CaCl_2$ = calcium chloride, $CaCO_3$ = calcium carbonate.

7.2.2 Management Measure Selection

This management measure was selected to provide general guidance on practices that can be integrated into highway and bridge maintenance and repair operations. The management measure also includes guidance for siting and constructing highways and bridges. The management measures for watershed protection; site development; new development runoff treatment; and construction site erosion, sediment, and chemical control (Management Measures 3, 4, 5, and 8) are also applicable to the planning and constructing of highways and bridges.

7.3 Management Practices

The use of structural and nonstructural runoff control practices during the planning, design, operation, and maintenance of highways and bridges can significantly mitigate the adverse effects of runoff. Specifically, by using environmentally sensitive highway and bridge designs and implementing proper operation and maintenance practices, highway authorities can reduce both the volume and concentration of contaminants generated by motor vehicle traffic and maintenance and repair operations. In addition, controls can be used to store and treat contaminants so that pollutant loadings can be further reduced or prevented from entering sensitive ecosystems.

7.3.1 Site Planning and Design Practices

A wide range of environmental planning and design management practices, especially those presented in Management Measures 3 and 4, can be used to reduce the environmental impacts of highways and bridges and can be initiated long before a road is completed. In general, highways and bridges should be planned so that mileage through sensitive environments, such as wetlands and estuaries, is minimized. River crossings should be avoided if possible, and sufficient setbacks should be established during construction to minimize disturbance of the surrounding environment. During the siting process, consideration should also be given to maintaining sufficient setbacks for the protection of drinking water sources. Efforts should be taken to avoid channelization and floodplain alteration to allow natural processes to continue after roads are in place.

Highway development is most disruptive adjacent to water bodies, riparian areas, and wetland areas because it increases sediment loss, alters surface drainage patterns, changes the subsurface water table, and results in loss of wetland and riparian habitat. Highway structures should not restrict tidal flows into salt marshes and other coastal wetland areas because such restrictions might facilitate the intrusion of freshwater plants and reduce the growth of salt-tolerant species. To safeguard these fragile areas, highways should be sited with sufficient setback distances between the highway right-of-way and any wetlands or riparian areas.

Bridge construction can also adversely affect water circulation and quality in wetland areas, necessitating special techniques to accommodate construction. By locating highways and bridges away from sensitive areas and establishing buffer zones where possible, environmental degradation from erosion and runoff can be mitigated during construction, operation, and maintenance of roadways.

As discussed previously, roads and highways have been shown to accumulate pollutants that are carried in runoff. Decreasing impervious cover by reducing the area of pavement or number of road miles could lower this pollution potential. However, each individual community should weigh the benefits of alternative road designs against the use of low-impact development techniques or treatment controls (see Management Measures 4 and 5, respectively). Where road surfaces are constructed, disconnecting and infiltrating runoff using structural runoff controls can mitigate impacts of roads and provide sufficient water quality protection.

7.3.2 Soil Bioengineering and Other Runoff Controls for Highways

Soil bioengineering techniques can be used to augment or replace structural slope stabilization practices such as retaining walls. They are appropriate for relatively moderate slopes where vegetation can be established easily. Soil bioengineering techniques can create wildlife habitats and promote infiltration of rainfall and runoff in addition to stabilizing slopes. Installation of bioengineering practices can be labor-intensive, and periodic inspection and maintenance, especially after large storms, is necessary to repair slumps and replace dead vegetation. Soil engineers or scientists should confirm that the stability and structural integrity of the site are appropriate for soil bioengineering practices. Several kinds of soil bioengineering practices are described by the U.S. Department of Agriculture (USDA, 1992):

7.3.2.1 Live stakes

The use of live stakes involves inserting and tamping live, rootable vegetative cuttings into the ground to create a living root mat that stabilizes the soil by reinforcing and binding soil particles together and extracting excess soil moisture. Live stakes are appropriate for repairing small earth slips and slumps caused by excessively wet soil and should be used only at sites with relatively uncomplicated conditions. They are especially useful when construction time is limited and an inexpensive method is desired. They can be used to secure erosion control measures and can be used in combination with other bioengineering techniques. Finally, they facilitate plant colonization by providing a favorable microclimate for plant growth. Native species that are appropriate for the soil conditions onsite should be used wherever possible.

7.3.2.2 Fascines

Fascines are long bundles of branch cuttings bound together into sausage-like structures. They are installed in contoured or angled trenches and are secured to the slope with both live and dead stakes. They reduce surface erosion and rilling, protect slopes from shallow slides, and reduce long slopes into a series of shorter slopes that trap and hold soil. They also enhance vegetative growth by creating a microclimate conducive to plant growth.

7.3.2.3 Brushlayers

Brushlayering is much like the fascine technique except branches are placed perpendicular to the slope contour. This method is more effective than fascines with respect to earth reinforcement and mass stability. Brushlayers break up the slope length, preventing surface erosion, and reinforce the soil with branch stems and roots, providing resistance to sliding or shear displacement. Brushlayers also trap debris, aid infiltration on dry slopes, dry excessively wet sites, and mitigate slope seepage by acting as horizontal drains. Brushlayers facilitate vegetation establishment by providing a stable slope and a favorable microclimate for growth.

7.3.2.4 Branchpacking

Branchpacking involves reinforcing a slope with alternating layers of live branch cuttings and compacted backfill. This technique is useful to repair small, localized slumps and holes in earthen embankments other than dams. Branchpacking produces a filter barrier that reduces erosion and scouring and provides immediate soil reinforcement. Branchpacking is not effective in slump areas more than 4 feet deep or 5 feet wide.

7.3.2.5 Live gully repair

Live gully repair is a technique that is similar to branchpacking but is used to repair rills and gullies. Live gully repairs offer immediate reinforcement and reduce the velocity of concentrated flows. They also provide a filter barrier that reduces further rill and gully erosion. This technique is appropriate only to repair rills or gullies less than 2 feet wide, 1 foot deep, and 15 feet long.

7.3.2.6 Live cribwalls

A live cribwall is a hollow, boxlike structure of interlocking untreated logs or timber members installed with backfill material and layers of live branch cuttings. The live cuttings eventually take over the structural functions of the wall once the roots have become established. Live cribwalls are appropriate for stabilizing the toe of a slope and reducing its steepness. They should not be used in areas that are subject to large lateral stresses. Cribwalls provide both immediate and long-term stabilization and are useful where space is limited. They should be tilted if the system is built on a smoothly sloped surface, or they can be constructed in a stair-step fashion.

7.3.2.7 Vegetated rock gabions

Vegetated rock gabions consist of wire mesh or chain-link baskets layered with live branch cuttings that take root inside the gabions and bind the structure to the slope. These structures are appropriate for stabilizing the toe of a slope and reducing its steepness, especially in areas where space is limited. They should not be used in areas that are subject to large lateral stresses and should not be more than 5 feet tall.

7.3.2.8 Vegetated rock walls

Vegetated rock walls consist of a combination of rocks and live branch cuttings used to stabilize the toe of steep slopes. These structures are appropriate for stabilizing areas where space is limited and natural rock is available. The wall should not exceed 5 feet in height.

7.3.2.9 Joint planting

Joint planting stabilizes slope faces by planting live cuttings in spaces between the stones of riprap. The plantings improve drainage, bind rock materials to the slope, and help prevent washout of fine materials. Joint planting can be used where riprap has already been installed, or it can be part of a new riprap installation.

7.3.2.10 Other runoff and sediment controls for highways

Other runoff controls, such as grassed swales and filter strips, wet ponds, extended detention dry ponds, and storm water wetlands, can be used to control highway runoff. These measures are described in detail in Management Measure 5. Additionally, sediment traps and basins and inlet protection (described in Management Measure 8) can be used to collect runoff from highways, especially during construction and repair operations when pollutant loadings are great.

Highway Management Plans for Storm Water Control

In Delaware County, New York, the Department of Public Works (DPW) is extending its highway runoff management program to include town roads. This involves inventorying and assessing town roads, identifying priority storm water management needs, training highway superintendents, and evaluating and monitoring management practices. The DPW plans to dedicate a storm water/highway engineer to assist towns in prioritizing their highway storm water projects. Funding will be provided through the Catskill Watershed Corporation's Stormwater Retrofit Program and matched with capital planning funds in town highway budgets. The intent of the program is to maximize efficiency by targeting the areas critically in need of redesign, repair, and rebuilding (Delaware County Departments of Planning and Public Works, 2003). For more information, contact the Delaware County Department of Watershed Affairs, (607) 746-8914.

7.3.3 Structural Runoff Controls for Bridges

Highway runoff controls have been extensively documented and implemented. A mitigation strategy specific to bridges is crucial, however, because of the unique limitations associated with bridge building and repair. These limitations include (Transportation Research Board, 2002a):

- A lack of lateral right-of-way on which to build mitigation measures, causing runoff to be drained back onto land;
- Topographic and slope constraints at some bridges that prohibit gravity drainage back to land;
- The need to factor additional weight of storm water piping into the design of a new or retrofitted bridge; and
- The need to address maintenance constraints and safety concerns.

The Transportation Research Board (TRB) (2002b) developed a report that addresses these and other issues specific to bridge runoff. The TRB described a process for assessing sites for the potential for bridge deck runoff to cause water quality problems and for developing mitigation procedures. The process is particularly applicable in the case of large bridge construction or reconstruction projects over sensitive or highly valued receiving waters. It is also applicable in cases where regulations and policies are ambiguous or require reconsideration. This report, *Assessing the Impacts of Bridge Deck Runoff Contaminants in Receiving Waters,* is available from the TRB at http://www.trb.org/.

7.3.3.1 Scupper drains with runoff conveyance systems

Bridges have traditionally been designed to direct runoff away from the roadway as efficiently as possible without regard to impacts on the environment below the deck. While there is a significant body of research on the environmental impacts of highway runoff, there are few studies that directly address the chemical characteristics of runoff from bridge decks, and even fewer that also address the effects of that runoff on biota or other receiving water uses. Several studies have shown that direct scupper drainage into some types of water bodies, such as small lakes, can result in localized increases of metal concentrations in sediments and in aquatic biota. (TRB, 2002a).

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More recently, bridge designs have been enhanced to address the potential effects of runoff pollutant loadings, especially on water bodies. The most prevalent mitigation practice is to direct the drainage from the bridge to an on-shore treatment system. For example, the runoff can be conveyed from scupper drains through a pipe onto the shore, from which it is sent to a retention pond or other runoff treatment practice. A scupper drain is an opening in the floor of a bridge that provides a means for rain or other water accumulated on the roadway surface to drain into the space beneath the structure (ODOT, 2001). Rather than draining directly to the water below, the runoff can be routed to the shore for treatment. The FHWA and EPA have developed recommendations on the design and use of scupper drains to address bridge deck runoff. Among the practices they recommend are:

- The spacing between scuppers should be maximized in accordance with established maximum hydrologic and hydraulic design. As scupper spacing increases, the volume of water that passes through each scupper increases, thus creating velocities high enough to flush outlets clogged by deposits from low-volume rainfalls.
- Careful detailing is critical when connecting scuppers to drain pipes. Because of poorly designed routing, drain pipes often create more problems than they prevent. For example, piping that is routed with too many elbows can easily clog, resulting in a buildup of contaminated runoff.
- Gravity flow collection systems should be used wherever possible.

Collection systems for scupper drains may be used to minimize the impacts of bridge runoff, although they may be expensive. Depending on the length of the bridge and traffic volume, as well as river size and climate, bridge runoff might constitute only a small fraction of the overall pollutant load to a receiving water body. Furthermore, the topography and approach slope at some bridge locations might preclude design or retrofit for gravity drainage back to land, therefore requiring the use of a pump to discharge the runoff into a suitable water quality treatment practice (TRB, 2002a). The addition of pumps could significantly increase the cost of the collection system and operation and maintenance requirements. In some cases, controlling runoff from other pollutant sources may be more cost-effective when a watershed approach is used.

7.3.3.2 Other runoff treatment practices

Runoff treatment practices like ponds, wetlands, infiltration basins and trenches, media filters, bioretention areas, vegetated swales, filter strips, and hydrodynamic devices (see Management Measure 5) can be installed on the shore to treat runoff collected and routed by scupper drains and pipes. If a bridge does not have scupper drains, runoff can be routed to the shore via gutters. Depending on site conditions, such as the space available for the practice, the suitability of the soils for filtration or infiltration, and the quantity and quality of the bridge runoff, some practices may be more cost-effective than others.

7.3.4 Bridge Operation and Maintenance Controls

Bridge repairs are those activities necessary to maintain the structural integrity and designated use of the bridge. Bridge repairs encompass a wide array of activities, ranging from minor operation practices, such as line painting, to major structural repairs. Bridge scraping and painting, which are required to prevent corrosion, can be significant sources of pollutant loads if proper management practices are not used.

Of the most common bridge maintenance activities, bridge painting has the greatest potential for environmental impact. A 1996 study found that up to 80 percent of steel bridges repainted each year had been painted with lead paint, and this material along with cleaners and abrasives, can directly enter the surrounding environment (Young et al., 1996). Paint overspray and solvents can be toxic to aquatic life (Dalton et al., 1985), and metal bridge cleaning has been found to pose a serious water quality problem (TRB, 2002b). The cost of implementing measures to mitigate the impacts of bridge painting are estimated to be an additional 10 to 20 percent for containment and 10 to 15 percent for waste disposal (Young et al, 1996).

Although most construction activities take place away from water bodies, bridge operation and maintenance activities occur within close proximity to a water body. Therefore, management practices to minimize potential adverse effects on the surrounding environment are recommended. It should be noted that, in some cases, federal regulations, including Section 404 of the Clean Water Act and Section 9 of the Rivers and Harbors Act (33 USC 401) might apply to these construction activities. Section 404 regulates the discharge of dredged or fill material to the aquatic environment or the nation's waters. Section 9 of the Rivers and Harbors Act prohibits the construction of any bridge, dam, dike, or causeway over or in navigable waterways without Congressional approval.

7.3.4.1 Enclosures

The following types of enclosures can be used to collect pollutants during bridge maintenance:

(1) *Free-hanging enclosures*. Free-hanging enclosures include tarps, drapes, plastic sheeting, screens, and rigid panels of which only two corners (or one side) are supported. Free-hanging tarps generally provide relatively low containment efficiency (estimated at no more than 50 percent). Considerations for material selection include visibility inside the enclosure, material strength, and air permeability. Free-hanging enclosures are not practical for large, high bridges where high winds can rip the materials or create a "sail effect."

(2) *Total structural enclosures*. Total structural enclosures are drapes, tarps, screens, plastic sheeting, or rigid panels attached to a rigid steel or wood framework, scaffolding, or existing walls. Design considerations include interior air quality, visibility, structural adequacy of the enclosure, portability, and reusability. Enclosures can be used to encapsulate only part of a large structure at a time. Therefore, portability and reusability should be considered.

(3) *Negative pressure systems*. Negative pressure containment systems are used to prevent dust from escaping from an enclosure when pressurized air blasting is used for paint removal. Such systems draw outside air into the enclosure to the surface being treated; the air then exits through a filter system. The resulting continuous air exchange eliminates leaks of paint dust and abrasives to the outside, improves worker visibility, and reduces health hazards and dust accumulation on structural surfaces and equipment. These systems can be cumbersome

and expensive, however, and it is sometimes difficult to maintain a constant negative pressure in the enclosure.

7.3.4.2 Containment and collection

Fully enclosed containment structures have been found to recover 80 to 95 percent of abrasives, paint particles, and dust (Appleman, 1992). The following practices can be used to contain and/or collect pollutants during bridge maintenance activities:

(1) *Cofferdams*. Cofferdams are temporary structures used to displace water and provide dry access to submerged support structures for bridges. Cofferdams can be used during bridge construction and maintenance operations involving painting or repairing of steel structures that are in contact with the water body.

(2) *Barges*. Barges situated below the bridge with tarps or shields attached from the barge to the bridge or work platform can be used for debris capture, although winds often make this practice infeasible.

(3) *Containment booms*. Containment booms can be placed in underlying waters to capture floating debris (e.g., paint chips, fines). Lead particles and abrasives usually sink, but use of booms keeps these materials from spreading downstream while they are suspended in the water column.

(4) *Vacuum sanders*. Vacuum sanders can be used to remove paint from bridges and collect dust and chips. Sanders have been shown to immediately capture 98 percent of the dust generated, which reduces cleanup of containment areas and offers increased safety to maintenance workers (USEPA, 2001).

7.3.5 Nonstructural Runoff Control Practices

The structural management practices for highways and bridge decks described previously are designed to reduce pollutant loadings to the environment by holding and treating the highway runoff generated by precipitation. Nonstructural management practices are designed to achieve source control and can be used to augment on-site structural or other runoff management facilities. Most of the nonstructural practices for managing highway runoff pollution are applicable to virtually all highway situations, even if a specific runoff problem has not been identified.

The following management practices for highway runoff are intended to reduce the volume of particulates available for transport by runoff or to filter and settle out suspended solids. Although the practices described do not represent the complete universe of highway management practices, they are among those commonly implemented across the United States.

7.3.5.1 Implement street sweeping

Curb systems act as traps for particulates and other pollutants. The advantage of well-maintained, traditional curbs is that they trap pollutants on the paved surface, and when combined with regular vacuum street sweeping, they can be effective at removing pollutants prior to mobilization in runoff. However, if they are not properly maintained, pollutants build up and are washed out by storm water.

Street sweeping is a common practice in many communities. Street sweeping programs can be optimized to significantly reduce trash and other pollutants on urban streets. Study results suggest that reductions of up to 80 percent in annual TSS and associated pollutants could be achieved by using bimonthly to weekly sweepings. Sweeping frequency would vary with patterns of precipitation, sediment accumulation, and resuspension. The effectiveness of any street sweeping operation will vary with land use, precipitation, and the accumulation dynamics of contaminated sediments (Sutherland and Jelen, 1997). Table 7.4 shows concentrations of constituents often found in street dirt.

Table 7.4: Street dirt chemical quality (Bannerman et al., 1983; Pitt, 1979; Pitt, 1985; Pitt, 2001).

Constituent	Mass of Constituent in Street Dirt (mg constituent / kg total solids)
Phosphorus	400–1,500
Total Kjeldahl Nitrogen	290–4,300
Chemical Oxygen Demand	65,000–340,000
Copper	110–420
Lead	530–7,500
Zinc	260–1,200
Cadmium	<3–5
Chromium	31–180

Sweeping technology can have a profound effect on sweeping results. Previously, sweepers were unable to pickup very fine sediments that can be highly contaminated. One study found that the effectiveness of conventional street sweeping equipment ranged from a 35 percent removal of large particles to an increase in the loading of small particles by 10 percent. The equipment performed more efficiently on a smooth asphalt street, showing a 12 percent reduction in small particles (Pitt, 2001). Today, new street sweeping technology has proven to be an effective management practice for reducing pollutant loads to waterways. High-efficiency pavement sweepers are thought to be very effective at picking up a large portion of the very fine particulate material that accumulates on street surfaces. A high-efficiency sweeper uses strong vacuums and the mechanical action of brooms, combined with an air filtration system that returns only clean air to the atmosphere. Minton et al. (1998) found that simulated results for high-efficiency sweepers in residential areas reduced annual TSS wash-off by 51 to 87 percent. Other sweepers reduced annual TSS in these same areas by up to 71 percent. When sweeping in major arterials with high pollutant loads, simulated results indicated that annual TSS wash-off was reduced by 49 to 85 percent. Other tested sweepers reduced annual TSS wash-off in major arterials by up to 24 percent (Minton et al., 1998). When a high-efficiency sweeper was tested in a tandem sweep behind a mechanical broom sweeper, it was able to pick up 141 percent more material than the mechanical broom sweeper (Schwarze Industries, 2004). When the high-efficiency sweeper swept directly after a regenerative air sweeper, it was able to pick up 44 percent additional material.

High-efficiency sweepers were also compared to wet detention vaults (see Section 5.3.1.1; Sutherland et al., 1998). Simulated results indicate that high-efficiency sweepers removed 40 to 75 percent of annual TSS, while wet detention vaults removed 75 to 91 percent. All removal efficiency ranges depended on sweeping frequency. These projected water quality benefits of high-efficiency street sweeping are based on modeling.

7.3.5.2 Consider alternatives to curbs

As a design alternative, eliminating curbs from roads and highways allows runoff to be filtered through vegetated shoulders or medians and infiltrate to the ground water. Where curbs are necessary for traffic control or other reasons, curb breaks can be incorporated to disconnect the impervious surface and direct runoff to pervious areas. This may not be feasible for streets with high traffic volume and/or on-street parking demand. The structural integrity of the pavement can be maintained by "hardening" the interface between the swale and the pavement with grass pavers, geo-synthetics, or a low-rising concrete strip along the pavement edge. Maintenance requirements for grass channels are generally comparable to those of curb and gutter systems and involve turf mowing, debris removal, and periodic inspections.

7.3.5.3 Install catch basin inserts

Catch basin inserts can be used to treat pollutants in runoff from curbs and road surfaces before entering the storm drain system. These devices are discussed in detail in Management Measure 5 (section 5.3.5.4).

7.3.5.4 Control litter and debris on roadsides

Roadside litter control practices that have traditionally been implemented to address health and aesthetic concerns can also improve runoff quality by limiting trash in runoff conveyance and treatment systems and receiving water bodies. An effective litter and debris control program should include the following source controls:

- Conducting regular trash and debris removal and disposal;
- Educating the public with signs along roads and at rest areas;
- Enforcing littering and illegal dumping laws;
- Sealing cracks and applying pothole surface treatments that minimize the loosening of aggregate and road base debris by tires; and
- Sponsoring Adopt-A-Highway or Adopt-A-Road programs. Many state highway administrations or departments of transportation sponsor Adopt-A-Highway programs that allow businesses and community groups to conduct litter removal and beautification activities on state-owned roads. The city and county equivalent is called Adopt-A-Road.

7.3.5.5 Manage pesticide and herbicide use

Over-application of pesticides and herbicides may cause excess chemicals to leach to ground waters or flow into surface waters. Herbicides and pesticides have the same toxic effect on aquatic plants and organisms as they do on the terrestrial plants and organisms to which they were applied. Practices such as applying according to label instructions, applying at the proper time, applying only the types and amounts necessary, and considering the environmental conditions and hazards at the site are important ways to prevent pesticides and herbicides from entering water bodies. Pesticides, herbicides, and integrated pest management are discussed at length in Management Measure 9 (section 9.3.2).

7.3.5.6 Reduce fertilizer use

Improper application of fertilizers along roadsides can result in excess nutrients being transported to surface waters or leaching to ground water. Methods to reduce fertilizer use are presented in detail in Management Measure 9 (section 9.3.2).

7.3.5.7 Reduce direct discharges

Direct discharges of highway runoff to receiving waters should be avoided wherever possible. This involves the use of collection/conveyance through closed conduits. Highway runoff should be routed through one or a combination of runoff treatment practices, as described in Management Measure 5, before it is discharged to receiving waters.

7.3.5.8 Practice dewatering

Dewatering is a temporary method used to filter sediment-laden water from excavated areas on construction sites prior to discharge to a storm drain or surface waters. Dewatering pumps are applicable wherever sediment-laden water must be removed from a construction site. Dewatering practices should be considered a last-resort control measure. Adequate erosion and sediment control measures must be considered first.

7.3.5.9 Practice spill prevention and control

Prevention and control of spills eliminates or minimizes the discharge of pollutants to water bodies. Water bodies adjacent to construction sites are at highest risk of contamination from an uncontained spill. Several steps can be taken to reduce the risks: handle hazardous and nonhazardous materials, such as concrete, solvents, asphalt, sealants, and fuels, as infrequently as possible and observe all federal, state, and local regulations when using, handling, or disposing of these materials. Spill control devices such as absorbent snakes and mats should be placed around chemical storage areas, and they can be used in an emergency to contain a spill.

7.3.5.10 Properly handle and dispose of concrete and cement

Concrete and cement-related mortars can be toxic to aquatic life. Proper handling and disposal should minimize or eliminate discharges into watercourses. Fresh concrete and cement mortar should not be mixed on-site, and both dry and wet materials should be stored away from water bodies and storm drains. These materials should be covered and contained to prevent contact with rainfall or runoff. Washout should not be discharged into streets, storm drains, drainage ditches, or watercourses. A washout area should be designated, and wash water should be treated on-site or discharged to the sanitary sewer.

7.3.5.11 Manage contaminated soil and water

Soil, ponded runoff, and ground water can become contaminated if exposed to hazardous materials and should be properly managed to prevent health hazards and minimize or eliminate discharge of pollutants to storm drains and watercourses. Excavation, transport, and disposal of contaminated soil and water, as well as hazardous waste, must be in accordance with the rules and regulations of EPA, the U.S. Department of Transportation, the Department of Toxic Substances Control, and state and local regulatory agencies.

7.3.5.12 Practice environmentally friendly winter road maintenance

Some of the most damaging runoff can be generated from the melting of snow or ice that has been treated with salts or other chemicals. For example, the buildup of salts along roadsides over the course of a winter can damage and reduce the effectiveness of structural controls such as vegetative filter strips and grass-lined channels. Salts in surface or ground waters can adversely affect water quality and damage wetlands. The corrosive effects of salts also damage road infrastructure, especially bridge decks. According to TRB (1991), road salt has caused more premature bridge deck deterioration than any other factor.

Deicing chemicals deposited on road surfaces can contaminate runoff, as can chemicals that are stored in a manner that puts them in contact with precipitation or runoff. Plowed snow piled in parking lots and along roadsides often contains pollutants such as chlorides, sand, and grit, as well as hydrocarbons and heavy metals. These piles should not be deposited into water bodies or stored near water bodies. Treated snow should never be stored on a frozen pond surface because it can cause density stratification, which can prevent reoxygenation in addition to chloride problems.

Three general types of management practices can be employed to reduce the impact of salt damage on the environment. The first is to implement anti-icing operations that help reduce the amount of chemicals required to maintain safe road conditions; the second is to use alternative deicing materials, which are less corrosive and are presumably less damaging to the environment. The third is to properly store salts or other deicing chemicals to prevent runoff contamination.

(1) *Anti-icing operations*. Anti-icing operations are performed before a storm starts. The purpose of these operations is to prevent snow or ice from accumulating on road surfaces. One of the main advantages of successful anti-icing strategies is reducing the amount of chemicals and abrasives used to keep roads clear. Since 1994, 15 states have participated in the FHWA's project to test and evaluate the effectiveness of anti-icing operations. Anti-icing operations typically use the same chemicals used for deicing, but in different forms. For example, test results found that pre-wetting deicing salt and using brine solutions are effective approaches and result in fewer handling problems.

The ultimate success of anti-icing operations depends on the timing of application. Central to this approach is the use of Roadway Weather Information Systems (RWIS), which report road conditions through pavement sensors that monitor pavement temperatures and the amount of anti-icing materials present on the pavement. When this information is combined with meteorological data and fed into a central database, various modeling techniques can be applied to accurately predict the start of ice formation on pavements and the appropriate times to start anti-icing operations. The cost of implementing and maintaining an RWIS must be compared to the cost of labor and materials for deicing and snow removal. For example, the West Virginia Parkway Authority installed four RWIS units along a 95-mile stretch of highway and calculated that the agency was able to save sufficient outlays for materials and labor to pay for the system within a year. In a state with fewer snowstorms, however, the economics of installing an RWIS may be less advantageous.

Another technology option is the installation of infrared sensors on the bottoms of snowplows. These sensors measure the actual temperature of the roadway as the truck passes over it, allowing a more accurate calculation of the amount of salt needed. As part of its "smart salting" program, the Vermont Department of Transportation installed trial sensors on the bottoms of four snowplows. The agency estimates that it was using 20 to 30 percent more salt than needed because of inaccurate temperature readings. The program has currently been expanded statewide, where the average reduction in salt usage is 28 percent, resulting in an approximate savings of $2.2 million (Lehner et al., 1999).

(2) *Alternative deicers*. Over the years, the FHWA and numerous states have experimented with alternative deicing chemicals, including liquid calcium magnesium acetate (CMA), liquid calcium chloride, liquid magnesium chloride, and liquid potassium acetate. Research has found that these chemicals have both advantages and disadvantages compared to salt (see Table 7.5). Calcium chloride works better at lower temperatures but is also corrosive. CMA appears to be much less harmful to the environment. Its disadvantage is that it is significantly more expensive than salt; the NRC estimated that CMA can cost 20 times more than salt and would increase the total cost of chemical application five-fold (Chollar, 1996). CMA is also less successful than other salts at lower temperatures and is slower to act than salt.

Table 7.5: Advantages and disadvantages of road salt and alternative deicing chemicals.

Type	Advantages	Disadvantages
Road salt	– Low cost ($30-40/ton) – Readily available	– Impact on the environment – Corrosiveness
Alternative deicing chemicals	– Reduced corrosivity – Reduced impact on the environment – $CaCl_2$ can be used in very low temperatures (-20°F)	– Higher cost (from several hundred dollars per ton to several thousand per ton) – CMA starts to act at a slower rate than salt

In general, alternatives to road salt are still being researched and tested throughout the Midwest and Northeast, but overall costs tend to be higher for these products. Less environmentally damaging products such as CMA, however, can be used selectively to protect sensitive areas like wetlands without dramatically increasing overall cost to the highway authority.

(3) *Proper storage of deicing chemicals.* Placing deicing chemicals in storage buildings minimizes the likelihood of polluting surface and ground waters with contaminated runoff and eliminates the economic loss from chemicals that are dissolved and washed away by precipitation. A permanent under-roof storage facility is the best way to protect chemicals from precipitation and runoff, but where this is not possible, salt piles and chemical containers should be stored on impermeable bituminous pads and covered with a tarp or other waterproof cover.

7.4 Information Resources

The U.S. Geological Survey (USGS) and the Federal Highway Administration (FHWA) developed an online searchable bibliography of more than 2,600 pertinent references to be published in the catalog of available information that is being collected to characterize pollutant loadings and impacts attributable to highway storm water runoff. The catalog includes reports on highway-runoff water quality, urban/storm water issues, atmospheric deposition, and highway/urban runoff management practices from the USGS, FHWA, EPA, and state transportation agencies. The database can be accessed at http://ma.water.usgs.gov/fhwa/biblio/default.htm.

The Local Technical Assistance Program Web site hosts a "Rural Roads Resources" page that includes a compendium of Web sites, manuals, videos, and other media pertaining to road design and maintenance. The site also hosts an email listserver pertaining to rural roads issues. The Local Technical Assistance Program Resources can be accessed at http://www.ltapt2.org/ by clicking "Resources."

The California Regional Water Quality Control Board produced *the Erosion and Sediment Control Field Manual* for the San Francisco Region in 1998. The document is available for a fee using an order form found at http://www.swrcb.ca.gov/stormwtr/orderform.html.

The FHWA published a study by Dorman et al. (1996) called *Detention and Overland Flow for Pollutant Removal from Highway Stormwater Runoff*, which provides guidelines for the design of management measures for the removal of pollutants from highway storm water runoff. The guidelines are based on the results of field and laboratory studies to verify design procedures and assumptions and the review of other studies. For a copy of this document, contact FHWA's Office of the Natural Environment by sending an email to environment@fhwa.dot.gov.

Fisheries and Oceans Canada published *Protecting Fish and Fish Habitat: Bridge Construction and Demolition*, a fact sheet that details the hazards to aquatic life of bridge construction and demolition and recommends practices to reduce environmental damage. This document is available at http://www.dfo-mpo.gc.ca/canwaters-eauxcan/infocentre/guidelines-conseils/factsheets-feuillets/nfld/fact18_e.asp.

In 1992, Northern Virginia Planning District Commission and Engineers Surveyors Institute produced the *Northern Virginia BMP Handbook: A Guide to Planning and Designing Best Management Practices in Northern Virginia*. This handbook is available for download at http://www.novaregion.org/pdf/NVBMP-Handbook.pdf.

The Staff Transportation Board of the National Research Council produced a primer for a study entitled *Environmental Impact of Construction and Repair Materials on Surface and Ground Waters*. It is written in nontechnical language and explains how the test methods and supporting computer software can provide answers to questions about the environmental impact of new construction or the repair or rehabilitation of existing highways (NCHRP, 2000). Published reports from NCHRP are available from http://www.trb.org.

The Transportation Research Board (TRB) published several studies that investigate the environmental impacts of activities related to transportation infrastructure. These publications are available at http://www4.trb.org/trb/onlinepubs.nsf. For example, the National Cooperative Highway Research Program developed a synthesis of information on environmental management practices for highway and street maintenance. This report, entitled *Best Management Practices for Environmental Issues Related to Highway and Street Maintenance*, is available in hard copy from the Transportation Research Board's bookstore (http://trb.org/bookstore/) for $30. Other titles include *Highway Deicing: Comparing Salt and Calcium Magnesium Acetate* (available electronically at http://trb.org/publications/sr/sr235.html or for $22 from the online bookstore); *Assessing the Impacts of Bridge Deck Runoff Contaminants in Receiving Waters—Volume 1:Final Report*, available electronically at http://gulliver.trb.org/publications/nchrp/nchrp_rpt_474v1.pdf, and *Assessing the Impacts of Bridge Deck Runoff Contaminants in Receiving Waters—Volume 2: Practitioner's Handbook*, available at http://gulliver.trb.org/publications/nchrp/nchrp_rpt_474v2.pdf. Publications pending as of spring 2005 include *Guidelines for the Selection of Snow and Ice Control Materials To Mitigate Environmental Impacts* (NCHRP Project 6-16) and *Winter Highway Operations* (NCHRP topic 34-10), which reports on advances and new practices since TRB's last guide for snow and ice control. Both publications will be available at http://www.trb.org.

The TRB's *Environmental Stewardship Practices, Procedures, and Policies for Highway Construction and Maintenance* (NCHRP 25-25(04)) includes numerous management practices in highway construction and maintenance. The guidance was developed from the literature, state transportation agency manuals and procedures, and the contributions of state departments of transportation and practitioners. The document serves as a guide to the development of environmental management systems and environmental strategic plans, both at the organizational level and in specific functional areas such as road construction, vegetation management, materials recycling, winter road maintenance, and many other topics. The document can be downloaded in PDF format from http://www4.trb.org/trb/crp.nsf/reference/boilerplate/Attachments/$file/25-25(4)_FR.pdf.

TRB's *Evaluation of Best Management Practices and Low Impact Development for Highway Runoff Control*, expected to be published in late 2004, includes a users' guide for management practice selection, a design manual, and monitoring guidelines to evaluate and optimize the control of runoff from highways. Visit http://www.trb.org, and enter "NCHRP 25-20" into the search field to access the report.

The Natural Resources Conservation Service (1992) published *Soil Bioengineering for Upland Slope Protection and Erosion Reduction,* which provides specifications for installing bioengineering practices to reinforce slopes and prevent erosion. This document is available for download at http://www.info.usda.gov/CED/ftp/CED/EFH-Ch18.pdf.

The U.S. Department of Transportation's (1995) *Best Management Practices for Erosion and Sediment Control* can be downloaded from the DOT's online publications site at http://isddc.dot.gov/.

The FHWA (1996) published the *Manual of Practice for an Effective Anti-Icing Program: A Guide For Highway Winter Maintenance Personnel*, which can guide maintenance personnel in developing a systematic and efficient practice for maintaining roads in the best condition possible during a winter storm. It describes the factors that should be understood and addressed in an anti-icing program, with the recognition that development of a program must be based on the specific needs of the site or region. It focuses on weather information and materials and methods that will best address site conditions such as level of service, highway agency resources, climatological conditions, and traffic. The manual can be downloaded in HTML format from http://www.fhwa.dot.gov/reports/mopeap/mop0296a.htm.

The Michigan Department of Transportation (1993) conducted a detailed study on the environmental effects and costs of using several deicing products, including salt, calcium magnesium acetate, an agricultural byproduct, a magnesium chloride product, calcium chloride, a type of concrete pavement, and sand. The study can be accessed at http://www.michigan.gov/documents/toc-deice_51451_7.pdf. More information on alternative deicers can be found at http://www.betterroads.com/articles/prod801.htm, http://www.forester.net/sw_0106_deicing.html, and http://www.wsdot.wa.gov/partners/pns/htm/resources.htm.

The Pacific Northwest Snowfighters Association Web site (http://www.wsdot.wa.gov/partners/pns/) provides resources pertaining to deicing and anti-icing products and practices, such as a list of approved products, deicing specifications, a fact sheet on magnesium chloride, and testing methods and protocols for deicing products (Washington State Department of Transportation, 2002).

Funded by EPA, the Composting Council Research and Education Foundation (CCREF), in conjunction with the United States Composting Council (USCC), developed *Compost Use on State Highway Applications* to promote compost use on state and local roadside applications. Its goal is to provide individuals and organizations—namely, roads and highways staff, policy makers, product specifiers, project designers and engineers, environmental officers, landscapers, and other interested parties—involved in the maintenance and management of roadsides and highways, with the tools necessary to use composted products to meet their specific project requirements. The document is available for download in PDF format at http://www.epa.gov/epaoswer/non-hw/compost/highway/.

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MANAGEMENT MEASURE 8 CONSTRUCTION SITE EROSION, SEDIMENT, AND CHEMICAL CONTROL

8.1 Management Measure

Plan, design, and operate construction site land disturbance activities such that:

- An approved erosion and sediment control plan or similar administrative document that contains erosion and sediment control provisions is prepared and implemented prior to land disturbance.
- Erosion is reduced and, to the extent practicable, sediment is retained on-site during and after construction.
- Good housekeeping practices are used to prevent off-site transport of waste material and chemicals.
- The application and generation of pollutants, including chemicals are minimized.

8.2 Management Measure Description and Selection

8.2.1 Description

This management measure is intended to reduce the amount of sediment generated from construction sites (erosion control) and reduce the off-site transport of sediment and construction-related chemicals (sediment and chemical control). This measure is intended to work in concert with the Watershed Protection, New Development Runoff Treatment, and Site Development Management Measures in a comprehensive watershed management program framework.

Several pollutants of concern are associated with construction activities, including the following: sediment; pesticides; fertilizers used for vegetative stabilization; petrochemicals (oils, gasoline, and asphalt degreasers); construction chemicals such as concrete products, sealers, and paints; wash water associated with these products; paper; wood; garbage; and sanitary waste (Washington State Department of Ecology, 1991).

The variety of pollutants present at a site and the severity of their effects are dependent on a number of factors:

- *The nature of the construction activity.* During the clearing and grading stage, sediment is likely to be the primary pollutant of concern since few other materials are present, whereas during the building phase, concrete wash, paints, varnishes, stucco, and other materials are being used on a daily basis, increasing the likelihood of spills.

- *The physical characteristics of the construction site.* Most pollutants generated at construction sites are carried to surface waters by runoff. Therefore, the factors that affect runoff volume, such as the amount, intensity, and frequency of rainfall; soil infiltration rates; surface roughness; slope length and steepness; and size of the denuded area, also affect pollutant loadings.

- *The proximity of surface waters to the nonpoint pollutant source.* As the distance separating pollutant-generating activities from surface waters decreases, the likelihood of water quality impacts increases.

The following section is an expanded discussion of the pollutants of concern that can be generated by and released from construction activities.

8.2.1.1 Sediment

Runoff from construction sites is by far the largest source of sediment in urban areas under development. Soil erosion removes more than 90 percent of sediment by weight in urbanizing areas where most construction activities occur (Canning, 1988). Table 8.1 illustrates some of the sediment loading rates associated with construction activities across the United States. As shown in Table 8.1, erosion rates from natural areas such as undisturbed forested lands are typically less than 1 ton/acre/year, whereas erosion from construction sites ranges from 7.2 to 500 tons/acre/year.

Loss of sediment can cause impacts both on and off the construction site. On-site loss of soil reduces or eliminates the remaining soil's ability to provide nutrients, regulate water flow, and protect plants. Losses of nutrients and nutrient-holding capacity result in a less-fertile environment for lawns and plants. Lost organic matter also results in increased soil density and compaction, which can reduce the available water-holding capacity on-site. These reductions result in poorer plant growth and reduced infiltration of fertilizers and pesticides, which can contribute to the transport of these chemicals by runoff into nearby lakes and streams. Finally, organic matter is a food source and habitat for beneficial microorganisms and invertebrates. If organic matter is lost due to erosion, the soil's natural ability to combat outbreaks of pests and diseases is reduced (SQI, 2000).

Eroded sediment from construction sites causes many problems in coastal areas, including adverse impacts on water quality, critical habitats, submerged aquatic vegetation beds, recreational activities, and navigation (APWA, 1991). Water quality impacts include unwanted biological growth caused by excess nitrogen and phosphorus, and increased turbidity. Eroded sediment can also build up in stream channels and lower flow capacity, resulting in more frequent flooding in areas that never flooded or rarely flooded in the past. Reducing the incidence of flooding can also be beneficial in alleviating the financial burden of cleaning up sediment-damaged areas (SQI, 2000). Excessive erosion and sedimentation also can reduce the capacity of reservoirs.

Table 8.1: Erosion and sediment associated with construction (USEPA, 1993).

Location	Problem	Reference
Franklin County, Florida	Sediment yield (ton/ac/yr): Forest < 0.5 Rangeland < 0.5 Tilled 1.4 Construction site 30 Established urban < 0.5	Franklin County, Florida, 1987
Wisconsin	Erosion rates range from 30 to 200 ton/ac/yr (10 to 20 times those of cropland).	Wisconsin Legislative Council, 1991
Washington, DC	Erosion rates range from 35 to 45 ton/ac/yr (10 to 100 times greater than agriculture and stabilized urban land uses).	MWCOG, 1987
Anacostia River Basin, Maryland and Washington, DC	Sediment yields from portions of the Anacostia Basin have been estimated at 75,000 to 132,000 ton/yr. Total basin acreage = 112,640 acres.	U.S. Army Corps of Engineers, 1990
Anacostia River Basin, Maryland and Washington, DC	Erosion rates range from 7.2 to 100.8 ton/ac/yr. Total basin acreage = 112,640 acres.	USGS, 1978
Washington	Erosion rates range from 50 to 500 ton/ac/yr. Natural erosion rates from forests or well-sodded prairies are 0.01 to 1.0 ton/ac/yr.	Washington State Department of Ecology, 1989
Alabama North Carolina Louisiana Oklahoma Georgia Texas Tennessee Pennsylvania Ohio Kentucky	1.4 million tons eroded per year. 6.7 million tons eroded per year. 5.1 million tons eroded per year. 4.2 million tons eroded per year. 3.8 million tons eroded per year. 3.5 million tons eroded per year. 3.3 million tons eroded per year. 3.1 million tons eroded per year. 3.0 million tons eroded per year. 3.0 million tons eroded per year.	Woodward Clyde, 1991

8.2.1.2 Pesticides

Insecticides, rodenticides, and herbicides are used on construction sites to improve human health conditions, reduce maintenance and fire hazards, and curb the growth of weeds and woody plants. Common pesticides employed include synthetic, relatively water-insoluble chlorinated hydrocarbons, organophosphates, carbamates, and pyrethrins. Over-application of pesticides on

Soil Erosion from Two Small Construction Sites in Dane County, Wisconsin

Most construction regulations require sites with more than 5 acres disturbed to have some type of erosion control plan. Sites that are less than 5 acres typically require minimal erosion control measures. To evaluate the significance of erosion on sites less than 5 acres as a source of sediment to surface waters, two small construction sites (less than 5 acres each) in Dane County, Wisconsin, were studied (USGS, 2000).

Results indicate that small construction sites are potential sources of high amounts of erosion and that sediment loads from the active construction phase are significantly higher than those during the preconstruction and postconstruction periods. These sediment loads were dramatically reduced when mulching and seeding were used to control erosion. The results of this study support the need for erosion control plans for small construction sites.

revegetated areas can lead to contamination of soils and subsequent contamination of surface water and ground water. The use of pesticides is controlled by federal or state regulations, such as the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) of 1996.

8.2.1.3 Petroleum products

Petroleum products used during construction include fuels and lubricants for vehicles, power tools, and general equipment maintenance. Specific petroleum pollutants include gasoline, diesel oil, kerosene, lubricating oils, and grease. Asphalt paving can be particularly harmful because it releases various oils after application until fully cured (NCHRP, 2000).

8.2.1.4 Fertilizers

Fertilizers are used on construction sites when revegetating graded or disturbed areas. Fertilizers contain nitrogen and phosphorus, which in large doses can adversely affect surface water quality, causing eutrophication.

8.2.1.5 Solid wastes

Trees and shrubs removed during land clearing contribute to the load of solid wastes generated during construction activities. Other common wastes are wood and paper from packaging and building materials, scrap metals, sanitary wastes, rubber, plastic and glass, and masonry and asphalt products. Improper disposal of food containers, paint canisters, cigarette packages, leftover food, and aluminum foil also contributes solid wastes to the construction site.

8.2.1.6 Construction chemicals

There are many sources of chemicals at construction sites. For example, chemicals such as paints, acids for cleaning masonry surfaces, cleaning solvents, asphalt products, soil additives used for stabilization, and concrete-curing compounds are used on construction sites and can be carried off in runoff. Other pollutants, such as wash water from concrete mixers, acid and alkaline solutions from exposed soil or rock, and alkaline-forming natural elements, can also be present and contribute to nonpoint source pollution. Improperly stored construction materials, such as creosote- or pressure-treated lumber or solvents, can lead to leaching of pollutants to surface water and ground water. People disposing of construction chemicals should follow all applicable state and local laws. Some chemicals may need to be disposed of by a licensed waste management firm.

Improper fueling and servicing of vehicles can lead to dumping of significant quantities of petroleum products onto the ground. These pollutants can then be washed off the site in urban runoff, even when proper erosion and sediment controls are in place. Pollutants carried in solution in runoff or attached to sediments may not be adequately controlled by erosion and sediment control practices (Washington Department of Ecology, 1991). Oils, waxes, and water-insoluble pesticides can form surface films on water and solid particles. Oil films can also concentrate water-soluble insecticides. Once present in runoff, these pollutants can be nearly impossible to control other than by the use of very costly water treatment facilities (Washington Department of Ecology, 1991).

In addition to spill prevention, one of the best methods to control petroleum pollutants is to retain the sediments that have come into contact with these chemicals through use of erosion and sediment control practices. Improved maintenance and storage facilities reduce the chance of contaminating a construction site. One of the greatest concerns related to the use of petroleum products is the method for waste disposal. Dumping petroleum product wastes into sewers and other drainage channels is illegal and could result in fines or site closure.

8.2.1.7 Contaminated soils

Contaminated soils can be encountered during excavation activities that uncover previously known or unknown site contamination. New contamination also can result from a spill or leak of a hazardous material used at the construction site (e.g., a release from a material or waste storage area). If previously unknown contamination is encountered, its nature should be determined. Sampling and analysis will be required to determine what types of contaminants are present and, therefore, how the contaminated soil needs to be handled.

8.2.2 Management Measure Selection

This management measure was selected to reduce sediment mobilization and transport off of the construction site area. This management measure was selected because construction activities have the potential to increased loadings of toxic substances and nutrients in water bodies. Various states and local governments regulate the control of sediment and chemicals on construction sites through spill prevention plans, erosion and sediment control plans, or other administrative devices. The practices provided herein are commonly used and well-described in handbooks and guidance manuals, and they have been shown to be both economical and effective.

The measures were selected for the following reasons:

- Setting numeric load reduction goals for construction site pollutant loadings is generally not practical; sediment and other pollutant loadings from exposed areas vary greatly, and some sediment loss is usually inevitable.

- Erosion and sediment control plans (ESCs) and specifications are required by many state and local governments to accomplish the performance goals for this measure. These ESC plans contain specifications and designs for the proper selection and placement of ESC practices. These practices have been proven to be effective when implemented at construction sites.

- Current procedure typically relies on a set of practices selected based on site-specific conditions.

- The combined effectiveness of erosion and sediment controls in systems is not easily quantified.

- An ESC plan is necessary to provide details regarding the selection, use, inspection, and maintenance of management practices to ensure they are effective in controlling erosion and preventing off-site discharges of sediment.

Eugene, Oregon's goals for erosion and sediment control on construction sites

The City of Eugene, Oregon, requires that, to the maximum extent feasible, management practices that meet a specified set of outcomes be employed at construction sites, including the following (NRDC, 1999):

- No deposit or discharge of sediment onto adjacent properties or into waterbodies.
- No degradation of waterbodies due to the removal of vegetation.
- No discharge or runoff containing construction-related contaminants into the city's runoff conveyance system or related natural resources.
- No deposit of construction-related material exceeding 0.5 cubic foot for every 1,000 square feet of lot size onto public rights-of-way and private streets and into the city's runoff conveyance system and related natural resources.

8.3 Management Practices

8.3.1 Erosion and Sediment Control Programs

8.3.1.1 Prepare erosion and sediment control plans

In many municipalities, erosion and sediment control plans are required under ordinances enacted to protect water resources (Table 8.2). These plans describe how a contractor or developer will reduce soil erosion and contain and treat runoff that is carrying eroded sediments. Plans typically include descriptions and locations of soil stabilization practices, perimeter controls, and runoff treatment facilities that will be installed and maintained before and during construction activities. In addition to special area considerations, the full ESC plan review inventory should include:

- Topographic and vicinity maps
- Site development plan
- Construction schedule
- Erosion and sedimentation control plan drawings
- Detailed drawings and specifications for practices
- Design calculations
- Vegetation plan

Table 8.2: ESC plan requirement for selected states (Adapted from USEPA, 1993; Environmental Law Institute, 1998).

State	General Requirements for ESC Plan
Delaware	ESC plans required for sites over 5,000 ft^2. Temporary or permanent stabilization must occur with 14 days of disturbance.
Florida	ESC plans required on all sites that need a runoff management permit.
Georgia	ESC plan required for all land-disturbing activities.
Indiana	ESC plan required for sites over 5 acres.
Maine	ESC plans required for sites adjacent to a wetland or water body. Stabilization must occur at completion or if no construction activity is to occur for seven days. If temporary stabilization is used, permanent stabilization must be implemented within 30 days.
Maryland	ESC plans required for sites over 5,000 ft^2 or 100 yd^3.
Michigan	ESC plans required for sites over 1 acre or within 500 ft of a water body. Permanent stabilization must occur within 15 days of final grading. Temporary stabilization is required within 30 days if construction ceases.
Minnesota	ESC plans required for land development over 1 acre.
New Jersey	ESC plans required for sites over 5,000 ft^2.
North Carolina	ESC plans required for sites over 1 acre. Controls must retain sediment on-site. Stabilization must occur within 30 days of completion of any phase of development.
Ohio	ESC plans required for sites over 5 acres. Permanent stabilization must occur within seven days of final grading or when there is no construction activity for 45 days.
Oklahoma	ESC plans required for sites over 5 acres.
Pennsylvania	All earth disturbance activities require implementation and maintenance of ESC practices to minimize the potential for accelerated erosion and sedimentation. Written ESC plans are required for all earth disturbance activities 5,000 square feet or greater. Upon completion of an earth disturbance activity or any stage or phase of an activity, the site shall be immediately seeded, mulched, or otherwise protected from accelerated erosion and sedimentation.
South Carolina	ESC plans required for all sites unless specifically exempted. Perimeter controls must be installed. Temporary or permanent stabilization is required for topsoil stockpiles and all other areas within seven days of disturbance.
Virginia	For areas within the jurisdiction of the Chesapeake Bay Preservation Act, no more land is to be disturbed than necessary for the project. Indigenous vegetation must be preserved to the greatest extent possible.
Washington	ESC provisions are incorporated into the state runoff management plan.
Wisconsin	ESC plans required for all sites over 4,000 ft^3. Temporary or permanent stabilization is required within seven days.

Brown and Caraco (1997) identified several general objectives that should be addressed in an effective ESC plan:

- *Minimize clearing and grading*. Clearing and grading should occur only where absolutely necessary to build and provide access to structures and infrastructure. This approach reduces earth-working and ESC control costs by as much as $5,000 per acre (Schueler, 1995). Clearing should be done immediately before construction, rather than leaving soils exposed for months or years (SQI, 2000).

- *Protect waterways and stabilize drainageways*. All natural waterways within a development site should be clearly identified before construction activities begin. Clearing should generally be prohibited in or adjacent to waterways. Sediment control practices such as check dams may be needed to stabilize drainageways and retain sediment on-site.

- *Phase construction to limit soil exposure.* Construction phasing is a process by which only a portion of the site is disturbed at any one time to complete the needed building in that phase. Other portions of the site are not cleared and graded until exposed soils from the earlier phase have been stabilized and the construction is nearly completed.

- *Stabilize exposed soils immediately.* Seeding or other stabilization practices should occur as soon as possible after grading. In colder climates, a mulch cover is needed to stabilize the soil during the winter months when grass does not grow or grows poorly.

- *Protect steep slopes and cuts.* Wherever possible, clearing and grading of existing steep slopes should be completely avoided. If clearing cannot be avoided, practices should be implemented to prevent runoff from flowing down slopes.

- *Install perimeter controls to filter sediments.* Perimeter controls are used to retain sediment-laden runoff or filter it before it exits the site. The two most common perimeter control options are silt fences and earthen dikes or diversions.

- *Employ advanced sediment-settling controls.* Traditional sediment basins are limited in their ability to trap sediments because fine-grained particles tend to remain suspended and the design of the basins themselves is often simplistic. Sediment basins can be designed to improve trapping efficiency through the use of perforated risers; better internal geometry; the installation of baffles, skimmers, and other outlet devices; gentler side slopes; and multiple-cell construction (see section 3.3: Sediment Control Practices).

ESC plans ensure that provisions for control measures are incorporated into the site planning stage of development. They also help to reduce the incidence of erosion and sediment problems, and improve accountability if a problem occurs. An effective plan for runoff management on construction sites controls erosion, retains sediments on-site to the extent practicable, and reduces the adverse effects of runoff. Climate, topography, soils, drainage patterns, and vegetation affect how erosion and sediment should be controlled on a site (Washington State Department of Ecology, 1989).

An effective ESC plan includes both structural and nonstructural controls. Nonstructural controls address erosion control by decreasing erosion potential, whereas structural controls are both preventive and mitigative because they control erosion and sediment movement. Typical nonstructural erosion controls include:

- Plans and designs to minimize disruption of the natural features (drainage, topography, vegetative cover);
- Phased grading to minimize the area of bare soil exposed at any given time;
- Scheduling of activities during the time of year with the least erosion potential; and
- Stabilization, e.g., mulching and seeding of exposed areas.

Structural controls include:

- Perimeter controls;
- Sediment basins and traps;
- Silt fences or filter fabrics;

- Stream crossing areas for natural and man-made areas; and
- Stabilization of cut-and-fill slopes caused by construction activities.

Some erosion and soil loss is unavoidable during land-disturbing activities. Although proper siting and design help prevent development of areas prone to erosion, construction activities invariably result in conditions where erosion can occur. To reduce the adverse impacts associated with construction, the construction management measure was written to promote the use of a system of nonstructural and structural erosion and sediment controls for incorporation into an ESC plan. Erosion controls reduce the amount of sediment transported off-site, thereby reducing the need for sediment controls and lowering overall costs. When erosion controls are used in conjunction with sediment controls, the size of the sediment control structures and associated maintenance may be reduced, decreasing overall treatment costs (SWRPC, 1991).

8.3.1.2 Provide education and training opportunities for construction personnel

One of the most important factors determining whether erosion and sediment controls will be properly installed and maintained on a construction site is the knowledge and experience of the contractor. Many communities require certification for key on-site employees who are responsible for implementing the ESC plan. Certification can be accomplished through municipally sponsored training courses. Municipalities also can hold mandatory preconstruction or pre-wintering meetings and conduct regular and final inspection visits to transfer information to contractors (Brown and Caraco, 1997). Information that should be covered in training courses and meetings includes the importance of ESC practices for water quality protection; developing

Contractor/Developer Certification Programs in Delaware and Maine

Delaware requires that at least one person on any construction project be formally certified. The Delaware program requires certification for any foreman or superintendent who is in charge of on-site clearing and land-disturbing activities for sediment and runoff control associated with a construction project. Responsible personnel are required to obtain certification by completing a Department of Natural Resources and Environmental Control-sponsored or approved training program. All applicants seeking approval of a sediment and runoff plan must certify that all personnel involved in the construction project will have a certificate of attendance at a Department-sponsored or approved training course before initiation of any land-disturbing activity (Delaware DNREC, no date). A description of this certification requirement is provided at the DNREC Web site at *www.dnrec.state.de.us/newpages/ssregs14.htm.*

The Maine Department of Environmental Protection offers the Voluntary Contractor Certification Program (VCCP), which is a nonregulatory, incentive-driven program to broaden the use of effective erosion control techniques. The VCCP is open to any contractor who is involved with soil disturbance activities, including filling, excavating, landscaping, and other types of earthworks. For initial certification, the program requires attendance at two 6-hour training courses and the successful completion of a construction site evaluation. To maintain certification, a minimum of one 4-hour continuing education course within every 2-year period thereafter is required. Local soil and water conservation district personnel will complete construction site evaluations during the construction season. Certifications are valid until December 31 of the second year after issuance. Certification entitles the holder to advertise services as a "DEP Certified Contractor" (MDEP, 1999). More information about this program is provided on the MDEP Web site at *janus.state.me.us/dep/blwq/training/is-vccp.htm.*

The California Department of Transportation's Storm Water Management Plan

The California Department of Transportation (Caltrans) operates one of the most comprehensive storm water drainage systems in the United States. It has recently undertaken a multifaceted program to investigate and address pollutant load reduction in California's storm water runoff. To improve storm water management, Caltrans created the Storm Water Task Force (SWTF) to monitor, train, and educate its employees and hired contractors about pollution prevention measures. The SWTF's goals are to raise awareness and to change work habits so that Caltrans employees can more effectively address storm water issues. The SWTF uses the following techniques to accomplish their goals (Borroum et al., 2000):

- Inspecting projects and facilities for compliance with erosion, sediment control, and waste management requirements.
- Providing classroom and on-the job training and consulting.
- Publishing a monthly storm water bulletin for employees and state and local regulatory agencies.
- Reviewing storm water pollution prevention plans for construction sites.
- Providing feedback on how well methods work and what improvements could be made to improve performance.
- Preparing specialized training materials, such as videos and model pollution prevention plans.
- Providing input for storm water guidance manuals and water pollution control specifications for highway design and construction.

and implementing ESC plans; the importance of proper installation, regular inspection, and diligent maintenance of ESC practices; and recordkeeping for inspections and maintenance activities. Training and education should logically extend to all on-site personnel responsible for implementing a construction runoff control plan.

8.3.1.3 Establish plan review and modification procedures

ESC plans should be flexible to account for unexpected events that occur after the plans have been approved, including:

- Discrepancies between planned and as-built grades;
- Weather conditions;
- Altered drainage; and
- Unforeseen construction requirements.

Changes to an ESC plan should be made based on regular inspections that identify whether the ESC practices were appropriate or properly installed or maintained.

8.3.1.4 Assess ESC practices after storm events

Inspecting an ESC practice after storm events shows whether the practice was installed or maintained properly. Such inspections also help determine whether a practice requires cleanout, repair, reinforcement, or replacement with a more appropriate practice. Inspecting after storms is the best way to ensure that ESC practices remain in place and effective at all times during construction activities.

8.3.1.5 Ensure ESC plan implementation

Because funding for ESC programs is not always dedicated, budgetary and staffing constraints may thwart effective program implementation. Brown and Caraco (1997) recommend several management techniques to ensure that ESC programs are properly administered:

- Local leadership committed to the ESC program;
- Redeployment of existing staff from the office to the field or training room;
- Cross-training of local review and inspection staff;
- Submission of erosion prevention elements for early planning review;
- Prioritization of inspections based on erosion risk;
- Requirement of designers to certify the initial installation of ESC practices;
- Investment in contractor certification and private inspector programs;
- Use of public-sector construction projects to demonstrate effective ESC controls;
- Enlistment of the talents of developers and engineering consultants in the ESC program; and
- Revision and update of the local ESC manual.

To facilitate public participation, a hotline can be established to allow for citizen "monitoring" and reporting of any illicit discharges. Materials should be distributed or public service announcements made to advertise the hotline.

An allowance item that acts as an additional "insurance policy" for complying with the erosion and sediment control plan also can be added to bid or contract documents (Deering, 2000a). This allowance covers costs to repair storm damage to erosion and sediment control measures as specified in the erosion and sediment control plan. This allowance does not cover storm damage to property that is not related to the erosion and sediment control plan, because this would be covered under traditional liability insurance. Damage caused by severe and continuous rain, windblown objects, fallen trees or limbs, or high-velocity, short-term rain on steep slopes and existing grades would be covered by the allowance, as would deterioration from exposure to the elements or excessive maintenance for silt removal. The contractor is responsible for complying with the erosion and sediment control plan by properly implementing and maintaining all specified measures and structures. The allowance does not cover damage to practices caused by improper installation or maintenance.

A study by University of North Carolina researchers measured the effects of erosion and sediment control regulations, inspections, and enforcement on stream biological condition at 17 construction sites in central North Carolina (Reice and Andrews, 2000). At each site, upstream, downstream, and at-site samples were taken before construction began, during the peak land disturbance, and after the project was completed and released by the regulatory agency. Benthic and fish communities, in addition to several water chemistry variables and leaf litter decomposition rates, were sampled. The researchers found a number of results:

- Virtually all at-site samples showed some degradation relative to upstream controls.
- Impacts at sites downstream from construction sites were highly variable.
- Degree of degradation was significantly affected by enforcement activities; stronger enforcement resulted in less environmental impact on the streams.
- The stringency of the erosion and sediment control regulations proved unimportant compared to enforcement.

They concluded that staffing, workload, attitudes, and enforcement activities strongly influenced downstream conditions.

8.3.2 Erosion Control Practices

Erosion controls are used to reduce the amount of sediment removed during construction and to prevent sediment from entering runoff. Erosion control is based on two main concepts: (1) disturb the smallest area of land possible for the shortest period of time, and (2) stabilize disturbed soils to prevent erosion from occurring. Table 8.3 shows cost and effectiveness information for several erosion control practices.

8.3.2.1 Schedule projects so clearing and grading are done during the time of minimum erosion potential

Often a project can be scheduled when the erosion potential of the site is relatively low. In many parts of the country, there is a certain period of the year when erosion potential is relatively low and construction scheduling could be very effective. For example, in the Pacific region, if construction can be completed during the six-month dry season (May 1 to October 31), temporary erosion and sediment controls may not be needed. In addition, in other areas of the country, erosion potential in northern and high-elevation areas is very high during the spring thaw. During that time, snowmelt generates a constant runoff that can erode soil. In addition, construction vehicles can easily turn the soft, wet ground into mud, which is more easily washed off the site. Therefore, in the north, limitations should be placed on clearing and grading during the spring thaw (Goldman et al., 1986).

8.3.2.2 Phase construction

Construction site phasing involves disturbing only small portions of a site at a time to prevent erosion in areas where no activity is occurring (CWP, 1997c). Grading and construction are completed and soils are effectively stabilized on one part of the site before they commence at another. This is different from the more traditional practice of construction site sequencing, in which construction occurs at only one part of the site at a time but site grading and other site-disturbing activities typically occur all at once, leaving portions of the disturbed site vulnerable to erosion. Construction site phasing must be incorporated into the overall site plan early on. Elements to consider when phasing construction activities include (CWP, 1997c):

- Managing runoff separately in each phase;
- Determining whether water and sewer connections and extensions can be included in the disturbed area and installed during the initial phases of disturbance; and
- Providing separate construction and residential accesses to prevent conflicts between residents living in completed stages of the site and construction equipment working on later stages.

Table 8.3: Cost and effectiveness of selected erosion control practices.

Practice	Percent TSS Removal	Effectiveness References	Cost (2001 Dollars[a])	Cost References
Earth dike	NA	NA	Small dikes: \$2.50–\$6.50/linear ft Large dikes: \$2.50/yd^3	NAHB, 1995; SWRPC, 1991
Pipe slope drain	NA	NA	\$5/linear ft for flexible PVC pipe; inlet and outlet structures additional	NAHB, 1995
Terraces	1%–12% slope: 70% less erosion 12%–18% slope: 60% less erosion 18%–24% slope: 55% less erosion	USEPA, 1993	Average: \$6/linear ft Range: \$1.20–\$14.50/linear ft	USEPA, 1993
Check dams	NA	NA	\$100/dam (constructed of rock)	NAHB, 1995
Seeding	Average: 90% Range: 50%–100%	USEPA, 1993	Average: \$0.10/yd^2 Range: \$0.05–\$0.25/yd^2 Maintenance costs: 15%–25% of installation costs	USEPA, 1993
Mulching	53%–99.8% reduction of soil loss 24%–78% reduction in water velocity	Harding, 1990	Average: \$0.38/yd^2 Range: \$0.21–\$0.87/yd^2	USEPA, 1993
Sodding	98–99%	USEPA, 1993	Average: \$2.20/yd^2 Range: \$1.10–\$12/yd^2 Maintenance costs: 5% of installation costs	USEPA, 1993
Erosion control blankets	70% wheat straw/30% coconut fiber: 98.7% Straw: 89.2%–98.6% Curled wood fiber: 28.8%–93.6% Jute mats: 60.6% Synthetic fiber: 71.2% Nylon monofilament: 53.0%	CWP, 1997a	Biodegradable materials: \$0.50–\$0.57/yd^2 Permanent materials: \$3.00–\$4.50/yd^2 Staples: \$0.04–\$0.05/staple	Erosion Control Systems, Inc., personal communication, March 14, 2001
Chemical stabilization	PAM: 77–93%	Rosa-Espinosa et al., No date	PAM: \$1.30–\$38.50/lb	Entry and Sojka, 1999; Sojka and Lentz, 1996

[a]Costs adjusted for inflation using the Consumer Pricing Index (BLS, 2001).

A comparison of sediment loss from a typical development and from a comparable phased project showed a 42 percent reduction in sediment export in the phased project (CWP, 1997c).

Phasing can also provide protection from complete enforcement and shutdown of the entire project. If a contractor is in noncompliance in one phase or zone of a site only, that will be the area affected by enforcement activities. This approach can help to minimize liability exposure and protect the contractor financially (Deering, 2000b).

8.3.2.3 Practice site fingerprinting

Areas of a construction site are often unnecessarily cleared. Site fingerprinting involves clearing only those areas essential for conducting construction activities, leaving other areas undisturbed. The proposed limits of land disturbance should be physically marked off to ensure that only the land area required for buildings, roads, and other infrastructure is cleared. Existing vegetation, especially vegetation on steep slopes, should be avoided and preserved through fencing, signage, and site plan notations.

8.3.2.4 Locate potential pollutant sources away from steep slopes, water bodies, and critical areas

Material stockpiles, borrow areas, access roads, and other land-disturbing activities should be located away from critical areas such as steep slopes, highly erodible soils, and areas that drain directly into sensitive water bodies to reduce the potential for pollutant loadings.

8.3.2.5 Route construction traffic to avoid existing or newly planted vegetation

Where possible, construction traffic should be directed over areas that must be disturbed for other construction activity. This practice reduces the net total area that is cleared and susceptible to erosion. It also may help to decrease the area of compacted soils.

8.3.2.6 Protect natural vegetation with fencing, tree armoring, and retaining walls or tree wells

Tree armoring protects tree trunks from being damaged by construction equipment. Fencing can also protect tree trunks, but it should be placed at the tree's drip line or critical root zone. A tree's drip line is the minimum area around the tree in which the tree's root system should be undisturbed by cut, fill, or soil compaction caused by heavy equipment. When cutting or filling must be done near a tree, a retaining wall or tree well should be used to minimize the cutting of the tree's roots, the quantity of fill placed over the tree's roots, or soil compaction.

8.3.2.7 Protect environmentally sensitive areas

When construction is taking place in an aquifer recharge area, wetland, floodplain, or other sensitive area, special consideration should be given to minimizing the environmental impacts of construction activities. Disturbance to these areas should be limited and measures taken to reduce impacts if work is conducted near or in these features. For example, the North Carolina Department of Transportation (NCDOT) used an innovative technique to reduce the impact of cleanup activities on sensitive wetlands surrounding the newly constructed Croatan Sound Bridge. NCDOT used industrial vacuums traditionally used by the shipbuilding and roofing industries to move materials off-site rather than running potentially damaging vehicles over the wetlands. Even with the purchase cost of the new equipment, NCDOT estimates a savings of more than $3 million.

8.3.2.8 Stockpile topsoil and reapply as a soil amendment to reestablish vegetation

Topsoil is essential to establish new vegetation, and it should be stockpiled and then reapplied to the site for revegetation. Reestablishment of vegetation is one of the most common and least expensive means to stabilize disturbed soils.

The Importance of Soil Amendments

Soil with adequate soil structure, pore space, organic content, and biological activity not only promotes the establishment of new vegetation, but it also provides water quality benefits. When soils are compacted during construction activities and organic matter is not replaced, the following consequences may occur (Low Impact Development Center, 2003):

- Reduced infiltration capacity, resulting in increased runoff, erosion, scouring, and sediment and other pollutant loads to receiving waters.
- Decreased ground water recharge rates.
- Reduced availability of subsurface water to plants, requiring homeowners to water more frequently.

Soil amendments minimize development impacts on native soils by restoring infiltration capacity and the chemical characteristics of healthy soils. Amended soils provide greater infiltration and subsurface storage, which helps to maintain predevelopment conditions. Soil amendments provide the following water quality benefits (Low Impact Development Center, 2003):

- Increased infiltration capacity of soil.
- Filtering and breakdown of potential pollutants.
- Decomposition of potential pollutants by soil microbes.
- Reduced need for fertilizers, pesticides, and irrigation due to increased nutrients and moisture-holding capacity in soil.
- Increasing soil stability, reducing erosion potential.
- Added protection to ground water resources, especially from heavy metal contamination.

Soil can be amended using compost, mulch, topsoil, lime and gypsum. A thorough analysis of the native soil should be conducted to maximize the benefits of soil amendments.

Soil should be amended at the completion of construction to avoid compaction from heavy equipment. Care should be taken to ensure that amendments are implemented during the right season and under the right conditions in relation to other landscaping activities.

8.3.2.9 Cover or stabilize soil stockpiles

Unprotected stockpiles are very prone to erosion and therefore must be protected. Small stockpiles can be covered with a tarp to prevent erosion. Large stockpiles should be stabilized by erosion blankets, seeding, and/or mulching.

8.3.2.10 Use wind erosion controls

Wind erosion controls limit the movement of dust from disturbed soil surfaces and encompass many different practices. Wind barriers block air currents and are effective in controlling soil movement due to wind. Many different materials can be used as wind barriers, including solid board fences, snow fences, and bales of hay. Sprinkling moistens the soil surface with water and must be repeated as needed to be effective for preventing wind erosion (Delaware DNREC, 1989); however, applications must be monitored to prevent excessive runoff and erosion.

8.3.2.11 Intercept runoff above disturbed slopes and convey it to a permanent channel or storm drain

Earth dikes, perimeter dikes/swales, or diversions can be used to intercept and convey runoff from above disturbed areas to undisturbed areas or drainage systems. An earth dike is a temporary berm or ridge of compacted soil that channels water to a desired location. A perimeter dike/swale or diversion is a swale with a supporting ridge on the lower side that is constructed from the soil excavated from the adjoining swale (Delaware DNREC, 1989). These practices should be used to intercept flow from denuded areas or newly seeded areas and to keep clean runoff away from disturbed areas. The structures should be stabilized within 14 days of installation. A pipe slope drain, also known as a pipe drop structure, is a temporary pipe placed from the top to the bottom of a slope to convey concentrated runoff down the slope without causing erosion (Delaware DNREC, 1989).

8.3.2.12 On long or steep, disturbed, or man-made slopes, construct benches, terraces, or ditches at regular intervals to intercept runoff

Benches, terraces, or ditches break up a slope by providing areas of low slope in the reverse direction. These structures keep water from proceeding down the slope at increased volume and velocity. Instead, the flow is directed to a suitable outlet or protected drainage system. The frequency of benches, terraces, or ditches will depend on the erodibility of the soils, steepness and length of the slope, and rock outcrops. This practice should be used if there is a potential for erosion along the slope.

8.3.2.13 Use retaining walls

Retaining walls can be used to decrease the steepness of a slope. If the steepness of a slope can be reduced, the runoff velocity and erosion potential can be decreased.

8.3.2.14 Provide linings for urban runoff conveyance channels

Construction activities often increase the velocity and volume of runoff. Increases in runoff velocity and volume often cause erosion in newly constructed or existing urban runoff conveyance channels. If the runoff during or after construction will cause erosion in a channel, the channel should be lined or flow control practices should be installed. The first choice of lining is grass or sod because they reduce runoff velocities and provide water quality benefits through filtration and infiltration. If the velocity in the channel would erode the grass or sod, turf reinforcement mats, riprap, concrete, or gabions can be used.

8.3.2.15 Use check dams

Check dams are small, temporary dams constructed across a swale or channel. They can be constructed using gravel, rock, gabions, or straw bales. They are used to reduce the velocity of concentrated flow and, therefore, to reduce erosion in a swale or channel. Proper design and maintenance of check dams is crucial to their ability to function as an erosion control measure. Design considerations include dams to control runoff velocity; hydraulic capacity to store and release runoff in a non-erosive manner; stability of dam construction materials; foundation preparation; construction moisture; and density control. Maintenance requirements include the periodic removal of sediment collected above the dam; immediate repair of damage; and removal of temporary dams when they are no longer needed (Loser, 2003).

8.3.2.16 Seed disturbed areas

Seeding establishes a vegetative cover on disturbed areas and is very effective in controlling soil erosion once a dense vegetative cover has been established. Seeding establishes permanent erosion control in a relatively short amount of time and has been shown to decrease solids load by 99 percent (CWP, 1997a). The three most common seeding methods are: (1) broadcast seeding, in which seeds are scattered on the soil surface; (2) hydroseeding, in which seeds are sprayed on the surface of the soil with a slurry of water; and (3) drill seeding, in which a tractor-drawn implement injects seeds into the soil surface. Broadcast seeding is most appropriate for small areas and for augmenting sparse and patchy grass covers. Hydroseeding is often used for large areas (in excess of 5,000 square feet) and is typically combined with tackifiers, fertilizers, and fiber mulch. Drill seeding is expensive and is cost-effective only on sites greater than 2 acres. Bare soils should be seeded or otherwise stabilized within 15 calendar days after final grading. Denuded areas that are inactive and will be exposed to rain for 15 days or more should also be temporarily stabilized, usually by planting seeds and establishing vegetation during favorable seasons. In very flat, non-sensitive areas with favorable soils, stabilization may involve simply seeding and fertilizing. The Soil Quality Institute (SQI, 2000) recommends that soils compacted by grading should be broken up or tilled before vegetating.

To establish a vegetative cover, it is important to use seeds from adapted plant species and varieties that have a high germination capacity. Supplying essential plant nutrients, testing the soil for toxic materials, and applying an adequate amount of lime and fertilizer can overcome many unfavorable soil conditions and establish adequate vegetative cover. Soils should be tested prior to application to determine the amount of lime or fertilizer needed. Specific information about seeds, various species, establishment techniques, and maintenance can be obtained from *Erosion Control & Conservation Plantings on Noncropland* (Landschoot, 1997) or a local Cooperative State Research, Education, and Extension Service (http://www.csrees.usda.gov/) or Natural Resources Conservation Service (http://www.nrcs.usda.gov) office.

8.3.2.17 Use mulches

Newly established vegetation does not have as extensive a root system as existing vegetation, and therefore it is more prone to erosion, especially on steep slopes. Additional stabilization should be considered during the early stages of seeding. This extra stabilization can be accomplished using mulches or mulch mats, which can protect the disturbed area while vegetation becomes established.

Mulching involves applying plant residues, compost material, or other suitable materials on disturbed soil surfaces. Mulch and mulch mat materials include tacked straw, wood chips, jute netting, coir/coconut fiber, and compost mix, and are sometimes covered by blankets or netting. Mulching alone should be used only for temporary protection of the soil surface or when permanent seeding is not feasible. The useful life of mulch varies with the material used and the amount of precipitation, but is approximately two to six months. Mulching and/or sodding may be necessary as slopes become moderate to steep, as soils become more erodible, and as areas become more sensitive.

During the times of the year when vegetation cannot be established, mulch should be applied to moderate slopes and soils that are not highly erodible. On steep slopes or highly erodible soils, multiple mulching treatments should be used.

The Texas Transportation Institute (2004) undertook a study to measure the performance of the use of compost and shredded wood mulches on highway rights-of-way. The institute found that compost applied to sand produced 92 percent vegetation cover, compost on clay produced 99 percent vegetation cover, and wood chips treated with a tackifier on clay produced 95 percent vegetation cover. Other treatments, including wood chips/tackifier on sand and wood chips with tackifier and germination stimulant on sand and clay did not produce adequate vegetation cover for erosion control (only 48 to 57 percent cover). They concluded that mulch could be advantageous as an erosion control method because it did not need to be removed after construction and it acted as a soil amendment to encourage vegetation establishment. Additionally, use of natural mulches such as compost and wood chips promotes recycling of waste materials and reduces the amount of wastes disposed of in landfills.

Hydromulches containing biosolids or other fertilizers are often useful on soils with poor nutrient organic content and in situations where there are steep slopes or other erosive forces that affect revegetation (e.g., wind).

8.3.2.18 Use sodding for permanent stabilization

Sodding permanently stabilizes an area with a thick vegetative cover. Sodding provides immediate stabilization and should be used in critical areas or where establishing permanent vegetation by seeding and mulching would be difficult. Sodding is also a preferred option when there is high erosion potential during the period of vegetative establishment from seeding. According to the Soil Quality Institute (SQI, 2000), soils that have been compacted by grading should be broken up or tilled before placing sod.

8.3.2.19 Install erosion control blankets

Turf reinforcement mats (TRMs) combine vegetative growth and synthetic materials to form a high-strength mat that helps prevent soil erosion in drainage areas and on steep slopes (USEPA, 1999). TRMs enhance the natural ability of vegetation to permanently protect soil from erosion. They are composed of interwoven layers of non-degradable geosynthetic materials, such as polypropylene, nylon, and polyvinyl chloride netting, stitched together to form a three-dimensional matrix. They are thick and porous enough to allow filling and retention of soil.

In addition to providing scour protection, the mesh netting of TRMs is designed to enhance vegetative root and stem development. By protecting the soil from scouring forces and enhancing vegetative growth, TRMs can raise the threshold of natural vegetation to withstand higher hydraulic forces on stabilization slopes, streambanks, and channels. In addition to reducing flow velocities, the use of natural vegetation provides removal of particulates through sedimentation and soil infiltration and improves the aesthetics of a site.

In general, TRMs should not be used:

- To prevent deep-seated slope failure due to causes other than surficial erosion;
- When anticipated hydraulic conditions are beyond the limits of TRMs and natural vegetation;
- Directly beneath drop outlets to dissipate impact force (although they can be used beyond the impact zone); or
- Where wave height might exceed 1 foot (although they may be used to protect areas up-slope of the wave impact zone).

The performance of a TRM-lined conveyance system depends on the duration of the runoff event to which it is subjected. For short-term events, TRMs are typically effective at flow velocities of up to 15 ft/sec and shear stresses of up to 8 lb/ft^2 (USEPA, 1999), however, specific high-performance TRMs may be effective under more severe hydraulic conditions. Practitioners should check with manufacturers for the specifications and performance limits of different products.

In general, the installed cost of TRMs ranges from $\$5/yd^2$ to $\$15/yd^2$ (USEPA, 1999). Factors influencing the cost of TRMs include: (1) the type of TRM material required; (2) site conditions, such as the underlying soils, the steepness of the slope, and other grading requirements; and (3) installation-specific factors such as local construction costs.

In most cases, TRMs cost considerably less than concrete and riprap solutions. For example, a project in Aspen, Colorado, used more than 23,000 yd^2 of TRMs to line channels for a horse ranch development project (Theisen, 1996). The TRMs were installed at a cost of $\$8.25/yd^2$. This cost was substantially less than the $\$20/yd^2$ estimate for the rock riprap alternative.

8.3.2.20 Use chemicals such as PAM to stabilize soils

Polymers can be used to reduce erosion and also to control sediment contained in runoff. Polyacrylamide (PAM) is a polymer produced mainly for agricultural use to control erosion and promote infiltration on irrigated lands (Sojka and Lentz, 1996). It is also being tested for use at construction sites to reduce erosion from disturbed areas (Aicardo, 1996; Roa-Espinosa et al., no date). When applied to soils, PAM binds to soil particles and forms a gel that decreases soil bulk density, absorbs water, and binds fine-grained soil particles.

PAM is available in powder form or as aqueous concentrate, in blocks and cubes, and as an emulsified concentrate; each type has benefits and drawbacks that alter its applicability in different settings and by different application methods. PAM costs $1.30 to $38.50 per pound (Entry and Sojka, 1999; Sojka and Lentz, 1996) and has been shown to achieve a 77 to 93 percent reduction in sediment loss from disturbed sites (Roa-Espinosa et al., no date).

Application of PAM improves surface water quality by decreasing suspended solids and the phosphorus, nitrogen, pesticides, pathogens, salts, metals, and BOD usually associated with sediment loading. However, PAM may detrimentally affect ground water quality by increasing leaching of nutrients, pesticides, and pathogens as a result of improved infiltration. Although careful application of PAM at prescribed rates can partially mitigate its negative effects on ground-water quality, its effects on water quality and wildlife are still unknown.

Questions have arisen as to PAM's environmental toxicity. Anionic PAM, the form found most often in erosion control products, has not been proven to be toxic to aquatic, soil, or plant species. The molecule is too large to cross membranes, so it is not absorbed by the gastrointestinal tract, is not metabolized, and does not bioaccumulate in living tissue. Cationic PAM, although not of major concern for erosion control applications, has been shown to be toxic to fish because of its affinity to anionic hemoglobin in the gills.

Most of the concern for PAM toxicity has arisen because of acrylamide (AMD), the monomer associated with PAM and a contaminant of the PAM manufacturing process. In laboratory experiments, AMD has been shown to be both a neurotoxin and a carcinogen. Current regulations require that AMD not exceed 0.05 percent in PAM products. Although there seems to be little risk from AMD as a result of prescribed application of PAM, it is uncertain what effects might result from spills, over-application, or other accidents.

Flocculation and filtration of colloidal solids in construction site runoff

Runoff discharged from an unstabilized sediment basin at a commercial construction site was not meeting water quality standards due to high suspended solids content, despite a filtering device installed at the basin's outflow. The filter was designed to filter larger particles and gross solids, but did not treat silt-sized and colloidal particles. To address the smaller particle sizes, the contractor installed a sump consisting of 2 parts: a pit into which a 1,000-foot pipe discharged runoff for settling and a grid of jute baffles that would filter finer floc. A polyacrylamide blend was used to stabilize the pit and baffle grid. Solid blocks of flocculant were placed in the upstream end of the discharge pipe to introduce the material gradually into the runoff stream. Mixing occurred in the pipe, settling of floc occurred in the quiescent pit, and the baffles filtered remaining solids and floc. Samples taken at inflow and outflow points show dramatic clarification of runoff (Price and Company, Inc., 2004).

Polymers for Sediment Control

Polymers also can be used to control sediments that have been mobilized and entrained in runoff. Minton and Benedict (1999) examined the use of polymers to clarify construction site runoff that had been detained on-site.

The researchers used a multi-phase system to remove sediments and associated pollutants from construction site runoff. The first phase involved collection of storm water at interception points using the permanent drainage system installed early in the construction period and/or building excavations (see Figure 8.1). The collected runoff was then diverted, usually by pumping, to one or more storage ponds. (The permanent postdevelopment detention and treatment system, as required by local regulations, could be used for this storage during the construction phase given that it has sufficient capacity to handle site runoff, with supplemental storage provided as necessary.) The water was then pH-adjusted to optimize flocculation based on the particular polymer used. Finally, the water was pumped to one of two treatment cells, during which time the polymer was added (upstream of the transfer pump to maximize mixing and flocculation).

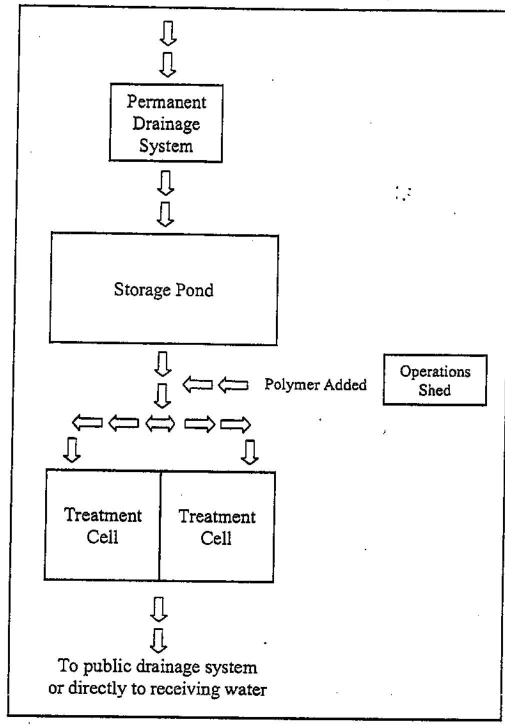

Figure 8.1: Schematic of the basic polymer treatment system (Minton and Benedict, 1999).

Two treatment cells were used so that settling could take place in one cell while runoff was pumped into the second cell. The floc was allowed to settle for a few hours to several days, with the most common practice being an overnight settling period. Water was discharged to the public discharge system using a float device with a 4-inch discharge system and a 12-inch clearance to keep the float from picking up settled sediment. Alternatively, the clarified water could be discharged to the sanitary sewer if problems arose in the treatment system.

Table 8.4 presents performance data for the six sites studied. Median turbidities of the untreated storm water varied between sites. These differences might have been caused by differences in the percentage of soil fines, the slopes, and the application of standard management practices. Developers at the test sites reported costs to be between 0.8 and 1.5 percent of the total construction cost, while another developer reported an approximate cost of $\$1/ft^2$ for the treatment system. Temporary storage and treatment ponds, as well as piping, pumps, and other equipment, accounted for the majority of the costs associated with polymer treatment.

Table 8.4: Summary of operating performance data for six test sites (Minton and Benedict, 1999)[a].

	Polymer Dosage		Influent Turbidity		Effluent Turbidity		pH Control	
Site	Range	Median	Range	Median	Range	Median	Frequency[b]	Type[c]
1	25–250	75	12–2,960	200	1–45	6	45%	acid
2	10–200	100	31–4,700	2,000	1.9–39	11	16%	both
3	50–>100	100	12.9–900	150	0.5–45	7	18%	soda ash
4	50–200	100	8–4,000	400	<1–32.5	6	0%	–
5	300–400	350	2,780–17,000	14,000	0.8–23	8	97%	soda ash
6	85–140	110	17–6,650	117	1.7–18	4	85%	both

[a] Excludes the start-up period when effluent turbidities were not yet at desired levels (usually a week or two for most sites). [b] Approximate percentage of the number of operating days on which pH adjustment occurred. [c] Most frequent form of pH adjustment: soda ash or sulfuric acid.

8.3.2.21 Use wildflower cover

Because of the hardy drought-resistant nature of wildflowers, in some cases they may be more beneficial as an erosion control practice than turf grass. Though not as dense as turf grass, wildflower thatches and associated grasses are expected to be as effective in erosion control and contaminant absorption. An additional benefit of wildflower thatches is providing habitat for wildlife, including insects and small mammals. Because thatches of wildflowers do not need fertilizers, pesticides, or herbicides, and watering is minimal, implementation of this practice may result in cost savings. A wildflower thatch requires several years to become established, but maintenance requirements are minimal once established. Native seeds should be used because they will be better adapted to local conditions. If possible, the seed source should be within 250 miles of the proposed project for promotion of native species.

8.3.3 Sediment Control Practices

Sediment controls capture sediment that is transported in runoff. Filtration and gravitational settling during detention are the main processes used to remove sediment from urban runoff. Table 8.5 shows cost and effectiveness information for several sediment control practices.

8.3.3.1 Install sediment basins

Sediment basins, also known as silt basins, are engineered impoundment structures that allow sediment to settle out of the urban runoff. They are installed prior to full-scale grading and remain in place until the disturbed portions of the drainage area are fully stabilized. They are generally located at the low point of sites, away from construction traffic, where they can be used to trap sediment-laden runoff. Basin dewatering is achieved either through a single riser and drainage hole leading to a suitable outlet on the downstream side of the embankment or through the gravel of the rock dam. In both cases, water is released at a substantially slower rate than would be possible without the control structure.

The following are general specifications for sediment basin design criteria as presented in Schueler (1997):

- Provide 1,800 to 3,600 cubic feet of storage per contributing acre (a number of states, including Maryland, Pennsylvania, Georgia, and Delaware, recently increased the storage requirement to 3,600 ft^3 or more [CWP, 1997b]).
- Surface area equivalent to 1 percent of drainage area (optional, seldom required).
- Riser with spillway capacity of 0.2 $ft^3/s/ac$ of drainage area (peak discharge for 2-year storm with 1-foot freeboard).
- Length-to-width ratio of 2 or greater.
- Basin side slopes no steeper than 2:1 (horizontal to vertical).
- Safety fencing, perforated riser, dewatering (optional, seldom required).

Table 8.5: Cost and effectiveness for selected sediment control practices.

Practice	Percent TSS Removal	Effectiveness References	Cost (2001 dollars[a])	Cost References
Sediment basin	Average: 70% Range: 42%-100%	CWP, 1997d; Millen et al., No date; USEPA, 1993	For 50,000 ft^3 of storage space: Average: $0.80/$ft^3$ Range: $0.25–$1.70/ft^3 storage For more than 50,000 ft^3 of storage space: Average: $0.40/$ft^3$ Range: $0.13–$0.52/ft^3 storage	USEPA, 1993
Modified risers and skimmers	Single orifice: 83% Perforated risers: 68%–94% Perforated risers w/filter fabric: 79% Skimmer: 83%–97%	Jarrett, 1999, Schueler, 1997	NA	NA
Sediment trap	50%–70%	Stahre and Urbonas, 1990	Average: $0.80/$ft^3$ storage Range: $0.25–$2.65/ft^3 storage Maintenance costs: 20% of installation costs	Brown and Schueler, 1997; USEPA, 1993
Silt fence	40%–100%	Barrett et al., 1995; Wishowski et al., 1998; CWP, 1997e	$3.80–$9.90/linear ft	SWRPC, 1991; USEPA, 1992
Inlet protection	NA	NA	$65–$131/inlet	USEPA, 1993
Stabilized construction entrance	NA	NA	Without wash rack: Average: $2,620/entrance Range: $1,310–$5,240/entrance With wash rack: Average: $3,930/entrance Range: $1,310–$6,550/entrance	USEPA, 1993
Vegetated filter strips	75-ft width: 54% 15-ft width: 84%	Yu et al., 1993	Established from existing vegetation: $0 Established from seed: Average: $530/acre Range: $270–$1,310/acre Established from sod: Average: $14,190/acre Range: $6,000–$63,300/acre Note: Values do not include land costs or costs associated with installing a level spreader	USEPA, 1993

[a]Costs adjusted for inflation using the Bureau of Labor Statistics Inflation Calculator. NA: Not available

Sediment basins can be classified as either temporary or permanent structures, depending on the length of their service. If they are designed to function for less than 36 months, they are classified as temporary; otherwise, they are considered permanent. Temporary sediment basins can also be converted into permanent urban runoff management ponds. Conversion minimizes additional disturbance and can be used where it will be difficult to restore an area previously used as a temporary sediment basin. When sediment basins are designed as permanent structures, they must meet all standards for wet ponds. It is important to note that even the best-designed sediment basin seldom exceeds 60 to 75 percent TSS removal. This number should be taken into consideration when selecting a sediment control practice. As described above, trapping efficiency in sediment basins can be improved through the use of advanced sediment-settling controls.

8.3.3.2 Use modified risers and skimmers

Because traditional riser designs provide little treatment to remove sediments, efforts have been made to improve the design of sediment basins to facilitate greater pollutant removal. Modifications to traditional designs that improve sediment removal efficiency include using perforated risers or perforated risers wrapped in a gravel jacket or filter fabric. An alternative to the riser is a skimmer device that floats on the surface of water in the basin (Faircloth, 1999). The skimmer is made of a straight section of PVC pipe equipped with a float and attached with a flexible coupling to a flow-controlled outlet at the base of the riser. Because the skimmer floats, it rises and falls with the level of water in the basin and drains only the cleanest top layer of runoff. Since the skimmer falls to the bottom of the basin as the basin drains, it is capable of more thorough dewatering than a traditional riser, thereby restoring the maximum runoff storage capacity. The sediment-removal performance of basins equipped with skimmer dewatering devices has been shown to be nearly 97 percent for a simulated 2-year, 24-hour storm (Schueler, 1997).

Jarrett (1999) tested the sediment-removal effectiveness of several types of basins (outlet placement, deeper/shallower, barrier/no barrier) and outlet designs, including perforated risers (with and without filter fabric), single-orifice risers, and several sizes of skimmers. Table 8.6 shows the sediment retention efficiency results of Jarrett's different treatments.

Jarrett drew the following conclusions from his study:

- Perforated risers and single-orifice risers had similar sediment losses.
- Deeper permanent pools resulted in greater sediment removal.
- Sediment loss was attributed partly to resuspension and partly to basin erosion.
- Perforated risers resulted in 1.8 times greater sediment loss than skimmers when the outlet devices were placed in the principal spillway.
- Barriers that trisect basin volume reduced sediment loss when perforated risers were used but did not reduce sediment loss when skimmers were used.
- Silt-sized particles were most likely to be lost from sediment basins.
- Longer dewatering time resulted in less overall sediment loss.

Table 8.6: Sediment retention efficiency[a] of sediment basins (Jarrett, 1999).

Treatment[b]	Outlet Control	Basin Size (m^3)	Hydrograph Volume Injected (m^3)	Emergency Spillway Used	Barrier Used	Dewatering Time (hr)	Permanent Pool Depth (m)	Sediment Loss (kg)	Sediment Retention Efficiency (%)
1	Perforated riser	140	100	No	No	24	0.15	32	79
2	Single orifice	140	100	No	No	24	0.15	26	83
5	Perforated Riser	140	100	No	No	24	0.46	1	92
6	Perforated riser with filter fabric	140	100	No	No	?	0.15	32	79
7	Skimmer	140	100	No	No	24	0.15	17	89
8	Perforated riser	140	100	No	Yes	24	0.15	24	84
9	Skimmer	140	100	No	No	24	0.15	20	87
10	Perforated riser	140	100	No	No	6	0.15	49	68
10	Perforated riser	140	100	No	No	168	0.15	9	94
10	Skimmer	140	100	No	No	6	0.15	22	86
10	Skimmer	140	100	No	No	168	0.15	5	97
11	Perforated riser	140	100	Yes	No	24	0.15	44	71
11	Skimmer	140	100	Yes	No	24	0.15	26	83
11a	Perforated riser	50	50	No	No	24	0.15	22	86
11a	Skimmer	50	50	No	No	24	0.15	7	95
3,4	Resuspension equaled 24% of sediment lost from basin								
3,4	Erosion from basin sides and bottom equaled 24% of sediment lost from basin								
1	Basin suspension was completely mixed during hydrograph inflow								
1	Basin suspension quickly stratified when inflow energy was reduced to zero								

[a]The 90 percent and greater TSS removal rates might be difficult to achieve in the field because (1) sizing criteria are much higher in Pennsylvania; (2) these were laboratory, not field, tests; and (3) maintenance was above average.
[b]In all treatments, effective soil injected was 154 kg.

8.3.3.3 Install sediment traps

Sediment traps are small impoundments that allow sediment to settle out of runoff water. They are typically installed in a drainageway or other point of discharge from a disturbed area. Temporary diversions can be used to direct runoff to the sediment trap. Sediment traps are ideal for sites 1 acre and smaller and should not be used for areas greater than 5 acres. They typically have a useful life of approximately 18 to 24 months. A sediment trap should be designed to maximize surface area for infiltration and sediment settling. This design increases the effectiveness of the trap and decreases the likeliness of backup during and after periods of high runoff intensity. The approximate storage capacity of each trap should be at least 1800 ft^3/acre of disturbed area draining into the trap (Smolen et al., 1988). (A number of states, including Maryland, Pennsylvania, Georgia, and Delaware, recently increased the storage requirement to 3,600 ft^3 or more [CWP, 1997b].)

8.3.3.4 Use silt fence

Silt fence, also known as filter fabric fence, is available in several mesh sizes from many manufacturers. Sediment is filtered out as runoff flows through the fabric. Such fences should be used only where there is sheet flow (no concentrated flow), and the maximum drainage area to the fence should be 0.5 acre or less per 100 feet of fence. To ensure sheet flow, a gravel collar or level spreader can be used upslope of the fence. Many types of fabrics are available commercially. The characteristics that determine a fence's effectiveness include filtration efficiency, permeability, tensile strength, tear strength, ultraviolet resistance, pH effects, and creep resistance.

The longevity of silt fences depends heavily on proper installation and maintenance. CWP (1997d) identified several conditions that limit the effectiveness of silt fences:

- The length of the slope exceeds 50 feet for slopes of 5 to 10 percent, 25 feet for slopes of 10 to 20 percent, or 15 feet for slopes greater than 20 percent.
- The silt fence is not aligned parallel to the slope contours.
- The edges of the silt fence are not curved uphill, allowing flow to bypass the fence.
- The length of disturbed area draining to the fence is greater than 100 feet.
- The fence receives concentrated flow without reinforcement.
- The fence was installed below an outlet pipe or weir.
- The silt fence is upslope of the exposed area.
- The silt fence alignment does not consider construction traffic.
- Sediment deposits behind the silt fence reduce capacity and increase breach potential.
- The alignment of the silt fence mirrors the property line or limits of disturbance but does not reflect ESC needs.

EvTEC tests a static slicing silt fence installer

A static slicing silt fence installer was recently tested by EPA's Environmental Technology Evaluation Center (EvTEC, 2001). The goal of the testing was to determine if slicing was as better method than trenching with respect to performance, cost, and ease of use. The static slicing method, an alternative to traditional trenching methods, involves inserting a narrow custom-shaped blade at least 10 inches into the ground and simultaneously pulling silt fence fabric into the opening created as the blade is pulled through the ground. The tip of the blade is designed to slightly disrupt soil upward, preventing horizontal compaction of the soil and simultaneously creating an optimum soil condition for future mechanical compaction. Compaction follows using a tire on the tractor that pulls the slicing machine. Post-setting and driving, followed with attaching the fabric to the post, finalizes the installation.

EvTEC found that the slicer performed as well as or better than the best trenching method and was superior to less stringent methods of trenching. Slicing took less time (1.75 to 4 times faster) and was therefore cost-effective because of man-hour savings. The slicing method prevented runoff seepage and blowout better than most trenching methods and performed as well as the best trenching method. Overall, the static slicing method offers several advantages over traditional trenching methods, including maneuverability, minimal soil-handling and manual labor, consistent depth and compaction, and ease of installation in windy conditions, on steep side slopes, through rocky soils, and in saturated conditions.

These conditions can be avoided with proper siting, installation, and maintenance. Silt fences typically have a useful life of approximately 6 to 12 months.

8.3.3.5 Install compost filter berms

Compost berms can be installed by spraying compost mixture along the perimeter of a denuded area to form a mound. The berms are designed to filter runoff by absorbing flows into the compost mixture's void space and gradually releasing them into the ground or offsite. They are usually installed at the bottom of a slope, but they also can be installed at the top of the denuded area to prevent clean runoff from entering exposed areas. Berms are typically installed in lieu of silt fence and are sized at 1 foot high and 2 feet wide (Tyler, 2001).

Compost berms can be used in conjunction with compost blankets (a sprayed layer of compost mix that functions as a mulch, see section 8.3.2.17); a berm at the top of the slope protects the compost blankets from erosion by preventing water from flowing underneath the protective layer, and a berm at the bottom of the slope provides filtration (Tyler, 2001).

Caine (2001) installed a triangular cross-section compost berm that was 16 to 18 inches high and 36 inches wide at its base. Installation cost was approximately $3.68 per linear foot. Runoff detention time was 17 to 26 minutes. Water was distributed throughout the berm and was released at multiple points. The berm filtered the runoff such that turbidity was reduced by 67 percent. Caine noted that the runoff mobilized humic and tannic acids from the organic material, causing the water passing through the berm to become discolored. One benefit of compost berms is that they do not require removal after construction is completed; they can be spread over the ground surface as topsoil or a soil amendment.

Mesh socks filled with composted material can be used in lieu of filter berms where the use of loose material is not practical, such as where flows might be concentrated near stream banks or shorelines (Goldstein, 2002). These filter socks function in the same manner as compost filter berms, but they are more contained.

8.3.3.6 Establish inlet protection

Inlet protection consists of a barrier placed around a storm drain inlet, which traps sediment before it enters the storm sewer system. There are five basic types of inlet protection structures: silt fence barriers, straw bale inlet barriers, block and gravel drop inlet filters, block and gravel curb inlet filters, and various excavated drop inlet protection measures (NAHB, 1995). The structures should be placed at the perimeter of the inlet structure. Inlet protection is appropriate for small drainage areas (1 acre or less) and can be used during rainy seasons (California Regional Water Quality Control Board, 1999). The structures can handle sheet flow with velocities less than 0.014 m^3/s; block and gravel barriers should be used in cases where concentrated flows exceed 0.014 m^3/s.

8.3.3.7 Designate and reinforce construction entrances

A construction entrance is a pad of gravel or rock over filter cloth located where traffic enters and leaves a construction site. As construction vehicles drive over the gravel, mud and sediment are collected from the vehicles' wheels. To maximize the effectiveness of this practice, the rock pad should be at least 50 feet long and 10 to 12 feet wide. The gravel should be 1- to 2-inch aggregate 6 inches deep laid over a layer of filter fabric. Maintenance might include pressure-washing the gravel to remove accumulated sediments and adding more rock to maintain adequate thickness. Runoff from this entrance should be treated before exiting the site. This practice can be combined with a designated truck wash-down station to ensure sediment is not transported off-site.

8.3.3.8 Install vegetated filter strips

Vegetated filter strips are low-gradient vegetated areas that are planted and used to filter overland sheet flow. Runoff must be evenly distributed across the filter strip. Channelized flows decrease the effectiveness of filter strips. Level spreading devices are often used to distribute the runoff evenly across the strip (Dillaha et al., 1989).

Vegetated filter strips should have relatively low slopes and adequate length and should be planted with erosion-resistant plant species. The main factors that influence the removal efficiency are the vegetation type, soil infiltration rate, and flow depth and travel time. These factors are dependent on the contributing drainage area, slope of strip, degree and type of vegetative cover, and strip length. Maintenance requirements for vegetated filter strips include sediment removal and inspections to ensure that dense, vigorous vegetation is established and concentrated flows do not occur.

8.3.3.9 Use vegetated buffers

Like filter strips, vegetated buffers provide a physical separation between a construction site and a water body. The difference between a filter strip and a vegetated buffer area is that a filter strip is an engineered system (soils, plants, slope, width, depth), whereas a buffer is a naturally occurring filter system. Vegetated buffers remove nutrients and other pollutants from runoff, trap sediments, and shade the water body to optimize light and temperature conditions for aquatic plants and animals (Welsch, no date). Preservation of vegetation for a buffer should be planned before any site-disturbing activities begin to minimize the impact of construction activities on existing vegetation. Trees should be clearly marked at the drip-line to preserve them and to protect them from ground disturbances around the base of the tree.

Proper maintenance of buffer vegetation is important. Maintenance requirements depend on the plant species chosen, soil types, and climatic conditions. Maintenance activities typically include fertilizing, liming, irrigating, pruning, controlling weeds and pests, and repairing protective markers (e.g., fluorescent fences and flags).

8.3.4 Develop and Implement Programs to Control Chemicals and Other Construction Materials

8.3.4.1 Develop and implement a materials management program

Areas where materials are stored at a construction site can be sources of runoff contamination due to poor housekeeping and accidental spills. Improving storage and materials management practices will help minimize exposure and risk. Erodible or potentially hazardous materials should be stored in such a manner as to prevent contact with rainfall or runoff. In general, materials should be stored in a secure, dry, covered area that is equipped with an impermeable floor and berms to prevent spills from reaching surrounding soils, ground water, and surface water. Conducting an inventory of all materials used on-site and assessing the potential they pose for contact with runoff will help in implementing effective controls.

Properly store, handle, and apply pesticides. In general, pesticides should be used only when absolutely necessary. Instructions listed on the packaging should be followed when using, handling, or disposing of these chemicals. Consideration should be given to local regulations that may govern the use or disposal of pesticide chemicals or their containers. To reduce the risk of contaminating runoff, the following practices should be implemented:

- Store pesticides in a secure, dry, covered area that has an impermeable floor.

- Provide curbs or dikes around the storage area to prevent spills and leaks from reaching unprotected areas.

- Provide site personnel with the proper pesticide spill response training and have adequate measures on-site to contain and clean up pesticide spills.

- Strictly follow recommended application rates and application methods.

- Handle pesticide wastes appropriately. Many pesticides are considered hazardous wastes when they are disposed of. Pesticide wastes should be managed as required by all applicable waste regulations.

Properly store, handle, and apply petroleum products. The following practices can help to reduce the risk of runoff contamination from petroleum products:

- Store petroleum products in designated areas that are covered, have impermeable floors, and are surrounded with dikes, berms, or absorbent pads to contain any spills.

- Provide site personnel with the proper spill response training and have adequate measures on-site to contain and clean up petroleum spills. Store spill cleanup equipment in fuel storage areas or on board maintenance and fueling vehicles.

- Conduct periodic preventive maintenance of on-site equipment and vehicles to prevent leaks.

Properly store, handle, and apply fertilizers and detergents. A number of steps can be taken to reduce the risks of nutrient pollution:

- Minimize the use of fertilizers and detergents. Determine the smallest amounts needed for the tasks at hand and avoid using unnecessary amounts. Apply fertilizers and use detergents only in the recommended manner and never in amounts greater than those recommended.

- When applying fertilizers to soil, apply them at a depth of 2 to 6 inches and not on the surface. This approach will limit the contact between runoff and nutrients.
- Apply fertilizers more frequently but at lower application rates.
- Implement appropriate erosion and sediment control practices that will control and limit the amount of nutrients leaving the site due to attachment to soil particles.
- Conduct washing/cleaning operations in designated areas that are equipped to contain wash water and prevent it from being discharged to the site runoff collection and conveyance system.
- Do not mix surplus products together unless following specific instructions from the manufacturer.

Properly store, handle, and apply hazardous products. Most problems associated with the disposal of hazardous materials are the result of carelessness, not following recommended procedures, or not using common sense. The following suggestions are meant to provide general guidance for disposal of hazardous materials:

- Determine what hazardous materials are being used on-site and which hazardous waste streams, if any, are generated as a result of construction activities. Once all of the hazardous materials used and hazardous wastes generated are identified, it is possible to implement an appropriate waste management and disposal strategy.
- Know the applicable hazardous waste regulations and the associated requirements for storing, marking, and disposing of wastes. Someone on-site should be trained to properly manage hazardous wastes. If waste disposal obligations are not clearly understood, contact the correct regulatory agency to find out what specific requirements must be followed.
- Use as much of a product as possible before disposing of containers. Containers that are not empty but have been stored for disposal can be sources of drips, leaks, or spills, and they can contaminate landfills or other disposal areas.
- Do not remove the original product label from the container. It contains important use, safety, and disposal information about the product.

8.3.4.2 Develop and implement a spill control plan

Construction sites should be equipped with suitable equipment to contain and clean up spills of hazardous materials in the areas where the materials are stored or used. Accidental spills of materials used at construction sites can be sources of runoff pollution if not addressed appropriately. All spills should be cleaned up immediately after they occur. Creation of a site-specific spill control and response plan in combination with spill response training for designated on-site personnel can be effective in dealing with accidental spills and preventing the contamination of soil, water, and runoff. Preparation of a spill containment, control, and countermeasures (SPCC) plan might be required to meet regulatory requirements (e.g., requirements regarding storage of specified chemicals above certain volume thresholds). Site managers should be aware of all applicable requirements and should contact regulatory authorities if requirements are not known.

Even if a formal plan is not required, preparing one is a good idea. In general, an SPCC plan should include guidance to site personnel on the following:

- Proper notification when a spill occurs;
- Site responsibility with respect to addressing the cleanup of a spill;
- Stopping the source of a spill;
- Cleaning up a spill;
- Proper disposal of materials contaminated by the spill;
- Location of spill response equipment programs; and
- Training for designated on-site personnel.

A periodic spill "fire drill" should be conducted to help train personnel on proper responses to spills and to keep response actions fresh in their minds.

8.3.4.3 Develop and implement a waste disposal program

Implementation of good waste disposal practices at construction sites can help to significantly reduce the potential for runoff contamination. Wastes generated at construction sites can include surplus maintenance chemicals, refuse building materials, hazardous wastes, or contaminated soil and spill cleanup materials. General practices to manage such wastes include solid waste disposal, recycling, hazardous waste management, and spill prevention and cleanup measures.

(1) *Develop procedures for disposal of construction wastes.* Construction projects can generate a significant amount of what is commonly referred to as "construction wastes." Such wastes are unique to the activity and might include the following:

- Trees and shrubs removed during clearing and grubbing;
- Packaging materials such as wood, paper, plastic, and polystyrene;
- Scrap or surplus building materials such as scrap metal, rubber, plastic, glass, and masonry;
- Paints and paint thinners; and
- Demolition debris such as concrete rubble, asphalt, and brick.

To ensure proper disposal of construction wastes, the following steps should be followed:

- Select a designated on-site waste collection area.
- Provide an adequate number of containers with lids or covers that can be placed over the containers prior to rainfall.

- Locate containers in a covered area when possible.
- Arrange for waste collection before containers overflow.
- Explore recycling options for specific wastes generated at the site. Wastes such as used oil, used solvents, and construction debris can often be reclaimed or recycled, thereby reducing the amount of waste actually requiring permanent disposal. Numerous companies can provide recycling services, including the provision and maintenance of on-site recycling containers.
- Implement appropriate response procedures immediately when a spill does occur.
- Plan for additional containers and more frequent pickups during the demolition phase of construction activities.
- Ensure that all construction wastes are disposed of at facilities authorized to receive such wastes.

(2) *Develop procedures for disposal of hazardous products.* The correct method of disposal of hazardous products varies with the product used. Follow the manufacturer's recommended method as printed on the product label.

(3) *Develop procedures for disposal of contaminated soils.* Options for disposal of contaminated soil depend on the nature of the soil contamination. Under no circumstances should contaminated soils be disposed of in adjoining properties or in swamps or other wetlands because they will still pose a threat to surface and ground water. The appropriate solid and/or hazardous waste regulatory agency should be contacted concerning the proper procedures for characterizing, removing, and disposing of contaminated soil. Typically, contaminated soils can either be excavated and removed or cleaned on-site. In situ techniques include applying chemicals that break down or neutralize the contaminant, venting or sparging the soil to oxidize the contaminant, and using biological treatment to metabolize and destroy the contaminant.

(4) *Develop procedures for disposal of concrete truck waste.* Many construction projects include the use of concrete. Usually the concrete is mixed off-site and delivered to the project by truck. The concrete is poured and a residual amount of concrete remains in the truck, or the concrete is found to be unacceptable and is rejected by the construction inspector or foreman. The truck may be cleaned of residual concrete on-site. Excess concrete and wash water should be disposed of in a manner that prevents contact between these materials and runoff. For example, dikes could be constructed around the area to contain these materials until they harden, at which time they can be properly disposed of.

(5) *Develop procedures for disposal of sandblasting grits.* Sandblasting is frequently used to remove paint and dirt from surfaces. The grit generated contains both the spent blasting grit (commonly sand or steel granules) and the particles of paint or dirt removed from the surface. Sandblasting residue can be a hazardous waste if the material removed contains hazardous metals such as cadmium, lead, and chromium, which are sometimes found in paints. For this reason, sandblasting residue should not be allowed to be released to the ground or discharged

to a storm sewer or sanitary sewer, where it can cause soil or water contamination. Instead, it should be evaluated to determine whether it constitutes a hazardous waste. If determined to be a hazardous waste, it should be properly handled and disposed of; if not a hazardous waste, it should be properly managed and disposed of as a solid waste. Dumping wastes into sewers and other drainage channels is illegal and can result in fines or job shutdown (USEPA, 1993).

(6) *Develop procedures for disposal of sanitary wastes.* Construction sites usually are equipped with temporary sanitary facilities such as portable toilets for on-site personnel. Sanitary wastes can also be disposed of through septic systems or sanitary sewers. The type of facilities used on-site will dictate the appropriate management practices used to deal with the wastes. Domestic waste haulers should be contracted to regularly remove the sanitary and septic wastes and to maintain the facilities in good working condition. This maintenance will help to prevent overloading of the system, which could result in discharges in runoff. All septic systems should be installed, operated, and maintained in accordance with appropriate regulations. Any discharges to the sanitary sewer systems should be done in accordance with local sewer authority regulations.

8.4 Information Resources

EPA's National Menu of Best Management Practices for Stormwater Phase II developed numerous fact sheets describing management practices for construction site operators. The fact sheets cover both erosion control and sediment control topics, and they include sections for applicability, design considerations, costs, and effectiveness. They are available on EPA's Web site at http://www.epa.gov/npdes/menuofbmps (select "Construction Site Stormwater Runoff Control").

California's *Storm Water Best Management Practice Handbook: Construction* outlines waste management practices in a set of fact sheets that include erosion controls (scheduling, velocity dissipation devices, slope drains, stream bank stabilization, polyacrylamide, preservation of existing vegetation, hydraulic mulch, hydroseeding, soil binders, straw mulch, geotextiles and mats, wood mulching, earth dikes, and drainage swales), sediment controls (silt fence, storm drain inlet protection, chemical treatment, sediment basins, sediment traps, check dams, fiber rolls, gravel bag berms, street sweeping and vacuuming, sandbag barriers, straw bale barriers, stabilized construction entrances and exits, stabilized construction roadways, entrance/outlet tire washing), and wind erosion control. It can be downloaded in PDF format from http://www.cabmphandbooks.org/Construction.asp.

The *Erosion and Sediment Control Field Manual* from the San Francisco Regional Water Quality Control Board describes management practices for construction site planning and management, erosion and sediment control, pollution prevention, and sampling guidelines. Descriptions of practices are concise and include full-color graphics and installation information including guidelines, timing, and limitations. The manual also includes the new Phase II regulations, sampling and monitoring guidelines, and long-term maintenance information. Also available are several erosion and sediment control videos (in English and Spanish); guidelines for construction projects; a CD training kit for construction site planning and management for compliance with NPDES requirements; and the1999 version of the *Erosion and Sediment Control Field Manual.* It can be purchased for $30 at http://store.abag.ca.gov/construction.asp.

The *Kentucky Erosion Prevention and Sediment Control Field Guide* from the Kentucky Division of Water covers the entire erosion and sediment control process. The guide begins with sections on pre-project planning and operational activities and continues with erosion prevention and sediment control by starting at the top of the hill, above the project site, and proceeding down the slope through the bare soil area, ditches and channels, traps and basins, and to the waterways below. The guide can be downloaded in PDF format from http://www.water.ky.gov/sw/nps/Publications.htm.

The Minnesota Local Technical Assistance Program offers courses, videos, and guidebooks pertaining to erosion control and drainage. More information about these products can be found at http://www.mnltap.umn.edu/.

There are several research laboratories that conduct independent testing of erosion control products. The Texas Transportation Institute's Hydraulics, Sedimentation, and Erosion Control Laboratory conducts side-by-side, full-scale, performance comparisons of roll-type erosion control materials and flexible channel liners. Product testing information can be found at http://tti.tamu.edu/enviro_mgmt/facilities/hec/. The St. Anthony Falls Laboratory has an "applied research" Web page (http://www.safl.umn.edu/research/applied/index.html) with links to studies gauging the effectiveness of erosion control products.

Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices (USEPA, 1992), published by EPA's Office of Wastewater Management, provides summary guidance on the development of storm water pollution prevention plans and helps users select appropriate management practices to control erosion and sediment loss resulting from construction activities. It was designed to provide technical support for construction activities that are subject to pollution prevention requirements under NPDES permits for storm water point source discharges. This document can be viewed in PDF format at http://www.epa.gov/npdes/pubs/owm0307.pdf or it can be ordered from the National Service Center for Environmental Publications (NSCEP) at http://www.epa.gov/ncepihom/index.htm or by calling 513-489-8190 (Publication # EPA 833-R-92-001).

CPESC, Inc. offers certification for erosion and sediment control professionals. This program is sponsored by the Soil and Water Conservation Society and the International Erosion Control Association to educate field professionals on the best methods for controlling erosion and sediment and to provide evidence of professional qualifications. More information about the certification program can be found at http://www.cpesc.net.

The City of Knoxville, Tennessee, developed a manual that describes storm water management practices that the city recommends. The manual includes an introduction to storm water management practices, a discussion of the theory of erosion control, steps for selecting practices, and detailed fact sheets for each practice that include design, inspection, and maintenance information. The fact sheets cover four subject areas: activities and methods, erosion and sediment, industrial and commercial, and storm water treatment. The manual can be downloaded in PDF format at http://www.ci.knoxville.tn.us/engineering/bmp_manual.

The Delaware Department of Natural Resources and Environmental Control has assembled course materials and associated standards and specifications that contain descriptions of Delaware's BMPs for erosion, sediment, and runoff control, as well as their certification requirements for contractors. These materials, entitled *Sediment and Stormwater Management Certified Construction Reviewer Course and Associated Delaware State and DOT Standards/Specifications*, can be obtained by calling 302-739-4411.

The North Carolina Department of Environment, Health, and Natural Resources (NCDEHNR, no date) developed a suite of references pertaining to erosion and sediment control, including the *Erosion and Sediment Control Planning and Design Manual*, which provides extensive details and procedures for developing site-specific erosion and sedimentation control plans. The *North Carolina Erosion and Sediment Control Field Manual* is a conveniently sized field reference for construction and installation of erosion and sedimentation control measures and devices (does not include design charts). The *North Carolina Sediment Control Inspector's Guide* explains how to conduct inspections and evaluate projects, what to look for, and how to interact with customers. The *North Carolina Erosion and Sediment Control Practices: Video Modules* demonstrate the actual construction of 12 of the most commonly installed erosion and sediment control measures. Information for purchasing these materials can be found at the NCDEHNR Web site at http://www.dlr.enr.state.nc.us/pages/sedimentation.html.

The Texas Department of Transportation developed specifications for the use of compost for erosion control in the form of temporary erosion control devices and biodegradable erosion control logs. These specifications include a description of the practice, materials required, and construction, installation, and maintenance of the control. The specifications and other information about the use of compost for erosion control can be found at the Texas Department of Transportation Web site at http://www.dot.state.tx.us/des/landscape/compost/specifications.htm.

The Composting Council Research and Education Foundation and the U.S. Composting Council (no date) developed a manual describing ways in which compost can be used for state highway projects. The manual includes case study examples of compost use for slope stabilization, vegetation establishment, and erosion and sediment control; compost specifications and analytical testing methods; and statistics describing compost usage. *Compost Use on State Highway Applications* can be downloaded in PDF format from http://www.epa.gov/epaoswer/non-hw/compost/highway/.

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MANAGEMENT MEASURE 9
POLLUTION PREVENTION

9.1 Management Measure

Implement pollution prevention and education programs to reduce nonpoint source pollutants generated from the following activities:

- The improper storage, use, and disposal of household chemicals, including automobile fluids, pesticides, paints, solvents, etc.;
- Lawn and garden activities, including the improper application and disposal of lawn and garden care products, and the disposal of leaves and yard trimmings;
- Turf management on golf courses, parks, and recreational areas;
- Commercial activities, including parking lots and gas stations;
- Improper disposal of pet wastes; and
- Activities that generate trash.

9.2 Management Measure Description and Selection

9.2.1 Description

This management measure is intended to prevent or reduce nonpoint source pollutant loadings generated from a variety of activities within urban areas. Everyday activities of citizens, municipal employees, and businesses have the potential to contribute to nonpoint source pollutant loadings. These activities include improper use and disposal of household chemicals, lawn and garden maintenance, turf grass management, operation and maintenance of diesel and gasoline vehicles, illicit discharges to urban runoff conveyances, commercial activities, and improper pet waste disposal. Reducing pollutant generation can decrease adverse water quality impacts from these sources.

The practices presented in this management measure are often referred to as source reduction practices. They are nonstructural in nature (i.e., they do not require infrastructure) and can be used to reduce pollutant generation and maintenance costs. Source control practice costs are typically associated with programmatic expenses such as signage, outreach materials, workshops, and development and enforcement of ordinances. Although agricultural sources are not specifically addressed in this chapter, agricultural sources in an urban or suburban watershed should also be considered when developing a pollution prevention plan (see Management Measure 1 – Program Framework and Objectives). Source controls for agriculture can be found

Getting in Step: A Guide to Effective Outreach in Your Watershed

Getting in Step is a guide published by EPA to provide a summary of useful tools for developing and implementing an effective watershed outreach plan. The manual uses a step-by-step approach to help watershed practitioners address public perceptions, promote management activities, and inform or motivate stakeholders. Getting in Step is divided into three parts, as follows:

- Part I presents the overall framework for developing and implementing an outreach plan. It provides specific information about defining goals and objectives; identifying the target audience; creating, packaging, and distributing the message; and evaluating the outreach plan.
- Part II provides tips and examples for developing and enhancing outreach materials, with emphasis on elements of composition and layout, using artwork and photos, establishing a watershed identity, packaging the watershed message, and estimating costs.
- Part III provides specific tips on working with the news media to gain improved media coverage of water quality issues.

Getting in Step also includes worksheets, graphics for use without permission, and information on additional outreach and education resources. The manual is available for download from http://www.epa.gov/owow/watershed/outreach/documents/getnstep.pdf or by calling Books on Demand at 1-800-521-3042.

in *National Management Measures to Control Nonpoint Source Pollution from Agriculture*, which can be accessed at http://www.epa.gov/owow/nps/agmm/index.html.

9.2.1.1 Household chemicals

Many everyday household chemicals are flammable, combustible, toxic, explosive/reactive, or corrosive. If these chemicals are released into the environment, they can pose long-term threats to human health, wildlife, vegetation, and other environmental resources. Unlike industrial hazardous wastes, not all household chemicals are regulated by federal, state, and local laws. In fact, the Federal Resource Conservation and Recovery Act, which regulates hazardous waste, has a special exemption for "household hazardous wastes" as defined in the act (Kopel, 1998). It is important to note that state and local regulations may be more stringent than federal regulations. The Federal Insecticide, Fungicide, and Rodenticide Act regulates the use and disposal of pesticides, herbicides, and fungicides through labeling. It is important that users of these chemicals follow label instructions carefully, because they provide specific information that help prevent harm to human and environmental health.

The four main avenues for household chemicals to become problem pollutants are through leaks and spills, improper use, improper storage, and improper disposal.

(1) *Leaks and spills*. Chemicals leaking from improperly maintained automobiles and lawn equipment or faulty containers can accumulate on roads, driveways, and lawns and be carried by runoff to receiving water bodies.

(2) *Improper use.* Failure to follow label instructions properly may result in over-application of fertilizers or pesticides and can lead to chemical accumulation in the soil and grass. These chemicals can leach to ground water or be carried by runoff to surface waters.

(3) *Improper storage.* Improper storage of chemicals can lead to spills that can contaminate runoff and ground water or result in dangerous chemical reactions.

(4) *Improper disposal.* It is a common practice for citizens to pour unwanted chemicals, such as detergents, cleansers, or automotive fluids, onto their lawns or driveways or directly down storm drains. Contrary to popular belief, most storm sewers do not connect to wastewater treatment plants—chemicals disposed of this way could be discharged directly to receiving water bodies. Additionally, when chemicals are poured down drains connected to a wastewater treatment plant or septic system, they could interfere with treatment systems by killing the bacteria that metabolize pollutants, causing water discharged from the plants to be contaminated. Ground water is also at risk because runoff can carry these chemicals through the soil to the water table. Product labels describe requirements for proper disposal and should be followed carefully.

(5) *Outdoor car washing.* This activity can result in high loads of nutrients, metals, and hydrocarbons being carried to receiving waters during dry weather conditions when the wash water flows into the storm drain system. According to surveys, 50 to 75 percent of households wash their own cars and 60 percent of those households wash their cars at least once a month (Schueler and Swann, 2000b).

9.2.1.2 Failing septic systems

Approximately one in four American households relies on a septic system to dispose of their wastewater. Septic systems have a failure rate of 5 to 35 percent, depending on soil conditions and other factors. When septic systems fail, the untreated or partially treated wastewater discharges to surface and ground waters. A survey conducted in the Chesapeake Bay watershed found that the average age of septic systems in the area was about 27 years, which is seven years beyond the design life of an unmaintained system. About half the owners indicated that they had not inspected or cleaned out their system in the previous three years. (Schueler and Swann, 2000b).

9.2.1.3 Lawn and garden activities

Lawn care practices are often targeted by watershed managers as contributors of pesticides and nutrients to runoff. A nationwide study by the U.S. Geological Survey (USGS) in 1999 found a high incidence of insecticides and herbicides in urban streams. Insecticides commonly used in homes, gardens, and commercial areas were found more frequently and in higher concentrations in urban streams than in agricultural streams. These concentrations often exceeded guidelines for the protection of aquatic life. Herbicides, such as those used for weed control, were found in 99 percent of sampled streams, but rarely at levels that exceeded guidelines.

A recent summary of the water quality monitoring efforts by USGS's National Water Quality Assessment Program (2004) revealed high concentrations of pesticides, most commonly diazinon, malathion, chlorpyrifos, and carbaryl, in urban waterways; these chemicals were typically found in higher concentrations in urban streams than in agricultural streams. Although several of these pesticides are used commonly in household applications, findings in Thornton Creek near Seattle suggested that many of the pesticides were from commercial or municipal activities because the chemicals are not readily available on the retail market.

Surveys showed that roughly half of the total diazinon applications in the San Francisco Bay Region were to lawns and landscaped areas. In 1995, 27 percent of urban creeks sampled in the San Francisco Bay Region demonstrated potentially toxic levels of diazinon (Katznelson and Mumley, 1997). Research on diazinon indicates that even proper use, characterized by following label instructions, can result in harmful levels of diazinon in urban streams (Schueler and Swann, 2000d).

While these results alone do not specify the relative contribution of lawn care activities to urban pollution, they do indicate that there is a need for watershed-specific management actions. Many aspects of the risks associated with commonly occurring pesticides in the environment are not yet clearly understood. Drinking water standards have only been established for 10 of the 75 pesticides detected by the USGS National Water Quality Analysis, and aquatic life criteria have been developed for only six (Graffy, 1998; USGS, 1999).

Maintaining a healthy lawn might require fertilizers, pesticides, and heavy watering in some areas. Overuse of fertilizers, pesticides, and water can lead to excessive growth, increased pest problems, and environmental damage. In terms of fertilizer inputs, nutrients typically are applied to lawns at about the same rates as for row crops. One study in Marquette, Michigan, indicated that nitrogen and phosphorus concentrations in runoff from lawns were five to 10 times higher than runoff from other land uses (Schueler and Swann, 2000e). Contrary to popular belief, it is possible to achieve a beautifully landscaped yard with judicious use of fertilizers, pesticides, and irrigation. A large body of literature by turf researchers shows that healthy and well-managed turf grass can actually slow runoff and trap pollutants (Beard and Green, 1994; Schueler and Swann, 2000c; USEPA, 1992). The products applied to lawns—fertilizers, pesticides, and herbicides—can pollute runoff if label instructions are not properly followed. Studies on the characteristics of urban lawns have shown that the soils are often compacted, increasing runoff to the point that it is comparable to runoff on some pavements (NCSCS, 2000). Fertilizers contain nitrogen and phosphorus, which become pollutants when runoff carries excess fertilizers into lakes and streams. Excessive nutrients stimulate algae growth that can lead to death and decay of aquatic vegetation due to light and oxygen deprivation.

Lawns also require physical maintenance in the form of mowing, raking, and removing weeds, clippings, and branches. Yard trimmings comprised 12 percent of the total tonnage of municipal solid waste generated in 2000, second only to paper products (USEPA, 2002). Alternative practices can reduce the quantity of yard wastes generated by lawns and enable reuse of yard wastes to extend the capacity of landfills.

9.2.1.4 Commercial activities

Runoff from commercial land uses, such as shopping centers, office parks, and parking lots or garages may contain high hydrocarbon loadings and metal concentrations that are twice those found in the average urban area. These loadings can be attributed to heavy traffic volumes and large areas of impervious surface on which automotive-related pollutants concentrate (refer to Management Measure 7, Bridges and Highways, for a discussion of automobile-related pollutants). Other commercial uses, such as vehicle maintenance, liquids storage, and equipment storage and maintenance, can also introduce pollutants to runoff.

In most communities, gas stations are designated as a commercial land use and are subject to the same controls as shopping centers and office parks. However, gas stations may generate high concentrations of heavy metals, hydrocarbons, and other automobile-related pollutants. Since gas stations have high potential loadings and pollutant profiles similar to those of industrial sites, good housekeeping controls, such as those used on industrial sites, are recommended.

Restaurants are sometimes considered hot spots for nonpoint source pollution because they generate oils and grease that can contaminate runoff when disposed of improperly. Grease can also clog sanitary sewer laterals if sinks are not equipped with grease traps or interceptors, resulting in sanitary sewer overflows and increased maintenance of sewer lines. Poor housekeeping practices in the outdoor areas of restaurants, such as storing food waste in uncovered or leaky garbage bins and dumpsters or hosing off floor mats in the parking lot, can cause bacteria, detergents, organic matter, and other pollutants to come into contact with runoff.

Municipalities can target pollution prevention campaigns to specific commercial activities that are suspected of contributing to nonpoint source pollution. Typically, these campaigns involve an assessment of commercial facilities to identify the types of waste produced. The campaigns also outline methods to reduce the total amount of pollutants generated on-site and to properly dispose of pollutants. A set of rules and use limitations that a commercial tenant must agree to as a condition of occupying a site can be implemented in commercial covenants, conditions, and restrictions.

9.2.1.5 Pet wastes

When pet waste is not properly disposed of, it can wash into nearby water bodies or be carried by runoff into storm drains. Since most urban storm drains do not connect to treatment facilities, but rather drain directly into lakes and streams, untreated animal waste can become a significant source of runoff pollution. As pet waste decays in a water body, the degradation process uses oxygen and sometimes releases ammonia. Low oxygen levels and the presence of ammonia, combined with warm temperatures, can be toxic to fish and aquatic life. Pet waste also contains nutrients that promote weed and algae growth. Perhaps most importantly, pet waste carries microbes, such as bacteria, viruses, and parasites, that can pose a health risk to humans and wildlife. For example, fatalities in sea otters off the coast of California have been traced to a protozoan, *Toxoplasma gondii*, found in cat feces. *T. gondii* can cause fatal brain infections in otters and muscle cysts in humans (Glausiusz, 2002). Pet waste can be controlled through enforcement of ordinances (e.g., warnings and citations, public education, signage, and disposal containers).

9.2.1.6 Trash

Trash and floating debris in waterways have become significant pollutants, especially near urban areas where a large volume of trash can be generated in a concentrated area. Trash contributes to visual pollution and detracts from the aesthetic qualities of the landscape. Boaters have complained that trash and debris clog engine intake valves and propellers, resulting in expensive repairs. Finally, municipalities must incur the cost of clean-up efforts to restore water quality.

9.2.2 Management Measure Selection

This management measure was selected to identify ways in which communities can implement practices that bring about behavioral changes to reduce nonpoint source pollutant loading from the sources listed in the management measure. Such activities include public education, proper management of maintained landscapes, source reduction, training and runoff control plans for commercial sources, pet waste management activities, and trash control. Communities can select practices that best fit local priorities and funding. It is important for the watershed manager to note that community acceptance is often the major determinant of whether education and outreach activities and administrative mechanisms such as certification and training requirements are practical and effective solutions.

9.3 Management Practices

9.3.1 Household Chemicals

A host of biodegradable cleaners and other less-toxic chemicals are commercially available. Such alternative products typically contain chemicals that rapidly break down in soil and water into fewer toxic constituents, or they are reusable or recyclable. These include low-phosphate or phosphate-free detergents and water-based products. These alternative products can be used in combination with traditional chemicals as part of an integrated pest management program or for everyday household cleaning. Although there may be instances when it is necessary to use stronger chemicals (for example, to target bacteria), often a simple, milder cleanser will do the job.

Although alternative products are generally less harmful than commercial cleaners, it is still just as important to follow their instructions for proper storage and handling. Alternative products and homemade mixtures should be stored in clean, store-bought containers and properly labeled to avoid confusion with food or drink (USEPA, no date; USEPA and Perdue University, 1997). While some alternative products may claim to be disinfectants, cleaners that are registered as disinfectants must meet EPA testing requirements. The EPA's *Source Reduction Alternatives Around the Home*, which is part of the *Consumer Handbook for Reducing Solid Waste*, provides a brief discussion of alternative cleaning methods as well as proper storage and handling procedures (USEPA, no date).

A 1994 study compared commercial cleaners with various alternative products, including lemon juice, vinegar, ammonia, baking soda, and borax. The study found that commercial cleaners were more effective than the alternatives at both soil removal and microbial reduction. Alternative cleaners were found to achieve soil removal with some additional work. Among the alternative cleaners, borax and ammonia were most effective at soil removal. Vinegar was most effective in reducing microbial contamination. The study recommended sequential use to maximize cleaning effectiveness (USEPA and Purdue University, no date).

The key to preventing household chemicals from entering receiving waters is to educate the public about the importance of taking care when storing and disposing of everyday materials.

The practices discussed below are intended to inform the public on proper procedures for handling and disposing of household chemicals to prevent pollution and to instill a sense of responsibility for their actions and choices as consumers.

9.3.1.1 Educate the public on proper storage and disposal of household chemicals

Watershed managers can produce outreach materials describing methods that citizens should follow to store household chemicals in appropriate containers and storage areas to prevent leaks, spills, accidental ingestion, and fire or explosion hazards. Tips can include covering piles of chemicals that can come into contact with rainfall or runoff; ensuring that containers for volatile, corrosive, or otherwise harmful chemicals are intact; and clearly labeling all containers with the name of the material and proper storage and disposal procedures. Pesticides, herbicides, and fungicides are addressed below in the Pest Management section.

Citizens should also be encouraged to follow the manufacturer's recommendations for disposal of household chemicals. Many communities across the country have implemented programs to collect and safely dispose of these chemicals, such as providing year-round collection facilities or sponsoring what many communities call "household hazardous waste" collection days. Effective outreach programs keep citizens informed about the location and hours of operation of disposal facilities and provide a list of waste products that are accepted.

Recycling of certain household chemicals, especially used oil and batteries, can reduce the amount of potentially harmful materials that enter a landfill. Many municipalities and automotive service stations provide used oil and antifreeze recycling facilities for "do-it-yourselfers" to encourage environmentally sound chemical management. Outreach materials, such as pamphlets and utility bill inserts, can be developed to inform the public of locations and hours of operation of local recycling facilities.

9.3.1.2 Conduct storm drain marking

Storm drain marking involves labeling storm drain inlets with painted or prefabricated messages that warn citizens of the environmental hazards of dumping materials into storm drains. Marking projects are typically conducted by volunteer groups in cooperation with local authorities. The messages can be a simple phrase to remind passersby that the storm drains connect to local water bodies and that dumping pollutes those waters. Some specify which water body the inlet drains to or name the particular river, lake, or bay. Common messages include "No Dumping—Drains to Water Source," "Drains to River," and "You Dump it, You Drink it. No Waste Here." Communities with a large Spanish-speaking population might wish to develop markers in both English and Spanish or use a graphic without text (Davenport, 2003).

9.3.1.3 Encourage responsible car washing practices

Schueler and Swann (2000b) summarized results of several surveys of automobile owners and their car washing behavior. The researchers found that 55 to 70 percent of households wash their own cars, with the remainder taking their cars to commercial car washes. Sixty percent of residents washed their cars at least once a month, and between 70 and 90 percent of residents reported that their car wash water drained directly to the street and presumably into the runoff conveyance system. These results indicate that an appreciable amount of wash water laden with detergents, dirt, and automotive fluids can wash into the storm drain system or directly into receiving waters in urban areas.

It is preferable for citizens to patronize commercial car washing facilities because they are mandated under the regulatory authority of the NPDES program (see the Introduction for a description of the NPDES program) to treat and/or reuse wash water, whereas residential car washing activities are exempt from requirements under Phase I MS4 permits and Phase II general permits (USEPA, 2003b). If commercial facilities are not available or if residents prefer to wash their cars themselves, they should be encouraged to wash their cars less often, especially in areas with water bodies sensitive to nutrient enrichment. Another practice to reduce the impact of car washing on receiving waters is to wash cars on grass or another permeable surface to filter dirt and detergents (this practice should be avoided in areas that recharge drinking water supplies). Additionally, citizens should use a sponge and bucket to reduce the amount of wash water used and to allow it to be disposed of down a household drain that is connected to the sanitary sewer or septic system. Finally, low-phosphate detergents should be used to minimize the eutrophic effects of wash water in receiving waters.

Community car washes, such as those conducted for fundraisers, are not specifically addressed in Phase II MS4 requirements, but may be a particularly large source of contaminated runoff. Some communities are experimenting with fundraiser registration, practices that block storm drains during community car washes, and the designation of pervious areas for the diversion of runoff. Kitsap County, Washington, uses a patented device called a Bubble Buster to divert water away from storm drains during community car washes (USEPA, 2003b).

9.3.2 Lawn, Garden, and Landscape Activities

Lawns are a significant feature of urban landscapes. This large area of managed landscape has the potential to contribute to urban runoff pollution due to over-fertilization, overwatering, over-application of pesticides, and direct disposal of lawn clippings, leaves, and trimmings. Also, erosion from bare patches of poorly managed lawns contributes sediment to watercourses, and disposal of lawn clippings in landfills can reduce the capacity of these facilities to handle other types of waste. Public education for citizens and municipal crews with respect to pest tolerance and proper handling of fertilizers, pesticides, water, and yard waste can greatly reduce the potential for adverse impacts to waters receiving runoff from lawns. Municipalities and watershed managers should develop an outreach campaign that targets citizens, lawn care businesses, landscapers, and municipal crews. Materials should highlight the following steps to help citizens and lawn care professionals maintain healthy, attractive lawns with less maintenance and fewer chemical inputs:

- Lawn conversion
- Soil building
- Grass selection
- Mowing and thatch management
- Minimal fertilization
- Weed control and tolerance
- Pest management
- Sensible irrigation

While all of the above practices are applicable to both citizens and lawn care professionals, they will differ when implemented due to differences in scale. For example, lawn care services may have multiple employees, carry large quantities of fertilizers and pesticides, and manage vast expanses of turf. Therefore, in addition to the above practices, good housekeeping is particularly important for lawn care professionals, landscapers, and municipal crews. Housekeeping includes implementing materials management and spill prevention plans and conducting employee training (see the Commercial Activities section). In addition, site development considerations for landscaped areas and golf courses should aim to protect local water bodies by avoiding sensitive areas, providing sufficient buffers, and ensuring erosion and sediment control during construction and maintenance activities (Center for Resource Management, 1996). See Management Measure 3—Watershed Protection and Management Measure 8—Construction Site Erosion and Sediment Control for more information about buffers and erosion and sediment control, respectively. Information resources specific to citizens and landscape professionals are provided at the end of this chapter.

Local cooperative extension services can provide assistance with the practices described in this section. State-specific cooperative extension service information is available from the Cooperative State Research, Education, and Extension Service (CSREES) at http://www.csrees.usda.gov/qlinks/partners/state_partners.html. Cooperative extensions are part of a nationwide organization authorized by Congress, and each state has designated a land grant university to administer its cooperative extension. Cooperative extensions conduct applied research and educational outreach such as workshops, conferences, fact sheets, and newsletters. These organizations are an excellent resource for information and assistance with lawn care practices. For example, the Virginia Tech Cooperative Extension Web site, http://www.ext.vt.edu/, maintains the *Database of Fact Sheets on Home Gardening and Insecticides/Pesticides*. The Rutgers University Cooperative Extension publishes fact sheets such as *How to Calculate the Amount of Fertilizer Needed for your Lawn* and *Best Management Practices for Home Lawns* (http://www.rce.rutgers.edu/).

NRCS's Backyard Conservation

USDA's Natural Resources Conservation Service (2000) Web site sponsors a Backyard Conservation Web site (http://www.nrcs.usda.gov/feature/backyard/) that presents technical information and management practices to "increase food and shelter for birds and other wildlife, control soil erosion, reduce sediment in waterways, conserve water and improve water quality, inspire a stewardship ethic, and beautify the landscape." The Web site includes 10 conservation practice standards, such as composting, mulching, nutrient management, pest management, and terracing, which have been modified for use in suburban landscapes.

9.3.2.1 Lawn conversion

Grasses are very water-hungry and labor-intensive landscaping plants when compared to ground cover, flowers, shrubs, and trees. Therefore, to reduce the maintenance requirements of a lawn and address problem areas where turf is difficult to grow, property owners could identify areas where turf grass can be replaced with other types of plantings. These areas include lawn edges, frost pockets, exposed areas, dense shade, steep slopes, and wet, boggy areas. Replacement vegetation that is best suited to local conditions should be chosen to replace turf. Recommendations for drought-tolerant plants are available from a local extension office. State-specific cooperative extension service information is available from the Cooperative State Research, Education, and Extension Service (CSREES) at http://www.csrees.usda.gov.

9.3.2.2 Soil building

Lawn owners should analyze their soil every one to three years to determine its suitability for supporting a lawn and to identify whether additives are needed or adjustments should be made to optimize growing conditions. Soil characteristics that should be measured include pH, fertility, compaction, texture, and earthworm content. Soil test kits (for pH and fertility) can be purchased inexpensively at a garden center, or samples can be analyzed for free by a local cooperative extension service. Soil tests reveal whether fertilizer or lime is needed, helping to avoid over-fertilization and loss of nutrients. Surveys have indicated that only 10 to 20 percent of citizens test their soil to determine fertilization needs (Schueler and Swann, 2000c).

Prior to planting, sandy and heavy clay soils may be amended by adding organic compost to improve aeration and nutrient-holding capacity. Compacted soil under an established lawn should be aerated to improve the flow of water, fresh air, and nutrients to the system. Aeration is a non-chemical technique that relieves compaction, increases rooting, helps prevent thatch accumulation, incorporates organic matter into the soil surface, and helps prevent damage by insects and disease (Troutman, 2003). Core cultivators, which aerate by pulling small plugs of soil from the lawn, can be found at many local rental agencies (Mugaas, 1999). Soil texture can be determined with a settling test or by squeezing a handful of moistened soil through the fist. If soils prove to be very sandy or very clayey, organic matter such as compost, manure, or grass clippings should be added (USEPA, 1992). While the presence of earthworms is an indicator of healthy soil, the presence of white, healthy roots is the ultimate goal. Rooting can be checked by cutting a four-inch deep slice or plug of turf and soil. Roots should be at least four inches deep, and the tips should be white. Poor root condition may be a result of compacted soils, ineffective watering practices, or poor fertilization (Troutman, 2003). If a lawn does need soil amendments (e.g., an adjustment to pH or aeration to address compaction) a local cooperative extension service can provide the technical guidance necessary to care for the lawn properly (USEPA, 1992). State-specific cooperative extension service information is available from the Cooperative State Research, Education, and Extension Service (CSREES) at http://www.csrees.usda.gov. For more information on soil amendments, see the discussion of Erosion Control Practices in Management Measure 8—Construction Site Erosion, Sediment and Chemical Control.

9.3.2.3 Grass selection

Grass seed is available in a wide range of cultivated varieties, so citizens are able to choose the grass type that grows well in their particular climate, matches site conditions, and is consistent with the property owner's desired level of maintenance. Consideration should be given to seasonal variations in rainfall and temperature. Several grass varieties have been developed with increased resistance to disease and insect damage, which reduces pesticide use. Some turf varieties have high levels of endophytes, a fungus that does not threaten the grass but eradicates common lawn pests such as billbugs, sod webworms, and aphids. Tall fescue, zoysia grass, and Bermuda grass tend to be highly resistant to insects (Audubon Society, 2000). Other varieties have been selected to be slow growing, which requires less mowing, fertilizer, and water. Care should be taken to select the species and cultivated variety that are best adapted to the site conditions. Selecting the correct variety will result in a healthier lawn that is better able to compete with weeds and resist insects and disease (Bruneau, 2001; USEPA, 1992).

9.3.2.4 Mowing and thatch management

Each turf grass variety has an ideal mowing height range. Turf grasses use water more efficiently and out-compete weeds better when kept at the higher end of the ideal mowing height range. Mowing grass too short decreases rooting and increases the need for frequent watering. Tall turf competes more vigorously against weeds and can usually tolerate more insect and disease pressure (Troutman, 2003). Property owners might need to mow grass more frequently to maintain a minimum healthy height, depending on the type of grass planted and the local climate. Property owners should understand that grass grows at different rates throughout the seasons. As a result, some lawns may need to be mowed every four or five days when they are growing rapidly (Troutman, 2003). Therefore, grass should be mowed only as needed. If excessive thatch (which can prevent nutrients and water from reaching grass roots) has developed, the lawn should be dethatched by raking or using an automated dethatcher, or it could be sprinkled with compost and then aerated. Some grasses are more prone to developing thick layers of thatch than others. A thatch layer less than ½ inch can be beneficial by providing insulation and increasing the turf's resiliency (Mugaas, 1999; Murphy, 1994; USEPA 1992).

To prevent insects and weeds, property owners should mow high and frequently, and keep mower blades sharp to avoid tearing or injuring the grass. Longer grass is exposed to more sunlight, which allows it to develop a deep root system and increases tolerance to drought, insect damage, and disease. Lawns should not be cut shorter than 2½ to 3½ inches because weeds can grow more easily in short grasses. Grass can be cut lower in the spring and fall to stimulate root growth, but not shorter than 1½ inches (Audubon Society, 2000; USEPA, 1992). Table 9.1 lists recommended mowing heights for various types of grasses.

Table 9.1: Mowing heights for various grass types (PCLAA, No Date).

Grass Type	Mowing Height
Kentucky Bluegrass	3.0 in.
Fescues & Ryegrass	3.0 in.
Bent grass	1.0 in.
Bermuda grass	1.0 to 1.5 in.
Zoysia grass	1.0 to 1.5 in.
St. Augustine grass	3.0 in.
Bahia grass	3.0 in.
Centipede grass	1.5 in.

9.3.2.5 Yard waste management

Recent concerns about landfill capacity have prompted a number of states to ban the disposal of yard waste in landfills (Fickes, 2002). Approximately 3,800 yard waste composting programs were operating in the United States during 2000 (USEPA, 2002). Most of these were located in the Northeast, Midwest, and South where landfill capacity is of concern and many states have

Yard Waste Ban

In Syracuse, New York, a 1992 ban on yard waste disposal resulted in 45 percent of households composting yard waste and 55 percent leaving clippings on the lawn. The ban, instituted by the Onondaga County Resource Recovery Agency (OCRRA) in North Syracuse, prohibited grass, leaves, and brush from being disposed of with the trash. OCRRA has run an eight-year, $300,000 public education campaign. OCRAA's outreach program involves home composting workshops; the distribution of flyers, and TV, radio, and newspaper ads with the themes "A Recipe for Compost," "Time for a Trim," and "Keep Your Clippings on the Lawn" (Lalonde, 2000).

instituted yard waste bans. In the West, where landfill capacity is relatively high and no statewide yard waste bans exist, there are only approximately 400 composting programs.

Yard trimmings accounted for nearly half the municipal waste eliminated or diverted through source reduction programs in 2000 (USEPA, 2002). Source reduction has been a successful component of municipal waste management, and is a major reason why landfill capacity at a national level remains relatively constant. In fact, source reduction is estimated to have prevented a 25 percent increase in solid waste in 2000. As of 2000, 34 states had more than 10 years of landfill capacity remaining, 12 had five to 10 years, and two had less than five years of capacity remaining. (USEPA, 2002).

Yard clippings can be managed by reapplying them to lawns, or by composting at home or at community composting facilities. Reapplying clippings to yards, known as grass-cycling, reduces solid waste and can decrease the need for fertilizer and water by adding nutrients and limiting evaporation. Yard clippings do not contribute to thatch buildup, because thatch is comprised of the stems and roots of grass, not the blades (Mugaas, 1999; Relf, 1997). Removing a mower's collection bag is an easy way to automatically incorporate grass-cycling into regular mowing activities (PLCAA, no date (a)). Yard waste can also be composted and reapplied to improve water retention, add nutrients, and reduce erosion (Relf, 2001). Full bans on disposal are not the only option for yard waste management; partial bans and voluntary programs can also help to encourage citizens to employ yard waste management practices such as composting and leaving clippings on the lawn. Communities can integrate yard waste into their solid waste management program by offering curbside collection services or providing public drop-off sites (USEPA, 1994).

9.3.2.6 Minimal fertilization

Based on the results of the soil test described above, a lawn might require additional nutrients to promote or maintain healthy growth. Nutrients can be partly supplied by leaving a moderate amount of fine grass clippings on the lawn after mowing—these clippings can provide nearly half of the required nutrients to the lawn and they hold in moisture, speed decomposition, and relieve the burden of landfills to handle excess yard waste. Additional nutrients can be supplied with compost or commercial fertilizers that are of an organic or encapsulated nitrogen type, but they should be applied at or below the rates prescribed on the packaging. Compost or organic and encapsulated nitrogen fertilizers reduce the risk of nutrient leaching and have been shown to release nutrients more gradually. Slow-release fertilizers are also beneficial for reducing nitrogen losses from soils that are prone to leaching (Bureau, 2001). Organic products offer the additional benefits of increasing soil condition and promoting the growth of desirable soil organisms.

Timing of fertilization is very important. Cool-season grasses respond best to fall fertilization followed by light applications of fertilizer in the spring. Warm-season grasses generally benefit more from spring and summer fertilization. Fertilizers require water for activation; a light watering is usually enough (note that fertilizer should not be applied if rainfall is expected).

Excessive fertilization causes unwanted growth and the need to mow more often. Fertilizing at the wrong time of year may favor the growth of weeds rather than healthy turf. Excessive fertilization along with excessive watering can lead to the buildup of thatch that can increase insect and disease problems (Troutman, 2003).

The City of Austin recently commissioned Texas A&M University to conduct a study of the potential effects of residential lawn care practices on water quality in Stillhouse Spring, located in the environmentally sensitive recharge zone of the Northern Edwards Aquifer. Water quality tests have shown that nitrate levels in the aquifer are among the highest in the city. Nine different fertility treatments on test plots were studied. The plots were tested for appearance and the amount of nitrogen, phosphorous, and potassium that leached through the soil to ground water. The study resulted in a reevaluation of recommended fertilization practices for citizens. Recommendations still include soil testing, careful calculation of fertilizer amounts, and grass-cycling. However, researchers found that organically fertilized plots had less nitrogen leaching, were denser and more attractive, and were successful in retaining soil moisture and decreasing runoff in storm events. Because soils in Austin are particularly high in phosphorus, citizens in the area are now advised to use low-phosphorus fertilizers (Provin, 2002). Additional studies of residential lawn care practices and regionally specific runoff from urban lawns would be a beneficial addition to the large body of research on turf grass.

A local cooperative extension service should be consulted about the proper use of fertilizers. State-specific cooperative extension service information is available from the Cooperative State Research, Education, and Extension Service (CSREES) at http://www.csrees.usda.gov.

9.3.2.7 Weed control and tolerance

A property owner must decide how many weeds can be tolerated before action is taken to eradicate them. A few weeds will not substantially interrupt the continuity of the turf. The best way to keep weeds at bay is to maintain a healthy, dense lawn that shades the ground surface, preventing weed seedlings from taking root. However, if weeds do take hold, they should be dug or pulled out. Chemical herbicides should be used to spot-treat weeds, not applied universally. A local cooperative extension service should be consulted about the proper use of herbicides. State-specific information regarding cooperative extension services is available from CSREES at http://www.csrees.usda.gov.

9.3.2.8 Pest management

Integrated Pest Management (IPM) is an effective and environmentally sensitive approach that relies on a combination of common-sense practices. IPM programs use current, comprehensive information on the life cycles of pests and their interaction with the environment. This

Targeted Herbicide Application

Targeted herbicide application, which uses infrared and other technologies, can help locate and control roadside weeds at lower costs than conventional weed control methods (Stidger, 2001). Patchen, Inc., which is located in Ukiah, California, manufactures small sensors that can be used on trucks or other equipment to pinpoint the location of undesirable plants and then target and spray the weed with herbicide. Each sensor views a 12-inch wide area and upon finding weeds, it signals a spray nozzle to deliver a precise amount of herbicide. The unit will spray only on weeds and not on bare ground. Several California Department of Transportation districts have already mounted the sensors onto equipment. According to company reports, a side-mounted strip of sensors at the rear of the vehicle lets the unit target and spray roadside weeds at 10 miles an hour. Sensors can be also used at night when there is less traffic because the sensors have their own light source. Compared to broadcast or manual spot spraying, sensors reduce the quantity of herbicide used and cut overall costs by 50 to 80 percent. Sensors also cut costs by reducing required work hours, because only the driver is needed to apply the herbicide.

Research at North Carolina State University (Burton and Skroch, 1997) developed an herbicide applicator to attach to weed mowers to control roadside vegetation. The unit applies a film of chemical to the weed stem as the mower cuts the plant. Between 70 and 90 percent of the herbicide is absorbed into the plant to prevent future growth. With other methods, as much as 80 to 90 percent of the sprayed chemical misses its target and is wasted.

The Minnesota Department of Transportation tested four innovative herbicide sprayer designs in an effort to reduce costs. According to a research report, all four sprayers saved money when compared to traditional sprayer use. Net annual savings from each of the four sprayers ranged between $23,255 and $65,812.

information, in combination with available pest control methods, is used to manage pest damage by the most economical means and with the least possible hazard to people, property, and the environment.

IPM is not a single pest control method but a series of pest management evaluations, decisions, and controls. IPM is a sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools. Biological controls involve the use of natural enemies to manage pests. Cultural practices include mowing, fertilization, irrigation, aeration, dethatching, and rolling. Physical controls include removal of insects and affected plant material by hand or removal of pests with store-bought traps. Chemical controls involve the use of pesticides. Municipalities can encourage citizens and lawn care professionals to practice IPM and train municipal maintenance crews to use these techniques for public open space.

Effective pest management begins with maintenance of a healthy, vigorous lawn that is naturally disease-resistant. Mulching can be used to prevent weeds where turf is absent; fencing can be installed to keep rodents out; and netting can be used to keep birds and insects away from leaves and fruit. Planting disease-resistant species and alternating different types of plants can help prevent infestation. In addition, simple pest prevention techniques can reduce the likelihood that pesticides will be needed. These include destroying hiding places such as diseased plants and fallen fruit, cleaning up pet waste, and removing puddles (USEPA, 1995). Citizens should monitor plants for obvious damage and should check for the presence of pest organisms. It is important to be able to distinguish beneficial insects and arachnids, such as green lacewings, ladybugs, and most spiders, from ones that will damage plants. When damage is detected or when harmful organisms are present, citizens should determine the level of damage the plant is able to tolerate. No action should be taken if the plant can maintain growth and fertility in the presence of these pest organisms. If controls are needed, there is an arsenal of low-impact pest management controls and practices to choose from that include preventative measures such as planting disease-resistant species and promoting beneficial organisms. See the USDA Regional Pest Management Centers Information System Web site at http://www.ipmcenters.org/ for more low impact strategies.

Integrated Pest Management (IPM) combines the use of these lower-impact practices with targeted chemical controls. Chemical controls are highly effective but may result in damage to or death of desirable species, such as bees. If strong chemical pesticides are applied improperly, they can contaminate receiving waters. Several less-toxic pesticide alternatives are available to prevent infestations or halt current infestations. Biopesticides, for example, are used to control pests without the use of poison. Biopesticides can be "biochemical," such as garlic and pheromones, or "microbial," such as bacteria, fungi and viruses (USEPA, 2003). Garlic and baking soda have been shown to be effective when applied as an aqueous solution to plants. Other pest control alternatives include insecticidal soap, which destroys pest membranes, *Bacillus thuringiensis* (a beneficial bacteria found in compost and other organic soil additives), milky spore (a natural bacteria that kills the grub phases of Japanese beetles), and dormant oil sprays applied when the plants are not growing. When used as a component of IPM programs, biopesticides can greatly decrease the need for conventional pesticides. The Biopesticides and Pollution Prevention Division in EPA's Office of Pesticide Programs promotes the use of biopesticides as components of IPM programs. The Biopesticides Web site, http://www.epa.gov/pesticides/biopesticides, provides information on biopesticide registration, active ingredients, product lists, and contact information.

Municipalities should try to select the least-toxic, least-water-soluble, and least-volatile pesticides possible. Pesticides should be evaluated based on their toxicity and their potential to run off to surface water or leach into ground water (Peacock et al., no date). Organophosphate pesticides, such as diazinon and chlorpyrifos, were popular because they target a broad range of pests and they are less expensive than newer, less-toxic pesticides. A risk assessment by EPA has determined that chlorpyrifos posed an unacceptable risk to public health, particularly children's health (USEPA, 2000). It was found that diazinon posed unacceptable risks to agricultural workers, birds, and other wildlife species. Chlorpyrifos was removed from retail sale and residential uses in 2001, and diazinon was phased out in 2004. Synthetic pyrethroids are more selective and typically much less toxic than organophosphates, yet they still can harm beneficial insects. When applying pesticides such as these, careful and judicious use is recommended to avoid harming non-target species.

Pesticide applicators should always read and follow instructions on the label. Pesticides should be applied to minimize drift or runoff, and they should not be sprayed near water sources. Application should be avoided during windy conditions or when rain is forecast. Granular applications should be avoided or minimized near impervious surfaces and bodies of water. Equipment should be checked for proper calibration before pesticide application. After pesticides are applied, label directions should be followed to safely dispose of containers. A local cooperative extension service can be consulted about the proper use of pesticides. State-specific information regarding cooperative extension services is available from CSREES at http://www.csrees.usda.gov.

Pest management methods can also be controlled legislatively. In response to the negative effects of many pesticides, some localities are planning to restrict or prohibit the use of certain hazardous pesticides (Johnson, 1999). For example, the city of Seattle and King County, Washington, intend to stop using pesticides that are deemed most hazardous to control bugs and weeds along roads, in parks, and on other public land. The plan will phase out the use of dozens of harmful pesticides as the city and county explore less toxic alternatives. Pesticides that will be phased out contain known cancer-causing ingredients, seep quickly into ground water or surface water, or are labeled highly toxic to birds, fish, or other animals. There will be exceptions to the ban on some chemicals, but generally only if there are major health or safety considerations.

Restrictions on the use of certain pest control products were also implemented in California. In 1994 a bill was passed that would restrict the sale and use of copper-containing root killers and copper and tri-butyl tin-containing cooling tower additives (City of Palo Alto, California, Environmental Compliance Division, 1997). These pest control products contribute to the Regional Water Quality Control Plant's exceedances of San Francisco Bay discharge standards. When used, these products are discharged to sanitary sewer systems or to storm drains that flow untreated to creeks and bays. Because cost-effective alternatives for these products are available, the Regional Water Quality Control Plant and other local wastewater treatment plants have urged restrictions on the three types of chemicals. In December 1995 the California Department of Pesticide Regulation adopted regulations that made it illegal to sell or use copper-based root control products and tri-butyl tin-containing cooling water additives within the nine San Francisco Bay area counties. These regulations became permanent in November 1996.

9.3.2.9 Point-of-sale education

Municipalities and local cooperative extensions can encourage IPM by promoting education at the point of purchase. Two studies found that most citizens who apply pesticides used home and garden centers as their source of information on pest management (Lajeunesse et al., 1997; Sclar et al., 1997). Educating store employees on less-toxic alternatives, keeping less-toxic materials in stock, and providing information on the proper use of pesticides will help facilitate the IPM process. Czapar et al. (1998) surveyed 656 retail stores in Illinois that sell pesticides. Approximately 83 percent of the survey respondents were willing to send employees to a training program on pesticides, safe handling practices, and how to recommend appropriate pesticides to customers.

The Bay Area Stormwater Management Agencies Association in the San Francisco Bay Area established the "Our Water, Our World" program to educate citizens on less-toxic alternatives to pesticides without using negative messages about conventional products. The program consists of partnerships with local retail stores that display alternative products and educational materials. The program also involves media and advertising campaigns, efforts to institute regulatory change, and monitoring of the effects of the program. Initial results from 20 participating stores indicated an increase in the sale of less-toxic products and employee satisfaction with the associated training programs (http://www.epa.gov/oppbppd1/PESP/strategies/2000/basmaa00.htm).

Bio Integral Resource Center IPM Partnership Program

The Bio Integral Resource Center (BIRC) in the San Francisco Bay Area has developed a partnership between water pollution prevention agencies, nurseries, hardware stores, and the local cooperative extension to educate the public on less-toxic pest management. The program focuses on educating consumers about pest control products at the point of purchase from nurseries and hardware stores. BIRC encourages stores to carry less-toxic products and trains employees on the use of these products.

BIRC also conducts a Healthy Garden Workshop, which is a four-hour public seminar to introduce home gardeners to various aspects of IPM such as monitoring, physical controls, horticultural controls, and biological controls. Additional topics include water conservation and the use of native plants. An illustrated Healthy Garden Handbook accompanies the workshop, and an instructor's guide is available to assist others who are interested in giving the class (http://www.pesp.org/2000/birc00-final.htm).

Alliance for Chesapeake Bay IPM Partnership Program

The Alliance for Chesapeake Bay IPM Partnership Program promotes IPM by citizens through a partnership with retailers in which less-toxic pest control options are labeled with the slogan, "From your home to our streams...Choose less toxic products." The program includes employee training workshops, IPM informational displays and fact sheets available at participating retail stores. Partnerships with garden clubs and Master Gardeners provide training on minimizing environmental impacts and less-toxic pest management techniques.

IPM information displays began appearing in retail locations in central Pennsylvania in March 2003. The IPM project is funded by the National Foundation for IPM Education and the Environmental Protection Agency. For more information contact: Susan Richards, 717-737-8622, http://www.acb-online.org/project.cfm?vid=89.

9.3.2.10 Sensible irrigation

The natural reaction of grasses to drought stress is to become dormant, halting growth, conserving resources, and turning dry and brown. In spite of this natural drought tolerance mechanism, many property owners strive to maintain lush, green lawns, even in times of dry weather. Watering practices vary from a light sprinkling to regular, sometimes excessive, automated watering. Underwatering fails to provide water below a few inches of soil, causing grasses to be fragile and shallow-rooted. Overwatering promotes excessive growth and humid, disease-prone conditions that can damage the lawn. Overwatering can also result in runoff and leaching of nutrients (PLCAA, no date (b)). One study found that overwatering increased by five to 11 times the amount of nitrogen leached (Morton et al., 1998).

It is best to water deeply, but not too often. Deep watering encourages the grass to grow deep roots, whereas shallow watering maintains shallow roots and reduces the lawn's ability to retain moisture during dry periods (USEPA, 1992). The lawn should be watered only when needed and sprinklers should be carefully calibrated to wet the soil to a depth of 6 inches without causing runoff. Additionally, watering should be done early in the morning to prevent excessive evaporation (USEPA, 1992). Determining and controlling the rate, amount, and timing of watering will reduce soil erosion, runoff, and fertilizer and pesticide movement. An irrigation system should be designed to have an average application rate that is less than the infiltration capacity of the soil to avoid surface ponding and to maximize water percolation. Trickle and drip irrigation systems can save water by more directly irrigating the roots, resulting in less evaporation than overhead sprinklers (Relf, 1996).

Moisture in a home lawn can be retained more efficiently with organic matter, mulch, shade, and windbreaks. Organic matter increases the capacity of sandy soils to hold moisture and the availability of moisture in clay soils. Mulching helps reduce evaporation and retain moisture and humidity. Providing partial shade, particularly in the summer, and blocking wind, can also decrease moisture demand (Relf, 1996).

9.3.3 Commercial Activities

9.3.3.1 Detect and eliminate illicit connections

Illicit connections are defined as "illegal and/or improper connections to storm drainage systems and receiving waters" (Caraco et al., 1998). A discharge of industrial wastewater to a storm sewer is "illicit" because discharges of that type would ordinarily require a permit under NPDES. Many building owners and operators are unaware that improper connections exist in their facilities. In extreme cases of illicit dumping, legal action is necessary.

Illicit discharge detection and elimination programs are designed to prevent contamination of surface and ground water supplies by monitoring, inspection, and removal of these non-storm water discharges, which are illegal if an ordinance has been enacted. These ordinances grant a municipality the authority to inspect properties suspected of releasing contaminated discharges into storm drain systems. Another important factor is the establishment of enforcement actions for those properties found to be in noncompliance or that refuse to allow access to their facilities. EPA (1999), in conjunction with the Center for Watershed Protection, published a model ordinance for illicit discharges on their model ordinances Web site (http://www.epa.gov/nps/ordinance/discharges.htm). The model ordinance includes language to address illicit discharges in general as well as illicit connections specifically from industrial sites. Municipalities should modify the language to take into consideration enforcement methods that are appropriate for the local area. The Center for Watershed Protection (Brown et al., 2004) also published *Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments*. This publication provides information on cost-effective methods to detect and eliminate illicit discharges from municipal storm drains. The document is available for download at http://www.cwp.org/PublicationStore/TechResearch.htm.

Identification of illicit and improper connections is necessary for all sanitary and storm sewer systems, especially in areas where pollutants with unknown sources have been detected in receiving waters. The level and type of industrial activities and the surrounding land uses will affect the methods used to identify illicit connections.

The following are some practices used to prevent, discover, and eliminate illicit connections:

- Conducting water quality monitoring and field screening at outfalls and in receiving waters to identify areas where pollutant levels are elevated. Consider bacterial source tracking analysis to determine the origins of elevated bacteria levels (see Section 2.3.5 for more information about water quality indicators and bacterial source tracking).

- Instituting building and plumbing codes to prevent connections of potentially hazardous pollutant sources to storm drains.

- Organizing structures to be inspected for illicit connections by building age, with older buildings identified as priorities. Businesses whose activities have the greatest potential to create sources that could adversely affect water quality and pose human health problems also should be given priority.

- Mapping each area to be surveyed and indicating the route of the sewer system and the locations of storm drains on the map. This enables watershed managers to estimate the likely locations of illicit connections.

- Surveying individual buildings to discover where connections to the storm drain exist.

- Inspecting sewer lines with television equipment to visually identify all physical connections.

- Comparing the results of field tests and video inspections with the known connections on the map. Areas with suspected connections should be further investigated.

- Instituting mandatory inspections for new development, redevelopment, and remodeling projects.

- Removing and testing sediment from catch basins or equivalent structures.

- Inspecting questionable connections to determine whether they should be connected to the storm drain system or to the sanitary sewer. Methods of illicit connection identification, such as dye testing, visual inspection, smoke testing, and flow monitoring, are described below.

  - *Dye testing*. Flushing fluorometric dye into suspected connections can be useful to identify illicit connections. Once the dye has been introduced into the suspected connection, the water in the collection system is monitored to determine whether a connection is present.

  - *Visual inspection*. Remotely guiding television cameras through sewer lines is another way to identify physical connections.

  - *Smoke testing*. Smoke testing is another method used to discover illicit connections. Zinc chloride smoke is injected into the sewer line and emerges via vents on connected buildings or through cracks or leaks in the sewer line. By monitoring and recording where the smoke emerges, crews can identify all connections, legal and illegal, to the sewer system. (Mechanisms on drains should prevent the smoke from entering buildings; however, in some instances, this will occur. It is important to notify the public that the smoke is nontoxic, though it should be avoided as it can cause irritation of the nose and throat in some people.)

- *Flow monitoring*. Monitoring increases in storm sewer flows during dry weather can lead investigators to sources of infiltration or flow due to illicit connections.

Rain can hamper efforts to monitor flows and conduct visual inspections. Smoke and dye testing are more accurate than visual inspection and are the preferred methods for identifying illicit connections.

The cost of smoke testing, dye testing, visual inspection, and flow monitoring can be significant and time-consuming. Site-specific factors, such as the level of impervious area, the density and ages of buildings, and land use will determine the level of investigation necessary. Case studies in Michigan have estimated the cost of two full-time field staff and other required support to be between $182,000 and $187,000 annually (Ferguson et al., 1997).

An illicit discharge detection program can be an effective method to reduce the quantity of pollutants related to industrial and commercial activities that enter the storm drain system. For example, the Montgomery County, Maryland, Department of Environmental Protection (MCDEP) has an illicit discharge detection and elimination program called "Pipe Detectives" that uses volunteer monitoring and community hotlines to identify suspicious discharges (MCDEP, 1997). When discharges are reported, DEP consults maps of surrounding areas and targets these areas for additional monitoring to narrow the search for the illicit connection. In one instance, a "milky white" discharge was reported in an area with many small businesses and large apartment buildings. Businesses were sent informational letters advising them of the discharge and requesting their assistance in identifying it by allowing MCDEP to survey the properties. Through this cooperative effort, three illicit connections were detected and removed, including a sink that was used to wash paintbrushes (the source of the milky white discharge).

The City of Portland, Oregon, addressed illicit discharges from industrial sites by developing a memorandum of agreement with the Oregon Department of Environmental Quality, the state agency charged with administering municipal storm water permits. The purpose of the agreement was to streamline the enforcement process by delegating authority to administer the permits to the city. The agreement specified the city's role in inspections, compliance, and enforcement. The first component of the city's Illicit Discharge Elimination Program involves the prioritization of storm water outfalls based on pipe size, land use, historical pollution problems, complaints, and monitoring data. These outfalls are subject to dry weather monitoring, and once pollutants are detected, upstream investigations are conducted. Second, the Connection Verification Program inventoried all connections to the MS4 from individual properties and reviewed them for questionable connections. A citizen complaint program and partnership agreements facilitate public input and participation and provide a low-cost way to improve enforcement efforts (Pronold, 2003).

The Santa Clara Valley (California) Nonpoint Source Control Program published a guide with pollution prevention practices for industrial facilities entitled *Best Management Practices for Industrial Storm Water Pollution Control* (Duke and Shannon, 1992). The guide presents 21 practices intended to reduce nonpoint source loadings from industrial and commercial activities, including employee and customer training; illicit discharge elimination; waste storage, handling, and disposal; equipment inspection and maintenance; facility design features; and storm water management. The guide presents detailed technical guidance for common pollutants generated by commercial and industrial activities. The Santa Clara Valley Nonpoint Source Control Program has other pollution prevention publications that target specific businesses, such as automotive repair, construction trades and roadwork, landscape/gardening and pool maintenance, mobile cleaners and detailers, and restaurants. Additional information can be obtained by contacting the Nonpoint Source Control Program Information Line at 800-794-2482.

9.3.3.2 Encourage good housekeeping practices at commercial facilities

One of the best and least-expensive ways to reduce or eliminate pollutants in runoff is to limit the exposure of materials that can be eroded or dissolved by rainfall and runoff. An inventory of the items on commercial sites that are exposed to rain and runoff provides useful information and a starting point for exposure-reduction activities. To help keep rain from contacting pollutants, businesses should be advised to keep dumpsters and other containers securely closed, store containers under cover, and cover stockpiled materials, such as gravel, wood chips, and building materials, with plastic sheeting. Businesses should be asked to clean up their sites, but not by washing grit and grime into the storm drain system. Instead they should pick up litter, sweep, dispose of sweepings in the garbage (unless they are hazardous and require special disposal), and use absorbent materials such as manufactured absorbent snakes, kitty litter, or sawdust to absorb oils.

9.3.3.3 Provide training and education for employees and customers

Education of employees and customers at commercial sites is key to establishing good pollution prevention practices. Training programs provide information on material handling and spill prevention and response to better prepare employees in case of an emergency. Employees should also be trained on the purpose, operation, and maintenance of pollution prevention management practices. Employees can be continually educated with periodic training courses and with signs reminding workers of good housekeeping practices. Customers should be informed of efforts to

Illicit Discharge Elimination Training

The Wayne County, Michigan, Department of Environment's Illicit Connection/Discharge Elimination Training Program provides training for county and local staff responsible for illicit discharge detection and elimination. The training program involves technical presentations, "hands on" instruction in investigative techniques, and provision of software to aid in program management. Each participant receives a notebook containing recommended standard operating procedures and field forms. State-of-the-art technology is employed, including Global Positioning System (GPS) for locating outfalls and a GIS/database software package developed by the County for site investigation. The goal of the software package is to promote coordination in reporting/tracking of illicit connections/discharges. The training program also instructs participants in the use of chemical analysis field kits for measuring water quality parameters. As of September 2002, the program had trained nearly 800 state, local and community personnel (Tuomari, 2003; Wayne County Department of Environment, 2001).

reduce waste and pollution using signage or pamphlets so they will be less likely to contribute to pollution problems that are ultimately the responsibility of the business.

9.3.3.4 Devise spill prevention, control, and clean-up plans

The best way to avoid runoff contamination from spilled materials is to prevent the spill from occurring. Careful storage of materials in sound, clearly labeled containers, and regular inspection and maintenance of equipment, are key practices to prevent spills. Materials stored outdoors should be covered and kept on a paved area to protect them from being mobilized by wind and runoff. If not roofed, the storage area should be designed to drain with a slight slope (approximately 1.5 percent) to an area that will provide treatment prior to disposal. Runoff from other areas should be excluded to reduce the volume of runoff requiring treatment by installing berms, curbs, or diversions on the perimeter of the storage area. Secondary containment should be used when liquids are stored, and runoff or spills from the containment area should be directed to the sanitary sewer where permissible or to an appropriate storage or treatment facility for reuse or disposal.

Business managers should develop and post a set of well-defined procedures for handling spills of any materials that might be exposed to rainfall or runoff. Procedures should cover small, easy-to-handle spills as well as large spills that require employees to contact emergency personnel. The procedures should emphasize that spills must be cleaned up promptly and should specify how each type of material should be handled. The use of water for clean-up should be strongly discouraged. Shop rags should be used for small spills of non-volatile chemicals, and used rags should be sent to a professional cleaning service to prevent them from causing a pollution problem in a landfill or other disposal area. Larger spills should be absorbed with vermiculite, sawdust, kitty litter, or absorbent "snakes." Disposal methods depend on the hazard level of the spilled material. Nonvolatile liquids can be cleaned up with a wet/dry shop vacuum and disposed of with the rest of the facility's waste. Drains or inlets to storm sewers should be plugged during spill remediation to prevent off-site export of pollutants.

9.3.3.5 Conduct an environmental audit

Another approach to pollution prevention at commercial sites is to focus on source reduction, which reduces the amount of waste materials that have the potential to contaminate runoff. A reduction assessment can be performed to evaluate the type and amount of materials currently used, processes conducted, and wastes generated. Such an assessment can provide recommendations for modifying the commercial process to generate less waste, using alternative raw materials to generate non-hazardous wastes, and identifying recycling options to reduce the amount of wastes that require disposal. EPA's Office of Pollution Prevention and Toxics Web site (http://www.epa.gov/oppt/pollutionprevention/) offers technical information and assistance about environmental audits for both businesses and state regulatory agencies (USEPA, 2001a).

9.3.3.6 Practice safe equipment washing and maintenance

It is important when washing and maintaining equipment to adhere to certain pollution prevention measures. The flow of water resulting from cleaning industrial equipment, must be discharged as process wastewater to the sanitary sewer and is not allowed in storm drains, in most cases. When cleaning greasy equipment or trucks, a special cleaning area should be designated and equipment installed to capture, pre-treat, and discharge the wash water to the sanitary sewer. In addition, instructional signs that prohibit changing vehicle oil, washing with solvents, and other activities should be posted in non-wash areas. Finally, sumps or drain lines should be installed to collect wash water for treatment and discharge to the sanitary sewer.

Waste materials from vehicle maintenance activities also deserve special attention. Proper storage of materials and proper disposal of waste products are imperative. For example, waste oil, antifreeze, spent solvents, and some other liquids can be recycled. Spent batteries, however, should not be discarded with trash, but must either be disposed of as a hazardous waste or returned to the dealer from whom they were purchased. In addition vehicle maintenance should be performed in an indoor garage, not in an outdoor parking area. If performing work outdoors, all oil and grease should be captured unless precautions are taken to prevent them from being carried in runoff, such as with the use of absorbent pads in inlets or grates.

9.3.3.7 Use care when performing construction, repairs, or remodeling

When repairing, remodeling, or constructing buildings there are several key techniques that can prevent adverse effects on natural systems. Paints should be mixed where spills can be recovered or cleaned easily, and an impermeable ground cloth should be used while painting. Paint chips and scrapings might contain lead and should be managed properly to prevent contamination of water or soil. Paint buckets and barrels of materials should be stored away from contact with runoff. During painting clean-up, if a water-based paint was used, brushes and equipment should be cleaned in a sink connected to the sanitary sewer; if oil-based paints were used, they should be stored or recycled and not be disposed of in the sink or storm drain. Spray painting requires a few extra precautions. Temporary scaffolding should be used to hang drop cloths or draperies to shield the user from the wind, to collect overspray, and to minimize the spreading of windblown materials. Users should be aware of air quality restrictions on spray paints that use volatile chemicals and should consider water-based spray paints instead to minimize adverse effects on air quality.

Sand blasting can be controlled to keep particles off of paved surfaces and out of storm drains by placing a tarp or ground cloth beneath the work to capture the blasting medium, protect the work area from wind, and capture airborne particles.

9.3.3.8 Proper disposal of pet waste

Pet owners have several options for properly managing pet waste. Collecting the waste and flushing it down the toilet, where it can be treated by a sewage treatment facility or septic tank, is the preferred method. Small quantities can also be buried in the yard (when ground water is not used in the home), where the waste can decompose slowly. When buried, the waste should be at least 5 inches below the ground surface and away from water bodies and vegetable gardens. In public areas, the waste can be sealed in a plastic bag and thrown in the trash, which is legal in most areas (Water Quality Consortium, 1999).

Many communities implement pet waste management programs by posting signs in parks or other areas frequented by pet owners, sending mailings, and making public service

Los Angeles County Pet Waste Program

The Los Angeles County Department of Public Works Environmental Programs Division developed a program to control pet waste (Lehner et al., 1999). By profiling various groups of pet owners, the division identified the best targets for reducing coastal pollution. The program included a multimedia campaign to educate new and existing pet owners about the water quality impacts of pet waste. The program also distributed clean-up kits to owners and installed plastic bag dispensers in parks. The division established partnerships with local pet stores and pet supply companies to promote the program.

announcements. Many communities have "pooper scooper" ordinances that govern pet waste clean-up. Some of these laws specifically require anyone who takes an animal off his or her property to carry a bag, shovel, or scoop. Any waste left by the animal must be cleaned up immediately (Hill and Johnson, 1994). In addition to postings, many communities have installed "pet waste stations" in popular dog parks. These stations contain waste receptacles as well as a supply of waste collection bags, scoops, and shovels.

9.3.4 Trash

When developing control strategies for trash, one should keep in mind the source of the trash and the most prevalent types of trash to target ways to control it. Second, the costs for each control strategy should be evaluated, and a budget should be developed that takes into consideration the services and facilities that are already available. Third, regular cleaning and maintenance of storm water control infrastructure is necessary to prevent the accumulation of trash at control structures from becoming a hazard. Finally, it is important to understand that control strategies should not just transport trash to another water body but should also reduce the quantity of trash entering water bodies.

There are two methods of trash control: source controls and structural controls. There are four source control types: community education, improved infrastructure, waste reduction, and clean-up campaigns. Community education, such as informing citizens about options for recycling and waste disposal and educating them about the consequences of littering, is one of the best ways to reduce the amount of trash that enters runoff control structures and receiving waters. Another topic that should be emphasized is proper trash storage and disposal. Improved infrastructure can include optimizing the location, number, and size of trash receptacles, recycling bins, and cigarette butt receptacles based on expected need. Waste reduction includes encouraging consumers to purchase products with less disposable packaging and manufacturers to reduce the amount of packaging they use. Finally, clean-up campaigns are an effective way to reduce trash. Municipal projects such as street sweeping (see section 7.3.5.1), receptacle servicing, and clean-up crews along roadsides can also be effective in preventing trash from accumulating and entering waterways. Municipalities should review their litter control program to determine if the number and placement of receptacles is adequate and if regular maintenance activities (e.g., sweeping, receptacle servicing) are preventing litter from entering receiving waters.

Structural controls include physical filtering structures and continuous deflection separation. Physical filtering structures concentrate diffuse, floating debris and trash and prevent it from traveling downstream. Some examples are trash racks, mesh nets, bar screens, and trash booms. Continuous deflection separation targets trash from storm flows during and after heavy precipitation and involves physical separation of solids and floatables from water in runoff detention structures.

The costs for trash controls vary depending on the method employed. For example, the cost of a community education program or a plan to increase the number of trash receptacles can be minimal, depending on the quality of existing programs and extent of existing infrastructure. On the other hand, a structural control strategy can be quite costly. Physical filtering structures, including trash racks, bar screens, and silt traps, can range from $250,000 to $1 million or more, not including maintenance. A large-scale, continuous deflection separation device for urban runoff can cost as much as $3 million (capital cost only).

9.3.5 Nonpoint Source Pollution Education for Citizens

Many citizens know very little about nonpoint source pollution. Schueler and Swann (2000a) reported that an estimated 41 percent of the population had an idea of what the term "watershed" means, and only 22 percent understood that runoff is the most common source of pollution to streams, rivers, and oceans. Therefore, watershed and nonpoint source education for citizens is important to increase awareness about the environmental consequences of everyday actions. A survey of the effectiveness of outreach programs showed that media campaigns and intensive training of target audiences are the most effective ways to effect change in citizen behavior (up to 10 percent change in behavior in target populations). Specifically, TV ads and programs, newspaper ads, radio ads, and direct mail campaigns were shown to be the most influential and memorable messages to the public. Table 9.2 provides a summary of cost information and target audiences for various outreach methods.

Table 9.2: Select cost and audience information for various outreach techniques (Worlton, 2003).

Element	Cost	Unit	Audience
Flyers	$0.40–$1.20	Each	Limited by requests
Fact Sheets	$0.40–$1.20	Each	Limited by requests
Radio	$2,000 or more	Per station	500,000–2,000,000
Television	$2,400 or more	Per month	250,000–500,000 per day
Billboards	$700	Per board	6,800 per day
Markers	$2.94	Each	0–5,000 per day
Trailers	$165	Per theater	5,000 or more per day

Schueler and Swann (2000a) recommend the following techniques to effectively market a watershed message:

- Present a simple, direct watershed message, repeat it frequently, use multiple types of media, and emphasize the connection between the message and a local water body.
- Develop awareness of the connection between yards, streets, storms, and streams.
- Pool resources with other local or regional organizations to expand the campaign's budget.

- Use cable network and public television channels for commercials and targeted TV programs to more effectively reach target audiences.

- Focus the campaign on one or more target audiences. Many communities are ethnically and culturally diverse, and a portion of the population speaks languages other than English, which requires a campaign specifically tailored to the local demographics. Communities can also direct messages to children or focus efforts towards reaching the disadvantaged, who otherwise might not have the opportunity to learn about or participate in programs and activities. A survey of watershed demographics and problem pollutants should be conducted to better identify target populations.

- Keep the message simple and humorous and develop durable, attractive, non-technical outreach materials.

- Educate and partner with private-sector companies such as septic tank cleaners, commercial car washes, and oil change franchises.

9.3.5.1 Use multilingual nonpoint source messages

Many communities are ethnically and culturally diverse, and a portion of the population speaks languages other than English. The messages contained in signs, brochures, advertisements, newsletters, and other outreach materials that are printed only in English are mostly lost on these groups. For example, in areas such as southern Florida and southern California, where a large proportion of the population consists of Spanish-speaking immigrants, it is important to reach out to non-English-speaking residents and inform them about storm water pollution issues and the importance of clean water, because their activities can generate a substantial amount of pollution. This type of expanded outreach program is not limited to these areas. Census 2000 figures show increasing minority populations in urban centers and suburbs such as Washington, DC (Fernandez, 2001; Cohn and Witt, 2001), and New York (Cohn, 2001), among others.

Outreach materials can be printed in multiple languages based on the demographics of a community. The North Central Texas Council of Governments (NCTCOG), as part of its pollution prevention and public awareness campaign, printed articles, press releases, brochures, flyers, and bill stuffers in both English and Spanish (NCTCOG, 2000). The University of Texas at Austin designed and installed storm drain markers in both English and Spanish (University of Texas at Austin, 1997).

9.3.5.2 Use classroom education to deliver nonpoint source messages

Providing nonpoint source education to children through schools delivers the educational message not only to students but to their parents as well, because children often take home what they learn. Watershed managers have partnered with educators and experts to develop storm water-related curricula for the classroom. Fortunately, these lessons need not be elaborate or expensive to be effective.

An example of this type of education is the Children's Water Festival in Albuquerque, New Mexico. Several hundred fourth-grade students from schools in the area engaged in hands-on earning activities about water science, history, geography, and drama. The Albuquerque-based Ciudad Soil and Water Conservation District used its "Rolling River" educational model to show how all the components of a watershed are connected and how changes in one part affect others. Students created a mini-river, purified water from the Rio Grande, and built aquifers from edible ingredients. They also used a computer model to make projections of water use in the future and a ground water model to see how water moves underground. Students analyzed water samples and played the roles of algae, fish, and raptors to understand how toxins can travel through the food chain. They created wetlands, simulated flood and drought situations, changed the infrastructure, and then observed the effects of their manipulations.

9.4 Information Resources

9.4.1 General

The Center for Watershed Protection published *Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments*. This publication provides information on cost-effective methods to detect and eliminate illicit discharges from municipal storm drains. The document is available for download at http://www.cwp.org/PublicationStore/TechResearch.htm.

EPA's GreenScapes program provides cost-efficient and environmentally friendly solutions for large-scale landscaping. GreenScapes encourages companies, government agencies, and other entities to make more holistic decisions regarding waste generation and disposal. The GreenScapes program emphasizes four elements: reduce, reuse, recycle, and re-buy. More information about the GreenScapes program can be found at the program's Web site at http://www.epa.gov/greenscapes.

EPA's Office of Solid Waste has released "A Collection of Solid Waste Resources" on CD-ROM. This resource contains more than 300 publications on hazardous and non-hazardous waste; documents are listed by topic and are searchable, and some documents are in both English and Spanish. More information about this CD-ROM is available at EPA's Office of Solid Waste Web site at http://www.epa.gov/epaoswer/osw/cdoswpub.htm.

EPA's Used Oil Management Program developed the "You Dump It, You Drink It" campaign aimed to educate the Hispanic automotive repair and service industry and consumers about the impacts of improper disposal of used oil. The campaign includes posers, brochures, and bumper stickers in both English and Spanish. These materials, a description of the Used Oil Management Program, and relevant publications, rules, notices, regulations, and links can be found at http://www.epa.gov/epaoswer/hazwaste/usedoil/index.htm.

Appropriate Technology Transfer in Rural Areas (ATTRA) published the guidance *Integrated Pest Management: Fundamentals of Sustainable Agriculture*, which provides a basic understanding of IPM for individuals interested in agriculture. It incorporates the steps that need to be taken prior to IPM implementation, the tools used, and some ideas about future trends for IPM. The ATTRA publication is available at http://www.attra.org/attra-pub/ipm.html (Dufour and Bachmann, 1998).

The City of Seattle's ProIPM (Seattle Public Utilities, 2000) is the Green Gardening Program's series of IPM fact sheets for landscaping professionals. The fact sheets were designed to assist landscapers in the field and when explaining the IPM approach to clients. Each provides essential facts about various northwestern United States pest or disease problems, including information regarding pest identification, life cycle information, monitoring, damage threshold, and treatments. The fact sheets are available for download at http://www.seattle.gov/util/Services/Yard/For_Landscape_Professionals/Integrated_Pest_Management/index.asp or by calling the Green Gardening Program at 206-547-7561. The ProIPM Web site also provides information about proper disposal methods for pesticide products.

The U.S. Air Force's PRO-ACT program is an environmental research service and information exchange clearinghouse (PRO-ACT, 2000). PRO-ACT's *Integrated Pest Management Fact Sheet* provides information regarding IPM policy and guidance, typical components of an IPM program, control techniques available to pest managers, and management practices that can be implemented in an IPM program. The fact sheet is available at http://www.afcee.brooks.af.mil/pro-act/fact/intpst.asp. PRO-ACT may be contacted by phone at 800-233-4356 or by e-mail at pro-act@hqafcee.brooks.af.mil.

The USDA Regional Pest Management Centers Information System Web site (http://www.ipmcenters.org/) provides information about agricultural commodities, pests, and pest management practices, as well as links to each of the four Regional Pest Management Centers. Users can access the complete Crop Profiles and Pest Management Strategic Plans databases, an IPM Expertise database, information on pesticide use, current pest management research, funding opportunities, and links to related sites. Additional region-specific information, news, and announcements can be found at the regional Web sites.

NRCS (no date) has prepared a backyard conservation tip sheet that provides the public with information on pest management. The tip sheet helps readers to identify the problem, to know what to look for, and to control various types of pests with mechanical, physical, biological, and chemical control strategies. The NRCS tip sheet is available at http://www.nrcs.usda.gov/feature/backyard/pdf/PestMgt.pdf.

The International Turf Producers Foundation (ITPF, no date) recently published *Water Right: Conserving Our Water, Preserving Our Environment*. The publication provides information about a variety of water topics, including water use and conservation, environmental and economic benefits of responsible landscape management, and landscape water conservation techniques. The document is available for download at http://www.turfgrasssod.org/waterright.html or can be obtained by contacting ITPF at 1855 Hicks Road, Suite C, Rolling Meadows, Illinois, 60008; 847-705-9898 or 800-405-8873.

Audubon Magazine published *The Audubon Guide to Home Pesticides* in 2000. This guide provides citizens with a list of popular pesticides, along with their typical uses, their toxicity to humans and wildlife, EPA's toxicity rating, and alternatives for each of the chemicals. The guide is available for download at http://www.magazine.audubon.org/pdf/pesti_chart.pdf.

The Pest Management Branch of the California Department of Pesticide Regulation published *Suppliers of Beneficial Organisms in North America*. The publication lists 143 commercial suppliers of 130 beneficial organisms that are used for biological control. Suppliers are located in Canada, Mexico, and the United States. The booklet is available for download at http://www.cdpr.ca.gov/docs/ipminov/bensuppl.htm.

The EXtension TOXicology NETwork (EXTOXNET) is a joint effort of the University of California at Davis, Oregon State University, Michigan State University, Cornell University, and the University of Idaho. EXTOXNET provides a variety of information about pesticides, including discussions of toxicological issues of concern; toxicology newsletters, fact sheets, and information briefs; pesticide information profiles; and other resources for toxicology information. The network can be accessed at http://ace.orst.edu/info/extoxnet.

The National Pesticide Telecommunication Network is a cooperative effort of Oregon State University and the U.S. Environmental Protection Agency. The network is a source of chemical, health, and environmental information about more than 600 pesticide active ingredients incorporated into at least 50,000 different products registered for use in the U.S. since 1947. The toll-free telephone service (800-858-7378) provides information about pesticide products, recognition and management of pesticide poisoning, toxicology, and environmental chemistry to any caller in the United States, Puerto Rico, or the Virgin Islands.

Nonpoint Education for Municipal Officials (NEMO) is an educational program created by the University of Connecticut for local land use decision-makers that addresses the relationship between land use and protection of natural resources, particularly water resources. NEMO is an award-winning program that uses remote sensing, geographic information systems, and Internet technologies. The NEMO model is being adapted around the country, and NEMO projects are being planned and implemented by various agencies and organizations. This nationwide group, under the leadership and coordination of the University of Connecticut NEMO Project, is called the National NEMO Network. Additional information about NEMO is available at http://www.nemo.uconn.edu/.

Organic Gardening magazine and Web site (http://www.organicgardening.com/) provide information about organic pest control and help users find soil-testing labs in their area.

Riversides is a Canadian nonprofit organization that promotes source control and nonpoint source pollution prevention strategies. An important component of the Riversides Web site is H_2infO: The Water Information Network, which provides information about current campaigns, resources, and services offered by the network. Also offered are listservers and links to agencies, associations, and non-governmental organizations. The H_2infO Web site can be accessed at http://www.h2info.org/. Also, H_2infO can be contacted at 590 Jarvis Street, Suite 200, Toronto, Ontario, Canada, M4Y 2J4; phone 416-392-1757; fax 416-960-9944; e-mail input@H2infO.org.

EPA's Biopesticide Web site provides users with specific information about biopesticides, including fact sheets, decision documents, product lists, labels, company lists, study reviews, bibliographies, regulatory information, and federal register notices. The Web site can be accessed at http://www.epa.gov/pesticides/biopesticides.

EPA (1995) published the *Citizen's Guide to Pest Control and Pesticide Safety*, which provides users with important information about pesticides, including steps to control pests in and around the home; alternatives to chemical pesticides; methods for choosing, using, storing, and disposing of pesticides; how to reduce exposure when others use pesticides; how to choose a pest control company; and what to do if someone is poisoned by a pesticide. The guide is available at http://www.epa.gov/oppfead1/Publications/Cit_Guide/citguide.pdf.

EPA (1999) published *Education Projects in the Office of Water: A How-to Guide for Developing Environmental Education Projects*. The document provides a road map for creating quality environmental education projects and outlines EPA's procedural guidelines for producing a product or supporting related projects already in existence. It also lists publications, contacts, and references, including Web sites, training opportunities, and available materials, that provide the reader with further detail and insight into the process of developing effective environmental education pieces. A list of agencies and organizations that have water-related environmental education programs and projects is provided in an appendix. The publication is available from EPA's National Service Center for Environmental Publications Web site at http://www.epa.gov/ncepihom. It can also be ordered by phone, fax, or mail from USEPA/NSCEP, P.O. Box 42419, Cincinnati, Ohio 45242-2419; toll-free 800-490-9198; fax 513-489-8695.

The Commonwealth of Kentucky published *Turfgrass: Best Management Practices for Protection of Water Resources* (USEPA, 2001b). The manual provides information and guidance on turf grass management practices that decrease adverse effects on water resources. Information about the manual, along with a list of commonly used best management practices for turf management, is available at http://www.epa.gov/Region4/water/nps/projects/ky94-2.htm.

The Council of State Governments (1999) published *Getting in Step: A Guide to Effective Outreach in Your Watershed.* The guide presents a step-by-step approach for developing and implementing an effective watershed outreach plan. *Getting in Step* is available for download in PDF format at http://www.epa.gov/owow/watershed/outreach/documents/getnstep.pdf or by calling Books on Demand (800-521-3042).

State-specific cooperative extension service information is available from the Cooperative State Research, Education, and Extension Service (CSREES) at http://www.csrees.usda.gov/.

The California Peer Review Project, funded by the California Integrated Waste Management Board, compiles and reviews scientific research on the health effects, environmental effects, and efficacy of alternative household products. The project allows interested parties to participate during the review process, and findings from these literature reviews are available for download on the Web site (http://www.peerreview.com/).

The Stormwater Quality Management Committee, sponsored by the Clark County Regional Flood Control District in Las Vegas, Nevada, has developed a Web site devoted to its campaign to prevent pollution from urban runoff. The site has a number of resources for developing education and outreach materials, including examples of a bus stop shelter ad campaign, public service announcements, brochures, and community presentations at http://www.lvstormwater.com/.

The EPA's Web site, *Yard Trimmings/Food Scraps,* provides basic information on the environmental and economic benefits of recycling yard waste and food scraps. It also includes descriptions of practices for citizens, links to case studies, and technical fact sheets. The site can be accessed at http://www.epa.gov/epaoswer/non-hw/muncpl/yard.htm.

In 1994 the EPA published *Composting Yard Trimmings and Municipal Solid Waste,* a 151-page manual on the inclusion of composting as part of an integrated solid waste management program. It provides guidance on program development, facility siting and design, and costs and benefits, and includes information on many helpful resources. This manual can be downloaded in PDF format at http://www.epa.gov/epaoswer/non-hw/compost/cytmsw.pdf.

The Region 4 DoD Pollution Prevention Partnership published *Best Management Practices Resource Guide—Household Hazardous Waste* to guide pollution prevention activities on military bases, but the information is applicable to any pollution prevention initiative. It includes guidance on proper management of household chemicals, as well as descriptions of applicable state and federal laws, regulations and reporting requirements, and state resources. It describes various types of collection programs, lists resources for disposal and recycling by material type, and includes examples of outreach and education materials. The resource guide is available in PDF format at http://www.p2pays.org/ref/13/12935.pdf.

9.4.2 Yards: General Resources

The Bay Area Water Pollution Prevention Agency's "Our Water, Our World" program published *Less-Toxic Pest Management: Problem Pesticides,* a fact sheet describing the current state of chlorpyrifos and diazinon regulation, as well as some additional pesticides of concern. It provides information on alternative pest management techniques and sources of additional information. The site can be accessed at http://www.ci.livermore.ca.us/wrd/pdf_files/pesticides.pdf.

The *National Foundation for IPM Education* (NFIPME) is a non-profit organization that promotes education, provides information, and encourages research on integrated pest management. The Web site, http://www.ipm-education.org/, contains links to sponsored programs and information on grants for pesticide environmental stewardship.

Robert Mugaas at The University of Minnesota Cooperative Extension published *Responsible Fertilizer Practices for Lawns.* The paper provides soil-specific information on fertilizer application practices to protect water quality. It can be accessed at http://www.extension.umn.edu/distribution/horticulture/DG6551.html.

9.4.3 Yard Resources for Homeowners

Water Quality and Home Lawn Care, by the North Carolina State University Cooperative Extension, takes citizens through the process of establishing a healthy lawn and maintaining it using practices that protect water quality. It provides specific instructions on watering, mowing, and fertilization. This fact sheet can be downloaded in PDF format from http://www.turffiles.ncsu.edu/PUBS/MANAGEMENT/HOMELAWN.PDF.

The U.S. EPA publication *Healthy Lawn, Healthy Environment* is a user-friendly brochure that describes lawn care practices for citizens. It covers the basic principles of soil building, mowing techniques, appropriate thatch buildup, and IPM. The brochure also discusses important considerations for citizens in selecting a professional lawn care service. The brochure can be downloaded in PDF format from http://www.epa.gov/oppfead1/Publications/lawncare.pdf.

9.4.4 Yard Resources for Lawn Care Professionals

The University of Florida Cooperative Extension maintains a database of fact sheets for lawn care professionals, *Professional Lawn and Landscape Fact Sheets*. The fact sheets cover athletic fields, golf courses, roadsides, interiorscapes and non-residential lawns. The fact sheets can be downloaded from http://edis.ifas.ufl.edu/TOPIC_Professional_Lawn_and_Landscape.

The North Carolina State University Cooperative Extension's fact sheet, *Water Quality & Commercial Lawn Care*, is a resource for lawn care professionals on fertilizer, mowing, and irrigation practices. It includes information on the leaching potential of specific chemicals, turf grass selection, and fertilizer use. The fact sheet is available in PDF format at http://www.turffiles.ncsu.edu/pubs/new/commcare.pdf.

The North Carolina State University Cooperative Extension has published *Pest Control for Professional Turfgrass Managers*. This document includes information on proper use and leaching potential for commonly used insecticides and herbicides. It provides information on tolerance and disease resistance for turf grass species. It is available for free download in PDF format from http://ipm.ncsu.edu/AG408/turfgrass.pdf.

Water Quality for Golf Course Superintendents and Professional Turf Managers, produced by the North Carolina State University Cooperative Extension, describes lawn care practices that help to protect water quality. The discussion covers turf grass selection, IPM, mowing, and fertilizer practices that are specific to commercial lawn care. The fact sheet is available as a PDF at http://www.turffiles.ncsu.edu/PUBS/MANAGEMENT/PROTURF.PDF.

North Carolina State University Cooperative Extension's fact sheet, *Water Quality and Pesticide Selection for Professional Turf Managers,* provides guidance on the chemical selection process and information on leaching potential and toxicity for herbicides, insecticides, and fungicides. The fact sheet is available as a PDF at www.turffiles.ncsu.edu/PUBS/MANAGEMENT/PESTFORMAT1.PDF.

The Cooperative Extension at Rutgers State University maintains an online *Database of Commercial Turfgrass and Landscape Maintenance Fact Sheets*, a resource for lawn care professionals. It is accessible at http://www.rce.rutgers.edu/pubs/subcategory.asp?cat=5&sub=35.

The Golf Course Superintendents Association of America (GCSAA) has developed a set of principles for the protection of water quality in golf course planning and siting, design, construction, and maintenance. These principles and practices are summarized in the online publication, *Golf and the Environment.* It can be accessed at http://www.gcsaa.org/resources/facts/principles.asp.

The Professional Lawn Care Association of America's *Grasscycling Guide* describes recommended mowing heights for various grass types, the benefits of recycling grass clippings, and simple techniques for returning grass clippings to lawns. The guide is available in PDF format at http://turf.ufl.edu/BMPmanual.pdf.

The Florida Department of Environmental Protection produced *Best Management Practices for Protection of Water Resources in Florida* to provide guidance on specific lawn care industry practices to protect water quality. The manual covers practices such as employee training, irrigation system design, the design and installation of landscapes, and irrigation system maintenance. It explains techniques for mulching, mowing and pruning, material disposal, fertilizer application, IPM, and spill prevention. It is available for download in PDF format at http://miami-dade.ifas.ufl.edu/programs/fyn/publications/PDF/GI-BMP6-20-02.pdf.

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MANAGEMENT MEASURE 10
EXISTING DEVELOPMENT

10.1 Management Measure

Develop and implement watershed management programs to reduce runoff pollutant concentrations and volumes from existing development and redevelopment:

- Identify opportunities to reduce pollutants in priority local and/or regional watersheds (e.g., improvements to existing urban runoff control structures, including the addition of infiltration, filtration, retention, and detention practices).
- Devise a schedule for implementing appropriate runoff controls.
- Limit destruction of natural conveyance systems.
- Where appropriate, preserve, enhance, or establish buffers along surface water bodies and their tributaries.
- Promote redevelopment that reduces runoff volumes and pollutants.

10.2 Management Measure Description and Selection

10.2.1 Description

The purpose of this management measure is to protect or improve surface water quality by developing and implementing watershed management programs that pursue the following objectives:

- Reduce surface water runoff pollution loadings from areas where development has already occurred.
- Reduce the volume and peak runoff rates of surface water runoff to reduce runoff flow, increase infiltration, and minimize habitat degradation and sediment loadings from erosion of streambanks and other natural conveyance systems.
- Preserve, enhance, or establish buffers that provide water quality benefits along water bodies and their tributaries.

Maintaining water quality becomes increasingly difficult as urbanization occurs and areas of impervious surface increase. Increased peak runoff volumes from impervious surfaces result in alteration of stream channels, natural drainageways, and riparian habitat. This alteration, in turn, results in elimination or reduction of predevelopment aquatic flora and fauna and degradation of predevelopment water quality. Other effects include increased bank cutting, streambed scouring, embedded cobbles, siltation, increases in instream water temperature, decreases in dissolved oxygen, and changes to the natural structure and flow of the stream or river.

Protecting water quality in urbanized areas is difficult because of many factors, including diverse pollutant loadings, large runoff volumes, limited areas suitable for surface water runoff treatment systems, the high implementation costs associated with structural controls, and the destruction or absence of buffer zones that can filter pollutants and prevent the destabilization of streambanks and shorelines.

An important nonstructural component of many watershed management plans is the establishment and preservation of buffers and natural systems (e.g., by policy, code, or ordinance). These areas help to maintain and improve surface water quality by filtering and infiltrating urban runoff. In areas of existing development, natural buffers and conveyance systems may have been altered as urbanization occurred. Where possible and appropriate, additional impacts on these areas should be minimized, and if the areas are degraded, their functions should be restored. Establishing and protecting buffers is most appropriate along surface water bodies and their tributaries where water quality and the biological integrity of the water body are dependent on the presence of an adequate buffer or riparian area. Buffers may be necessary where the buffer or riparian area:

- Reduces significant nonpoint source pollutant loadings;
- Provides habitat necessary to maintain the biological integrity of the receiving water;
- Reduces undesirable thermal impacts on the water body; or
- Reduces erosion.

Structural practices may be a suitable option to decrease the nonpoint source pollution loads generated from developed areas in addition to nonstructural controls (see Management Measure 9: Pollution Prevention). In such situations, a watershed plan can be used to integrate the construction of new surface water runoff treatment structures and to retrofit existing surface water runoff management systems.

Retrofitting is a process that involves the modification of existing surface water runoff control structures or surface water runoff conveyance systems that were initially designed to control flooding, not to serve a water quality improvement function. By enlarging existing surface water runoff structures, changing the inflow and outflow characteristics of such devices, and increasing runoff detention and retention time, sediment and associated pollutants can be removed from the runoff. Retrofit of structural controls is often the only feasible alternative for improving water quality in developed areas. Where existing development or financial constraints limit treatment options, targeting or identifying priority pollutants and selecting the most appropriate retrofits that will result in the greatest improvement to water quality may be necessary.

Once key pollutants have been identified, an achievable water quality target for the receiving water should be set to improve current levels based on an identified objective or to prevent degradation of current water quality. Extensive site evaluations should then be performed to assess the performance of existing surface water runoff management systems and to pinpoint low-cost structural changes or maintenance programs for improving pollutant removal efficiency. Where flooding problems exist, source controls, low-impact development (LID), and infiltrative controls should be incorporated into the design of surface water runoff controls. Available land is often limited in urban areas, and the lack of suitable areas frequently restricts the use of conventional pond systems. In heavily urbanized areas, sand filters, biofilters, or water quality inlets with oil/grit separators might be appropriate for retrofits because they do not limit use of the land.

10.2.2 Management Measure Selection

The first and second components of this management measure were selected to encourage communities to develop and implement watershed management programs. Local conditions, availability of funding, and problem pollutants vary widely among communities. Watershed management programs allow communities to select and implement the practices that best address local needs. Prioritizing local and/or regional pollutant reduction opportunities and setting schedules for implementing appropriate controls were selected as logical starting points for establishing an institutional framework to address nonpoint source pollutant reduction. The first two parts of Section 10.3: Management Practices, "Identify, Prioritize and Schedule Retrofit Opportunities" and "Implement Retrofits as Scheduled" address these two components.

The third and fourth components of this management measure were selected to preserve, enhance, and establish areas within existing development, such as natural streams, ponds, and wetlands and aquatic buffers, that provide positive water quality benefits. These natural systems provide efficient runoff conveyance as well as aesthetic benefits. These components are addressed by the third, fourth, and fifth parts of Section 10.3: Management Practices: "Restore and Limit the Destruction of Natural Runoff Conveyance Systems," "Restore Natural Streams," and "Preserve, Enhance, or Establish Buffers."

The fifth component is addressed by part 5 of Section 10.3: Management Practices, "Revitalize Urban Areas." This component was selected to encourage redevelopment of urban areas that may be contributing to water quality problems via impervious surfaces, contaminated soils, or land uses that result in poor runoff quality or increased runoff volumes. Multiple goals such as surface water and ground water quality improvement, soil remediation, and quality-of-life enhancements may be simultaneously achieved using such an approach.

The Brownfields program, managed by EPA under the authority of the Small Business Liability Relief and Brownfields Revitalization Act of 2002 (USEPA, 2002b), promotes redevelopment of these areas and also can be an effective source of funding and expertise to achieve the above goals. The Act

- Provides legislative authority for the Brownfields program including grants for assessment and clean-up;
- Expands the current Brownfields program by increasing its funding authority up to $200 million per year including up to $50 million per year to assess and clean up brownfields with petroleum contamination;
- Expands eligibility for assessment and clean-up grants;
- Includes a new provision for direct clean-up grants of up to $200,000 per site;
- Streamlines current requirements for the brownfields clean-up revolving loan fund and makes funding available to nonprofit organizations;

- Applies the Davis Bacon Act, which maintains local wage and labor standards for federal construction work, on the same terms as the authority for the current program; and

- Makes funds available for technical assistance, training, and research.

More information about the Small Business Liability Relief and Brownfields Revitalization Act can be found at http://www.epa.gov/brownfields/sblrbra.htm.

Cost was a major factor in the selection of this management measure. EPA acknowledges the following constraints to implementing nonpoint source controls for existing development:

- High costs and other limitations inherent in treating existing sources to levels consistent with the standards set for developing areas;

- Frequent lack of suitable areas for structural treatment systems that can adequately protect receiving waters;

- Lack of universal cost-effective treatment options;

- Frequent lack of funding for mandatory retrofitting; and

- Extraordinarily high costs associated with implementing retention ponds and exfiltration systems in developed areas.

10.3 Management Practices

10.3.1 Identify, Prioritize, and Schedule Retrofit Opportunities

In the watershed assessment phase of the urban runoff management cycle, watershed managers should identify water bodies that have been degraded by urban runoff and prioritize them for restoration based on the costs and benefits for watershed stakeholders. One method to halt further degradation and initiate water body recovery is to retrofit existing runoff management practices or conveyance structures. It is important for watershed managers to have clear goals and realistic expectations for retrofitting existing structures. Each retrofit project should be planned in the context of a comprehensive watershed plan, and managers should have a clear set of objectives to ensure that the project results in measurable improvements in hydrologic, habitat, and/or water quality indicators.

10.3.1.1 Evaluate existing data

The first step in identifying candidate sites for storm water retrofitting is to examine existing data. These data can include results from a watershed assessment, topographic maps, land use or zoning maps, property ownership maps, aerial photos, and maps of the existing drainage network. For example, results from a watershed assessment can be used to identify areas with good habitat and water quality that should be protected, as well as areas with poor habitat and water quality that need to be improved. Topographical maps can be used to delineate drainage units within the watershed at the subwatershed and catchment levels. Land use or zoning maps can be used to estimate areas of high impervious cover to target areas that contribute a large amount of runoff to receiving waters, while property maps provide land ownership data. Finally, aerial photographs can be used to identify open spaces that can be more easily developed into runoff management facilities. According to the Center for Watershed Protection (CWP, 1995a), the best retrofit sites:

- Are located adjacent to existing channels or at the outfall of storm drainage pipes;
- Are located within an existing open area;
- Have sufficient runoff storage capacity;
- Are feasible for diverting runoff to a potential treatment area (forested or vegetated area) or structural management practice; and
- Have a sufficient drainage area to contribute meaningfully to catchment water quality.

Specific areas well-suited for new runoff controls include undeveloped parkland and open space, golf courses, wide floodplains, highway rights-of-way, and edges of parking lots.

Information for potential retrofit sites, such as location, ownership, approximate drainage area, utility locations, and other pertinent details, can be compiled in a retrofit inventory sheet (CWP, 1995a). A site visit can provide information on site constraints, topography, adjacent sensitive land uses, receiving water conditions, utility crossings, and other considerations that would affect the feasibility of implementing the management practice. At this point, a conceptual sketch for rerouting drainage and siting management practices should be drawn and preliminary cost estimates made for each site.

10.3.1.2 Choose appropriate management practices based on site conditions

The choice of one potential retrofit site over another for management practice implementation can be based on several different factors in addition to site limitations and cost. For instance, the preliminary goals of a retrofit program may be to preserve streams or reaches known to have high-quality habitat or exceptional water quality. The goal of another program may be to restore poor habitat and degraded water quality. The program may elect to target particular land uses thought to contribute the majority of pollutants to receiving waters. Retrofit facilities also can be installed to treat runoff from large parts of a watershed or subwatershed (regional controls), thereby requiring fewer overall projects. Once retrofit sites are identified and prioritized, a schedule for installing new facilities or updating old facilities should be devised.

10.3.1.3 Incorporate low-impact development practices into existing development

In many cases, sites that are already developed can be retrofitted with low-impact development practices such as biofilters, rain barrels, rooftop greening, and cisterns (see Management Measure 5 for a more detailed discussion of these practices). Soil rehabilitation and tree planting can also contribute to the reduction of runoff. All of these practices can be designed on a small scale to accommodate space constraints that may be present on developed sites. The use of these practices will aid in retaining runoff on-site and help to reduce the total volume of runoff reaching receiving waters. For example, in Washington, DC, trees have saved $4.74 billion in gray infrastructure costs per 30-year construction cycle, and reduced the need for storm water retention structures by 949,000 ft^3 (NALGEP, 2003).

The City of Chicago has incorporated low-impact development practices such as rooftop greening and downspout disconnection into its urban runoff management strategy. The City Hall Rooftop Garden is a $1.5 million retrofit project to demonstrate the benefits of green roofs. The city has published *A Guide to Rooftop Gardening* (http://www.cityofchicago.org/Environment/GreenTech/pdf/GuidetoRooftopGardening.pdf) to communicate the lessons learned from this project and provide information to the public on green roof development. The city is also targeting flood-prone areas for its downspout disconnection campaign, distributing door hangers and brochures to residents, and encouraging the use of rain barrels (Murante, 2003).

The *Low-Impact Development Design Strategies: An Integrated Design Approach* (Prince George's County, Maryland, Department of Environmental Resources, 2000) and the Low Impact Development Center Web site (http://www.lowimpactdevelopment.org/) can provide more information about these and other practices appropriate for existing developments. Additionally, a search for "urban forestry" on the USDA Forest Service's Web site (http://www.fs.fed.us/) produces many good references about how trees can be used to reduce runoff volume and improve runoff quality.

10.3.1.4 Identify undeveloped and privately owned land for acquisition

In addition to the installation of conventional storm water management practices, the acquisition and preservation of open space in developed watersheds can protect against the threat of further development, reduce runoff volume, and provide storm water treatment. This practice involves the identification of parcels in a developed watershed that are undeveloped or privately owned and can be protected or restored to provide storm water benefits by attenuating additional runoff volume and peak flow. This watershed-wide planning effort involves mapping open space, cadastral data (e.g., property boundaries, subdivision lines, buildings), drainage systems, urban forests, floodplains, and other land use data. The planning effort also involves selecting sites based on their proximity to receiving waters, the condition of the soil and vegetation, and ease of purchase. Selected parcels are purchased, restored if necessary, and modified to receive and retain more runoff using berms or diversions (O'Leary, 2003). For more information on land acquisition, see Management Measure 3: Watershed Protection.

10.3.1.5 Use routine maintenance as an opportunity for retrofitting existing infrastructure

One of the major challenges in controlling runoff from existing development is the potentially high cost of retrofitting infrastructure to reduce runoff quantity and improve quality. One way to reduce costs is to modify runoff controls during routine maintenance procedures. Retrofits can be constructed as part of the routine maintenance and repair of urban infrastructure. This approach requires less capital outlay for retrofit compared to large-scale, capital-intensive approaches. For example, pervious surfaces can be installed when resurfacing parking areas, and newly disturbed areas can be restored to the desired vegetative condition (e.g., forest or meadow). When storm water ponds are dredged every few years, sediment forebays can be redesigned to improve performance.

Retrofitting Catch Basins for On-Street Runoff Storage

An example of a retrofit to reduce downstream impacts of urbanization can be found in the towns of Skokie and Wilmette, Illinois. These towns are urban areas that are served by a combined sewer system (CSS). Both communities wanted to control CSS surcharge but did not want to build expensive relief sewers. As a result, they were willing to try alternative approaches. The towns decided to modify street cross sections and storm drain inlets to allow runoff to be stored temporarily on the street surface during storm events to reduce hydraulic loading to CSSs. The street surface storage projects combined the following elements (USEPA, 2000b):

- Street storage.
- Downspout disconnection.
- Flow regulators.
- Subsurface storage.
- New storm and combined sewer systems.
- Improvements to existing storm and combined sewer systems.

The projects involved installing a system of street berms, 7 to 9 inches high, at the curb line to detain water on the street. Flow regulation devices were installed at catch basin outlets to reduce the rate of storm water flow to the CSS. Both the street surface and the inlet structure were used for storage. Subsurface storage facilities were also installed in the street right-of-way and in other public areas at critical points in the system and in pedestrian walkways, parking areas, and high-traffic areas, where ponding was unacceptable.

The project resulted in a number of benefits. Researchers estimated a cost savings from using street storage rather than conventional sewer separation systems. Estimated costs for the Skokie system are approximately 38 percent of conventional sewer separation system costs. Berm costs are a small fraction of the overall cost of the CSS surcharge relief project. Another benefit of the storage system is traffic control. Berms can function as speed humps and help control traffic. The street storage system also reduces the volume and frequency of combined sewer overflows, resulting in less runoff-related pollution entering receiving waters. Icing of ponded areas during the winter was not a problem because retention times were relatively short (less than 30 minutes), but consideration should be given to safety hazards associated with ponded water during periods of high rainfall.

10.3.2 Implement Retrofit Projects as Scheduled

CWP (1995b) describes six common types of retrofitting projects:

- Modifying existing runoff management facilities;
- Constructing new management practices at the upstream end of road culverts;
- Constructing new management practices at storm drainage pipe outfalls;.
- Constructing small instream practices in channels;
- Constructing management practices at the edge of large parking areas and
- Constructing new management practices in highway rights-of-way.

10.3.2.1 Retrofit existing runoff management facilities

Many older dry detention basins were designed for the singular purpose of flood control. In some cases, a facility of this type can be converted into an extended detention pond/wetland or a conventional wet pond. If this retrofit is designed well, it will increase pollutant removal capabilities and aquatic habitat functions without losing any of its flood control benefits. This modification also typically results in only minimal impacts on the surrounding environment. Dry detention ponds can be modified to accommodate a greater variety of species by transforming them into constructed wetlands or installing aquatic platforms, which are shallow benches on which aquatic vegetation can be planted (see Section 5.3.1.3 for more information about constructed wetlands; Fairfax County Environmental Coordinating Committee, 2002).

The retrofit process often includes:

- Analyzing existing hydraulic characteristics and the flood control design specifications of the facility;
- Determining whether there is available storage for water quality treatment;
- Excavating the pond bottom to create permanent pool storage (for pond and wetland systems) if water quality storage is available;
- Raising the embankment or modifying the outlet structure to obtain additional storage if extended detention is needed;
- Increasing the flow path from inflow point to discharge point by using baffles or earthen berms or by regrading the pond's contours to increase particulate settlement; and
- Addressing safety considerations, such as fencing and adding underwater benches or shallow fringe areas along shorelines, to reduce the risk of drowning.

Bioengineering to enhance water quality benefits

The City of Griffin, Georgia, constructed a bioengineering system within the North Griffin Regional Detention Pond and within a forested wetland area downstream of the pond to improve water quality in the receiving waterbody, Flint River. The bioengineering system is comprised of specific species of vegetation that provide natural filtration and breakdown of pollutants in runoff. The wetland plants selected include cattail, bulrush, pickerel weed, soft rush, wool grass, southern cutgrass, and shallow sedge. Experts chose these species based on their anticipated ability to break down and filter various pollutants commonly found in runoff. The system has low maintenance requirements and relatively low construction and operating costs in comparison to conventional treatment facilities. In addition to water quality benefits, the system will enhance wildlife habitat (City of Griffin, no date). The Consulting Engineers Council of Georgia recognized the project design and performance success with an Engineering Excellence Award in February 2000. The Georgia Environmental Protection Division and USEPA Clean Water Act (CWA) Section 319(h) Program also acknowledged the project's achievement (Greuel and Feldner, 2001). A detailed summary of this project is available in EPA's Section 319 Success Stories, Vol. III at http://www.epa.gov/owow/nps/Section319III/GA.htm.

10.3.2.2 Modify the upstream end of road culverts

A good retrofit opportunity can sometimes be found at the upstream end of a road culvert. A gabion, concrete weir structure, or riser/barrel control structure can be installed to create a small, permanent micropool excavated to provide water storage, water quality, and habitat benefits. This method can be used to provide a dry extended detention basin with a maximum depth of 6 feet above the culvert invert. If the upstream area is open floodplain, it might be possible to construct a wet pond or extended detention pond/wetland retrofit.

Cost-Effectiveness Study of Retrofitting Runoff Treatment Facilities

EPA's Office of Research and Development investigated retrofitting wet-weather flow treatment facilities to determine their feasibility and cost-effectiveness (Moffa et al., 2000). The following retrofit scenarios were analyzed:

- Converting or retrofitting primary settling tanks with dissolved air flotation and lamellae (thin, flat membranes or layers) and/or microsand-enhanced plate or tube settling units.
- Retrofitting existing wet-weather flow storage tanks to provide enhanced settling/treatment and post-storm solids removal.
- Converting dry ponds to wet ponds for enhanced treatment.
- Retrofitting wet-weather flow storage tanks for dry-weather flow augmentation.
- Using storage for sanitary sewer overflow control.
- Retrofitting for industrial wastewater control in a combined sewer system.
- Bringing outdated/abandoned treatment plants back on-line as wet-weather flow treatment facilities.

The cost-benefit analysis examined site-specific, operational, cost, and design parameters. Each retrofit scenario was analyzed over a range of flow and/or volume conditions. The study revealed that in certain circumstances, retrofitting existing wet-weather flow treatment facilities is technically feasible and can be more cost-effective than construction of new conventional control and treatment facilities. The authors concluded that these results were highly site-specific and recommended that retrofitting existing control facilities be identified as one of several alternatives to reduce impacts from storm events. The full report is available at the Office of Research and Development's Web site at http://www.epa.gov/ednnrmrl/news/main.htm.

Because roadways are not constructed as runoff management embankments, special measures might be necessary to ensure that these facilities meet dam safety specifications for seepage control and passage of the 100-year storm. Consideration and evaluation of secondary impacts, such as modification of the 100-year floodplain, creation of fish migration barriers, and changes to the wetland hydrologic regime is also warranted with this type of retrofit.

10.3.2.3 Modify storm drainage pipe outfalls

A volume of runoff can be diverted at or near a storm drainage pipe outfall to a sand filter, peat-sand (or other medium) filter, bioretention system, centrifugal deflection system, off-line wetland or pond system, or other water quality treatment facility for treatment before it reenters a receiving water.

10.3.2.4 Add retention structures to channelized streams

Small weir walls or check dams can sometimes be placed in small, previously channelized streams to retain sediments and create a ponding area for wetland vegetation. This type of retrofit is usually easy to install and can provide moderate pollutant removal benefits. Because it can potentially affect channel design flows and the floodplain, however, careful analysis must be conducted before the instream practice is implemented. In addition, cleanout frequency should be considered before selecting this practice, as regular maintenance will be needed to remove trapped sediments.

10.3.2.5 Install runoff management practices in or adjacent to large parking areas

Retrofit practices can be installed near large parking lots to capture, detain, and/or treat runoff. Infiltration practices such as bioretention areas, porous pavement, sand filters, and underground vaults are good candidates. Two examples of successful use of bioretention areas can be found at http://www.epa.gov/owow/nps/bioretention.pdf (USEPA, 2000a). In addition, a case study illustrating the effectiveness of porous pavement in reducing runoff is provided at http://www.epa.gov/owow/nps/pavements.pdf (USEPA, 2000b).

10.3.2.6 Construct new practices in highway rights-of-way

Existing highway systems can have significant open spaces for the installation of various practices. For example, cloverleaf open space can be an ideal location for storm water wetlands and pond systems if drainage areas and patterns allow. Care must be taken to avoid creating a safety hazard for traffic, and maintenance access should be an integral part of the design.

10.3.2.7 Install trash-capturing devices

Trash racks are inclined metal grates that trap floatables as water passes through. The racks can be installed at storm sewer inlets or outfalls or in the stream itself. These structures effectively remove trash from the water, but they require a high level of maintenance (inspection for damage or clogging after storms and regular trash removal). If these racks are poorly maintained, their effectiveness decreases and they can clog, which can cause a flood hazard. A less-expensive alternative to metal trash racks is plastic mesh trash collectors with floating piers that stretch across the width of the stream. They are easier to maintain because they are simply removed and replaced with a new collector.

The applicability of these trash collection methods is limited to small streams with relatively low flow and low-level trash inputs. More substantial trash collection methods, such as vortex devices that use centrifugal force to separate floatables from water, can be installed to handle larger flows or high trash loads.

10.3.2.8 Install inlet and grate inserts

A wide variety of inserts that trap oil and grease from parking lots, maintenance yards, and streets are also commercially available. These can be used with or without trash capture in storm drain inlets and grates. Inspection and maintenance one to four times per year (depending on pollutant concentrations in runoff) is usually recommended. Catch basin inserts are discussed in more detail in Management Measure 5 (section 5.3.5.4).

10.3.3 Restore and Limit the Destruction of Natural Runoff Conveyance Systems

Existing development has likely resulted in a modification of natural drainage patterns as compared to predevelopment conditions. As a result, increases typically occur in imperviousness, runoff, peak flows during storm events, erosion, and pollutant transport. The use of traditional runoff management technology, such as piping, channeling, and curbing, has aggravated these impacts.

Efforts should be made to restore previously developed or redeveloping sites so they more closely mimic predevelopment hydrologic conditions. The predevelopment condition should be estimated based on historical records and existing slopes, soils, and natural drainage features. Consideration should be given to the time of concentration—the time it takes water to travel from the farthest point in a subwatershed to the outlet. (Sites might contain multiple subwatersheds and multiple outlets.) Paving and curbing substantially reduce time of concentration, resulting in high peak flows during storms. Time of concentration can be increased substantially by modifying drainage patterns and installing infiltration and detention practices. The practices presented in this section can be used to increase time of concentration on a particular site. Additional technical guidance for restoration practices can be found at EPA's River Corridor and Wetland Restoration Web site at http://www.epa.gov/owow/wetlands/restore (USEPA, 2002a). Another resource is *Stream Corridor Restoration: Principles, Processes, and Practices* (FISRWG, 1998), which can be downloaded at http://www.nrcs.usda.gov/technical/stream_restoration/newgra.html or ordered by contacting the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161; telephone 703-605-6000 or 800-553-NTIS; e-mail orders@ntis.fedworld.gov.

10.3.3.1 Disconnect impervious areas

Roof downspouts can be disconnected from streets and culverts and runoff diverted over vegetated areas or infiltration systems (for treatment) or into cisterns or rain barrels (for reuse; see Management Measure 5 for more information on these practices). Also, roadway runoff can be converted to sheet flow and directed to vegetated buffers, infiltration devices, or other pervious areas.

Rooftop runoff also can be controlled with a vegetated roof cover. These systems consist of a high-quality waterproof membrane covered by drainage material, a planting medium, and vegetation. Vegetated roof covers use foliage and a lightweight soil mixture to absorb, filter, and detain rainfall. The systems are designed to control high-intensity storms by intercepting and retaining water until the rainfall peak passes (USEPA, 2000d). Additionally, vegetated roof covers improve insulation and reduce the amount of reflected solar radiation, resulting in lower temperatures in urban areas. More information about vegetated roof covers can be found at http://www.epa.gov/owow/nps/roofcover.pdf.

The City of Portland, Oregon, encourages residents to reduce the connectivity of impervious surfaces through its Downspout Disconnection Program, originally established in 1996 to address problems with combined sewer overflows. Through an interagency agreement, the local plumbing code was revised to allow downspout disconnection without a permit. The program has developed safety standards that establish criteria for the feasibility of a disconnection, as well as an inspection and maintenance program to ensure safety. Homeowners can choose to have the city disconnect a downspout free of charge, or they can disconnect it themselves and receive a cash incentive. Since the start of the program, nearly 17,000 homes have been disconnected and data have been collected on an additional 20,000 potential disconnections (Hottenroth, 2003).

More information about the Downspout Disconnection Program can be found at http://www.portlandonline.com/oni/index.cfm?c=28992.

10.3.3.2 Encourage overland sheet flow

Concentrated flow of runoff during storms results in decreased time of concentration, decreased infiltration, and increased erosion due to high runoff velocity. Careful regrading to reduce steep slopes slows runoff, promotes infiltration, and reduces erosion. (Note that regrading efforts should not result in increased compaction; if compaction has occurred, soil amendments and rehabilitation may be necessary.) A level spreader, which typically consists of a shallow, gravel-filled trench that receives concentrated flows and converts them to sheet flow, can be installed to convey runoff to vegetated areas. A flat, grassy area can also be used to promote overland flow.

10.3.3.3 Increase flow path

Increasing the path of runoff results in increased storm water detention and increased travel time. Directing concentrated flows from impervious areas to infiltration areas, swales, dry wells, cisterns, or bioretention facilities increases the time it takes for runoff to leave the site and mitigates peak runoff flows.

10.3.3.4 Use open swales in place of traditional storm drain systems

Grassed swales are an effective and natural means of conveying runoff. Because the water comes into contact with vegetation, the runoff velocity decreases, which promotes infiltration, reduces erosion, and lengthens time of concentration. Because grassed swales are wider and shallower than conventional channels, runoff is less concentrated. They are especially appropriate alongside roadways or on the border of a site. Swales can be combined with terraces and infiltration devices to enhance runoff retention. Swale installation requires a minimum amount of excavating and regrading. Vegetation should be established immediately to prevent excessive erosion; while vegetation is being established, geotextiles or turf reinforcement mats can be used to stabilize exposed soils in the swale.

One neighborhood in Seattle, Washington, underwent a transformation from conventional to natural drainage systems as part of a pilot project, called "SEA Street" (for Street Edge Alternatives), conducted by Seattle Public Utilities. Monitoring before and after the installation of swales indicated a decline from approximately 5,000 cubic feet of runoff from 8 inches of rain to only 132 cubic feet of runoff from 9 inches of rain. The project, which cost approximately $800,000, was equivalent to the cost of a conventional curb-and-gutter system and provides additional water quality benefits and an anticipated boost to property values (Taus, 2002). More information about this project can be found at http://www.ci.seattle.wa.us/util/About_SPU/Drainage_&_Sewer_System/Natural_Drainage_Systems/Street_Edge_Alternatives/index.asp.

10.3.3.5 Establish vegetation throughout the site

Vegetation intercepts rainfall, decreases runoff velocity by increasing surface roughness, and promotes infiltration. Establishing vegetated areas in strategic locations that currently receive runoff from impervious areas requires minimal effort, especially when native plant species are used. Excess compaction of these areas by heavy equipment should be avoided. To enhance the benefits of vegetated areas, part of a site can be regraded during redevelopment activities to direct runoff to these areas. See Management Measure 3: Watershed Protection (section 3.3.3.8) for a discussion of urban forestry practices that can help in achieving these goals.

10.3.3.6 Reestablish ground water recharge

Traditional development techniques that focus on quickly conveying runoff off-site have resulted in decreased infiltration of rainfall to ground water. This ground water deficit results in a lowered water table and decreased seepage and baseflow in streams during dry periods. Infiltration practices can be installed to promote ground water recharge. Such practices include infiltration trenches, infiltration basins, sand filters, biofiltration systems, and vegetated areas underlain by permeable soils (see Management Measure 5: New Development Runoff Treatment).

A Watershed Restoration Plan for the Norwalk River Watershed

Habitat quality and water quality in the Norwalk River watershed of southeastern Connecticut have been degraded by erosion, sediment, pesticides, excessive algae growth, driftwood and other impoundments, and other types of pollution associated with increased watershed urbanization (NWRI, 1998). In 1997 federal, state, and local government agencies, environmental groups, and concerned citizens formed the Norwalk River Watershed Initiative (NRWI) to halt further degradation and promote water quality recovery. Subcommittees were tasked with developing goals for four key issues: (1) habitat restoration; (2) land use, flood protection, and open space; (3) water quality; and (4) stewardship and education.

The NWRI assessed existing water quality and riparian conditions based on data collected by the Connecticut Department of Environmental Protection, U.S. Geologic Survey, and U.S. Department of Agriculture. They also identified land uses that contribute to water quality problems, areas where stream channels had been modified by dams or flood control projects, and point sources such as municipal wastewater treatment facilities.

Based on the results of the assessment, the NWRI developed the Norwalk River Watershed Action Plan, which describes specific objectives and action items to accomplish those objectives for each of the four key areas listed above. Each objective contains a list of specific tasks with the implementing group clearly identified, the proposed time line for each task, and a measure of the tasks' success. The NWRI also developed an outreach program to foster stewardship and to educate watershed residents about the impacts of daily activities that contribute to the degradation of the Norwalk River watershed.

For more information on the Watershed Action Plan or to obtain a copy of the plan, contact the Norwalk River Watershed Coordinator, Connecticut Department of Environmental Protection, Bureau of Water Management, 79 Elm Street, Hartford, CT 06106; telephone 860-424-3096; e-mail tessa.gutowski@po.state.ct.us.

Restoration in the Anacostia River Watershed

The Anacostia River has been cited nationally as exemplifying urban watershed problems (AWRC, 1998). These problems are typified by

- Conversion of natural drainage networks into man-made channels.
- Increased runoff and urban pollutants from impervious surfaces.
- Channel erosion and associated loss of aquatic habitat from changes in land use.
- Sediments laden with toxic substances and other pollutants from motor vehicles.
- Electrical transformers, past applications of persistent pesticides, poorly timed applications of fertilizers, combined sewer overflows, atmospheric deposition, and pet waste.
- Thousands of tons of trash and debris.

As a result of this degradation, in 1987 a concerted effort to restore and protect the Anacostia watershed was initiated in the form of the Anacostia Watershed Restoration Agreement and the establishment of the Anacostia Watershed Restoration Committee (AWRC), which involved the District of Columbia, Montgomery and Prince George's counties in Maryland, the State of Maryland, the U.S. Army Corps of Engineers, the Metropolitan Washington Council of Governments, and the Interstate Commission on the Potomac River Basin. The cooperative effort was expanded in 1996 with the creation of the AWRC's Anacostia Watershed Citizens Advisory Committee (AWCAC). The AWCAC has brought formal recognition of the importance and need for citizen input and involvement in the restoration.

The AWRC established a framework to guide long-term restoration efforts and identified 580 restoration projects to correct existing environmental problems and enhance overall ecosystem quality. As of 1997 approximately $20 million had been spent on implementing roughly 29 percent of the 580 identified projects, with additional millions of dollars spent on planning, design, land acquisition, and maintenance. An additional $54 million had been spent on engineering controls designed to reduce the impacts of combined sewer overflows on the tidal river and of leaking, aging sewer lines on tributary streams. As a result of the restoration efforts, the submerged aquatic vegetation once absent from the river is beginning to reappear, signaling some improvement in water clarity, as the volume and concentrations of pollutants from urban runoff have been reduced. The successes have required the identification of problems and associated solutions, coordination of programs, and the mobilization of critical government, political, and financial resources. Key features in the success of the Anacostia program have been the development of common watershed restoration goals and the identification and establishment of partnerships.

More information about the Anacostia Watershed Restoration Project can be found at http://www.anacostia.net/awrc.htm.

10.3.3.7 Protect sensitive areas

Areas that should be considered for preservation and restoration at sites with existing development include riparian areas, 100-year floodplains, wetlands, woodlands and valuable trees, and areas with permeable soils. Steep slopes and erosive soils should be protected and stabilized to the extent possible.

10.3.4 Restore Natural Streams

Streams degraded by prior urbanization should be restored, if possible, using preexisting conditions as a goal or guideline. Eight restoration tools can be applied to help restore urban streams. These tools are intended to compensate for stream functions and processes that have been diminished or degraded by prior watershed urbanization. Best results are usually obtained when the tools are applied together; otherwise, the same sources that degraded the stream remain unchanged, causing similar effects.

A resource for information about restoring natural streams is *Stream Corridor Restoration: Principles, Processes, and Practices* (FISRWG, 2000), which is available for purchase or download at http://www.usda.gov/stream_restoration/newgra.html. Another resource is *Urban Stream Restoration: A Video Tour of Ecological Restoration Techniques* (Riley, 1998b), which is available for purchase at http://www.noltemedia.com/nm/urbanstream/index2.html. Finally, the Center for Watershed Protection developed 11 manuals, collectively called the Urban Subwatershed Restoration Manual Series, that present the information needed to restore small urban watersheds in a format that can easily be accessed by watershed groups, municipal staff, environmental consultants, and other users. The manuals are available for a fee in hard copy or as a download at http://www.cwp.org/USRM_verify.htm.

10.3.4.1 Partially restore the predevelopment hydrologic regime

The primary objective of storm water management is to reduce the frequency of bankfull flows and other erosive events in the contributing watershed. This is often done by constructing upstream storm water retrofit ponds that capture and detain increased storm water runoff for up to 24 hours before release (i.e., extended detention). Extended detention systems are often designed to control the one-year, 24-hour storm. Storm water retrofit ponds are often critical in the restoration of small and mid-sized streams, but they might be less cost-effective in larger streams and rivers unless implemented on a watershed basis.

10.3.4.2 Stabilize channel morphology

Over time, urban stream channels can become enlarged and are subject to severe bank and bed erosion. Therefore, it is important to stabilize the channel and, if possible, restore equilibrium to the channel geometry. In addition, it is useful to provide undercuts or overhead tree canopy to improve fish habitat. Depending on the stream order, the impervious cover in the watershed, and

Restoring Channel Morphology in a North Carolina Stream

Long Leaf Creek is located in an urbanized watershed along coastal North Carolina (Sotir, 2000). The stream had deepened and widened as a result of increased runoff and severe storms, including hurricanes. The changes resulted in reduced aesthetic value, damaged riparian vegetation and aquatic and terrestrial habitats, and degraded water quality. Managers selected a soil bioengineering approach over other alternatives after considering such issues as erosion control, streambank stabilization, safer and healthier environment, flood control, timely project completion, environmental and aesthetic improvement, property loss minimization, hydraulic efficiency, and cost feasibility. They installed live fascines, brush layer/live fascine combinations, joint planting, and vegetated geogrids.

The survival rates of the live vegetation ranged from 60 to 80 percent depending on the species used; maintenance proved to be a key factor in survival rates. Several important needs were identified, including studying bed conditions in areas that have had high deposits of mobile materials, employing sophisticated grade control structures, following installation procedures and maintenance schedules, and encouraging communication and cooperation between engineers and wetland scientists.

the height and angle of eroded banks, a series of different tools can be applied to stabilize the channel and prevent further erosion. Bank stabilization measures include revegetated riprap and soil bioengineering methods (see Management Measure 7) such as willow stakes, brush bundles, bio-logs, lunker structures, and rootwads.

10.3.4.3 Restore instream habitat structure

Most urban streams have poor instream habitat structure, often typified by indistinct and shallow low-flow channels within a much larger and unstable storm channel. The goal is to restore instream habitat structure that has been blown out by erosive floods. Key restoration elements include creating pools and riffles, confining and deepening the low-flow channels, and providing greater structural complexity across the streambed. Typical tools include installation of log check dams, stone wing deflectors, and boulder clusters along the stream channel.

Urban Stream Restoration in the Waukegan River, Illinois

An urban stream restoration project is underway in the Waukegan River in Illinois to repair channel instabilty caused by runoff from impervious surfaces and lack of storm water controls. The project uses biotechnical bank restoration to stabilize streambanks and low stone weirs to restore pool and riffle sequences. A habitat monitoring design was also used to document water quality changes. The project has improved biological diversity through pool and riffle restoration, yet it did not significantly improve stream fisheries. For more information about the project, refer to *Section 319 Nonpoint Source National Monitoring Program: Successes and Recommendations* (NCSU, 2000).

10.3.4.4 Reestablish riparian cover

Riparian cover is an essential component of the urban stream ecosystem. Riparian cover is necessary to stabilize banks, provide large woody debris and detritus, and provide shade to maintain water temperatures. Reestablishment of the riparian cover plant community along the stream network is often essential to achieve the goals and objectives of the program. This can entail active reforestation of native species, removal of exotic species, or changes in mowing operations to allow gradual succession. Establishment of an urban stream buffer can achieve many of these objectives (see section 3.3.3.6 of Management Measure 3 for a discussion of setbacks/stream buffer zones).

Citizen Involvement in Planting Riparian Forests

In Lexington, Kentucky, a unique program is underway to restore riparian areas to local streams. Because the city's limited budget does not allow for an expensive riparian planting effort, Reforest the Bluegrass was established as a cooperative effort by local private and nonprofit organizations, citizen groups, and government agencies. Reforest the Bluegrass provides training for citizen volunteers to participate in replanting efforts. The program provides public education for participants and for local residents through outreach, while significantly reducing program costs. Participants are taught the value of riparian systems in protecting water quality, combating the "urban heat island" effect, and providing habitat for wildlife. As of April 2002, nearly 4,000 volunteers had planted 108,000 seedlings. The program was financed with $85,000 from local government and $50,000 from private donations, compared with an estimated cost $675,000 if the project had been completed by contractors (Gabbard and Poe, 2003).

Restoring Atlanta's Watersheds

The International Life Sciences Institute's Risk Science Institute (RSI) was tasked with assessing the condition of streams in Atlanta, Georgia; developing a watershed management implementation plan; and identifying specific watershed restoration activities that would improve riparian habitat and water quality in four example subwatersheds (RSI, 1998). They identified several habitat and water quality impacts that can be attributed to urbanization, including

- Increased magnitude and frequency of bankfull and subbankfull events.
- Stream channel dimensions out of equilibrium with hydrologic regime.
- Enlarged, highly modified channels.
- Increased sediment load due to upstream channel erosion.
- Decreased baseflow.
- Decreased wetted perimeter.
- Degraded in-stream habitat structure.
- Reduced large woody debris.
- Increased number of stream crossings, which are potential barriers to fish migration.
- Fragmentation and narrowing of riparian forests.
- Degraded water quality.
- Increased summer stream temperatures.
- Reduced aquatic diversity.
- Combined sewer overflows.

To address these issues, RSI developed a watershed management program for the Atlanta region that includes the following elements:

- Creation of an institutional framework for watershed management (Management Measure 1).
- Development of a comprehensive storm and surface water control program.
- Establishment of erosion and sediment control programs.
- Establishment of detention pond requirements.
- Expansion of the tree canopy.
- Management of buffers, sensitive areas, and floodplains.
- Establishment of land development provisions.
- Daylighting of streams.
- Relocation of utilities.
- Eradication of invasive and exotic species.
- Development of a public education and outreach campaign.

RSI also developed several objectives for the watershed management program and identified environmental indicators that can be used to gauge the effectiveness of management activities (see Management Measure 2). Finally, RSI examined four subwatersheds to identify specific management practices that can be used to fulfill the objectives of the watershed management program. In each case study, they identified the activities in the subwatershed that were contributing to resource degradation and suggested methods, such as separating storm and sanitary sewers and improving storm water infiltration, that would reduce runoff to prevent further waterbody degradation. These methods would also increase the effectiveness of in-stream and riparian restoration activities. RSI then identified site-specific restoration activities such as streambank stabilization, riparian buffer management, and creation or restoration of in-stream habitat.

For more information about the Watershed Management Program for Atlanta or to receive a copy of RSI's report, contact the Risk Science Institute, International Life Sciences Institute, 1126 16th Street, NW, Washington, DC 20036-4810; e-mail rsi@ilsi.org.

10.3.4.5 Protect critical stream substrates

A stable, heterogeneous streambed is often a critical requirement for fish spawning and secondary production by aquatic insects. The bed of an urban stream, however, is often highly unstable and clogged by deposits of fine sediment. It is often necessary to mechanically restore the quality of stream substrates at points along the stream channel. Often, the energy of urban storm water can be used to create cleaner substrates through the use of flow concentrators and other manufactured devices. (See Management Measure 5 for more information about these practices.) If thick deposits of sediment have accumulated on the bed, mechanical sediment removal might be needed.

10.3.4.6 Promote recolonization of the aquatic community

It may be difficult to reestablish the fish community in an urban stream if downstream fish barriers prevent natural recolonization. In these instances it is important to seek the judgment of a fishery biologist to determine whether downstream fish barriers exist, whether they can be removed, or whether selective stocking of native fish is needed to recolonize the stream reach.

10.3.4.7 Daylight streams

Daylighting involves returning a stream that has been buried in a pipe or culvert to the surface. In many cases the stream can be restored to its original channel, but sometimes a new channel must

Daylighting Jolly Giant Creek, Arcata, California

A classic example of daylighting is Arcata, California's Jolly Giant Creek (Pinkham, 1998). The daylighting and stream restoration project was initiated in 1991 by a high school biology teacher, Lewis Armin-Holland, and Humboldt State University students Melissa Bukosky and Tom Hagberg. They initially started the project to provide environmental education to high school and college students on stream ecology and restoration, but Bukosky continued to gather data and designed a new channel and restoration plan for the creek.

The Redwood Community Action Agency, a nonprofit regional development organization, obtained a grant from the California Department of Water Resources Urban Streams Restoration Program. Other funding sources included U.S. Fish and Wildlife Service Challenge Cost-Share, the city of Arcata, and donations from a local heavy equipment contractor and the National Tree Trust. A substantial amount of volunteer labor was used for revegetation and to conduct assessment and monitoring. Funding for the project totaled $120,000.

The first phase of the stream restoration project included removing nearly 100 feet of culvert; installing a sedimentation basin, a ⅓-acre pond, and 75 feet of new stream channel; providing bank stabilization and flow control measures; and rerouting the stream through an older dry channel with existing riparian vegetation. The second phase involved creating a new channel within the old, wider channel at an abandoned mill site; creating berms around part of the property; restoring more than 400 feet of the Jolly Giant Creek; and providing a seasonal wetland and wet weather detention pond with substantial runoff storage capacity.

For more information contact Richard Pinkham, Senior Research Associate, Rocky Mountain Institute, 1739 Snowmass Creek Road, Snowmass, CO 81654; telephone 970-927-3807; e-mail rpinkham@rmi.org.

be engineered. Flow control structures and flood control measures can be incorporated into the design of the new or restored channel. Planting, restoring, and maintaining streambank vegetation and providing a diversity of instream habitat for submerged aquatic vegetation, fish, and aquatic insects are important aspects of the stream restoration project.

Daylighting typically requires a large capital investment for acquiring permits, engineering designs and expertise, equipment and labor for excavation, and plantings and labor to establish desirable stream morphology. Because communities are typically in favor of daylighting projects, many of these costs can be offset by recruiting sponsors such as property owners, community groups, housing associations, municipalities, environmental groups, and contractors. The benefits of a daylighting project for a particular stream reach should be carefully considered and weighed against the cost to determine whether the project is worthwhile.

A source of information is *Daylighting: New Life for Buried Streams*. In addition to summary findings, recommendations, and conclusions, the report provides information about completed and proposed daylighting projects (Pinkham, 2000).

10.3.5 Preserve, Enhance, or Establish Buffers

Stream buffers may be present as part of previous development, but it is unlikely that existing buffers were established or maintained to maximize pollutant removal. As the intensity of surrounding development increases, runoff and pollutant loads increase and can result in damage to the buffer. If the buffer is not protected from disturbance or excessive traffic, it can deteriorate over time. Buffers serve several important functions: they help improve soil and water quality, stabilize streambanks, decrease flood severity, replenish ground water supply, and provide wildlife habitat (Schultz et al., 1996). Some steps that can be taken to preserve or enhance existing buffers include:

- Delineating buffer boundaries and establishing management zones within the buffer (streamside, middle, and upland zones);
- Developing vegetative and use strategies within these zones;
- Establishing provisions for buffer crossings;
- Integrating structural runoff management practices where appropriate to protect the buffers and to augment their performance; and
- Developing buffer education and awareness programs.

A buffer can be established in the area between the stream and existing development when buildings are set back from the stream to prevent damage from flooding. These areas can be mapped and buffer boundaries established based on runoff and pollutant loadings. In some cases, impervious surfaces in the buffer need to be removed or parts of the buffer regraded to ensure maximum pollutant removal efficiency. The buffers are then divided into three zones—the streamside, middle, and upland zones—that contain different types of vegetation and accomplish pollutant removal in different ways (Herson-Jones et al., 1995). Design considerations for stream buffers are discussed in more detail in Management Measure 3.

10.3.6 Redevelop Urban Areas to Decrease Runoff-Related Impacts

10.3.6.1 Encourage infill development

Infill development is a tool planners use to encourage siting of new development on unused lands in existing urban areas. Infill development usually works in tandem with community redevelopment initiatives to foster revitalization of existing neighborhoods by replacing dilapidated buildings and underused properties with new housing or businesses. However, from a water quality perspective, if infill development is promoted on unused lands in existing developed areas, sites should be selected that result in decreased pollutant loadings and runoff volumes. Open space that provides valuable flood control and pollutant removal functions should be preserved or enhanced if possible. Trees within existing developments should be protected or replanted as necessary.

Infill and redevelopment can be employed in either large or small projects. One impediment to more widespread implementation of infill projects is the existing condition of a potential redevelopment site in terms of environmental constraints. The restrictive nature of many land use regulations and pressing social and economic issues may also impede implementation. Faced with these constraints, local governments often need to modify local zoning or building codes to make infill development and redevelopment more inviting to developers. Experience has shown that citizen involvement has often been a catalyst for leveraging funding or revising codes for this type of renewal.

10.3.6.2 Assess vacant, abandoned lots and areas of potentially contaminated soils to promote redevelopment

In many urbanized areas, changes in development patterns and economic decline have resulted in deterioration or abandonment of industrial and commercial sites. Many of these sites have contaminated and compacted soils that discharge polluted runoff during and after storms. These underused areas can be identified and assessed to determine if redevelopment or remediation can result in significant reductions in pollutant loadings or flow to improve surface water or ground water quality. Social and economic benefits may also accrue. Redevelopment plans can include the use of practices such as disconnection of impervious areas to reduce the total effective impervious area (see section 4.3.2) or infiltration practices including bioretention and onsite runoff storage.

EPA's Office of Solid Waste and Emergency Response has a brownfields initiative that encourages the redevelopment of abandoned, lightly contaminated industrial sites in economically stressed communities (USEPA, 1999). The program provides funding and guidance to help communities locate potential brownfields redevelopment sites, to perform soil and ground water assessments to determine the nature and extent of contamination, and to promote environmental clean-up and redevelopment of these sites. The program includes tax incentives for potential redevelopers and waivers of liability for past contamination. It encourages federal, state, and local coordination of enforcement activities and stakeholder and community involvement to identify and plan new uses for brownfields to promote environmental health and safety, environmental justice, and economic growth for economically depressed communities.

The brownfields initiative has several advantages for communities with underused, potentially contaminated sites. It provides a catalyst for assessment of urban areas for sites in need of clean-up and redevelopment to improve the community's surface water and ground water quality, quality of life, and property values. Redeveloping properties that have already been disturbed helps to prevent development of greenfields—undeveloped suburban areas—and slows the growth of imperviousness in the outskirts of urban areas. It also provides an incentive for communities to alleviate soil and ground water contamination and to convert abandoned, eyesore lands to viable businesses, recreational facilities, or other uses.

In 2002, the brownfields program was expanded and strengthened through ratification of the Small Business Liability Relief and Brownfields Revitalization Act (see http://www.epa.gov/brownfields/sblrbra.htm for more information). More information about EPA's Brownfields Initiative is available at http://www.epa.gov/brownfields.

Chicago Calumet Initiative

Calumet is located on the southeast side of Chicago along the Calumet River, adjacent to Lake Michigan, that has been subject to more than 120 years of heavy industrial activity. Calumet currently has thousands of acres of contaminated brownfields located amongst open space that serves as habitat for many types of wildlife, including birds listed by the state as endangered or threatened.

In 2000 Chicago mayor Richard Daley and former Governor George Ryan launched the "Calumet initiative," a revitalization project that involves brownfields clean-up, the preservation of land and wetlands, urban forestry, renewable energy, and low impact development. The City is working in partnership with the Illinois Department of Natural Resources, the U.S. Forest Service, EPA, the Fish and Wildlife Service, the Illinois Environmental Protection Agency, and 15 other governmental partners.

The Initiative includes plans to redevelop 3,000 acres of brownfields into a region with sustainable industries such as a new Ford Motor Company supplier park that uses low impact development techniques and minimizes runoff to adjacent waterbodies. The Calumet Tax Increment Financing District was established to encourage industries to relocate to the revitalized area.

The Calumet Open Space Reserve will provide 4,800 acres of rehabilitated and preserved wetlands and crucial habitat for the 700 plant and 200 bird species that occupy the land currently. The property will be managed through a watershed-based ecological management strategy combined with land acquisition and preservation (NALGEP, 2003).

10.4 Information Resources

The *Anacostia Watershed Restoration Progress and Conditions Report 1990–1997* summarizes accomplishments and ongoing projects of the Anacostia Watershed Resoration Committee as they relate to their six restoration goals. In addition, the report provides recommendations to the committee for future actions to sustain and further promote the restoration effort.

The Federal Interagency Stream Restoration Working Group (2000), which is a collaboration among of 15 federal agencies including EPA and USDA, published *Stream Corridor Restoration: Principles, Processes, and Practices*. This document covers background information about stream corridors, including processes, characteristics, and disturbances; development of a stream corridor restoration plan; and application of restoration principles to stream corridor projects. *Stream Corridor Restoration: Principles, Processes, and Practices* can be purchased or downloaded in PDF format at http://www.nrcs.usda.gov/technical/stream_restoration/newgra.html.

Riparian Buffer Strategies for Urban Watersheds (Herson-Jones et al., 1995) provides guidance on riparian buffer programs used to mitigate the impact of urban areas on nearby streams. The document uses the results of a national survey of riparian buffer programs as well as a comprehensive review of riparian buffer literature to make recommendations on buffer design. It also analyzes buffer pollutant removal potential and pollution prevention techniques via chemical, biological, and physical processes. It is available for purchase at http://www.mwcog.org/ic/95703.html.

The Save Our Streams Program is a national watershed education and outreach program by the Izaak Walton League (no date). The league offers many stream-related resources, including information on stream projects and publications such as *A Citizen's Streambank Restoration Handbook*. The Save Our Streams Program can be reached by e-mail at sos@iwla.org, by calling 1-800-BUG-IWLA, or by visiting the Web site at http://www.iwla.org/sos.

The Natural Resources Conservation Service's National Conservation Buffer Initiative Web site (http://www.nrcs.usda.gov/feature/buffers/) contains information about buffers, links to technology information, and buffer initiative contacts (NRCS, no date).

Urban Restoration: A Video Tour of Ecological Restoration Techniques (Riley, 1998b) is a video tour of six urban stream restoration sites. It includes background information on how the projects were funded and organized with community involvement and the history and principles of restoration. Additionally, examples are presented of stream restoration in very urbanized areas, recreating stream shapes and meanders, creek daylighting, soil bioengineering, and ecological flood control projects. A companion to the video is *Restoring Streams in Cities: A Guide for Planners, Policymakers, and Citizens* (Riley, 1998a). This book includes detailed information on all relevant components of stream restoration projects, from historical background to hands-on techniques. The book and video can be purchased at http://www.noltemedia.com/nm/urbanstream/index2.html.

EPA and the LID Center conducted a literature review of LID studies to assess the state of knowledge about LID practices (USEPA, 2000c). The final report contains a brief overview of LID principles and programmatic issues such as use, ownership, and cost. The heart of the document is a summary of the information available regarding the pollutant removal effectiveness of the most common LID practices. The report is available for download in PDF format at http://www.epa.gov/owow/nps/lidlit.html. This page also contains links to low-impact development fact sheets on bioretention, vegetated roof covers, permeable pavements, and street surface storage of runoff.

EPA's River Corridor and Wetland Restoration Web site contains general information about restoration and its benefits, a list of restoration guiding principles that cover the entire life of a restoration project from early planning to postimplementation monitoring, restoration project descriptions, and links to other restoration resources. The site is located at http://www.epa.gov/owow/wetlands/restore.

The Center for Watershed Protection developed 11 manuals, called the Urban Subwatershed Restoration Manual Series, that present the information needed to restore small urban watersheds in a format that can easily be accessed by watershed groups, municipal staff, environmental consultants, and other users. The manuals are available for a fee in hard copy or as a download at http://www.cwp.org/USRM_verify.htm.

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MANAGEMENT MEASURE 11
OPERATION AND MAINTENANCE

11.1 Management Measure

Develop a program for regular inspection and maintenance of urban runoff management practices.

- Develop and implement an operation and maintenance plan for urban runoff management practices. The plan should include scheduled inspections, scheduled maintenance activities, and scheduled evaluations of operation and maintenance practices.
- Inspect, maintain, and repair runoff treatment controls to maintain design treatment capacity.
- Inspect, maintain, and restore riparian buffers.

11.2 Management Measure Description and Selection

11.2.1 Description

The maintenance of storm water controls is essential to ensure that overall program goals are met and that each management practice or set of practices continues to function as designed. Storm water controls need to be periodically inspected and maintained as necessary to fine-tune performance, prevent malfunction, and address any problems that may arise. Although maintenance issues should be a major consideration during the management practice selection process, they are often overlooked and inadequately planned for and budgeted. As a result, many management practices fail to perform as intended.

An operation and maintenance (O&M) plan is one way to systematically ensure that scheduled inspections, maintenance, and practice evaluations occur. Formalizing an operation and maintenance plan also can be helpful in determining and securing the funding necessary to properly operate and maintain runoff management practices.

Program managers should consider incorporating the following elements in their operation and maintenance programs:

- Scheduled inspections (based on climate, precipitation, and runoff management practice);
- Scheduled maintenance activities, such as removal of forebay sediment;
- Use of maintenance checklists to systematize and document the inspection process; and
- Initial and follow-up monitoring of management practices to establish performance baselines and trends to guide maintenance activities.

Maintenance activities may vary by management practice. For example, vegetation management is necessary for some extended detention wet ponds and constructed wetlands to maintain optimal removal efficiency, to avoid the net export of nutrients during winter, and to maintain design flow patterns. Removal of sediment build-up is essential to maintain properly functioning practices. Infiltration devices must be protected and maintained to prevent pore clogging and loss of infiltration capacity.

Preventative maintenance may also be necessary to protect the performance of management practices. Run-on sedimentation from off-site areas may need to be addressed through stabilization measures to prevent unnecessary maintenance expenditures.

The incorporation of maintenance considerations into management practice designs will often reduce subsequent maintenance costs and repairs and help to avoid failures. For example, the removal of material from sediment traps can be facilitated by designs that allow easy access to accumulated sediments without specialized equipment. Safe and convenient access to inlet and outlet structures can reduce maintenance costs and prevent nuisance flooding. Finally, the use of proper construction techniques and phasing can reduce the potential for initial clogging of infiltration devices during the construction process.

Enforcement of inspection and maintenance programs is crucial to their success. A 1992 study in Maryland evaluated 250 storm water practices to determine whether they were being maintained in compliance with the state's Stormwater Management Act. The researchers found that after a few years, approximately one-third of the practices were not functioning as designed, and most required maintenance. Approximately one-half of the facilities were undergoing sedimentation and many had problems with clogging (Lindsey et al., 1992). Implementing the practices described under this management measure can help develop an effective O&M program for continued effectiveness and longevity of runoff management practices.

11.2.2 Management Measure Selection

This management measure was selected because improper operation and maintenance of runoff control practices can result in poor performance and increased discharge of pollutants to downstream waters. Flooding may occur and downstream channel stability could be jeopardized. Poorly maintained runoff systems also may increase risks to public safety and the potential for property damage.

To prevent these potential impacts, effective maintenance programs should include standards for the inspection and maintenance of runoff controls. The entities responsible for maintaining runoff controls must be clearly identified and adequate resources must be provided to conduct the necessary maintenance activities. Because maintenance issues are critical to successful program implementation, they should be planned for at the outset of the runoff management program and conducted continuously for the lifespan of the practice(s).

The following section contains descriptions of specific O&M requirements for various types of management practices.

11.3 Management Practices

11.3.1 Establishing an Operation and Maintenance Program

The following section outlines several practices that will facilitate development of a runoff control O&M program.

11.3.1.1 Establish a runoff control operation and maintenance ordinance

One way for local governments to ensure that maintenance of runoff control facilities is performed is to establish an ordinance that mandates these activities. The O&M language in a runoff control ordinance can specify that runoff management practices must be designed to facilitate easy maintenance and require that regular maintenance activities be performed.

EPA (2000) has provided model ordinance language (at http://www.epa.gov/nps/ordinance) that includes consideration of maintaining runoff control management practices. Ordinance language examples from across the country are provided, including a sample maintenance agreement, a sample easement and right-of-way agreement, an inspection checklist, and a performance bond.

It is important for O&M ordinances to contain language that requires the identification of the specific entity or entities responsible for long-term maintenance and requires regular inspection visits. The ordinance also should provide design guidelines that can help ease the maintenance burden, such as the inclusion of maintenance easements. Note that runoff control ordinance language regarding the maintenance of erosion and sediment control practices differs from that regarding maintenance of postconstruction controls because of the short-term nature of the former.

The City of Alexandria, Virginia has incorporated inspection and maintenance requirements into the Alexandria Zoning Ordinance. The ordinance requires the submission of a long-term inspection and maintenance plan that identifies all maintenance requirements and responsible parties. A standard maintenance and monitoring agreement approved by the city council is required for urban runoff practices in Alexandria and cannot be modified without council approval (Bell, 1997).

11.3.1.2 Make provisions for maintenance in the design and construction of management practices

Because maintenance programs play such an important role in ensuring the proper operation of most structural practices and some source controls, emphasis should be given to maintenance issues when identifying management practices under any runoff management program. Making provisions for maintenance at the design and construction phase involves identifying the urban runoff practices to be used when designing a new facility. Practices should be designed so that maintenance equipment (mowers and vacuum trucks) can easily access the site. Many practices have been designed with inadequate pre-treatment (i.e., without a sediment basin at the inlet), and they have not performed as anticipated. Inlet and outlet structures also tend to clog easily without proper design and maintenance. Adequate size and storage volume based on expected sediment loads from the contributing drainage area should be factored into the design of inlets and pre-treatment structures.

11.3.1.3 Identify mechanisms for program funding

It is important to identify the entity responsible for operating and maintaining structural runoff control practices. The responsible party can be a property owner, homeowners' association, certified contractor, or local government agency. Local governments may assume the responsibility of maintaining privately owned facilities. When private entities do not fulfill their maintenance responsibilities and the facilities fail, the burden of maintaining runoff control and performing downstream restoration may ultimately fall under the local government's responsibility. Public financing for maintenance of both public and private facilities can be generated from general tax revenues, storm water utility fees, inspection or permit fees, or dedicated contributions. Sources of funding should be dedicated to runoff program budgets and or maintenance programs whenever possible. A discussion of these and other financing options for maintenance of runoff control facilities is provided in Chapter 8 of the Watershed Management Institute's *Operation, Maintenance, and Management of Stormwater Management Systems* (1997).

It is important that the funding source for maintenance of runoff control facilities be supported by the public. The Watershed Management Institute (1997) stresses the importance of public education to inform citizens about the locations and functions of runoff control facilities and the importance of regular maintenance. The institute believes that citizens and government officials will be more willing to allocate funds to projects that they know will provide tangible benefits to the community. The institute also recommends that funding programs for maintenance activities have the following attributes:

- Be based on a stable source of consistent funds that will ensure a long-term commitment of personnel, equipment, and materials;
- Be compatible with the local organizational structure to allow use of existing billing, collection, and bookkeeping operations;
- Include provisions for four essential operations: (1) program administration; (2) accounting and budgeting; (3) revenue management; and (4) information management;
- Be based on an equitable, understandable, and defensible fee or rate structure;
- Be continually reviewed and updated to meet the changing maintenance needs of the runoff control program; and
- Be consistent with applicable state laws and regulations.

11.3.1.4 Plan regular inspections

Inspections are essential to maintain the successful operation of the facility. Inspectors should have on hand equipment necessary for taking measurements and making minor repairs, be trained in identifying and remedying problems, and have a set of standard inspection procedures from which to work. An inspection schedule and checklist for each type of management practice should be developed and followed. Inspections and maintenance should be conducted both on a regular schedule and following storms to identify and repair any damage.

11.3.1.5 Schedule maintenance, cleaning, and debris removal to avoid sediment accumulation

Sediment and debris can contain hazardous contaminants and can clog filtration and infiltration practices, reducing their effectiveness over time. In addition to major structural controls, maintenance programs should include measures for cleaning catch basins and drainage channels. Establishment of an effective O&M program should include the creation of maintenance logs and identification of specific maintenance triggers for each class of control (e.g., removing sediment from forebays every year and retention ponds every five years, cleaning catch basins at least annually prior to the rainy season, removing litter from channels twice a year). If maintenance activities are scheduled infrequently, regular inspections should be made to ensure that the control is operating adequately. Additionally, maintenance should be performed following significant storms.

11.3.1.6 Make provisions for monitoring treatment criteria

Regularly monitoring the influent to and effluent from structural management practices will support program goals by facilitating development of a database to track the effectiveness of these practices, which can help guide future decisions about management practice implementation. These data will make it easier to quantify the performance of the practice and determine the behavior of the system as a result of regular maintenance.

11.3.1.7 Implement training and certification programs to provide educational opportunities for management practice operators

Training and certification programs are gaining popularity around the country at both the state and local levels. Municipalities sometimes use contractors to conduct inspections and maintenance because resources are not available to purchase equipment and hire dedicated staff. Good training programs can ensure that inspections and maintenance activities are carried out in a thorough and consistent manner. Also, training programs can be customized to address local concerns and conditions such as high flows, highly erodible soils, or invasive species.

11.3.1.8 Disposal of residuals

Runoff can carry both natural and anthropogenic pollutants and materials to receiving waters. Natural materials, such as leaves and soils, can accumulate in the system and cause localized flooding. Anthropogenic sources, which include oil and grease, heavy metals, deicing materials, and litter, can become adsorbed to leaf litter and sediments (Lenhart and Harbaugh, 2000). The mixed composition of solids that are removed from the storm drain system (termed residuals) can require special handling and treatment, which increases disposal costs (Field and O'Shea, 1994). The characteristics of residuals tend to vary with season and land use. Table 11.1 summarizes the results of a number of studies analyzing residuals in runoff (Field and O'Shea, 1992; Marquette University, 1982; Schueler and Yousef, 1994).

Table 11.1: Properties of urban storm water solids/residuals (adapted from USEPA, 1999).

Properties of Residuals	Wet Ponds[1]	Sediment Basin[2]	Swirl and Helical Bend Solids Separators[3]	In-Line Upsized Storm Conduit[4]	Urban Storm Water Runoff Residuals[5]
Solids					
Volatile Suspended Solids	6%	104–155 mg/l	107,310 mg/l	25,800 mg/l	90 mg/l
Total Suspended Solids	43%	233–793 mg/l	344–1,140 mg/l	161,000 mg/l	415 mg/l
Nutrients					
Phosphorus	583 mg/kg	< 5 mg/l	<5 mg/l	0.3–2,250 mg/l	502–1,270 mg/kg
Total Kjeldahl Nitrogen	2,931 mg/kg	<5 mg/l	<5 mg/l	0.3–2,250 mg/l	1,140–3,370 mg/kg
Heavy Metals					
Zinc	6–3,171 mg/kg				302–352 mg/kg
Lead	11–748 mg/kg				251–294 mg/kg
Chromium	4.8–120 mg/kg				168–458 mg/kg
Nickel	3–52 mg/kg				69–143 mg/kg
Copper	2–173 mg/kg				251–294 mg/kg
Cadmium	No detect–15 mg/kg				
Iron		6.1–2,970 mg/l	6.1–2,970 mg/l	6.1–2,970 mg/l	
Hydrocarbons	2,087-12,892 mg/kg				

[1] Scheuler and Yousef, 1994
[2] Marquette University, 1982 (Racine, Wisconsin)
[3] Marquette University, 1982 (Boston, Massachusetts)
[4] Marquette University, 1982 (Lansing, Michigan)
[5] Field and O'Shea, 1992

A system for managing residuals in runoff should address the proper handling and disposal of both liquid and solid residuals. Ponds, infiltration practices, vegetative controls, and catch basin inserts have different removal mechanisms, and the type of residuals generated from these practices will vary. All residuals should be tested for contamination (unless the management entity has determined that residuals from an individual practice or category of practices pose no hazard), and maintenance employees should be trained in properly identifying and handling contaminated waste according to the requirements of the Resource Conservation and Recovery Act (RCRA) and state and local regulations (USEPA, 1999). Removal mechanisms and requirements for specific practices are described below.

Non-hazardous solids in residuals can be recycled, sent to a landfill, or applied to land. Land application involves spreading the material on designated land at approved application rates. The material should not be applied to cropland, but application to a nonagricultural vegetated area may be appropriate (USEPA, 1999). Disposal of the waste in a landfill may be the most expensive option because of travel costs, testing requirements, and disposal fees (Lenhart and Harbaugh, 2000).

There are a number of low-cost options for recycling. Coarse sand and gravel can be used for road base, and road sand can be recycled for winter maintenance activities. The City of Olympia, Washington uses dried solids from treatment systems by mixing them with cement. The organic portion of residuals can be composted after removing the coarse inorganic materials. These organic residuals can then be combined with yard debris, leaves, straw, or soil. The Washington Department of Transportation mixes solids with mulch and bark for use as topsoil along roadsides (Lenhart and Harbaugh, 2000). In general, urban runoff residuals have very low nutrient content and thus require mixing with high nutrient content organic matter to provide fertilization benefits (Field and O'Shea, 1994).

Additional considerations for the disposal of residuals include air and noise pollution from machinery operation at the disposal site, unpleasant odors, possible ground water or surface water contamination, and public health. To address these issues, local and state agencies should address the following when developing guidelines for disposal of residuals: application rates, treatment requirements, site suitability, and proximity to schools, parks, and residential areas (Field and O'Shea, 1994).

The City of Everett, Washington uses a source separation system that requires operators of vacuum trucks to determine whether contamination of residuals is suspected based on sheen, odor, and color. Residuals suspected of contamination are handled in accordance with state and local regulations. Otherwise, materials are collected and recycled as aggregate material on medians and selected roadsides after being tested for contamination (Lenhart and Harbaugh, 2000).

11.3.2 Source Control Operation and Maintenance

11.3.2.1 Infrastructure

(1) *Street sweeping.* Street cleaning reduces pollutants carried in runoff from street surfaces. The frequency of cleanings should reflect the rate of pollutant buildup and should increase just before the rainy season. An effective program requires that street sweeping be conducted on a regular basis. Sweeper operators require training, and equipment needs to be maintained regularly to ensure that it is functioning as designed. Finally, parking restrictions can be implemented to guarantee adequate cleaning despite on-street parking. Table 11.2 shows O&M costs associated with street sweeping. See Management Measure 7 for more information about types of street sweepers (brush vs. vacuum sweepers and their relative effectiveness, section 7.3.5.1) and roadside trash removal (section 7.3.5.4).

Table 11.2: Street sweeper O&M costs (adapted from CWP, 1998).

Maintenance Considerations		Sweeper Type	
		Mechanical Sweeper	Vacuum-Assisted Sweeper
O&M costs (1998 dollars)	Cost ($/curb mile)	30	15
	Weekly sweeping ($)	1,680	946
	Biweekly sweeping ($)	840	473
	Monthly sweeping ($)	388	218
	4 times per year sweeping ($)	129	73
	Twice per year sweeping ($)	65	36
	Annual sweeping ($)	32	18
Expected life (years)		5	8

(2) *Storm drain flushing*. This practice is used to remove deposited materials from storm drain pipes to maintain their flow capacity. The flushing schedule should be designed to prevent excessive buildup based on estimated inputs from the contributing drainage areas, cleaning history, and visual inspections. Flushing is performed either at or upstream from problem areas. There are costs to consider for collecting and disposing of sediments, debris, and flush water, in addition to supplying flush water and treating sediment-laden water if the storm drains are being flushed to a receiving water body.

(3) *Catch basin cleaning*. Cleaning catch basins removes excess pollutants, thereby reducing high pollutant concentrations in a storm's first flush, preventing clogging, and restoring sediment-trapping capacity. Maintenance should target areas with the greatest pollutant loading and those near sensitive water bodies. A maintenance log should be kept to track progress. If there are many catch basins in a community, mechanical cleaners (vacuums or bucket loaders) may be required; otherwise, hand cleaning will suffice. Proper record-keeping, waste disposal, and safety procedures are essential for a successful program.

(4) *Highway, bridge, and road maintenance*. Maintenance of roads and bridges can be a

Sediment Removal from Catch Basins

The Delaware County, New York, Department of Public Works, with the assistance of the Catskill Watershed Corporation, purchased a vacuum truck capable of removing sediment from culverts and catch basins. The truck, which has a 30-foot pipe reach and a 12 cubic yard storage capacity, is available for use by neighboring counties based on need and availability. In the first month of operations, approximately 700 cubic feet of sediment was removed. The sediment s disposed of without posing a threat of contamination to the Cannonsville and Pepacton reservoirs. The County will be sampling sediment in an attempt to quantify the amount of contaminants removed (Delaware County Departments of Planning and Public Works, 2003).

significant source of pollutants. Some methods to prevent materials from contaminating runoff are limiting the use of salts; using suspended tarps, vacuums, or booms to reduce pollutant drift onto waters from scraping and painting; and training road crews in proper waste control and disposal methods. Treatment controls also can be used on-site to reduce the amount of polluted runoff that enters receiving waters. Runoff reduction, conveyance, and treatment practices (e.g., infiltration swales in median strips) can be incorporated into the design of new roadways and bridges to help contain pollutants from traffic as well as from maintenance activities. For more information about runoff management practices for roads, highways, and bridges, see Management Measure 7: Bridges and Highways.

11.3.2.2 Trash in channels and creeks

Clean-up of trash from streams and storm water conveyance infrastructure can reduce pollutant levels in downstream waters. Areas where dumping occurs frequently can be identified and inspected regularly, and "no littering" or "no dumping" signs can be posted to deter future dumping. Steep fines for dumping may also discourage potential transgressors. Associated costs for these practices are the purchase of signs and equipment, paying personnel to conduct inspections and clean-up, and providing landfill space to dispose of recovered items. Cost savings can be achieved through community or volunteer clean-up programs.

11.3.3 Treatment Control Operation and Maintenance

Runoff treatment controls require periodic inspection and maintenance to ensure that sediment, trash, and overgrown vegetation are not impeding their performance. Regular inspections should be performed along with routine maintenance. Nonroutine maintenance may be required to repair structures, control erosion, and remove unwanted vegetation. Table 11.3 and the following practices describe maintenance costs, activities, and schedules for several categories of urban runoff treatment practices.

Table 11.3: Maintenance costs, activities, and schedules for runoff control practices in 1998 dollars (Adapted from CWP, 1998).

Category	Management Practice	Annual Maintenance Cost (% of Construction Cost)	Maintenance Cost for a "Typical" Application	Maintenance Activity	Schedule
Detention ponds or vaults	Dry ponds	~1%	$1,200	– Cleaning and removal of debris after major storms (>2" rainfall) – Harvesting of vegetation when a 50% reduction in the original open water surface area occurs – Repair of embankment and side slopes – Repair of control structure	Annual or as needed
				– Removal of accumulated sediment from forebays or sediment storage areas when 60% of the original volume has been lost	5-year cycle
				– Removal of accumulated sediment from main cells of pond once 50% of the original volume has been lost	20-year cycle

Table 11.3 (continued).

Category	Management Practice	Annual Maintenance Cost (% of Construction Cost)	Maintenance Cost for a "Typical" Application	Maintenance Activity	Schedule
Ponds	Extended detention ponds, wet ponds, multiple pond systems, "pocket" ponds	3%–6%	$3,000–$6,000	– Cleaning and removal of debris after major storm events (>2" rainfall) – Harvesting of vegetation when a 50% reduction in the original open water surface area occurs – Repair of embankment and side slopes – Repair of control structure	Annual or as needed
				– Removal of accumulated sediment from forebays or sediment storage areas when 60% of the original volume has been lost	5-year cycle
				– Removal of accumulated sediment from main cells of pond once 50% of the original volume has been lost	20-year cycle
Wetlands	Shallow wetlands, pond wetlands, "pocket" wetlands	~2%	$3,800	– Cleaning and removal of debris after major storm events (>2" rainfall) – Harvesting of vegetation when a 50% reduction in the original open water surface area occurs – Repair of embankment and side slopes – Repair of control structure	Annual or as needed
				– Removal of accumulated sediment from forebays or sediment storage areas when 60% of the original volume has been lost	5-year cycle
				– Removal of accumulated sediment from main cells of pond once 50% of the original volume has been lost	20-year cycle

Table 11.3 (continued).

Category	Management Practice	Annual Maintenance Cost (% of Construction Cost)	Maintenance Cost for a "Typical" Application	Maintenance Activity	Schedule
Infiltration practices	Infiltration trench	5%–20%	$2,300–$9,000	– Removal of accumulated sediment from forebays or sediment storage areas when 60% of the original volume has been lost	5-year cycle
				– Removal of accumulated sediment from main cells of pond once 50% of the original volume has been lost	20-year cycle
	Infiltration basin	1%–3%	$150–$450	– Cleaning and removal of debris after major storm events; (>2" rainfall) – Mowing and maintenance of upland vegetated areas – Sediment cleanout	Annual or as needed
		5%–10%	$750–$1,500	– Removal of accumulated sediment from forebays or sediment storage areas when 50% of the original volume has been reduced	3- to 5-year cycle
Open channel practices	Dry swales, grassed channels, biofilters	5%–7%	$200–$2,000	– Mowing and litter/debris removal – Stabilization of eroded side slopes and bottom – Nutrient and pesticide use management – Dethatching of swale bottom and removal of thatching – Discing or aeration of swale bottom	Annual or as needed
				– Scraping of swale bottom, and removal of sediment to restore original cross-section and infiltration rate – Seeding or sodding to restore ground cover (use proper erosion and sediment control)	5-year cycle

Table 11.3 (continued).

Category	Management Practice	Annual Maintenance Cost (% of Construction Cost)	Maintenance Cost for a "Typical" Application	Maintenance Activity	Schedule
Filtration practices	Sand filters	11%–13%	$2,200	– Removal of trash and debris from control openings – Repair of leaks from the sedimentation chamber or deterioration of structural components – Removal of the top few inches of sand, and cultivation of the surface, when filter bed is clogged	Annual or as needed
				– Clean-out of accumulated sediment from filter bed chamber once depth exceeds approximately ½ inch, or when the filter layer will no longer draw down within 24 hours – Clean-out of accumulated sediment from sedimentation chamber once depth exceeds 12 inches	3- to 5-year cycle
	Bioretention	5%–7%	$3,000–$4,000	– Repair of erosion areas – Mulching of void areas – Removal and replacement of all dead and diseased vegetation – Watering of plant material	Biannual or as needed
				– Removal of mulch and application of a new layer	Annual
	Filter strips	$320/acre (maintained)	$1,000	– Mowing and litter/debris removal – Nutrient and pesticide use management – Aeration of soil on the filter strip – Repair of eroded or sparse grass areas	Annual or as needed.

11.3.3.3 Ponds and wetlands

Extended dry detention ponds are submerged only during storms and are dry between storms. Depending on the type of vegetative cover used, they may require mowing at least once a month to maintain turf grass cover, or once a year to prevent the establishment of woody vegetation. Sediments should be removed when they are dry and cracked to separate them from vegetation more easily. Pilot or low-flow channels require inspection to prevent undermining of concrete channels and overgrowth of stone channels. Inlets and outlets should be cleared of sediment and debris to prevent clogging.

Wet ponds are susceptible to algae blooms as a result of high nitrogen levels and may need to be cleaned periodically. Sediments that accumulate in the pond inlet or forebay should be removed more frequently than fine sediment, which collects near the pond outlet. Sediment removal requires draining the pond (some water to maintain fish populations should be left), collection of solids, and drying and testing of the residuals before disposal. Pond water should be disposed of in a locally approved manner; it should be tested for pollutants and released to the receiving water, if allowed, or pumped and hauled to a disposal facility. During the period in which the stockpiled materials are drying, erosion controls should be implemented to prevent sediment loss. All structures and surrounding areas should be inspected for leakage, seepage, corrosion, and wear and tear. Inspectors and crews should pay special attention to structural integrity to ensure that ponds operate safely.

Constructed wetlands should be inspected approximately four times per year to determine if they are retaining and discharging storm water at an appropriate rate and whether maintenance is needed. Constructed wetlands require periodic cropping; removal of trash, weeds, invasive species, or woody vegetation; repair of animal burrows in embankments; and clearing of inlets and outlets. Side slopes should be stabilized with vegetative cover to prevent erosion. Wetland plants should be thinned and transplanted as necessary to maintain adequate cover throughout the wetland. In general, semiannual sediment removal is recommended to ensure that treatment capacity is maintained. Mosquitoes may be a problem in some areas, and introducing natural predators such as mosquito fish (*Gambusia*) can be one method of control. Consultation with a wetland scientist is recommended to ensure that the constructed wetland functions as intended.

11.3.3.4 Infiltration practices

Infiltration practices, such as basins, trenches, vegetated swales, and porous pavement, are subject to clogging from sediment, oil, grease, and microbes. Clogging impairs their effectiveness in reducing runoff volume and pollutant loading to downstream waters. When clogging occurs, standing water tends to collect. Seasonal water table fluctuations or ground water mounding can also cause standing water. Facility inspection during dry periods will identify whether standing water is present and provide clues to the possible causes. Inspections should include a site assessment of the contributing drainage area because sediment accumulation in a facility stems from erosion in surrounding areas that can be prevented if the areas are adequately stabilized. The frequency of required maintenance depends on loads from the contributing drainage areas.

If clogging results in pooling, sediment can be removed to restore the facility to its original capacity. If the standing water results from high water table conditions, the facility owner should consider converting the site to a permanent pool facility such as a constructed wetland or detention pond. For systems designed with filter fabric to collect sediments, periodic inspections can identify when and where the mesh should be replaced. In cold climates where street sanding occurs in the winter, the filter fabric in infiltration devices adjacent to roads and parking lots should be replaced prior to spring.

Promotion of a vegetative cover will help to maintain percolation rates, slow runoff velocity, and minimize ground water pollution. To maintain aeration and permeability, nonvegetated basins require tilling or disking and leveling after sediment is removed. Vegetated filters adjacent to infiltration trenches should be cleared of sediments periodically to prevent sediment loading to the trench.

Regular monitoring of infiltration rates after storms will indicate when maintenance is required to maintain the system's treatment design capacity.

11.3.3.5 Filtration practices

Filtration practices include media filters (typically sand) and biofilters. Sand filters contain two phases: a sedimentation chamber and a filtration chamber. The sedimentation chamber can be inspected by measuring to determine if the deposited sediments are becoming deep enough to interfere with the filtration chamber. Different types of sand filters require different levels of maintenance. The Austin sand filter system usually requires maintenance every five to 10 years, depending on the stability of soils in the contributing areas, and can be treated like a dry detention facility. The filter component can be raked of fine sediments or skimmed with a shovel to restore permeability. The Washington and Delaware sand filter sedimentation chambers, which maintain a pool of water, should be vacuumed to remove sediment when inspections identify accumulation greater than 75 percent of capacity. Filtration chambers for these systems may need to be cleaned of fine particles as frequently as twice per year to maintain their efficiency and prevent overflows. A flat-bottomed shovel can be used to remove the sediment-laden filter media and roughen surfaces to improve permeability.

Each system should be inspected for vandalism, leaks, cracks, or damage to concrete at least once per year. These problems should be remedied immediately. Forebays should be pumped or cleaned as necessary. All materials removed from the systems should be tested for contamination and to identify how the material should be disposed of (e.g., as clean fill, in a landfill, or as a hazardous waste).

Biofiltration system vegetation should be mowed periodically to maintain an optimum height (2 to 6 inches) that maximizes infiltration and minimizes runoff velocity. Special effort should be made to promote native species and exclude invasive species, which can grow too vigorously and reduce treatment capacity. Some natural vegetation replacement is desirable, such as wetland plants that colonize a low-lying biofilter. Inspection and maintenance records should reflect these changes.

Biofiltration facilities should be inspected and maintained regularly. Sediment removal is an important and sometimes expensive part of biofilter maintenance. Sediment should be removed when it fills 20 percent of the design depth in any spot or starts to cover vegetation. Efforts should be made to return the system to its original topographic and vegetative condition once the sediment has been removed. Inlets and outlets should be cleared of particles and debris to prevent backups and overflows. Biofiltration systems may also need periodic replacement or amendment of system soils if clogging has occurred.

Maintenance equipment for the tasks described previously, along with purchase and rental costs, is presented in Table 11.4.

Table 11.4: Typical O&M equipment and material costs (WMI, 1997).

Equipment	Purchase	Rent (per day)
Grass Maintenance		
Hand mower	$300–$500	$25–$50
Riding mower	$3,000–$7,000	$75–$150
Tractor mower	$20,000–$30,000	$150–$450
Trimmer/edger	$200–$500	$25–$35
Spreader	$100–$200	$20–$30
Chemical sprayer	$200–$500	$25–$40
Vegetative Cover Maintenance		
Hand saw	$15–$20	$5
Chain saw	$300–$800	$15–$35
Pruning shears	$25–$40	$5
Shrub trimmer	$200–$300	$25–$35
Brush chipper	$2,000–$10,000	$100–$300
Sediment, Debris, and Trash Removal		
Vactor truck	$100,000–$250,000	$700–$1,200
Front-end loader	$60,000–$120,000	$250–$500
Backhoe	$50,000–$100,000	$250–$500
Excavator	>$100,000	$400–$1,000
Grader	>$100,000	$400–$1,000
Transportation		
Van	$18,000–$30,000	$50–$100
Pickup truck	$15,000–$25,000	$50–$100
Dump truck	$40,000–$80,000	$100–$200
Light-duty trailer	$3,000–$6,000	$50–$100
Heavy-duty trailer	$10,000–$20,000	$100–$250
Miscellaneous		
Shovel	$15	$5
Rake	$15	$5
Pick	$20	$5
Wheelbarrow	$100–$250	$15–$25
Portable compressor	$800–$2,000	$50–$150
Portable generator	$750–$2,000	$50–$150
Concrete mixer	$750–$1,500	$50–$100
Welding equipment	$750–$2,000	$50–$100
Materials		
Topsoil	$35–$50/cubic yard	
Fill Soil	$15–$30/cubic yard	
Grass seed	$5–$10/pound	
Soil amenities	$0.10–$0.25/square foot	

Table 11.4 (continued).

Equipment	Purchase	Rent (per day)
Materials (continued)		
Chemicals	$10–$30/gallon	
Mulch	$25–$40/cubic yard	
Dry mortar mix	$5/50-pound bag	
Concrete delivered	$60–$100/cubic yard	
Machine/motor lubricants	$5–$10/gallon	
Paint	$20–$40/gallon	
Paint Remover	$10–$20/gallon	

11.4 Information Resources

The South Carolina Department of Health and Environmental Control (2000) published *A Citizen's Guide to Stormwater Pond Maintenance in South Carolina*, which is available for download in PDF format at http://www.scdhec.net/eqc/admin/html/eqcpubs.html. The booklet is intended as a guide for homeowners' associations and others responsible for the proper maintenance of storm water ponds. Photos and descriptions of nuisance aquatic plant species are presented in the guide to aid in identifying these species and removing them from ponds. Copies of the guide are available from Ward Reynolds at 843-747-4323.

The Stormwater Manager's Resource Center (CWP, no date) has sample O&M checklists available for download from its Web site (http://www.stormwatercenter.net/). When at the site's homepage, click on "Manual Builder" and choose "Construction and Maintenance Checklists" from the pull-down list. There are checklists for the following practices: ponds, infiltration trenches, infiltration basins, bioretention facilities, sand filters, and open channel practices.

11.5 References

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MANAGEMENT MEASURE 12
EVALUATE PROGRAM EFFECTIVENESS

12.1 Management Measure

Develop and implement a program to evaluate and improve the effectiveness of the urban runoff management program.

12.2 Management Measure Description and Selection

12.2.1 Description

The purposes of this management measure are to:

- Determine whether implementation of the runoff management program framework is protecting and/or improving water quality by evaluating management practices that are being used to meet Management Measure 1. If these practices aren't effective, improvements to the runoff management program framework should be implemented.

- Periodically reassess the watershed (see Management Measure 2) to determine whether water quality has improved or declined. Based on this assessment, each management measure should be reevaluated to determine whether additional practices should be implemented, if improvements should be made to existing practices, or if specific practices should be discontinued.

12.2.2 Management Measure Selection

This management measure was selected because runoff management programs need to be dynamic (i.e., they need to be periodically adjusted to respond to changing conditions and optimize program effectiveness and expenditures). Areas where program improvement is possible should be identified. Programs that are periodically reviewed and evaluated also are perceived as being more effective, and they will be more likely to receive the public and political support necessary to achieve success. The basic elements of a successful program evaluation are described in this management measure.

12.3 Management Practices

12.3.1 Assess the Runoff Management Program Framework

It is important for watershed managers to objectively assess the runoff management program framework to determine whether the goals of the Program Framework and Objectives Management Measure (Management Measure 1) are being met. This effort should be undertaken periodically to identify aspects of the program that need to be strengthened or revised. Each aspect of the program framework will require a different type of measurement. Watershed managers can choose from both qualitative and quantitative measures as indicators of program effectiveness, using the watershed baseline conditions as a point of reference (see Management Measure 2: Watershed Assessment). Quality assurance and quality control procedures should be followed regardless of whether qualitative or quantitative measures are used.

There are several factors that should be considered when designing an evaluation program. First, some urban management practices, or aspects of their implementation that can be analyzed, vary with time of year, phase of construction, or length of time after installation. Another consideration is that variables generally will not directly relate to management measure implementation, as most urban management measures are combinations of several management practices. Evaluation of management measure implementation, therefore, usually will be based on separate assessments of two or more management practices, and the implementation of each management practice will be based on a unique set of variables. Finally, it is very important to consider the purpose of the program when selecting the variables for which the information is collected.

EPA has developed the Web-based *Measurable Goals Guidance for Phase II MS4s* to assist small municipal separate storm sewer system (MS4) owners and operators in complying with the requirement to select measurable goals to evaluate the effectiveness of individual control measures and the storm water management program as a whole. Even though this document is intended for use by NPDES-permitted MS4 operators, it contains guidance valuable to any institution developing a storm water management program that includes management practices and methods for program evaluation. It includes examples of management practices with corresponding measurable goals and environmental indicators that can be used to document the effectiveness of both management practices and storm water programs. The guidance is available online at http://cfpub.epa.gov/npdes/stormwater/measurablegoals/index.cfm.

12.3.1.1 Qualitative measures

Urban runoff management programs can be evaluated using any number of qualitative measures, such as those presented by WMI (1997a):

- Project permit review times
- Frequency of inspections
- Evaluation by targeted groups
- Appearance of control practices on sites
- Response time for complaints
- Number of permits issued
- Number of individuals trained
- Recognition by others
- Enforcement actions taken
- Maintenance activities
- Reduced number of complaints

For example, Delaware uses the number of individuals attending training courses and receiving state certification as one measure of program success. In addition to monitoring water chemistry, sediments, and the biological community, Florida measures program success by the number of local government storm water utilities implemented, as well as the number of educational and public involvement activities.

Watershed managers can use a combination of measures to assess their program framework based on goals and priorities that were identified at the outset of program implementation. In addition to the qualitative measures listed above, watershed managers can track the implementation, operation, and maintenance of management practices as indicators of the success of a program framework. See Section 12.3.2 for a discussion of management practice tracking.

12.3.1.2 Quantitative measures

Another way for watershed managers to gauge the effectiveness of their runoff management program framework is to quantitatively determine if water quality or habitat has improved. Quantitative measures include:

- Chemical monitoring of practices
- Chemical monitoring of receiving waters
- Biological monitoring of receiving waters (bioassessments)
- Habitat assessments
- Stream flow monitoring
- Stream shoreline condition assessments
- Sediment monitoring (deposition, chemistry)
- Measuring the volume of material removed by street sweeping and catch basin cleaning
- Temperature monitoring

See the section 12.3.3, "Gauge Improvements in Water Quality Resulting from Management Practice Implementation" for a more thorough discussion of the different types of monitoring that can be used to gauge changes in water quality after practice implementation.

12.3.1.3 Quality assurance/quality control

An integral part of the design phase of any monitoring project is quality assurance/quality control (QA/QC). Development of a quality assurance project plan (QAPP) is the first step for incorporating QA/QC into a monitoring project. The QAPP is a critical document for the data collection effort inasmuch as it is used to integrate the technical and quality aspects of the planning, implementation, and assessment phases of the project. The QAPP documents how QA/QC elements will be implemented throughout a project's life. It states expectations and requirements and provides procedures for data collection and data management that are specific to the project. Development and implementation of a QA/QC program, including preparation of a QAPP, can require up to 10 to 20 percent of project resources (Cross-Smiecinski and Stetzenback, 1994). A thorough discussion of QA/QC is provided in Chapter 5 of EPA's *Monitoring Guidance for Determining the Effectiveness of Nonpoint Source Controls* (USEPA, 1997).

12.3.2 Track Management Practice Implementation

Implementation monitoring can be used to determine the extent to which management measures and practices are implemented in accordance with relevant standards and specifications. This involves establishing a program that tracks either whether the practices have been implemented or whether management practices have been operating and maintained as designed. For example, some states and municipalities have developed programs that track and record septic tank maintenance or erosion and sediment control practices, or that inventory all runoff control structures.

It is not always possible to track the implementation of every management practice of interest. Sampling a subpopulation and extrapolating the findings to the entire population may be preferred due to time, funding, or personnel constraints. Lack of adequate legal authority may also hinder the collection of data sufficient to track management practice implementation. If an inventory of all management practices of interest is not possible, care should be taken to prepare a statistically valid sampling plan. The primary basis for selecting a design approach should be based on a careful review of study objectives and the pros and cons of each sampling method. An extensive discussion of the different sampling designs and methods for analysis can be found in *Techniques for Tracking, Evaluating, and Reporting the Implementation of Nonpoint Source Control Measures: Urban* (USEPA, 2000), which is available on EPA's Nonpoint Source Web site at http://www.epa.gov/owow/nps/urban2.html. Below are several tools that can be used to track management practice implementation.

12.3.2.1 Track permits

States and local agencies employ a variety of legal mechanisms, including nuisance prohibitions, general water pollution discharge prohibitions, land use planning and regulation laws, building codes, health regulations, and criminal laws to regulate urban nonpoint source water pollution (Environmental Law Institute, 1997). Although not all pollutant-generating activities are covered by these mechanisms, they present opportunities for inventorying management practice implementation. Activities that are typically regulated in some manner include erosion and sediment control, onsite sewage disposal systems, runoff from development sites, construction activities, and industrial activities. A permitting system places on the applicant the burden of obtaining and supplying all necessary data and information to obtain the permit. Issuance of these permits encourages compliance with local laws and regulations in the construction and operation of management practices.

12.3.2.2 Use operation and maintenance records

In many instances, proper operation and maintenance of a management practice are as important as proper design and installation. Regular inspection of management practices can identify the need for repairs or retrofits in addition to identifying areas in the watershed that require additional management resources. If the right types of information are collected when a management practice is installed, it becomes much easier to track operation and maintenance activities and ascertain the cost and effectiveness of the practice.

12.3.2.3 Use geographic information systems

Geographic information systems (GISs) are useful tools for inventorying management practice implementation. A GIS can detect and track trends in management practice implementation, land treatment, changes in land use, and virtually any data related to management practices and water quality. Another advantage is the ability of a GIS to update information and integrate it with existing data in a timely manner. GISs allow watershed managers to do more than just manage information in a database—they are powerful analysis tools that can be used to design sampling protocols for tracking studies and help watershed managers analyze program effectiveness by integrating land treatment and water quality information.

12.3.2.4 Develop surveys

Surveys of property managers and developers can be used to collect background information about management practice implementation, such as:

- Type, number, and size of management practices installed
- Management practice location/watershed
- Land use (i.e., residential, commercial, industrial)
- Percent impervious area
- Inspection results
- Operation and maintenance practices

Maryland's GIS-Based Restoration Project Tracking Database

The Maryland Department of Natural Resources has developed a Restoration Project Tracking Database that provides a list of riparian forest buffer and stream restoration projects by watershed and county with details such as waterway; length, width, area, and other quantifiers as appropriate; and details about the project such as owner type, planting reason, year established or completed, and project components. These data can be displayed in tabular format and are linked on the Web site to an interactive GIS for the public and interested parties to browse (MDNR, 2004). The database can be accessed at http://dnrweb.dnr.state.md.us/watersheds/surf/tracking/track_map.htm.

Maryland also has a "BMP Tracking Reports" Web site (http://dnrweb.dnr.state.md.us/watersheds/surf/bmp/) that provides tributary-specific information regarding implementation of management practices. This information is used to help measure Maryland's progress in reducing nonpoint source pollution and meeting the goals of the Chesapeake Bay 2000 agreement. Users can choose a statewide management practice summary report or they can generate a report by tributary. They list 3 categories of practices: urban practices, resource protection and improvement practices, and agricultural practices. The data for each management practice type is summarized by year in units appropriate for the practice. For example, the urban practice "Erosion and Sediment Control" was implemented on 2,213 acres in 2000, 11,133 acres in 2001, and 10,442 acres in 2002. More information is provided for each practice, including a photo, a brief description, and general pollutant removal information for different land use applications (if the practice is applicable in multiple settings). The pollutant removal information is limited to nitrogen, phosphorus, and sediment.

To complete these efforts, Maryland DNR developed estimates from the Departments of Agriculture, Environment, and Natural Resources. This information was compiled from data received from volunteer groups and county, state, and federal reports provided to each department.

- Dates of management practice installation
- Design specifications
- Type of water body or area protected
- Previous management practices used
- Erosion and sediment control plans (for construction)
- Dates of plan preparation and revisions
- Date of initial plan implementation
- Total acreage under management
- Certification requirements

Watershed managers can use the information obtained from these surveys to identify locations for new management practices and to more closely examine practices used upstream of waters known to be degraded to determine if they are operating as designed or if they require redesign or maintenance.

12.3.2.5 Consider expert evaluations

Expert evaluations may be needed to augment or verify information provided in surveys. Experts are especially useful in determining the following:

- Proper design
- Proper installation
- Adequacy of operation and maintenance plans and activities
- Verification of conclusions derived from self-evaluations (i.e., an objective third party's review of data and reports)

Each of these tools can be used to help watershed managers locate management practices and identify those that are not performing as expected (i.e., not meeting the goals of the management measures). These tools can be used separately or in combination to obtain and organize management practice data and use it to better meet the goals of the management measures.

12.3.3 Gauge Improvements in Water Quality Resulting from Management Practice Implementation

Watershed managers can determine the effectiveness of the runoff program by monitoring changes in water quality after the management measures and practices are implemented. The most fundamental step in the development of a monitoring plan is to define the goals of the monitoring program. Monitoring goals are broad statements such as "to measure improvements in Elephant Butte Reservoir" or "to verify nutrient load reductions into the Chesapeake Bay." Designing a monitoring plan also includes selecting sampling variables, a sampling strategy, station locations, data analysis techniques, the length of the monitoring program, and the overall level of effort to be invested.

Once the monitoring goals have been established, existing data and constraints should be considered. A thorough review of literature pertaining to water quality studies previously conducted in the geographic region of interest should be completed before starting a new study.

The review should help determine whether existing data provide sufficient information to address the monitoring goals and what data gaps exist.

The next step should be to identify project constraints such as finances, staffing, and time. Clear and detailed information should be obtained on the time frame for management decisions, the amounts and types of data that must be collected, the level of effort required to collect them, and the equipment and personnel needed to conduct the monitoring. This will determine whether available personnel and budget are sufficient to implement or expand the monitoring program.

As with its design, the program's level of monitoring is largely determined when goals and objectives are set, although there is some flexibility for achieving most monitoring objectives. Watershed managers should determine the appropriate timeframe and geographic scope of the monitoring program based on program goals and objectives. For example, if the objective is to determine the effectiveness of a nutrient management program for reducing nutrient inputs to a downstream lake, monitoring a subwatershed for five years or longer might be necessary.

Watershed managers also need to determine the size of the watershed, because many have an influence on stream characteristics and water quality, and therefore on the complexity of the monitoring program design. These factors include drainage patterns, stream order, stream type, climate, number of landowners in the area, homogeneity of land uses, watershed geology, and geomorphology. An analysis of these considerations in combination with budgetary and time constraints will determine the exact nature of the monitoring program.

It is important to ensure that expectations for the monitoring program are realistic. Ward et al. (1990) identify the following key steps to ensure that policymakers and other stakeholders know the types of information that a monitoring program can produce:

- Perform a thorough review of the legal basis for the management effort and define the resulting implications for monitoring.
- Review the administrative structure and procedures developed from the law in order to define the information expectations of the management staff.
- Review the ability of the monitoring program to supply information.
- Formulate an information expectations report for the monitoring system.
- Present the information expectations report to all users of the information.
- Develop consensus as to an agreeable formulation of information expectations and related monitoring system design criteria.

The next task when developing a monitoring program plan is to set monitoring objectives, which are more specific statements than goals and can be used to complete the monitoring design process. The objectives must be detailed enough to allow the designer to define precisely what data will be gathered and how the resulting information will be used.

Another important aspect of setting up a monitoring and evaluation program is variable selection. Variables should be selected based on the monitoring objectives. For example, if a dissolved oxygen problem is suspected, then dissolved oxygen should be monitored in addition to biochemical oxygen demand, sediment oxygen demand, temperature, and nutrients. Surrogate measures can also be used to satisfy monitoring objectives. For example, if the objective is to monitor the condition of salmon spawning areas, surrogate measures are necessary because the condition of salmon spawning areas is a composite of many factors. Good surrogate variables would be stream bank undercut, embeddedness, and vegetative overhang (Platts et al., 1983). The corresponding surrogate goals could be to reduce cobble embeddedness and to increase vegetative overhang to appropriate levels for salmon spawning. Subsequent monitoring goals could be to document changes in cobble embeddedness and vegetative overhang.

Because there are numerous variables to choose from and monitoring budgets are limited, some method to prioritize variable selection is often necessary. Table 12.1 shows groups of variables and examples of each. When available, existing data should be used to guide variable selection. Further discussion on variable selection, prioritization, and optimization are provided by USDA (1996), MacDonald et al. (1991), and Sherwani and Moreau (1975). In some cases, optimal variable selection is not possible, which may be due to lack of local data. In such cases, the researcher might need to rely on professional judgement and the review of monitoring programs of similar nature and scope.

Table 12.1: Examples of variables that can be measured to assess changes in management practice implementation and water quality.

Variable Type	Examples
Physical and chemical water quality data	Flow (streams), temperature, transparency, suspended sediment, sedimentation transparency, suspended sediment, sedimentation rate, dissolved oxygen, pH, conductivity, alkalinity/acid neutralizing capacity (lakes), and nutrients.
Biological data	Bacteria, algal biomass, macrophyte biomass and location, macroinvertebrate and fish populations.
Precipitation data	Total rainfall, rainfall intensity, storm interval, and storm duration.
Land use data	Treatments applied to land, current and historical use of the land, spatial and temporal information on land use activities, and changes in land use made before and during a project.
Topographic data	Slope length, slope steepness, slope shape, channel slope, channel side slope.
Soil characteristics data	Hydrologic soil group, soil organic carbon content, depth to water, net recharge, aquifer media, and vadose zone characteristics.

Designing and implementing a monitoring program often requires an interdisciplinary approach that may require interagency coordination and input. In many cases, technical staff will need to integrate "new" monitoring with what is already being done to demonstrate to program managers that duplicate work is not proposed. The most effective way to achieve this goal is to bring all the involved agencies and other stakeholders in the monitoring effort together. One or more agencies should coordinate to clarify project roles and responsibilities. Agreements to participate can be formalized as commitments and specified in the quality assurance project plan.

Such coordinated cooperation permits each involved party to offer the results of its ongoing activities to the monitoring effort, lessens the burden on each participating agency, and may decrease overall project costs. For example, USGS might already have a tracking system for management practices, while other agencies, including the U.S. Fish and Wildlife Service and EPA, might have other ongoing monitoring programs. When multiple agencies are involved in the monitoring program, each can benefit from the others' efforts.

Two types of objectives will be discussed in this section: analyzing trends in water quality and measuring the effectiveness of management practices.

12.3.3.1 Conduct trend monitoring

Trend monitoring can be useful for determining whether there has been a change in the extent to which management measures and management practices are being implemented. Trend monitoring involves long-term tracking of changes in one or more parameters. Public attitudes, land use, and the use of various urban management practices are examples of parameters that could be measured with trend monitoring.

Isolating the impacts of either individual or sets of management measures and management practices on water quality also requires trend monitoring. Because trend monitoring involves measuring a change (or lack thereof) in some parameter over time, it is necessarily of longer duration and requires establishment of a baseline. Any changes in the measured parameter are then detected in reference to the baseline. Baseline monitoring requires ascertaining the existing conditions before some management action or change in land use occurs. Factors such as weather conditions should be considered if baseline monitoring is to be used as a reference point for trend analysis and management decisions. The ability to relate water quality changes to changes in land management depends on the quality and quantity of data collected on land management practices.

Public attitudes, land use, and the use of various urban management practices are examples of parameters that could be measured with trend monitoring. Isolating the impacts of management measures and management practices on water quality also requires trend monitoring. For example, an objective of trend analysis can be to answer the question, "Is water quality changing over time?"

12.3.3.2 Conduct effectiveness monitoring

Effectiveness monitoring involves evaluating individual management practices or groups of management practices to determine the extent of pollution control they provide. Monitoring for individual management practices can typically be conducted on a plot or field scale, whereas monitoring for management practice systems is usually conduced on a watershed scale. Studies of some individual practices can be conducted in a relatively short time (less than five years), while others might take longer. Evaluation of management practice systems is typically conducted over a long term (more than five years) because management practice implementation can take years to affect water quality. In fact, there may be a lag in response time that may be 10 to 20 years or longer. This type of monitoring is difficult due to the presence of pollutant reserves in soil and sediments, the effect of many land uses within a study area, the variety of approaches that landowners use to implement similar management practice systems, and the need to track land management as well as water quality and climatic variables.

A guidance manual describing protocols for monitoring the effectiveness of storm water management practices, *Urban Stormwater BMP Performance Monitoring*, is available for download in PDF format from the International Stormwater Best Management Practices Database Web site (http://www.bmpdatabase.org/docs/Urban Stormwater BMP Performance Monitoring.pdf). Along the same lines, EPA's Environmental Technology Verification Center offers the *Protocol for the Verification of Stormwater Source Area Treatment Technologies* (http://www.epa.gov/etv/pdfs/vp/04_vp_stormwater.pdf).

12.3.4 Develop and Implement a Schedule to Improve the Management Program Framework

Data on management practice effectiveness and water quality should be carefully reviewed to determine where deficiencies in the runoff management exist. Effectiveness monitoring results should be compared with expected values published in the literature or with values provided with proprietary products. If the system is underperforming, possible causes should be considered:

- Is the practice properly designed and sized?
- Are site conditions (geology, land use, etc.) inappropriate for this practice?
- Were maintenance activities not performed as scheduled or needed?
- Were influent pollutant concentrations different than expected?

The next step is to determine whether the management practice needs to be retrofitted, replaced, or removed. Is pretreatment needed? Should a treatment train approach be used? Should additional capacity be added? Should maintenance be scheduled more frequently? A plan should be developed to implement proposed changes on a practice-by-practice basis.

A review of monitoring data on ambient water quality should be conducted to determine if water quality is improving. Consideration should be given to activities or events that might have skewed results (i.e., flooding, drought, landslides, significant changes in surrounding land use). If water quality has not improved, the following questions should be asked:

- Are management practices not performing as well as they should be?
- Were the wrong practices selected?
- Are additional practices needed?

Monitoring data should be examined to determine which pollutants and sources (if known) are a problem, and additional activities to address these sources should be proposed.

Once a list of planned changes to the program has been compiled, each project should be prioritized. Projects that should receive a higher priority are those that are most likely to improve water quality, those that the community has shown support for or is likely to support, and those that are relatively straightforward or inexpensive to implement. Implementation of proposed projects should be completed before the next program evaluation (usually within five years).

12.4 Information Resources

Restoring Life in Running Waters: Better Biological Monitoring (Karr, 1998) describes how and why biological monitoring and multi-metric indices can be used to assess environmental degradation and how this information can be integrated into regulatory and policy decisions. This book can be purchased at bookstores or ordered from Island Press at http://www.islandpress.com/.

Monitoring Guidance for Determining the Effectiveness of Nonpoint Source Controls, published by EPA's Office of Water in 1997, gives an overview of nonpoint source pollution and covers the development of a monitoring plan, data analysis, quality assurance/quality control, and biological monitoring. It can be ordered through EPA's National Service Center for Environmental Publications at http://www.epa.gov/ncepihom/index.htm.

Techniques for Tracking, Evaluating, and Reporting the Implementation of Nonpoint Source Control Measures: Urban (USEPA, 1998) helps local officials to focus limited resources by establishing statistical sampling to assess, inspect, or evaluate a representative set of management practices, erosion and sediment controls, and onsite wastewater treatment systems. The document can be downloaded in PDF format at http://www.epa.gov/owow/nps/urban.pdf, or it can be ordered through EPA's National Service Center for Environmental Publications at http://www.epa.gov/ncepihom/index.htm.

EPA's Volunteer Monitoring Program provides technical assistance, serves as a regional contact for volunteer programs, manages grants to state agencies that organize volunteer monitoring programs, and provides information exchange services for volunteers. A listserver is available for volunteer monitoring program coordinators on the EPA Web site, http://www.epa.gov/owow/monitoring/volunteer. Also available are a national newsletter for volunteer monitors, a directory of volunteer monitoring programs, and manuals on volunteer monitoring methods and planning and implementing volunteer programs.

Urban Stormwater BMP Performance Monitoring: A Guidance Manual for Meeting the National Stormwater BMP Database Requirements presents monitoring protocols for studies measuring the effectiveness of storm water management practices and is available for download in PDF format from the International Stormwater Best Management Practices Database Web site (http://www.bmpdatabase.org/docs/Urban Stormwater BMP Performance Monitoring.pdf).

EPA's Environmental Technology Verification Center developed the *Protocol for the Verification of Stormwater Source Area Treatment Technologies* (http://www.epa.gov/etv/pdfs/vp/04_vp_stormwater.pdf), which establishes guidelines for measuring the effectiveness of storm water treatment technologies. The protocol was developed to ensure that technology verification studies are carried out in a consistent and objective manner that assesses the appropriate performance characteristics.

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COMMONWEALTH ACTION ON STORMWATER

The Commonwealth Government through Environment Australia (part of the Department of the Environment & Heritage) is delivering three complementary funding programs to demonstrate ways to improve coastal and marine water quality.

A shared aim is to promote best practice and innovation in the policies and practices of organisations that have a substantial impact on water quality in coastal areas and cities.

The common strategy is the provision of funding as a catalyst for the construction of on-ground works. The funding is targeted to coastal councils, industry, water management organisations and state agencies.

The programs are:

CLEAN SEAS PROGRAM (Commonwealth component - CSP). The CSP supports sustainable stormwater and wastewater management. Since 1997, $30m has been committed to 35 nationally significant projects. Funding is from Natural Heritage Trust 1.

URBAN STORMWATER INITIATIVE (USI). Over $6m has been committed since 1999 for 9 demonstration projects. Funding is from the *Living Cities* program.

CLEANING OUR WATERWAYS INDUSTRY PARTNERSHIP PROGRAM (COWIPP). Over $2m has been committed since 2001 for 14 projects where industry is demonstrating innovative approaches to water management. Funding is from the *Living Cities* program.

The programs are an initial step by the Commonwealth in addressing the substantial cost of improving stormwater management across Australia.

Further information on the programs and projects is available at:

www.ea.gov.au/coasts/programs

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GLOSSARY

Adsorption	Bonding of metals and nutrients onto the surfaces of suspended particles, by way of physical, chemical and biological processes, and their removal by a process of sedimentation of the suspended particles.
Aeration	The injection of air through diffusers into water bodies, or rapid mechanical mixing of the surface of water bodies to promote entrainment of atmospheric air into the water column. A treatment process adopted in situations of high loading of oxygen demanding substances
Aerobic or Oxic Zone	An environment in which there is free oxygen.
Anaerobic or Anoxic Zone	An environment devoid of oxygen
Aquifer	Rock formation containing water in recoverable quantities.
Aquifer Recharge	The infiltration or injection of natural waters or recycled waters into an aquifer providing replenishment of the groundwater resource.
Aquifer Storage and Recovery	Injection of recycled water into aquifers for storage, which may be recovered later to meet water demands.
Baseflow	The underlying flow rate that cannot be directly attributed to storm events.
Basket	A simple steel mesh collection device placed in pits of gross pollutant traps to collect debris and rubbish.
Beneficial Use	The use of any element or segment of the environment that contributes to public benefit, welfare, safety, health or aesthetic enjoyment.
Best Management Practice (BMP)	Structural measures used to store or treat urban stormwater runoff to reduce flooding, remove pollution or to provide other amenities.
Biofilm	A gelatinous sheath of algae and micro-organisms, including benthic algae and bacteria, formed on gravel and sediment surfaces and surfaces of large plants.
Buffer Zones	A vegetated strip between the edge of a stream or drainage channel and a land use activity, designed to trap the lateral overland flow borne pollutants.
Catchment	A topographically defined area, drained by a stream such that all outflow is directed to a single point.
Channel	The bed and banks of a stream or constructed drain.
Colloids	Fine abiotic and biotic particles of typically 0.1 um to 1 nm in diameter.

Detention (Dry) Basins	A basin designed to temporarily detain, storm or flood waters, to attenuate peak flows downstream to acceptable levels.
Discharge	The volume of flow passing a predetermined section in a unit time.
Dissolved Oxygen (Do)	The level of dissolved oxygen in streams is a critical property sustaining aquatic biota, and in determining the risk of occurrence of anoxic conditions.
Drainage Network	The system of channels and pipes and overland flow pathways which drain a catchment area. Networks typically comprise a main drain, branch drains, and collector drains.
Effluent	Treated or untreated liquid waste flowing from agricultural and industrial processes, or from sewage treatment plants.
Effluent	Sanitary, industrial or agricultural discharge from wastewater treatment plants or treatment lagoons.
Environmental Flow	The release of water from storage to a stream to maintain the healthy state of that stream.
Event	A single precipitation and associated runoff occurrence.
Filter	A layer of granular material designed to intercept fine particulate material. It may be used as part of a subsoil drain, or as a structure to treat surface runoff prior to recharge of groundwater or discharge to a drain.
Floodway	Corridor of land identified as a major stormwater flow path, often is association with a minor (pipe or channel) flow path.
Geomorphology	Processes of weathering, flow and sediment transport which determine the pattern of drainage features across a catchment, and the equilibrium between sediment accumulation in channels and sediment re-suspension.
Geotextile	A thin, flexible permeable sheet of synthetic material used to allow the transmission of water through the pores of the material while preventing the transmission of soil particles.
Greywater	A combination of wastewater from the laundry, bathroom and kitchen.
Gross Pollutant Trap (GPTs)	A trap designed to intercept coarse particulate material (by sedimentation) and trash and debris (by screens or booms). GPTs may be incorporated into the inlet pits, collector drains or main drains.
Groundwater	Subsurface water from which wells, springs, or bores

	are fed.
Industry	Refers to the following sectors: commercial, manufacturing, processing, petroleum, power generation, tourism and mining.
Industrial Effluent	Liquid waste produced by industry and its processes.
Industrial Purposes	Use of recycled water by industry for purposes including cooling processes, operation of boilers, manufacturing and processing activities, washdown and cleaning, window washing, toilet and urinal flushing and other uses (eg. dust suppression and irrigation of grounds).
Impermeable Or Impervious Surface	The part of the catchment surfaced with materials which prevent infiltration of rainwater into the underlying soil and groundwater.
Infiltration Pit, Trench, Basin	A stone filled pit, trench or detention basin designed to enhance runoff infiltration into the subsoil and groundwater zones.
Integrated Catchment Management	Managing natural resources within a 'whole of system' approach. In a stormwater context, it requires a whole of catchment and total urban water cycle based design and management approach, with integral consideration of land and water processes and values.
Irrigation	The watering of crops, pasture, golf courses, parks, gardens and open spaces, which may involve using different applications (eg. drip, trickle, spray and flood).
Load-Based Licensing	A licensing, system, where charges are based on the type of discharge, the amount of discharge and the sensitivity of the receiving environment. This is instead of charges being based on a fixed fee.
Loading	The total mass of a pollutant discharged during a storm event. The term may also be used to describe the mass of pollutant intercepted (g/sq metre) by a device during a storm event, or on an annual basis.
Multiple Use	Facilities meeting a range of functions eg. urban waterways accommodating drainage, pollution interception, landscape, recreation and water supply functions.
Non-Potable Purposes	The use of water for purposes other than drinking, cooking, bathing and laundry: for example, irrigation of gardens, lawns and toilet flushing.
Off-Line and On-Line	Off-line facilities are located adjacent to but off the drain or major flow pathway, to treat low flows or the discharge of a branch drain. On-line or in-line

	facilities are located within the drain or major flow pathway to treat event flows.
On-Site and Off-Site	On-site facilities are located on individual residential or development blocks to enhance local detention and interception of runoff and pollutants. Off-site facilities are located on drainage networks to provide area-wide detention and interception of runoff and pollutants.
Oil Trap or Separators	A stilling tank configured to separate lighter oily matter, scums and hydrocarbons from stormwater.
On-Site Stormwater Detention (OSD)	A requirement for developers of land to compensate for increased runoff due to increases in imperviousness on blocks.
Overland Flow	The component of rainfall (excess) which is not removed by infiltration and discharges down the slope as surface flow.
Performance Bond	A risk premium paid to a financial institution to guarantee that funds are available for rehabilitation or restoration if the enterprise fails.
Permeable (Porous) Pavement	Pavements comprising materials which facilitate infiltration of rainwater and transfer to the underlying sub-soil.
Potable	Water of a quality suitable for drinking, cooking, bathing and laundry purposes.
Point Source and Non-Point Source Pollution	Point source is any discernible confined and discrete conveyance, including pipes, channels, conduits. Non-point source is a diffuse pollution source without a single point of origin or specific discharge point
Pollutant Retention	The proportion of pollutant load intercepted and retained by a device, either on an event or annual basis.
Pollution Control Ponds	A shallow pool of water, characterised by areas of emergent aquatic plants and open water, designed to intercept event discharges and enable adsorption and sedimentation of pollutants, and to support a diverse range of micro-organisms and plants associated with the breakdown of organic material and uptake of nutrients. The detention of event flows and settling of suspended particles and associated pollutants is a key component of pond pollutant interception processes.
Rainwater Tanks	Tanks used to collect and store rainfall from household roofs for beneficial use.
Recycled Water	Treated stormwater, greywater or black water

	suitable for a range of uses eg. toilet flushing. irrigation, industrial processing or other suitable applications.
Recycled Water	Appropriately treated effluent and urban stormwater.
Remobilisation	The transformation of sedimented pollutants by microbial or chemical processes into a dissolved form and transfer by diffusion from the sediment pore water into the water column.
Runoff	The portion of precipitation on a drainage area or surface that is discharged from the drainage area to drainage.
Sediment Trap	A structure designed to intercept and retain sediment transported by the flow.
Sedimentation	The physical process of settling of suspended particulates under forces of gravity. The sedimentation efficiency is a function of eddy forces in the settling basin, and the period of detention of flow in the basin.
Sewage	The used water of community or industry, containing dissolved and suspended matter.
Sewer Mining	Diversion and treatment of raw sewage for on-site purposes such as irrigation.
Sewer Overflow	The discharge of sewage to surface water or stormwater drainage as a result of sewage flow exceeding the sewer capacity (infiltration of rainwater), or sewer blockage.
Stormwater	All surface water runoff from rainfall, predominantly in urban catchments. Such areas may include rural residential zones.
Street Sweeping	The removal of particulates and litter from street surfaces by sweeping or vacuuming.
Subsidy	Non-repayable grant money.
Sub-catchment	A topographically defined area drained by a tributary or branch drain of a primary stream or main draining a catchment.
Subsurface Drain	A drain designed to intercept sub-soil water and thereby lower the soil water table.
Swales	A grassed open channel, designed to intercept and convey surface runoff to a drainage network inlet, promote infiltration, promote interception of particulate material by the vegetation, and to provide a landscape element.
Swirl Separator	A device which uses the flow energy to create a vortex, enhancing the separation by gravity of water

	and particulate materials.
Total Urban Water Cycle Based Management	The integrated management of all components of the hydrological cycle within urban areas (surface water, soil inter flow, groundwater, water supply and recycled wastewater) and the landscape to secure a range of social, economic and environmental benefits.
Treated Effluent	Liquid waste flowing from agriculture and industry processes, or sewage treatment plants, that has been subjected to screening, sedimentation, biological and chemical processes to improve its quality.
Wastewater	The used water of community, industry, or agriculture, containing dissolved and suspended matter.
Water Quality	The chemical, physical and biological condition of water.
Water Resource	The sources of supply of ground and surface water in a given area.
Water Sensitive Urban Design	Design of subdivisions, buildings and landscape which enhances the opportunities for at-source conservation of water, rainfall detention and use, infiltration, and interception of pollutants in surface runoff from the block.
Wetlands (Artificial)	A shallow pool of water, characterised by extensive areas of emergent aquatic plants, designed to support a diverse range of micro-organisms and plants associated with the breakdown of organic material and uptake of nutrients. Wetlands may be designed as permanent wet basins (perennial), or alternating between dry and wet basins (ephemeral), or combining these two systems (extended detention).

Sources: Australian Guidelines for Urban Stormwater Management in National Water Quality
Management Strategy, No. 10. Agriculture and Resource Management Council of Australia and New Zealand and Australian and New Zealand Environment and Conservation Council, 2000.
Draft Queensland Water Recycling Strategy. Queensland, Department of Natural Resources, 2001.

OVERVIEW

SCOPE

This introduction to urban stormwater management has been prepared by Environment Australia as part of the Living Cities Urban Stormwater Initiative. It outlines current challenges and approaches for improving urban stormwater management within a water cycle framework.

This is not a technical manual, rather an analysis of current trends, research and best practice for managing stormwater in Australia. It is a starting point for delving into a feature of our cities that has been often ignored, but is now recognised for its capacity to be both a major source of pollution or a major resource.

INTRODUCTION

Australians live in the driest inhabited continent. Managing scarce water resources requires a complete water cycle approach to protecting the country's unique ecosystems.

The variability of rainfall and runoff is more extreme than other parts of the world. Australians have made a large investment in stored water capacity to supply rural and urban users in this climate.[1] While stormwater runoff from the cities is about equal to the amount of drinking quality water that is supplied at considerable cost each year, little stormwater is captured, with most adding to the pollution of waterways.[2]

Urban stormwater is defined as runoff from urban areas, including the major flows during and following rain, as well as dry-weather flows.[3] Many factors influence the amount of stormwater and the contaminants that are transported by it, including:

Duration and intensity of rainfall.
Proportion of impervious surfaces.
Shape of the land.
Landuse.
Design and management of stormwater systems.[4]

In addition to washing contaminants from the atmosphere, rainfall in the form of stormwater runoff flushes material accumulated on surfaces including litter, dust and soil,

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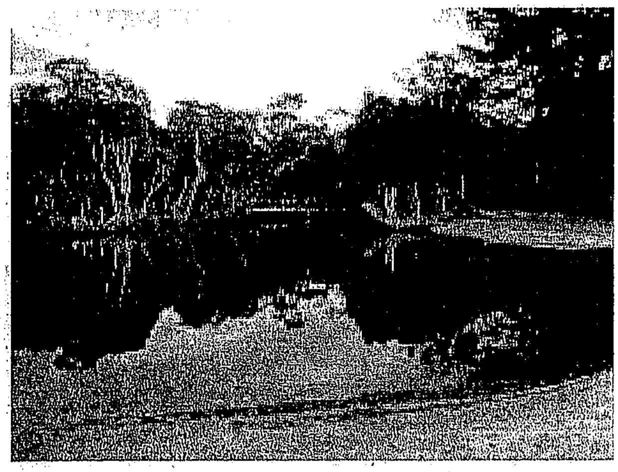
[1] Dowsett, Brigid (1994). *The management of stormwater: from a problem to a resource*. Sydney Water Project, p. 1.
[2] Dowsett, p. 1.
[3] Agriculture and Resource Management Council of Australia and New Zealand, & Australian and New Zealand Environment and Conservation Council (1996). *Draft guidelines for urban stormwater management*. Canberra, p. 1.
[4] *Draft guidelines*, p. 1.

fertilisers and other nutrients, chemicals and pesticides, micro-organisms, metals, oils and grease into waterways.[5]

Overall, about 12% of Australia's rainfall finds its way into surface streams. By contrast, in highly urbanised zones up to 90% of the rainfall may flow into the stormwater system. These flows are complemented by dry weather drainage, flows from garden watering, washdowns and illegal discharges.[6] In some systems wet weather overflows from sewerage systems create significant health and environmental impacts on our waterways.



Sisters Creek coastal lagoon, North West Tasmania – polluted by combined stormwater and sewage discharges. Pollution is proving to be a risk to the environment, tourism and public health. The Commonwealth Government is providing funding of $3m in a partnership with the Sisters Beach and Boat Harbour communities, the Waratah-Wynyard Council and Tasmanian Government to address the problem.

In the past, the prime objective of urban stormwater management has been flood mitigation. Local councils can be held liable for flood damage caused by stormwater.[7]

Traditionally in Australia, stormwater has been transported separately from the sewerage system. Unlike sewage, stormwater has received little, if any, treatment. The aim has been to channel the stormwater as rapidly and invisibly as possible from within our urban areas to the nearest waterway, usually on the coast.[8]

The necessity to deal with both the quantity and quality of runoff is now recognised. The 'hard' engineering strategy for the management of stormwater is being modified by an increase in the application of Water Sensitive Urban Design (WSUD).[9] This strategy focuses on the sources of runoff and pollution and the tools to contain and reuse the water within urban housing, commercial and industrial areas.

Today we have the tools to focus on Ecological Sustainable Development (ESD) in stormwater management. Stormwater can be treated as a resource that can bring environmental, economic and social benefits to our urban areas. Rather than going to

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[5] *Draft guidelines*, p. 1.
[6] *Draft guidelines*, p. 1.
[7] Commonwealth Environment Protection Agency (1993). *Urban stormwater: a resource too valuable to waste*. Canberra, p.21.
[8] Dowsett p. 1.
[9] Dowsett p. 1

waste and causing pollution, through capture, treatment and reuse, stormwater can become a major alternative to damming more rivers to ensure water supply.

CHAPTER 1

MAJOR ISSUES FOR URBAN STORMWATER SYSTEMS

ECOLOGICAL SUSTAINABLE DEVELOPMENT
MANAGING STORMWATER QUANTITY
MANAGING STORMWATER QUALITY
Visual Water Quality
Contaminants and Nutrient Control
- — Suspended Solids
- — Nutrients
- — Oxygen Demanding Materials
- — Micro-organisms
- — Toxic Organics
- — Toxic Trace Metals
- — Oils and Surfactants
- — Litter
- — Algal Blooms

Management Interventions
Community Benefits
Source Control
Interception during the passage of contamination
Management of receiving waters
NEW URBAN INFRASTRUCTURE
Multiple Use Corridors

ECOLOGICAL SUSTAINABLE DEVELOPMENT

Ecological Sustainable Development (ESD) has been described as:

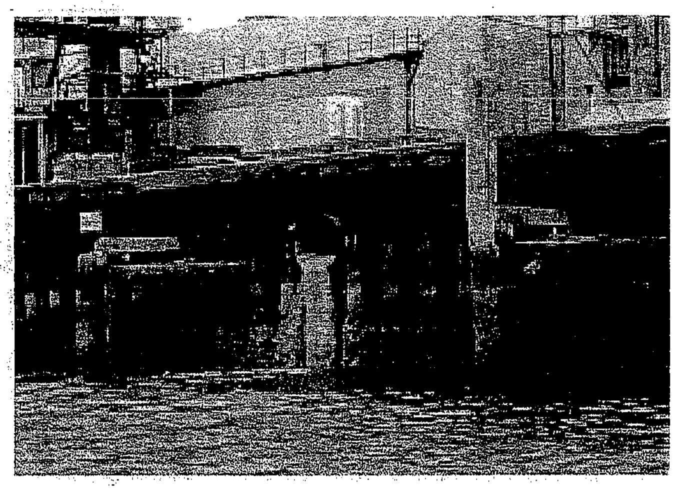
"Development that uses, conserves and enhances the community's resources so that ecological processes, on which life depends, are maintained and the total quality of life now and in the future can be increased".

National Strategy for Ecological Sustainable Development.
The National Strategy aims to develop water management policies based on an integrated approach to water resources, including total catchment management, public participation, and water allocations. To make these policies effective requires a mix of mechanisms based on: pricing, regulation, monitoring, institutional arrangements and property rights. In Australia's federal system this is a complex cocktail of responsibilities and funding arrangements.

In this context, the coastal zone is a major focus. It supports about 80% of the Australian population, with 96% living in cities and large towns. Many of these people are clustered in the coastal State capitals. Even so, although around 70% of Australia's coastline remains sparsely inhabited, the population of the non-metropolitan coastal zone has doubled in the last 20 years. In contrast, the Australian population as a whole grew by only one third.

In urban areas in most parts of Australia, the population engaged in residential, industrial, intensive agricultural, transport, and service activities is placing increasing pressure on waterways.

Many of the pressures are on estuaries. Here, the impacts of stormwater discharges will depend on the type of estuary. The well-flushed drowned river estuaries are generally least susceptible to stormwater pollution. The areas within drowned river valleys and barrier beach estuaries that tend to be most susceptible to pollution are at the tidal limit on the tributary watercourses. At these locations, pollutants have a long residence time that can result in algal growth and depressed oxygen concentrations. Coastal lakes are the most susceptible waterway due to the absence of tides. All types of waterway require an increased focus and resources to improve the management of the quantities and qualities of stormwater flowing into them to make up for a lack of action over decades when the issue was treated as "out of sight, out of mind".[10]



Stormwater discharges at Port Adelaide, South Australia. The Commonwealth is providing $800,000 to a working partnership with industry and the Port Adelaide Enfield Council to improve stormwater management in Adelaide's largest concentration of factories and most diversely polluted waterway.

MANAGING STORMWATER QUANTITY

Large stormwater flows invariably cause extensive pollution with high organic and sediments loads, sudden discharges from flooded sewers and growing piles of litter and rubbish being carried in drainage channels.[11] Where properties are regularly affected, flood mitigation works have been constructed. Alternatively, the properties have been resumed and buildings demolished to create open space for recreation and use as flood detention basins.

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[10] *NSW Environment Protection Authority (1997).* **Managing urban stormwater: Council handbook: draft November 1997.** *Chatswood, NSW, p. 89.*

[11] *Commonwealth Environment Protection Agency (1993).* **Urban stormwater: a resource too valuable to waste.** *Canberra, p. 6.*

Increases in stormwater runoff volumes have resulted from increasing urbanisation and the accompanying growth of impervious surfaces. Up to 70% of the impervious area in urban catchments is set aside for transport (40-50% for roads). Effective planning of flow paths across urban areas can reduce the speed and increase filtering and infiltration of stormwater runoff. Combined with effective detention and retention basins, large loads of sediment can be intercepted before they impact on the ecosystems of urban waterways.

Minimising the runoff from frequent storm events minimises sediment runoff and sewage overflows. It also counteracts remobilisation of pollutants that have been captured in the 'treatment train' of stormwater measures. The optimum solution for managing an increased volume of runoff is to encourage infiltration, storage and reuse.

MANAGING STORMWATER QUALITY

With water being a national priority, the Council of Australian Governments representing the Commonwealth, State, Territory and Local Government in Australia at the highest level, has adopted a National Water Quality Management Strategy (NWQMS). This Strategy includes a major focus on water quality linked to Ecological Sustainable Development, that is:

"To achieve sustainable use of the nation's water resources by protecting and enhancing their quality while maintaining economic and social development'.[12]

To achieve this objective, a three-tiered approach to water quality management - national, state, and local - is focused on regional catchments. In practice, each sphere of government uses its own water quality planning, environmental policy and regulatory tools to address the challenge.[13]

In a coordinated approach, long-term management of water resources calls for a collective vision. This vision needs to be based on:

A clear set of environmental values.
A good understanding of links between human activity and water quality.
Effective management frameworks, including:
Explicit goals for management.
An agreed level of protection to be achieved.

- Regulatory mechanisms (impact assessment).
- Reporting and monitoring arrangements.[14]

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[12] **Australian and New Zealand Environment and Conservation Council, & Agriculture and Resource Management Council of Australia and New Zealand (1999).** ***Australian and New Zealand guidelines for fresh and marine water quality (draft).*** **Environment Australia, Canberra.**
[13] *Australian and New Zealand guidelines.*
[14] *Australian and New Zealand guidelines.*

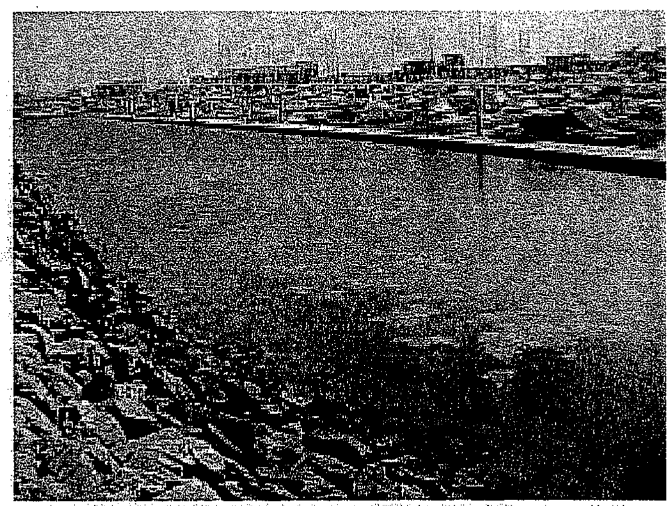
VISUAL WATER QUALITY

The most obvious aspect of a pollution problem is deteriorating visual water quality. Outbreaks of blue-green algae, piles of foam, significant fish kills, cloudy and highly coloured water, and oil slicks are examples of visual problems.
Floating inorganic debris and litter, such as steel drums, car tyres, bottles, aluminium cans and foam boxes, raise community concerns. They can harm wildlife and damage their natural habitats as well as threatening public safety.

Organic debris, such as leaves, timber, paper, cardboard and food will in the short term cause visual pollution. When this material decays, it releases nutrients. It may form rich organic sediment that can cause algal blooms.

Quality can also be affected by the temperature of waterways which may increase following urbanisation, as impervious areas act as efficient heat co: temperature of stormwater runoff could rise between 5 and 10 deg further increase in temperature can occur if the riparian vegetation is removed. This temperature increase can slow the growth rates c invertebrates.[15]

Can't see the point of this one here – no reference to it in the neighbouring text



Algal blooms in a nutrient-enriched waterway discharging to Adelaide's Gulf of St Vincent, South Australia.

CONTAMINANTS AND NUTRIENTS

The contaminants in stormwater can be grouped according to their water quality impacts. They include:
- Suspended solids.
- Nutrients, primarily nitrogen and phosphorous.

[15] Sharpin, M.G. & Morrison, A.J. (1995). Towards ecologically sensitive drainage systems. In *Preprints of papers: the second international symposium on urban stormwater management 1995: integrated management of urban environments.*

- Biological and chemical oxygen demanding materials.
- Microganisms.
- Toxic organics.
- Trace organics.
- Toxic trace metals.
- Oils and surfactants.
- Litter.[16]

SUSPENDED SOLIDS

Suspended solids have two main constituents:
Organic, primarily from sewage.
Inorganic, primarily from surface runoff.

Turbidity from suspended solids reduces light penetration in water, affecting the growth of aquatic plants. When silts and clays settle, they may smother bottom dwelling organisms and disrupt their habitats. Since metals, phosphorous and various organics are adsorbed and transported with these particles, sediment deposits may lead to a slow release of toxins and nutrients in the waterway.[17]

NUTRIENTS

Potential sources of nutrients are:
- Sewage overflows.
- Industrial discharges.
- Animal wastes.
- Fertilisers.
- Domestic detergents.
- Septic tank seepage.

Excessive amounts of nutrients, such as nitrogen and phosphorous, can promote rapid growth of aquatic plants, including toxic and non-toxic algae.[18] This excessive growth results in:
Production, during the day, and consumption, during the night, of a large amount of oxygen by the plants. This wide variation can cause fish & marine organisms to die.

Biological smothering of other plant forms.

Deposition and formation of organic sediment.

The most effective management of nutrients once in the stormwater system is to settle out the silt and clay particles that have the nutrients attached to their surface. Up to 85% of phosphorus and 70 - 80% of nitrogen can be isolated as particulate matter. Although sediment traps collect some clay-sized particles, the majority are settled on the many

[16] *Urban stormwater: a resource too valuable to waste*, p. 7.
[17] *Urban stormwater: a resource too valuable to waste*, p. 7.
[18] Dowsett. Brigid (1994). *The management of stormwater: from a problem to a resource.* Sydney Water Project, p. 9.

surfaces found in water pollution control ponds and constructed wetlands. These surfaces form a basis for microbial activity that can reduce the impact of pollutants. They are referred to as thin film bio-reactors.

OXYGEN DEMANDING MATERIALS

Sources of oxygen-demanding materials are biodegradable organic debris, such as decomposing food and garden wastes, and the organic material contained in sewage. Biological and chemical oxygen-depleting substances can cause water-borne diseases and present serious health risks. The biological and chemical oxygen demands of sewage overflowing into stormwater systems are high. If oxygen levels become too low, fish will die.[19]

MICRO-ORGANISMS

Bacteria and viruses found in soil and decaying vegetation, and faecal bacteria from sewer overflows, septic tank seepage and animal waste, are common contaminants in stormwater after heavy rain. Pathogens and micro-organisms, including bacteria, viruses and faecal coliforms, cause water-borne diseases. They can present serious health risks from cholera, typhoid, infectious hepatitis and a range of gastrointestinal diseases.[20]

TOXIC ORGANICS

These include garden pesticides, industrial chemicals and landfill leachate. They may cause long-term ecological damage and threaten human health.[21] Organochlorine pesticides, herbicides and insecticides can be accumulated in organisms and persist in the environment over long periods.[22]

TOXIC TRACE METALS

Heavy metals and some industrial chemicals can cause a severe impact on aquatic life. Industrial chemicals can enter stormwater from a number of sources including sewerage overflows, illegal dumping and accidental spillages.

Dust from brake and clutch linings of motor vehicles coupled with waste from degrading roadways and water pipes can inject ammonia, hydrogen sulphide and heavy metals (mercury, cadmium, lead and zinc) into the stormwater system. These metals can also be released from landfills through leaching and by poor agricultural practices.

OILS AND SURFACTANTS

Rubber from tyres and oil and grease washed from road surfaces, domestic and industrial sites, plus surfactants from detergents used for washing vehicles, are common sources of toxic pollutants in stormwater.[23]

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[19] Dowsett, p. 9.

[20] Dowsett, p. 9.

[21] Dowsett, p. 9.

[22] Dowsett, p. 9.

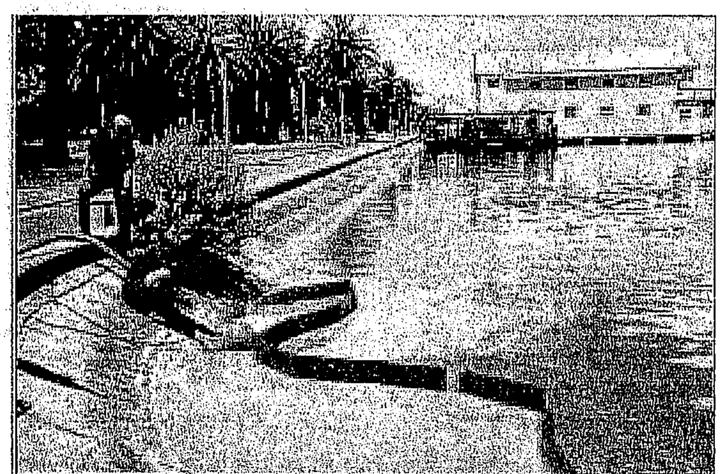
[23] *Urban stormwater: a resource too valuable to waste*, p. 7.

LITTER

This includes organic waste matter, paper, plastics, glass, metal and other packaging materials from paved areas in urban catchments.[24]

ALGAL BLOOMS

An algal bloom is caused by "the rapid excessive growth of algae, generally caused by high nutrient levels and favourable conditions".[25] Algae are a natural component of aquatic environments, and even when they are abundant, it is not necessarily a problem. Often a proliferation of microscopic algae can have beneficial effects on fisheries and aquaculture industries such as oyster or mussel farms by increasing the amount of food available. However, when algal blooms increase in intensity and frequency, the results can cause community concern, health problems, and in some cases can be catastrophic to the environment.[26]



Part of the algal bloom that forced the closure of Swan/Canning Estuary waterways in Perth, Western Australia, in 2000

Algal blooms can upset the natural balance of plant and animal ecosystems in a waterway or wetland. They can degrade recreation, conservation and scenic values, and interfere with economic uses such as fisheries and tourism. An over-abundance of algae can choke waterways, clog pipes, and block out the light to other plants, such as seagrasses. Excessive algal growth can eventually kill seagrass beds. When an algal bloom dies, the process of decay can use up all the available oxygen in the water, effectively suffocating other aquatic life. Some species of algae can produce toxins.[27]

Most strategies to address problems of algal blooms require reduction in the loads of phosphorous entering waterways from runoff. Planning on a catchment basis needs to consider pollutant loads from the various existing land uses and any proposed land uses in the whole catchment.

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[24] *Urban stormwater: a resource too valuable to waste*, p. 7.
[25] Water and Rivers Commission (1998). *Water Facts 6: algal blooms*. East Perth, p. 10.
[26] *Water Facts 6*, p. 10.
[27] *Water Facts 6*, p. 10.

MANAGEMENT INTERVENTIONS

COMMUNITY BENEFITS

A well-designed and integrated stormwater system can provide community benefits including:

- Minimising flooding of property.
- Protecting downstream water bodies from the contamination in urban runoff.
- Providing aesthetic values within the urban landscape.
- Providing recreational facilities on water bodies and in multiple use drainage corridors.
- Providing nature conservation habitat in urban areas for birds and other valued species.
- Providing water for reuse.[28]

To achieve these benefits there are three areas of focus:

1. Source control.
2. Interception during the passage of contaminants.
3. Management of receiving waters.

SOURCE CONTROL

The main approaches to minimising the impacts of the sources of pollution are:

1. Ensuring development is consistent with water sensitive urban design principles.
2. Minimising soil loss from construction sites and land development.
3. Careful location of sewer surcharge points to reduce discharges and minimise their impacts.
4. Minimising the area of impervious surfaces.
5. Street sweeping, litter trapping and pit cleaning.
6. Employing detention, storage and reuse facilities such as rainwater tanks.
7. Public education.[29]

Source control education techniques concentrate on making the public aware of issues such as:

1. Application of fertilisers, herbicides and pesticides to domestic gardens.
2. Car washing techniques, minimising the amount of water used and undertaking washing on pervious surfaces where possible.
3. Disposal of grass clippings and other organic matter from garden maintenance.
4. Removal of pet droppings, particularly from impervious surfaces.
5. Management of oil and other household chemicals.[30]

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[28] Cullen, Peter (1995). The Cinderella resource: urban stormwater in a dry country. In *Preprints of papers: the second international symposium on urban stormwater management 1995: integrated management of urban environments*, p. 12.
[29] Cullen, p. 12.

Education activities can include labelling drainage pits to indicate the waterway that is impacted by this stormwater drain entry.[31] Education of particular groups such as dog-owners, can play a key role in source control. The Environment Protection Authority (EPA) of New South Wales estimates the amount of dog faeces washing into Sydney's rivers from stormwater drains each year would fill more than 10 Olympic-sized swimming pools.[32]

The wet weather peak overflow problem from sewage pipes into stormwater drains and then waterways is a significant problem in most Australian cities. Water penetrates the sewerage system via illegal stormwater connections, surface runoff into sewer gullies, and cracked and broken pipes. The volume of water exceeds capacity, causing the designed sewer overflow relief points to discharge to waterways. Studies in the Sydney area have shown that there are up to 6,000 overflow points that are capable of discharging raw sewage into the stormwater system.[33]

CASE STUDY: IMPLEMENTING SOURCE CONTROL
Bayside Beaches, Melbourne.

Bayside is located on the eastern side of Port Phillip. It includes 20 kms of beaches, including some of the most popular around the Bay. A number of beaches are often closed following heavy rain when faecal pollution and litter from the urban stormwater system rises beyond safe contact levels for swimming. The Commonwealth's Clean Seas Program provided $120,000 to assist the City of Bayside and Melbourne Water to:
- Identify the sources of the contamination.
- Implement a program of litter minimisation and control.

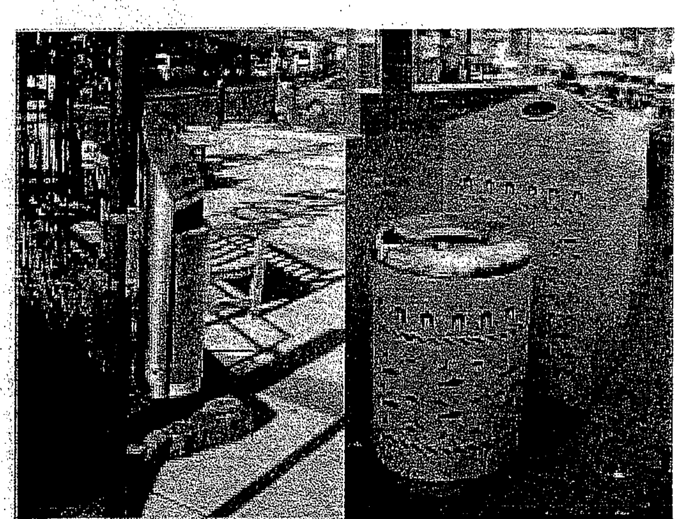
Through sterol sampling, boating and fishing activities were identified as some of the sources of faecal pollution as well as sewer leaks and illegal connections of domestic sewerage lines to the stormwater system. Action has been taken to address these problems.

To minimise stormwater litter discharges:
- 16 in-pit traps were located at hot spots in commercial and retail centres.
- 32 cigarette butt bins were installed at problem sites (50% of the litter stream was tobacco related)
- 23 recycling bins were set up for cans and bottles.
- The Considerate Business Education Program was initiated to encourage

[30] Sharpin, M.G., Morrison, A.J., & Goyen, A.G. (1995). Managing the stormwater environment. In <u>*Environmental aspects of urban drainage: seminar proceedings*</u>, 22 August 1995, ed. M.G. Sharpin. Stormwater Industry Association: Sydney.
[31] Sharpin, Morrison & Goyen.
[32] *Beale, Bob & Woodford, James (1994). Our polluted waterways : now it's dangerous to drink.* Sydney Morning Herald, *29 July 1994.*
[33] Booker, N.A., Priestley, A.J. & Ocal, G. (1995). Storm sewer overflow treatment technologies: a review of current processes. In *Preprints of papers: the second international symposium on urban stormwater management 1995: integrated management of urban environments*, p. 336.

shop keepers and their customers to improve their handling of waste.

The actions resulted in a considerable reduction in stormwater pollution from the targeted sites and provided an excellent demonstration project for other councils designing and implementing their stormwater management plans.



Bayside beaches litter source control, Melbourne, Victoria.

Through environment protection regulation, sewerage utilities are being forced to reduce sewer overflows, and eventually eliminate them. Management of storm sewer overflows means managing the sewer hydraulics and redirecting flows to minimise the impact of storms. Water Sensitive Urban Design can be a key tool in this process.

Whichever techniques for water management are selected they require a detailed understanding of the sewer network, catchment characteristics, receiving water quality and sensitivity, and urban landuse patterns. Solutions can range from simple detention basins, temporary storage, advanced physical and chemical treatment facilities, and removing and treating sewage locally for recycled water use (sewer mining).34

INTERCEPTION DURING THE PASSAGE OF CONTAMINANTS

Once pollutants are carried by stormwater from their source, the main approaches to interception are:

- Vegetated floodways.
- Gross pollutant traps.
- Wire baskets in sumps and kerb inlet pits.
- Filtration screens and sand filters.
- Oil and trash booms.
- Bio-retention and infiltration systems (e.g. swales);
- Water pollution control ponds.
- Wetlands.

34 Booker, Priestly & Ocal, p. 336.

- Retarding basins.
- Detention basins.
- Buffer zones between development and receiving waters.[35]

MANAGEMENT OF RECEIVING WATERS

If the pollutants have escaped source control and interception measures in the treatment train, the main approaches to management of receiving waters are:

- Zoning of water-based uses.
- Monitoring and prohibition of water activities when quality is unsatisfactory.
- Zoning and treatment of foreshores to encourage appropriate uses.
- Maintenance of healthy ecosystems.[36]

NEW URBAN INFRASTRUCTURE

MULTIPLE USE CORRIDORS

Increasing numbers of urban authorities are moving to incorporate holistic approaches to water management. They are working with planners and developers to use new techniques in a field which has persisted with narrowly focused approaches first implemented in the early 1900s.

Councils in most cities of Australia have powers to levy developer charges to cover the costs of stormwater management infrastructure. Some councils and developers are examining opportunities to create multiple use corridors that provide both stormwater management and beneficial functions within Water Sensitive Urban Design (WSUD). The provision of stormwater infrastructure is being integrated with water supply, sewerage, electricity, communication, transport, recreational areas, waterways and wildlife corridors.

An ecologically-based stormwater planning and management approach recognises components of urban drainage systems as ecosystems in their own right. It also acknowledges that some natural ecosystems have been irreversibly modified in urban environments.

[35] Cullen, p. 12.
[36] Cullen, p. 12.

CHAPTER 2

STORMWATER MANAGEMENT

REGULATION
Pricing, Competition and Innovation in Urban Water Supplies
NATURAL RESOURCE MANAGEMENT
National Land & Water Resources Audit
Land Use Planning
Integrated Catchment Management
Stormwater Management Planning
RETROFITTING
MONITORING, EVALUATING AND REPORTING
RISK MANAGEMENT FOR WATER QUALITY
ACCOUNTABILITY
State of Environment Reports
Catchment Audits
Statement of Joint Intent (SOJI)
COMMUNITY / GOVERNMENT PARTNERSHIPS
Community Participation
Indigenous Involvement
Conflict Resolution

REGULATION

In Australia the responsibility for managing urban stormwater rests mainly with local government. However, State and Territory governments have overall responsibility for land and water use planning and management. A range of government agencies and statutory authorities are involved in waterway and catchment management. In some states, catchment management trusts or catchment management boards have been established to prepare plans, undertake works and encourage community participation.

Local government is increasingly obliged to consider issues relating to resource management incorporating national and state level policies.[37] Through the Intergovernmental Agreement on the Environment, State and Territory governments have undertaken to include national considerations such as Ecological Sustainable Development (ESD) and international undertakings relating to protecting wetlands and endangered species in their planning activities.[38]

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[37] Agriculture and Resource Management Council of Australia and New Zealand, & Australian and New Zealand Environment and Conservation Council (1996). *Draft guidelines for urban stormwater management.* Canberra, p. 6.
[38] *Draft guidelines for urban stormwater management*, p. 7.

PRICING, COMPETITION AND INNOVATION IN URBAN WATER SUPPLIES

In many urban areas, drainage is the highest cost component of water infrastructure. However, some engineered practices are not the most cost effective options when external costs and impacts are taken into account.[39]

Port Phillip Bay, Melbourne, Victoria – endpoint for stormwater discharges.

In February 1994, the Council of Australian Governments (COAG) agreed to implement a strategic framework for important water reforms in Australia. These reforms cover a range of areas including water pricing, institutional arrangements, sustainable water resources management, and community consultation. The agreement was ratified by COAG in April 1995, when it agreed to a program of implementing these and other related reforms under National Competition Policy arrangements.

The water reform framework sets out requirements for:
- Wastewater management and water quality.
- Water related research.
- Public consultation and education.

The goals of this framework are to:
- Encourage innovative practices in providing water services while recognising the need to retain economies of scale in infrastructure to ensure net public benefit.
- Provide a level of certainty for private investment in the water services market by specifying the regulatory framework (health, environment, financial, etc) in which potential new entrants will operate.
- Facilitate competition in water services.
- Ensure there is a transparent, sustainable and equitable approach to the pricing of water and wastewater services while still ensuring reliability and consistency in the quality and safety of water services.

This framework promotes innovation in stormwater storage and reuse as a supplement to existing water services, and the potential to eliminate the need for future new water supply dams which carry large penalties in infrastructure and environmental costs.

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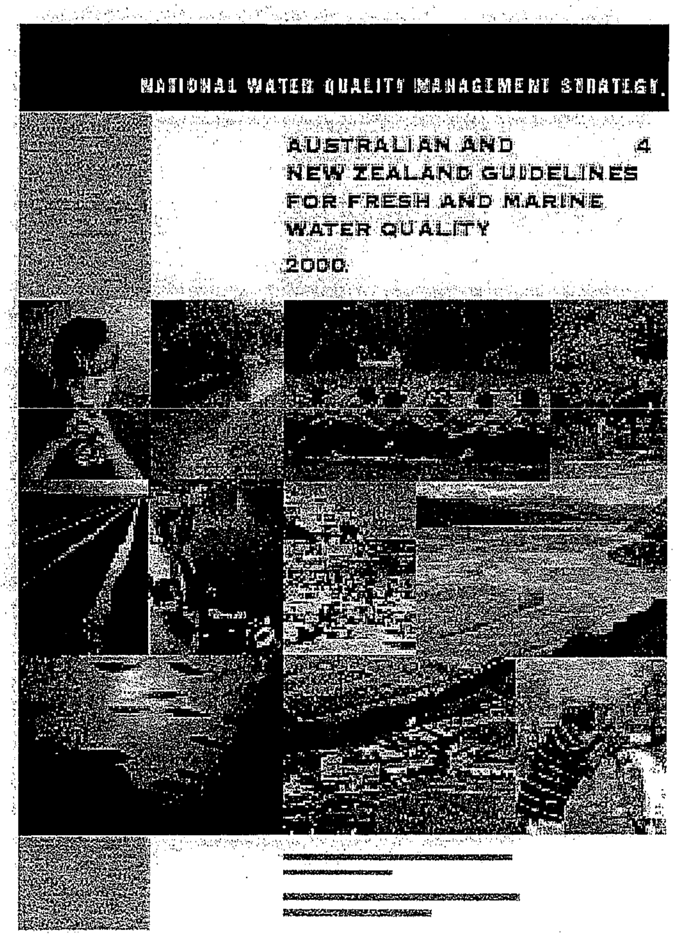
[39] *Draft guidelines for urban stormwater management,* p. 3.

NATURAL RESOURCE MANAGEMENT

The policy objective of the National Water Quality Management Strategy (NWQMS) is "to achieve sustainable use of the nation's water resources by protecting and enhancing their quality while maintaining economic and social development."[40] This objective is being pursued through a set of national technical guidelines on many aspects of the water cycle. Details are available at http://www.affa.gov.au/nwqms. One of the most relevant guidelines under the NWQMS is the Australian Guidelines for Urban Stormwater Management.



[40] Australian and New Zealand Environment and Conservation Council, & Agriculture and Resource Management Council of Australia and New Zealand (1999). *Australian and New Zealand guidelines for fresh and marine water quality (draft).* Environment Australia, Canberra.

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NATIONAL LAND AND WATER RESOURCES AUDIT

The National Land and Water Resources Audit has received $32M over five years as part of the Commonwealth's role in assisting natural resource management. The Audit is taking stock of Australia's natural resource base. It includes a National Water Resources Assessment. This Assessment focuses on the extent, supply capabilities and demand for water, including environmental needs.[41]

LANDUSE PLANNING

Under landuse planning, development control and resource management agencies work to a common, legally formalised hierarchy of mutually consistent planning instruments. Landuse and water allocation plans operate under a catchment planning umbrella that identifies the natural resources issues within particular catchments, the outcomes sought, and strategies for addressing them.[42]

INTEGRATED CATCHMENT MANAGEMENT

Natural Resource Management (NRM) is built around Ecological Sustainable Development, community empowerment, integrated management, targeted investment, accountability and minimising bureaucracy.[43] A fundamental first step in applying NRM in urban catchments is to establish agreed environmental values for receiving waters and their ecosystems.

Regional catchment management plans are a major part of integrated natural resource management. They can underpin investment strategies to avoid dissipating resources through fragmented structures and piecemeal investment in uncoordinated small-scale projects. This approach reinforces the concept that everyone, both urban and rural people, live in a catchment and are affected by, and affect the catchment.[44]

As part of the move to integrated NRM, integrated approaches to urban water services are emerging across Australia in response to conditions of financial accountability, limits to the sustainability of water use, and changing community attitudes to the protection of the environment and resource management. This change requires the integration of catchment management strategies.[45]

Guiding principles of Integrated Catchment Management (ICM) are:

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[41] Department of the Environment and Heritage (1999). *Unpublished submission presented to House of Representatives Standing Committee on Environment and Heritage Inquiry into catchment management. Draft*, p. 20.

[42] Farrier, David (1999). Legal models for integrated land and water planning and management. In *Second international river management symposium: speaker papers*, International River Management Symposium, Riverfestival: Brisbane, p. 115.

[43] State of Victoria (2000). *Unpublished submission to House of Representatives Standing Committee on Environment and Heritage Inquiry into catchment management*, p. 5

[44] State of Victoria. *Unpublished submission*, p. 10.

[45] Lawrence, I. & Reynolds, C. (1995). Integrated urban water planning. In *Preprints of papers: the second international symposium on urban stormwater management 1995: integrated management of urban environments, Melbourne, 11-13 July 1995*. Institution of Engineers: Canberra, p. 43.

- Total water cycle based planning and management.
- Total catchment based planning and management.
- Integration of subdivision and allotment design with stormwater management.
- Adoption of integrated infrastructure and service provision.
- Adoption of ESD approaches.
- Community involvement.[46]

To meet these principles, an ICM strategy describes:
- The water and related environmental values across the catchment.
- The stream flow and constituent loads that are sustainable at critical points across the catchment.

Permissible land uses and management practices which are consistent with meeting the sustainable loads and flows.[47]

Natural resource management at Hobart, Tasmania – treated stormwater and wastewater is redirected from discharging into the Derwent Estuary to irrigate crops.

The primary value of ICM is that it recognises that the effects of land and water use and environmental impacts are interconnected. It acknowledges that actions in the upper catchment will have cumulative impacts on other areas downstream and that a holistic approach to the planning and coordination of land and water management is essential. It can ensure conservation and maintenance of biodiversity. For example, tree planting for groundwater or riparian management can contribute to biodiversity conservation if habitat needs are considered in decisions about the locations and species chosen for planting.[48]

The catchment management approach is an effective way of engaging all the community, including those involved in landuse planning, natural resource management, primary production and conservation in working together to improve the overall management of

[46] Lawrence & Reynolds, p. 43.
[47] Lawrence & Reynolds, p. 43.
[48] Department of the Environment and Heritage, *Unpublished submission. Draft*, p. 8.

their local area. Introducing new management techniques and strategically investing in wastewater and stormwater reuse (water reclamation) technology can create regional economic drivers for agriculture and industry, changing stormwater quality problems into ESD opportunities.[49]

CASE STUDY: INTEGRATED CATCHMENT MANAGEMENT
Carrara Catchment, Gold Coast, South East Queensland

The Carrara catchment, of the Nerang River system and Moreton Bay, is suffering from environmental degradation including bank erosion, urban runoff, increased sediment loads and acid sulphate soils. Moreton Bay is exhibiting seagrass and wetland loss, the intrusion of urbanisation into wetland areas, localised harmful algal blooms and loss of biodiversity.

An Integrated Catchment Management approach by Gold Coast City Council, and development company, Nifsan, is based on a treatment train approach. Techniques used include trapping gross solids and sediment, using bioretention systems, oil and grease separators, cascading channels, source control measures, multi-purpose retarding basins and stream naturalisation and restoration processes.

The project serves as a demonstration site for the other 17 councils under the South East Queensland Regional Water Quality Management Strategy, and other regions undergoing similar development pressures around the Australian coast. Under the Urban Stormwater Initiative, the Commonwealth is providing over $1m to bring the project to fruition.

STORMWATER MANAGEMENT PLANNING

Although urban stormwater and treated wastewater are recognised increasingly as important economic resources, they are not widely used to augment supplies in expanding urban areas. Recent research and demonstration projects have shown that stormwater and treated wastewater can be exploited in a cost effective and environmentally sensitive manner for new urban developments.[50] In this context:

- Water reclamation can reduce potable water demand by as much as 50%.
- Properly managed stormwater flows provide important flow return to streams, offsetting the environmental impact of upstream water supply diversions and reducing the need for costly in-ground stormwater infrastructure.
- The enhanced use of natural drainage corridors and depressions can provide open space, landscaped and recreational areas and conservation benefits increasing the amenity of new urban developments (multiple use corridors).
- Treatment of stormwater and wastewater closer to source, minimises uncontrolled discharge of water containing high suspended solids, nutrients and organic material.[51]

[49] Department of the Environment and Heritage, *Unpublished submission. Draft*, p. 8.
[50] MacCormick, A.B. (1995). Economically sustainable storm and wastewater reuse in new urban developments. In *Preprints of papers: the second international symposium on urban stormwater management 1995: integrated management of urban environments*, p. 459.
[51] MacCormick, p. 459.

In many cities in Australia, councils are required to develop a Stormwater Management Plan (SMP) to cover capital works, services, asset replacement programs and activities aimed at protecting environmentally sensitive areas and to promote ecological sustainability.[52]

Typically, the SMP identifies:

- The existing and future values of a catchment.
- Stormwater management objectives to protect these values.
- The range of land use constraints.
- The range of corridor or drainage measures related to flow, interception of pollutants, provision of open space and recreation, conservation areas, urban stormwater reuse requirements and retention of the natural values of urban streams.

RETROFITTING

The retrofitting of stormwater management systems is a major financial issue for Australian cities. Providing effective structural, stormwater management strategies within existing urban areas is generally expensive and often difficult due to site constraints.

MONITORING, EVALUATING AND REPORTING

The primary goal of monitoring is to characterise the prevailing water quality and ecological conditions in a stormwater system and receiving water bodies, test compliance with water quality objectives and assessment of development and management actions. Impact assessment requires good data before and after the management and development actions. A combination of physical, chemical and biological monitoring is advantageous, as the macroinvertebrates commonly used in biological monitoring respond to long-term water quality conditions, while physical and chemical monitoring reflects instantaneous conditions.

Pre-development monitoring is essential to understand the extent of the catchment problems. The opportunity to carry out this type of water quality monitoring pre-development, is often limited due to existing landuses.

Most urban land development classed as Green Field Development is on land used previously for agriculture. Often the catchment characteristics have been impacted upon. If there is urbanisation further up the catchment, considerable water quality problems may exist already.

One of the issues in managing and planning new areas is to accept the incoming water quality problems, and to address this issue plus the proposed development impacts, so that the final discharge water quality is improved downstream.

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52 NSW Environment Protection Authority (1997). *Managing urban stormwater: Council handbook: draft November 1997.* Chatswood, NSW, p. 4.

CASE STUDY: MECHANISMS FOR MONITORING, EVALUATING AND REPORTING
Melbourne, Victoria

Melbourne Water has developed a useful approach for reporting on water quality in the urban and rural waterways around Melbourne. Water quality monitoring results are compared to target values, for each individual waterway or segment of a waterway. The target values are defined in State Environment Protection Policies prepared by the Environment Protection Authority.[53]

The result is the 'Stream Water Quality Index', that rates water quality as 'very good' to 'very poor', depending on how results of sample analyses compare with the desired conditions.

RISK MANAGEMENT FOR WATER QUALITY

In several Australian cities, the public is regularly confronted by public health warnings about waterways and beaches impacted by effluent overflows after significant rainfall events. In the past, risk management and legal liability have only appeared to be targeted at threats from flooding rather than deteriorating coastal water quality. However, the Wallis Lake (Mid North Coast NSW) oyster pollution crisis, where there was a large number of hospitalisations and a death, raised a new awareness of the impacts of urban stormwater. It became clear that councils and State agencies ignore qualitative considerations in managing urban waterways at their own environmental, legal and financial risk as well as the risk of the economic base of industries including fishing, recreation and tourism.[54]

ACCOUNTABILITY

There are a range of stormwater accountability mechanisms being employed in Australia including:

STATE OF ENVIRONMENT REPORTS

Monitoring of catchment management programs (stormwater management is a component) is required to assess their effectiveness. Information generated as part of this assessment can be useful as input into State of Environment (SoE) reports.

CATCHMENT AUDITS

Catchment audits can be prepared, following completion of fieldwork data collection. A report (audit), summarising the findings of the data collection and fieldwork activities, is undertaken to highlight the key stormwater management issues, their location, nature and severity. Plans can be prepared noting the location of the management issues in each sub-catchment, which could also be noted on a geographical information system. An

[53] Melbourne Water (1999). *Waterways and drainage: operating charter*, p. 5.
[54] Eberhardt, Jan (1999). Partnerships leading to effective implementation. In *Second international river management symposium: speaker papers*, p. 104.

assessment of the relative importance of problem sources can be made, to assist with allocating priorities for management and funding.

STATEMENT OF JOINT INTENT (SOJI)

The NSW Healthy Rivers Commission has developed the concept of a 'Statement of Joint Intent' (SOJI), to ensure different government agencies are accountable to agreed goals and catchment strategies.[55] The basis of this approach is that:

Agreed actions are specified in terms of auditable processes and procedures.

Each state agency's responsibilities under the SOJI are publicly acknowledged by their Chief Executive Officers and included in annual performance reporting.
Council undertakings as part of the reporting statement are widely publicised in the local media to provide local communities opportunities to 'audit' their own local Council's performance in relation to catchment and stormwater plans.

An independent 'quality assurance' mechanism is put in place to ensure that action taken by all signatories truly reflects the commitment made as part of the SOJI.[56]

COMMUNITY / GOVERNMENT PARTNERSHIPS

Community/Government Partnerships involve commitments to consult and work together for improved environmental and resource management. However, this does not absolve governments from their responsibilities to make decisions and take action.[57]

COMMUNITY PARTICIPATION

There is no single community participation model, as each project brings a unique combination of geography, community profile and resource issues into play. Some methods of encouraging community participation include:

- In-depth interviews of key stakeholders.
- Site meetings.
- Environmental care groups.
- Public workshops.
- Indigenous participation.
- Involvement of other organisations, individuals and experts.

CASE STUDY: COMMUNITY PARTICIPATION - MOONEE PONDS CREEK LITTER INITIATIVE
Melbourne, Victoria

[55] Eberhardt, Jan (1999). Partnerships leading to effective implementation. In *Second international river management symposium: speaker papers*, p. 104.
[56] Healthy Rivers Commission, p. 105.
[57] Eberhardt, p. 105.

A recent study has shown that more than three million items of litter enter the Moonee Ponds Creek drainage system each year. Much of this litter ends up in the Yarra Estuary and Port Phillip Bay. This pollution of waterways and beaches is a hazard to aquatic life. It reduces amenity for residents and visitors, and threatens economic activities.

Community education is part of the remediation project at Moonee Ponds Creek, providing an opportunity to effectively control litter through a coordinated, catchment-based approach. It will serve as a demonstration model for other cities implementing stormwater management plans. The activities include:

- Initiation of a community litter education program - moving beyond a simplistic "technical fix" that relies only on structural measures.
- Coordinated mail-outs to households, tram advertising and targeted programs aimed at business and industry.
- A major clean-up day and other community activities including the involvement of Waterwatch groups and the Scientists in Schools program.
- Promotion through local and regional media.
- Community information signage where works are being carried out.

Clean-Up Australia is working with the project steering committee to attract business sponsorship for:

- Clean-up events involving councils, agencies and the community in the catchment.
- Implementation of a 'Waste Reduction Accreditation Program' with business in the catchment.

The project demonstrates the benefits of cooperation across government, private enterprise, research bodies and the community. The Commonwealth has provided funding of $925,000 to assist Melbourne Water, 4 local councils, the CRC for Catchment Hydrology, Clean-up Australia, Melbourne Airport and Melbourne Ports Corporation implement the project.

INDIGENOUS INVOLVEMENT

The preparation of catchment management and stormwater management plans, includes identifying Indigenous sites and social traditions, where they link to water management. This process involves participation and consultation with Indigenous communities and often brings with it an enrichment and better understanding of natural resource issues pre-development.

CONFLICT RESOLUTION

Stakeholders in stormwater management may hold conflicting objectives and this could disrupt the planning process. Where there are competing community interests, or real or perceived alternative solutions, there can be strong objections, and often the threat of litigation.

Stormwater managers can establish a process of consultation with stakeholders involving education and information material being distributed, so any debate can proceed with participants involved being better informed. At times, it may be necessary for mediation by a third party, or as a last resort, action in an environment court.

CHAPTER 3

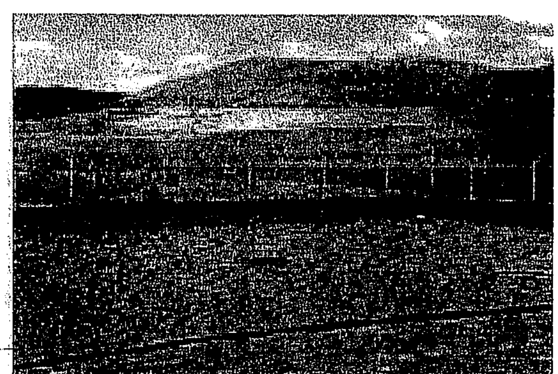
URBAN STORMWATER CONNECTIONS TO NATURAL SYSTEMS

INTRODUCTION
SOILS
ACID SULPHATE SOILS
VEGETATION
COASTAL AND ESTUARINE ZONES
NATURAL WETLANDS
GROUNDWATER AQUIFERS

INTRODUCTION

Before urbanisation, most leaves, rotting vegetation, animal droppings, sticks, dust and sand, stayed more or less where they fell. Now the ecology of many urban waterways is changed forever. Excessive amounts of organic material are washed from expanses of sealed surfaces, accumulate and break down on the bottom of rivers and harbours. This process creates a stagnant environment, reducing the oxygen available for aquatic life.

The increased stormwater flows from urbanisation can accelerate stream velocities and cause severe stream channel erosion. Sediment washed off construction sites and other unsealed surfaces is discharged into the same waterways, causing increased siltation and affecting the local currents required to sustain a healthy environment. This can impact on natural wetlands and the biodiversity of waterways.[58] As well, litter pollution in the stormwater system increases risks to human health and can destroy food sources or the habitats of aquatic life.[59]



Stormwater and wastewater reuse in Brighton, Tasmania – helps reduce pollution of the Derwent Estuary and increase productivity on farmland.

[58] **Roesner, Larry A. & Brashear, Robert W. (1999). Are BMP criteria really environmentally friendly?, p. 1368**
[59] Jago, Richard A. (1999). An end-of-pipe approach to the control of urban litter. *Waterfall: journal of the Stormwater Industry Association*, 12, April 1999, p. 13.

The most common practice is to use detention basins to slow down the post-urbanisation flow. However, experience with these facilities shows that while they reduce downstream flooding, they are not effective at reducing the erosion in stream channels.[60]

Stormwater management requires a broader focus. Best practice needs to take into account the complex interactions between the hydrology, geomorphology, ecology, soil, landuse and cultural characteristics of a catchment and its watercourse network. Failure to understand these interactions may result in the implementation of well-intentioned management techniques that have a greater environmental impact, than that associated with untreated stormwater.[61]

In the management of the impacts of stormwater, the approach of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000) points to an approach that includes identifying:

- Receiving waters to be protected.
- Environmental values including:
  - Protection and maintenance of aquatic ecosystems.
  - Recreation, either passive or active.
  - Water supply for irrigation or stock.
  - Domestic water supply.
- Broad water quality objectives based on guidelines.
- Local conditions (and data) that may require some tailoring of the guidelines, for example:
  - the ecological character of waterways change from headwaters to estuary. Adopting a single objective for nutrients or sediment and applying it along the length of a system is unrealistic and could be counterproductive.
  - Occasionally naturally high concentrations of heavy metals occur in streams through no influence of urbanisation.

SOILS

Soil types have considerable influence on water quality. Before planning and designing for urban development and stormwater management systems, it is essential to test and analyse soil types within a catchment,

Excessive salinity is among major challenges in some developing areas. It is a form of soil degradation that indicates an imbalance in a catchment. It is caused when salts stored in the soil profile are mobilised and brought nearer the surface by rising water tables. The principal cause of rising water tables is the replacement of native woody vegetation with introduced crops and pastures, that use water at a lower rate. This results in "leaking" of surplus rainfall water into groundwater systems, causing water tables to rise. As water tables rise, they bring up dissolved salts from lower in the soil profile. These can be

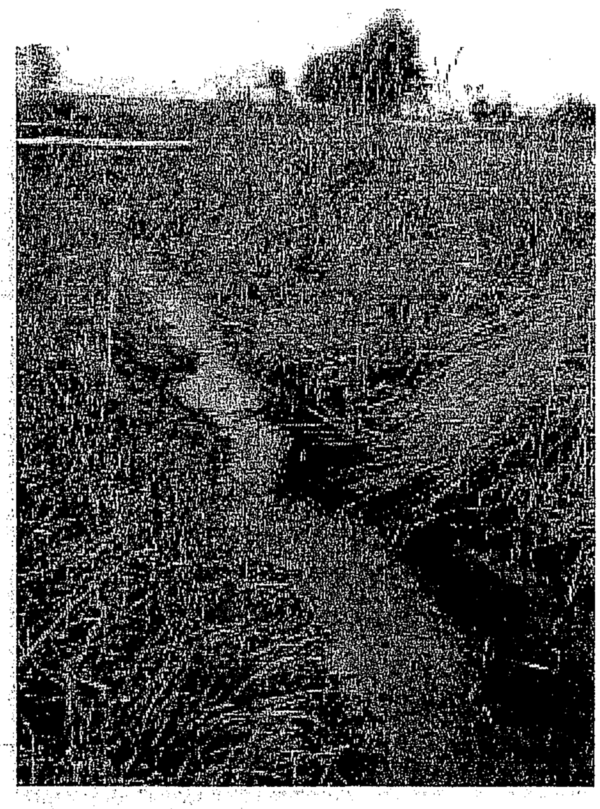
[60] Roesner, Larry A. & Brashear, Robert W. , p. 1368.
[61] NSW Environment Protection Authority (1997). *Managing urban stormwater: Council handbook : draft November 1997*. Chatswood, NSW., p. 95.

washed into stormwater systems in excessive amounts eventually affecting the biodiversity of waterways and other environmental values.

ACID SULPHATE SOILS

Nationally there is an estimated 40,000 sq kms of coastal acid sulphate soils containing over 1 billion tonnes of sulphide compounds. Urban development, agricultural production and flood control works has acidified large areas of coastal catchments, resulting in significant environmental, social and economic costs.
In an undisturbed state, acid sulphate soils are harmless and are known as Potential Acid Sulphate Soils (PASS). However, when drained and exposed to air, PASS soils become actual Acid Sulphate Soils (ASS). After rainfall, sulphuric acid is produced in large quantities often with heavy metals. Toxic slugs are formed which enter stormwater systems and travel to the sea, killing aquatic life along the way. A sign of the impact of these effects of ASS has been large fish kills in NSW and Queensland.

A range of techniques is being trialed to remediate ASS sites. However, minimising soil disturbance appears to be the best strategy for reducing further threats of stormwater pollution.



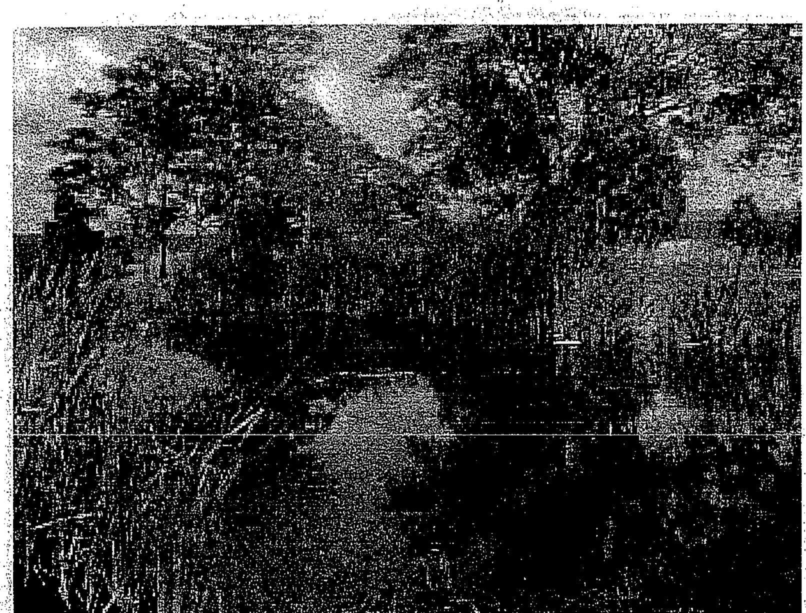
Acid sulfate runoff in an agricultural drain, at Smithton, Tasmania.

VEGETATION

Removal or changes to vegetation affects the natural balance of ecosystems, including water flows. Vegetation reduces stormwater runoff and promotes absorption and infiltration. Plants take up water and stabilise groundwater levels. Naturally vegetated areas produce only about 10% runoff. In dense urban areas, up to 90% of rainfall ends up in stormwater runoff.

This urban runoff transports nutrient loads into remnant urban bushland, encouraging the growth of exotic weeds.

With urbanisation and the need to design for sustainable environments, vegetation is a key measure used by planners and landscape architects in emulating pre-development conditions.



A constructed stormwater treatment wetland at Lake Macquarie, New South Wales.

Riparian zones are part of this approach. These are vegetated buffer strips bordering water courses. Without a well-managed riparian zone, excessive sediment enters the stormwater system from overland flow or the erosion of channel banks. When this sediment discharges into waterways from the stormwater system, it tends to clog the streambed, smothering native flora, and destroying the egg-laying sites of fish.[62]

CASE STUDY: STORMWATER AND IRRIGATION REUSE SYSTEM AND RIPARIAN REMEDIATION
Lake Illawarra and Mullet Creek, Wollongong, NSW

Lake Illawarra is currently failing to meet standards for recreational use following heavy rain. Mullet Creek delivers the greatest proportion of pollutants into Lake Illawarra of any creek system in the lake's catchment.

[62] *Australian Water and Wastewater Association*, In House of Representatives Standing Committee on Environment and Heritage. *Inquiry into catchment management, Unpublished submissions*, p. 15.

Intense rainfall in Mullet Creek's upper catchment contributes to stormwater contamination problems and flooding in the lower reaches. In this lower zone, residential stormwater runoff contributes more nitrogen, phosphorus and suspended solids than industry.

In response, a stormwater flood control and reuse pond is being constructed alongside Mullet Creek. This will capture, treat and reuse stormwater on 3 sports ovals. An extensive community consultation process, based on a simple electronic decision support system, is supporting complementary source control and revegetation projects along the Creek.

The Commonwealth Urban Stormwater Initiative is providing over $300,000 to support this integrated approach to stormwater management.

COASTAL AND ESTUARINE ZONES

Poor water quality and sediment loads are the most serious pollution issues affecting Australia's coastal and marine environments. The 1995 State of the Environment Report found that pollution from the land contributes up to 80% of all marine pollution and is a major threat to the long-term health of coastal waterways. Stormwater affects ecological processes, public health and social and commercial use of marine resources.

A creek polluted by combined stormwater and sewage discharges enters the sea at **Sisters Beach, Tasmania.**

Coastal lakes, which have limited ocean water discharge, have been particularly affected by urban and rural runoff. Significant losses of saltmarsh and mangroves around urban areas, caused by land reclamation and stormwater pollution, are affecting fish and other sea life that use the mangroves as nurseries and feeding grounds.[63]

> **CASE STUDY: USING RIPARIAN ZONES AND CONSTRUCTED WETLAND SYSTEMS FOR STORMWATER MANAGEMENT**
> **Lake Macquarie, NSW**
>
> Deforestation and urbanisation of the Lake Macquarie catchment has resulted in significant impacts on the water quality of the Lake. Major problems include:
>
> Increased sediment loads and accelerated catchment erosion.
> Elevated nutrient and bacterial levels.
> Heavy metal pollution.
> Litter pollution.
> Loss of habitat.
> Loss of aesthetic value.
>
> An integrated stormwater management project in the catchment is using a multi-objective approach led by Lake Macquarie City Council. The project is being supported by Commonwealth funding of $448,000 under the Urban Stormwater Initiative. Pollution control is being implemented at a range of sites surrounding the Lake. Measures include the construction of saltmarshes, mini-wetland systems and sediment traps. A number of simple, low cost treatment devices based on the current understanding of natural ecosystem processes are being trialed. Riparian plantings, source control campaigns and catchment management education with the community, residential developers and industry are complementary activities.

Australia has the world's largest area and greatest diversity of tropical and temperate seagrasses. However, elevated nutrients and sediments from stormwater runoff have caused serious diebacks of temperate seagrass beds in Southern Australia. Around half of the seagrass in the estuaries of New South Wales and the majority of seagrass in Victoria's Westernport Bay have been lost. Tasmania, the South Australian gulfs, and South-West Western Australia have also suffered serious declines in seagrass. Stormwater has also been a contributor to the major loss of seagrass in Hervey Bay in Queensland, causing a significant decline in the dugong population.

NATURAL WETLANDS

Water plants or macrophytes, are the main building block of wetlands. Emergent and submerged species assist a number of biological processes that enhance water quality. The plants:

- Add oxygen to the water.

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[63] *Coasts and Clean Seas Initiative: Coastal "Hot Spots", Ocean Outfalls, Sewage, and Stormwater*, Bruce Gray, Local Water Quality Management Planning Program, Coastal Strategic Planning Program, Department of Environment and the Heritage, p. 2 iii.

- Attract suspended solids from the water column to the surfaces of the plant.
- Provide habitat for micro-organisms, invertebrates, fish and birds.[64]
- Provide surfaces for Biofilms to trap nutrients.

GROUNDWATER AQUIFERS

An aquifer is a permeable geological formation made up of rock or sediment that can contain and convey groundwater. Recharge of aquifers occurs naturally as rainwater infiltrates through overlying soils or below streams and lakes.

There are vast areas of these water basins across Australia. Aquifers are found in areas under a number of coastal cities including Perth, Adelaide, Newcastle and areas of Sydney. While aquifers have the ability to purify water via the activities of micro-organisms they need careful management to protect them from urban stormwater pollution.

[64] Sainty, Geoff (1999). Waterplants in constructed wetlands: getting it right or wrong. In Wood, J.A. (ed.) (1999). *Stormwater 2000: the green with the gold: conference proceedings 26-28 April 1999*. Stormwater Industry Association.

CHAPTER 4

FLOOD IMPACTS IN URBAN DEVELOPMENT

INTRODUCTION
TRUNK DRAINAGE
Past Practices
RETENTION BASINS
RETARDATION BASINS
STORMWATER DETENTION BASINS
On-Site Detention
ENERGY DISSIPATORS

INTRODUCTION

As catchments are urbanised, the environmental impact of increased runoff from roads, roofs and other sealed surfaces can be significant. These changes from natural landscapes can have a number of effects on stream flow, including:

- More frequent flooding and erosion.
- Faster rising and falling flood levels.
- Increased flows in streams that are often dry.
- Reduced groundwater flow due to decreasing rainfall infiltration.

Loss of natural flood storage areas is occurring with encroachment of development on urban floodplains.[65] In this context, there is an increasing focus on retaining and reusing as much stormwater as possible while maintaining the flows that are necessary for the ecological integrity of waterways and groundwater systems.

The quantity of stormwater runoff from Australian cities is about equal to the amount of high quality imported water they use, so there is potential for expanded collection, storage and reuse of stormwater for non-drinking purposes. Urban stormwater is generally not of a high quality, but with treatment it can be used for:

- Toilet flushing.
- Hot water systems.
- Lawns, gardens and playing fields.
- Car washing.
- Fire extinguishing systems.
- Artificial lakes and wetlands.
- Industrial cooling towers.

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[65] Bewsher, D. & Still D. (1995) On-site stormwater detention in NSW: past, present and future. In *Preprints of papers: the second international symposium on urban stormwater management 1995: integrated management of urban environments, Melbourne, 11-13 July 1995*. Institution of Engineers: Canberra, p. 359.

- Recharging groundwater supplies.
- Some vegetable crops.[66]

Flood management strategies are being complemented by water conservation and water quality considerations. Some councils and water authorities are examining a scheme of transferable stormwater discharge rights for new developments. This would allow developers to purchase the right to discharge stormwater from other developers who have retained pre-development runoff flows though stormwater management techniques. This would result in an overall decrease in the cost of complying with an On-Site Detention (OSD) policy in some catchments. It would direct the cost of preventative measures onto those responsible for generating stormwater runoff.[67]

TRUNK DRAINAGE

PAST PRACTICES

The traditional approach to 'improving' a natural urban waterway, creek or overland flow path was to increase its capacity, which generally involves excavation, filling and lining large channels with grass or concrete. However, this can result in the destruction of habitats necessary to maintain a diverse aquatic ecosystem.[68] Pool and riffle zones, organic debris and aquatic flora may be removed and a uniform environment created. As a consequence, flow distribution and velocity characteristics are likely to be less variable. This can result in a reduced diversity of aquatic life.

Urban flood mitigation works such as levees with outlet gates or road embankments with culverts across estuaries can significantly alter the tidal regime and salinity of waterways. This can have a negative impact on mangroves, saltmarsh and seagrass habitats upstream of these barriers.

Increasingly new urban development is being planned and designed to increase their sustainability. Natural creeks and gullies are retained wherever possible as part of the stormwater and flood flow design, and modifications made in a sympathetic manner to manage water velocity and retention. Where treatment structures such as wetlands are created, they are often placed outside the natural stream channel (off-line) rather than interfering with the stream's natural features. In these cases, wetlands should incorporate a bypass channel for high flows in large storms. The bypass will reduce the threat of wetlands being 'washed out' with trapped sediment and pollutants being remobilised and deposited downstream.

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[66] Commonwealth Environment Protection Agency (1993). *Urban stormwater: a resource too valuable to waste*. Canberra, p. 2.
[67] *Urban stormwater: a resource too valuable to waste*, p. 11.
[68] Sharpin, M.G. & Morrison, A.J. (1995). Towards ecologically sensitive drainage systems. In *Preprints of papers: the second international symposium on urban stormwater management 1995: integrated management of urban environments*, p. 39.

RETENTION BASINS

On-site retention reduces the need for high cost infrastructure further down the catchment. Its feasibility depends on soil, groundwater, topography and climate.[69] Treatment train measures in a retention system could include:

- Urban lakes as biological treatment systems.
- Water pollution control ponds and wetlands acting as physical and biological treatment systems.
- Gross pollutant traps on stormwater channels intercepting litter, debris and coarse sediments.
- Temporary 'off-line' sediment detention ponds as part of land development works to intercept and treat stormwater from development sites before it is either discharged into the stormwater system or reused.
- Retention of natural creeks augmented by retardation basins in preference to the construction of trunk stormwater pipe systems and concrete-lined drains.[70]

RETARDATION BASINS

Dry retardation basins have either short or extended detention times. Those with short detention times aim to reduce peak storm flows from urbanised areas. Dry retardation basins are only marginally effective, in improving water quality, because the residence time (often less than two hours) may be too short to remove or moderate physical and chemical pollutants.[71] Dry retardation basins usually fill during large storms, they lack permanent water to maintain a biological community for treatment, and infrequent flushing may resuspend previously deposited sediments.[72]

Traditionally, retarding basins have been located in the middle reaches of a catchment, where watercourses are perennial and aquatic ecosystems are reasonably well developed. An alternative approach involves installation of numerous integrated controls in the upper reaches of water courses, where flows are generally ephemeral and aquatic ecosystems are less well developed. This maximises the length of protected watercourse and minimises any environmental impacts. However, construction and maintenance costs are usually higher.[73]

CASE STUDY:
Geographe Bay, WA

Geocatch, a community-based organisation in partnership with the Shire of Busselton and the assistance of $250,000 from the Commonwealth's Clean Seas Program has focused on reducing stormwater impacts on the Vasse River and Geographe Bay.

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[69] *Urban stormwater: a resource too valuable to waste*, p. 11.
[70] *Urban stormwater: a resource too valuable to waste*, p. 11.
[71] *Urban stormwater: a resource too valuable to waste*, p. 15.
[72] *Urban stormwater: a resource too valuable to waste*, p. 16.
[73] Sharpin & Morrison, p. 40.

The consortium has constructed a range of treatment devices including vegetating detention basins with wetland plants. The basins slow incoming water allowing sediments to settle and the plants to adsorb nutrients. As the basins fill up, the cleaner water on the top flows into the river.

STORMWATER DETENTION BASINS

Regional detention basins are typically designed into a residential development scheme, and ensure that the overall discharge from the scheme is held at pre-development levels, or even reduced to lower levels. These basins can also be retro-fitted within existing urban areas, or even into bushland settings.

Wet detention basins (ponds), with a permanent pool of water, have been designed to detain stormwater for gradual discharge. The pond helps improve water quality by sediment removal, uptake of nutrients from aquatic plants, chemical transformation and stormwater reuse.[74]

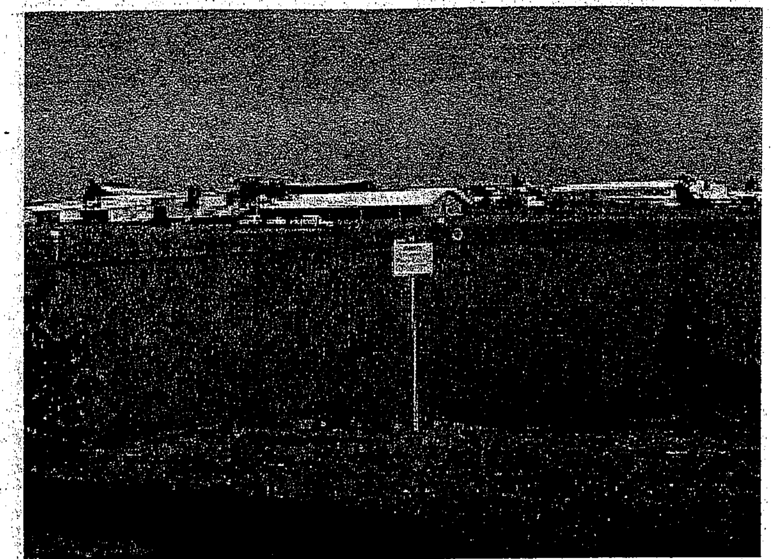
CASE STUDY: STORMWATER DETENTION AND REUSE SYSTEM
Hervey Bay, Queensland

Wide Bay Water at Hervey Bay is taking an innovative approach to managing stormwater impacts on coastal waterways while adding to reclaimed water resources for agriculture in the region.
Hervey Bay shares the Great Sandy Strait with the World Heritage- listed Fraser Island. The waterways are a prime calving ground for families of humpback whales. Tens of thousands of tourists visit each year to view the creatures. However, Hervey Bay's rapid growth is adding sediment from building sites, litter, including glass and plastics, oils, metal dust from brakepads and rubber from tyres to the cocktail of stormwater pollution entering the Bay.

Wide Bay Water is constructing a treatment scheme that will use detention ponds in the urban areas to store, filter and redirect stormwater into the sewerage system at night when there are low effluent flows. The stormwater will add to the volume of wastewater being reused to increase productivity on sugar and tea tree plantations surrounding the city.

The Commonwealth's Clean Seas Program is providing over $800,000 to support this innovative reuse of infrastructure.

[74] Dowsett. Brigid (1994). *The management of stormwater: from a problem to a resource.* Sydney Water Project, p. 25.



Warning signs lining a stormwater detention basin at Hervey Bay

ON-SITE DETENTION

In long established urban areas the drainage system may well have 'evolved' rather than been planned for the extent of existing or future development. When most of the future development involves infilling the existing urban area, problems are likely to result from the increasing load (quantity and quality) on the stormwater drainage system. One management option is on-site stormwater detention (OSD).[75] Best practice in on-site detention involves:

- Maximising outflow at the onset of storms in order to conserve storage capacity.
- Quality enhancement through separation and treatment of first flushes.
- Use of screened outlets to closely control flow rate and capture litter, debris and sediment.
- Frequency-staged storage employing 'storage' in lawns and garden soils, depressions in public open spaces, open and covered pavements such as car parks, but in a staged fashion, so that each storage comes into operation only when the preceding one is full.
- Tailwater compensation to control discharge when the bed of a storage lies below the water surface in the receiving drain.
- Pump discharge regulation for controlling pumping from basement tanks in buildings.

The benefits of OSD are:

- It can be funded immediately (i.e. by the developer) and does not require capital outlays from stormwater management authorities.
- It protects downstream properties from increase in flooding resulting from new developments.
- Public land for larger detention basins may not be available adjacent to existing trunk drainage systems.

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[75] Ribbons, S., Warwick, M. & Knight, G. (1995). Section 94 contributions or on-site detention: Council's dilemma. In *Preprints of papers: the second international symposium on urban stormwater management 1995: integrated management of urban environments*, p. 27.

- The cost of upgrading existing drainage systems is often beyond the financial means of councils.
- The OSD system tackles the problem at its source, before the increased flows and pollution enters a major stormwater system and waterways.
- Some water quality improvements will result from deposition of coarse particles and the trapping of litter on inlet and outlet-protecting screens.[76]
- Groundwater recharge and reuse storage can reduce spills and water consumption releasing reservoir storage for environmental flows.

The disadvantages of OSD are:

- Regulations, and design methods adopted by councils are sometimes over-simplistic (and can therefore be unfair to developers).
- Under some hydrological conditions, storage's located in the lower parts of catchments can increase flow rates downstream due to lags in the system.
- Maintenance is a major problem, and OSD places a large administrative burden on councils and a possibly an onerous duty on property owners to ensure regular de-silting.
- It provides little scope for stormwater pollution reduction, especially for dissolved pollutants, and those attached to fine sediment particles.[77]

ENERGY DISSIPATORS

Restraining flow to stop erosion of stream banks and channels is often necessary, where natural slopes increase velocity. In nature, streams stabilise when the energy flow forces are dissipated, eg. in pools and riffles. In engineered channels, in streams that have increased flows, or in cases where the channels are restricted and directed under culverts or into pipes, it is often necessary to reduce velocity by constructing energy dissipaters to stop erosion. Dissipaters can be 'natural' (rocks, trees and grass) or 'engineered' (concrete blocks and timber bollards).

[76] Bewsher, D. & Still D., p. 361.

[77] Upper Parramatta River Catchment Trust (1994). *On-site stormwater detention handbook.* Sydney.

CHAPTER 5

WATER SENSITIVE URBAN DESIGN

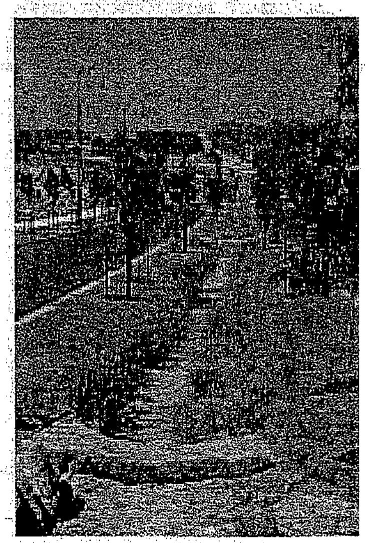
INTRODUCTION

TREATMENT TRAINS
Best Management Practices
Source Controls
In-Transit Controls
Entering Receiving Waters

STORMWATER MANAGEMENT PLANNING

INTRODUCTION

The water cycle is a complex interaction of rainfall, evapo-transpiration, overland flow and groundwater flow. Water Sensitive Urban Design (WSUD) grew out of a recognition of the linkages in the water cycle between urban development, stormwater systems and the quality of downstream ecosystems.[78] WSUD is based on a holistic approach to water cycle management and regional natural resource management. These approaches can be linked to catchment management networks and strategies. They feed into planning by individual councils and then into their operational and works programs and forward budget allocations.



Lynbrook, Melbourne, Victoria – water sensitive urban design being applied in an estate developed by the Victorian Land and Regional Development Corporation.

[78] Natural Heritage Trust Waters and Rivers Commission. Techniques to Improve Urban Stormwater Quality: workshop notes, The Institution of Engineers Australia, p. 5.

The application of water sensitive planning and management principles involves incorporating water resource issues early in the landuse planning process. It addresses water resource management at the catchment, suburban, precinct, cluster and allotment scale. WSUD makes the entire stormwater treatment network part of the urban fabric via multiple use corridors and best management practice (BMP) treatment trains. Vegetated swales, filter strips, extended detention basins and constructed wetlands are all part of fully functioning stormwater treatment systems. It maximises infiltration and on-site storage, treatment and reuse and utilises natural runoff channels where appropriate.

If regulators set a target for permissible allotment discharges of stormwater, then designers will examine options for reusing stormwater in toilets, hot water systems, irrigation systems and infiltration zones. More sustainable landscaping, roof gardens, bio-retention, water tanks, better road drainage design and better planning become options for achieving the targets. Reduced stormwater discharge means less stress on creeks and rivers, resulting from reduced erosion, sedimentation and flooding.

WSUD builds on a multi-disciplinary approach. For instance, landscape architects can combine with ecologists to select a range of natural wetland species that enhance pollutant removal and create attractive residential and industrial estates.[79] Planners can incorporate multiple-use corridors to provide stormwater infiltration, filtering and flow paths and dry weather recreation areas. The community can play a role in defining the types of passive recreational pursuits and water features that are most attractive. Engineers can provide designs that function effectively as stormwater management systems, ensuring minimal risk of flooding and disease while protecting ecosystems.[80]

Aritst's impression of the **'Inkerman Oasis" apartment development, Melbourne, Victoria,** that incorporates water sensitive urban design.

[79] Natural Heritage Trust Waters and Rivers Commission, p. 3.
[80] Natural Heritage Trust Waters and Rivers Commission, p. 3.

Natural processes which control runoff, are in constant change. Typically, streams change course, natural erosion occurs, and vegetation and soil permeability change with the seasons. When humans alter the land within a catchment, the changes to the natural processes accelerate, creating a need for constructed stormwater management systems.[81] However, if WSUD is implemented then there can be long term savings in overall water management infrastructure. Water utilities faced with the decision to expand water distribution and stormwater infrastructure (headworks) to meet the needs of extra population, need to make a comparison between the lifecycle cost of:

New and existing infrastructure required to meet the (conventional) additional water supply demand and additional stormwater load.

New practices which decrease potable water consumption and stormwater load, and encourage water reuse and environmental sustainability.

A comparative analysis of economic externalities, such as environmental and social consequences of traditional and WSUD systems, is crucial. Of all landuse changes that affect an area's hydrological cycle, urbanisation is the most important. However, other landuse changes within a catchment such as agriculture, forestry and mining also alter the hydrological cycle and create a need for stormwater management.

CASE STUDY: MORETON BAY INTEGRATED STORMWATER DEMONSTRATION PROJECT
Brisbane, Queensland.

Sections of Brisbane River flowing into Moreton Bay have sediments with concentrations of pollutants up to 35 times above safe levels. The Bay contains a Ramsar wetland and supports migratory birds, dugongs and turtles. It also is under pressure from a rapidly growing urban population and intensive agricultural development in the catchment.

The project has established wetland/wetpond stormwater treatment facilities to trial structural approaches supported by community and industry education campaigns to improve discharges to the Bay.

The project has received $970,000 from the Commonwealth's Clean Seas Program.

TREATMENT TRAINS

BEST MANAGEMENT PRACTICES

In most catchments, a number of water quality management measures may be implemented in series, forming a stormwater treatment train based on:

[81] Evangelisti & Associates, Landvision & V.& C. Semeniuk Research Group (1995). Water resources management study: Middle Canning catchment (stage 1, volume 1). Perth, p. 51.

- Avoiding pollution wherever possible through appropriate control of the pollutant source.
- Minimising stormwater pollution by in-transit measures.
- Managing the effects in receiving waters as a last resort.[82]

The 'treatment train' approach to integrated stormwater management improves the overall performance of a water quality treatment system. Generally, the more 'best management practices' (BMP's) incorporated into the system, the better the performance. However, BMP's will fail if poorly located within the treatment train or not properly maintained.

SOURCE CONTROLS

This series of measures in a treatment train can include:

- Community awareness (education) programs.
- Improved landuse planning and regulation.
- Tightening permissible discharges and licensing provisions.
- Providing incentives for adopting innovations and best practice.
- Improving street cleaning effectiveness.
- Controlling and treating sewage overflows.
- Isolating high pollutant source areas for extra attention.
- Encouraging and enforcing construction site management.
- Enhancing and monitoring landfill management.
- Installing and cleaning litter traps.
- On-site detention/retention applications.
- Seriously exploring stormwater infiltration and reuse options.
- Rehabilitating, expanding and protecting buffer zones.[83]
- Examining opportunities for discharge rights trading.

IN-TRANSIT CONTROLS

This series of measures in the treatment train can include:

- Gross pollutant traps.
- Swale systems.
- Detention basins.
- Ponds and wetlands.[84]

ENTERING RECEIVING WATERS

This series of measures in the treatment train can include:

- Gross pollutant traps.
- Catch basins.
- Floating booms.

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[82] Moore, Linda (1998). A manual for managing urban stormwater quality in Western Australia. In *Stormwater: keeping it clean: conference proceedings*, 27 October 1998, ed. John Anderson Wood. Stormwater Industry Association, Sydney, p. 2.

[83] Moore, p. 2.

[84] Moore, p. 2.

- Ponds and wetlands.
- Receiving waters management e.g. aeration, phoslock clay.[85]

Within these processes, there are generally 3 levels of treatment:

Primary

- Screening of gross pollutants.
- Sedimentation of coarse particles.

Secondary

- Sedimentation of fine particulates.
- Filtration.

Tertiary

- Enhanced sedimentation and filtration.
- Biological uptake.
- Absorption on to sediments.

In most circumstances, a treatment train approach is appropriate to optimise pollutant removal. The types of primary, secondary and tertiary treatment systems are described in Chapters 6, 7 and 8.

STORMWATER MANAGEMENT PLANNING

Best practice stormwater management for land development is implemented by the developer in harmony with the local council's stormwater management scheme and the catchment management plan. Both are based on the principles of ecologically sustainable development. Land developers and builders are generally responsible for ensuring that their development does not result in significant worsening of existing stormwater management problems. Urban land developments should only occur in areas where a land capability assessment has indicated that stormwater management practices are capable of achieving this objective.

Developers are encouraged to improve existing stormwater systems (eg. degraded creeks) and avoid using natural waterways or natural wetlands for stormwater treatment purposes. Alternatively, development using WSUD principles based on total water cycle management can be attractive to prospective purchasers, increase the value of adjacent land, and may avoid expensive new infrastructure. The value of land adjacent to stormwater treatment measures, such as water quality control ponds and constructed wetlands, is usually higher than for land adjacent to a conventional drain.

CASE STUDY: WSUD DEVELOPMENT
Kogarah Town Square, Sydney, NSW

Urban renewal of Kogarah Town Square involves the construction of 220 residential apartments, 225 parking spaces, commercial retail space and a public library. The development is situated on the ridge between the densely urbanised catchments of the Cooks River and the Georges River which flow into Botany Bay. Both the rivers and the

85. Moore, p. 2.

Bay are degraded. They are under pressure from increasing urban consolidation, traffic densities and industrial activities.

The project aims to reduce the impact of stormwater through conservation and efficiency by:
- Reducing the reliance on mains water.
- Managing stormwater quantity and quality through capture, reuse and treatment.

Stormwater filtration will occur through a specially designed garden bed. In periods of high stormwater flow, surge tanks will regulate the water flow prior to discharge into the stormwater system. Of the 7,500 kilolitres of rain that falls on the site annually, 85% is captured and used.

About 60% is used to flush toilets, the remainder to irrigate the gardens in the courtyards, while 25% passes through the gardens and is purified and stripped of most of the nutrients. The reuse scheme separates the dirtiest water from the Town Square pavement and treats it separately from the relatively clean water from the roofs. The water reuse within the development represents a saving in the order of 17% of mains water.

The project has been supported by the Commonwealth's Urban Stormwater Initiative with $629,000 in partnership with Kogarah Council, Sydney Water and the development company, High Trade Pty Ltd.

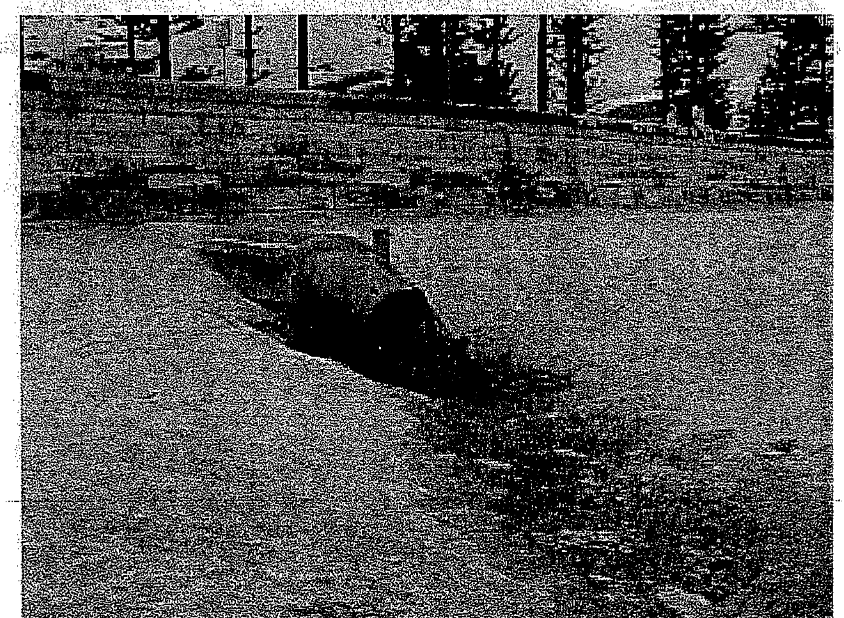
CHAPTER 6

PRIMARY CONTROLS FOR POLLUTION MANAGEMENT

INTRODUCTION
GROSS POLLUTANT
GROSS POLLUTANT TRAPS
LITTER BASKETS
TRASH RACKS
FLOATING BOOMS
CATCH BASINS
OIL AND GRIT ARRESTORS

INTRODUCTION

Historically, stormwater management has focused on end-of-pipe and structural solutions, such as gross pollutant traps and artificial drainage channels. Now, best management practice is moving towards solutions closer to the pollution source and an integration of structural and non-structural solutions. However, this process can be slowed by attitudes ingrained from the many decades under the old systems. Potential pollutants such as vegetation, that makes up to 80% of the non-particulate solids in runoff, are still looked on as 'natural material', that belongs in the landscape and mistakenly by extension in the drainage system.



A Sydney beach stormwater drain with litter net at **Manly, New South Wales.**

Leaf litter is not at all natural in the quantities that reach urban drainage systems. Under natural processes the vast majority of the material remains in the forest floor layer, holding runoff for slow release and gradually decaying to return nutrients to the soil. In the urban setting, the tree and shrubs are often as dense as it might have been prior to European settlement. However, now many drop leaves onto roofs, paved areas and manicured lawns. They are washed into drainage systems where they can deplete oxygen in waterways and create odours and water soluble compounds that impact on aquatic life.[86]

The community generally regards litter in stormwater as ugly. Many also mistakenly believe that litter has little environmental impact because it consists of benign materials in use every day. The litter stream includes millions of cigarette butts that persist for up to 20 years. They are rich in carcinogens and can be swallowed by aquatic animals.

Litter is unsightly, environmentally damaging and can cause blockages to stormwater management systems. For instance, drink cans made of aluminium are chemically reactive, highly toxic in some phases and may degrade in the low pH of anaerobic zones. Medical and sanitary waste and glass bottles, usually in fragments, are a hazardous feature of bottom muds.[87] A high proportion of all litter, sinks to the bed where it binds the surface or becomes embedded in sediments, to disrupt the activity of bottom dwellers.

Plastics now dominate the stormwater litter stream and can take over a century to decompose. If an aquatic animal dies after swallowing plastics, it decomposes long before the litter, which floats on to threaten more animals. Polystyrene also floats down stormwater drains and into the sea. It can lodge in gills and obstruct the guts of susceptible species.

The aesthetic effect of litter has a profound influence upon the value people attach to their waterways. This could alone, justify the removal of these materials from stormwater, but the case for serious underlying water quality impact by these materials is even stronger.[88] Litter and debris can have significant economic impacts in tourism areas and in marine engines through their intakes. The bulk of this marine litter comes from stormwater.[89]

GROSS POLLUTANT

Methods of reducing gross pollutant impacts include:

- Preventative measures (education and awareness) including drain labelling, working with manufacturers to reduce packaging and encouraging recycling.
- Removal of gross pollutants (street cleaning).

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86 Nicholas, p. 23.

87 Nicholas, D.I. (1997). Primary treatment of stormwater runoff: its place in the scheme of things. In *Science and technology in the environmental management of the Hawkesbury-Nepean Catchment: proceedings, 10-11 July 1997*, eds. Steven Riley, Wayne Erskine & Surendra Shrestha. Institution of Engineers and the Geographical Society of New South Wales: Sydney, p. 23.

88 Nicholas, p. 24.

89 Allison, R.A., Walker, T.A., Chiew, F.H.S., O'Neill, I.C., & McMahon, T.A. (1998). *From roads to rivers: gross pollutant removal from urban waterways.* Cooperative Research Centre for Catchment Hydrology: Clayton, Vic.

- Capture of gross pollutants in the drainage system.
- Bio-remediation of pollutants (mainly applicable to nutrients and heavy metals).
- Remedial clean-up methods.[90]

Before a particular stormwater treatment technique or treatment train can be determined, characteristics of the catchment area, objectives for the receiving waters, soil and groundwater requirements have to be considered.

Despite education, awareness and street cleaning programs, large amounts of gross pollutants are reaching and degrading waterways. A catchment study in Sydney showed that previous estimates of the number of litter items moving through the stormwater systems can be significantly underestimated, and that organic material and sediment are consistently the main components of gross pollutant loads.[91]

The results from the study indicated that about three-quarters of gross pollutants is organic material, mainly leaves and twigs. This was observed consistently across different land-use types. However, despite the large amounts of organic gross pollutants transported by stormwater, they are not a major source of nutrients (Total Phosphorous and Total Nitrogen).[92]

In the study, only 20 percent of the litter and less than 10% of the organic material transported by the flow in urban waterways, was transported as floating material. This indicates that floating gross pollutant traps (e.g. booms) only capture small fractions of the gross pollutants being transported.[93]

Outcomes from the study's monitoring program indicate that gross pollutant concentrations generally peak before the peak of the storm (first flush effect) as the stormwater flow initially collects surface pollutants deposited since the last rainfall event or street sweeping. However, most of the gross pollutant load is transported during peak discharges. To capture the maximum amount of gross pollutants, trapping systems may need to be designed to treat high discharges but these could take up large areas of expensive urban land.[94]

Although gross pollutant loads and concentrations vary considerably during runoff events, the composition of the gross pollutants remains relatively consistent. This suggests that organic and other litter materials are transported in similar ways through drainage networks. It is therefore not possible to capture exclusively one component of gross pollutants by only treating one part of the storm event, for example capturing most of the litter by removing the first part of the runoff.[95]

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[90] Allison, R.A., p. 6.
[91] Allison, R.A., p. 82.
[92] Allison, R.A., p. 82.
[93] Allison, R.A., p. 82.
[94] Allison, R.A., p. 82.
[95] Allison, R.A., p. 82.

In the catchment study, litter items mostly entered the drainage network from commercial areas. This is mainly due to the actions of pedestrians and motorists. They contributed large quantities of plastic and paper items, especially food and drink items and very high numbers of cigarette related items (approximately 35% of the total number of items).[96]

Results suggest that appropriately designed and properly sited treatment trains can mitigate stormwater impacts on stream communities. However, the resulting aquatic communities differ greatly from those in undeveloped catchments and reflect a fundamental alteration in stream biodiversity.

GROSS POLLUTANT TRAPS

Gross pollutant traps (GPT's) are designed to trap litter, debris and coarse sediments in drains.[97] The traps are often large concrete structures. Sometimes they are complemented by a weir or upstream swales along a stream bank.

Litter from a gross pollutant trap installed on the Ross River Creek, Townsville, Queensland.

GPT's range from quite simple screens, which might be used for a single inlet pit, to structures which straddle channels and may have a twenty-metre footprint. They are designed to remove coarse materials from the mid-range rainfall events accounting for the majority of total runoff. Generally they are designed with combinations of screening, stilling, settlement, flotation and flow separation techniques. Some also catch fine particles by filtration through the coarser material already retained.[98] All require regular maintenance.

[96] Allison, R.A., p. 82.
[97] Commonwealth Environment Protection Agency (1993). *Urban stormwater: a resource too valuable to waste*. Canberra, p. 11.
[98] Nicholas, p. 24.

The principle design stages for GPT's are:

- Providing monitoring data for pollutant load estimation and storage sizing.
- Selecting the desirable sediment and litter capture sizes for particular catchment characteristics.
- Selecting the storm frequency to be accommodated.
- Site location considerations for selecting exposed or enclosed traps.
- Aesthetic acceptability.
- Devising a maintenance schedule to limit chemical and biochemical activity between services.
- Providing ease, frequency and safety of maintenance.
- Installation and operating costs.[99]

CASE STUDY: STORMWATER LITTER CONTROL

Cudgen Creek, Kingscliff, NSW

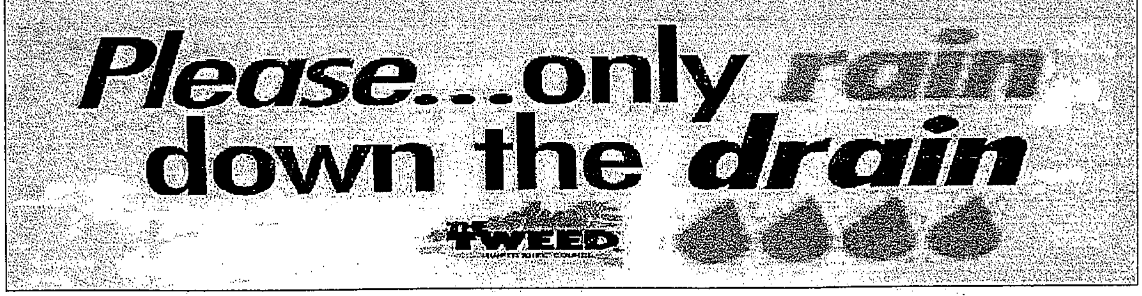
Litter and other pollutants were being discharging into Cudgen Creek from the urban stormwater system. The pollution was fouling the coastal waterways at Kingscliff, a popular family holiday destination on the north coast of NSW.

In partnership with on-ground action Tweed Shire Council and local high school students, the Commonwealth provided $85,000 from the Clean Seas Program to:

- Install 2 gross pollutant traps.
- Establish a community awareness program.

The traps were trapping pollutants, made up mainly of grass clippings, leaf litter and sediments, at the rate of 2.4 tonnes per year.

A media campaign was launched based around the students' analysis of the constituents of the traps.Two years after the campaign, 84% of respondents to a survey were able to indicate how they had changed their individual practices to reduce impacts on stormwater.



There are two principle types of GPTs - those that hold their pollutant load in the 'dry' state, and those that hold it 'wet'. 'Dry' traps are generally cheaper to maintain because of the lower costs for litter disposal (removal to landfill). 'Wet' traps are generally efficiently cleaned using eductor suction equipment, but the wet waste is toxic, and many authorities require it to be treated or disposed of under environmental safeguards for liquid waste.

99 Nicholas, p. 24.

'Wet' traps which are not regularly maintained can add to the pollutant load due to biochemical reactions between pollutants (dissolved and in suspension in the collection chamber) washing out of the trap in the next storm.

In Australia, there are a number of traps that are either commercially available or have the support of standard designs, including the following:

- Canberra University, Willings – large concrete steel stilling basin.
- Department of Public Works, North Sydney Council – on-line chamber, punch perforated steel skip.
- Baramy – precast concrete self cleansing through slotted steel grate.
- Copatrawl – nylon meshed sock installed on–line in a chamber.
- CDS Technologies, Swirl Separator – screen based off-line using cyclone principles.
- Rocla Stormceptor - precast on-line trap and wet chamber.
- Swynburne in line litter separator – floating boom diverter to off-line settlement well.
- Stormwater Systems Filtration Boom – end of pipe net curtain.
- Net Tech - end-of-pipe net bag.
- Humeceptor – precast on-line with wet storage well.
- Nicholas Ski-Jump – screen based on-line end-of-pipe dry store.
- Ecosol range of filtering, retention and storage units.[100]
- Enviropod - retrofitted gully basket.
- Storm Filter - uses several filter cartridges to extract a range of pollutants.
- SPEL Stormceptor – series of chambers to trap grit, sludge, fuel and oil.

LITTER BASKETS

Use of litter baskets in drainage systems is becoming common practice in urban areas in Australian cities. Entry gates to drains below streets can be either side-entry or horizontal grates. Side-entry has been favoured in Australian cities because of rainfall intensity. Side entry pit traps (SEPT's) are baskets that are placed inside the entrances to the drainage system from road gutters.[101]

SEPT's can trap significant quantities of gross pollutants. They are cheap to install and can be used to target specific areas because they can be installed on individual drainage entrances. They can capture up to 85% of the litter load and up to 75% of the gross pollutant load entering the drainage system.[102] There is an increasing tendency to replace traditional side entry systems with either grate or modified side-entry designs that perform a limited amount of litter and debris trapping functions.

Litter baskets have limitations including:

- Potential to aggravate upstream flooding if blocked by litter and vegetation.
- Potential odours and health risk to workers when handling trash.
- Trapped material may be re-mobilised.

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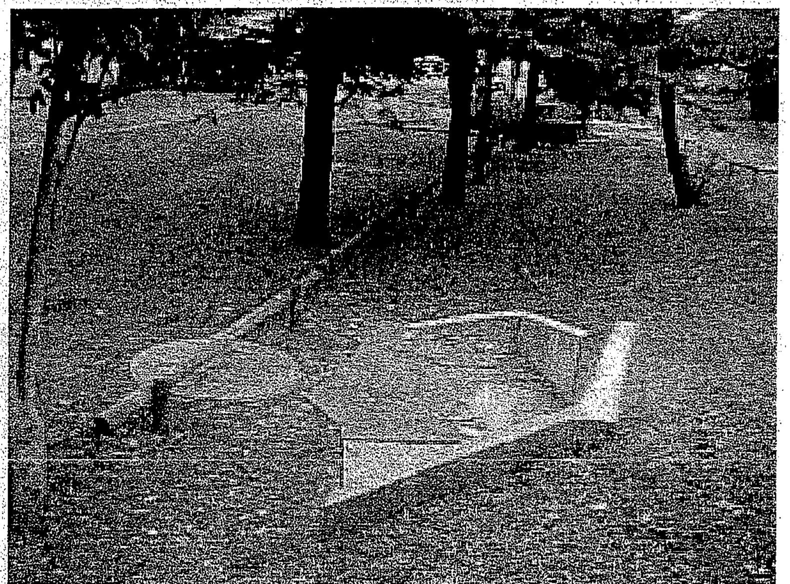
[100] Nicholas, p. 24.
[101] Allison, R. A., p. 82.
[102] Allison, R. A., p. 82.

- Moderate to high maintenance costs.

TRASH RACKS

Trash racks are a form of gross pollutant trap that have a steel grating or bars across the stormwater flow path to collect litter. They are not designed to collect fine particles or suspended solids. This form of trap has aesthetic limitations, and debris collected on the rack may block the flow, causing up-stream flooding and odours. Like all trap systems, their effectiveness is limited to the frequency of their maintenance.



A trash interception device at Manly, New South Wales.

FLOATING BOOMS

Floating booms can be deployed for a variety of pollution management roles including collection of oils and litter. Booms have difficulty trapping material which is partly submerged. They need space and low water velocities to effectively trap most floating debris.

CATCH BASINS

Catch basins or catch traps are stormwater pits with a depressed sump that accumulates sediment. They can catch larger 'heavy' sediments and non-floatable materials in a stormwater system, and are generally used in the following situations:
Upstream of other stormwater treatment measures to enhance their performance.
Retrofitting into existing areas, particularly on roads with high traffic volumes.

Catch basins/traps have limitations such as:

- Potential for re-suspension and release of nutrients and heavy metals from sediments.
- Moderate to high cleaning costs.

Catch basins/traps can be combined with litter baskets to increase the trapping efficiency by collecting floatable litter and debris.

OIL AND GRIT ARRESTORS

Oil and sediment arrestors can have different design and operating dynamics, ranging from plate separators, to vortex, swirl and dynamic separators. The separated materials are either collected or delivered to a nearby sanitary sewer. Oil and sediment separators are often sited in car parks and other points of high traffic density in commercial centres.

CHAPTER 7

SECONDARY & TERTIARY TREATMENT FOR POLLUTION CONTROL

INTRODUCTION
INFILTRATION
INFILTRATION BASINS
WATER QUALITY CONTROL PONDS
CONSTRUCTED WETLANDS
Wetland Performance
Flow Distribution
Water Harvesting
IN-LAKE TREATMENTS
Aeration
Flocculation
Purification
ROOF GARDENS

INTRODUCTION

Managing stormwater runoff is often thought of in terms of structural measures including:

- Multi-purpose water management corridors.
- Detention and retention basins.
- Artificial wetlands.
- Gross pollutant traps.
- Stormwater reclamation systems.

These highly visible measures can be combined with non-structural measures, including:

- Land use zoning.
- Limits on the proportion of hard surfaces in housing estates and allotments.
- Vegetated buffers and setbacks.
- Industrial and transport spill control programs.
- Road maintenance and sweeping programs.
- Public education.
- Control of pet faeces through regulations and providing public bag dispensers.
- Drain labelling.

A number of the structural and non-structural controls focus on increasing stormwater infiltration where the soil and groundwater conditions are appropriate.

INFILTRATION

There is increasing stormwater runoff with the growing proportion of hard surfaces accompanying urban expansion and consolidation. Communities are turning to infiltration into the groundwater system to manage growing stormwater flows. Pre-treatments are usually needed to avoid groundwater pollution from dissolved pollutants. Sand filters, grassed swales and porous pavements, can be effective treatment techniques, especially in car parks, commercial and industrial sites. Roof runoff, which is relatively clean, can be directly infiltrated into the soil near a building by connecting the downpipe to a subsoil drain system with an overflow for large events.[103]

In Perth, sandy soils allow road runoff to be directed towards numerous local infiltration basins that are no more than fenced excavations. Depending upon the pollutant load, these filters require periodic maintenance by removing the surface layer of sand holding oils and sediments. Similarly, porous pavers require regular cleaning to remain effective.

INFILTRATION BASINS

Stormwater infiltration basins work by seepage through the floor. They enhance water quality through filtration and absorption of soluble pollutants onto soil particles. They can also provide flood protection and reduce storm flow velocities to minimise sediments discharging into waterways.

CASE STUDY: 'S.P.A.R.S' INFILTRATION AND PURIFICATION - Concord, Sydney, NSW

The Atlantis Corporation has tested an infiltration system based on drainage cells. They call it SPARS - Stormwater Purification And Reuse System.[104]

A trial has been conducted involving Concord Council and the Environment Protection Authority (EPA), with assistance from the NSW Government's Stormwater Trust. The area chosen included five streets near Powells Creek, which flows into Homebush Bay near the Sydney Olympic site.[105]

The SPARS system involved constructing a road shoulder of porous paving and grass blocks able to quickly absorb runoff. After the runoff has filtered through this medium, it moves into biologically engineered soil below. From there, the runoff is collected in drainage tanks, which continue the purification process and divert water into nearby retention tanks. The technology captures and filters the initial runoff that contains the

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103 Sharpin, M.G. & Morrison, A.J. (1995). Towards ecologically sensitive drainage systems. In Institution of Engineers. National Committee on Water Engineering (1995). *Preprints of papers: the second international symposium on urban stormwater management 1995: integrated management of urban environments, Melbourne, 11-13 July 1995.* Canberra, p. 40.

104 Atlantis 'S.P.A.R.S' Concord trial starting soon. (1999). *SIA Bulletin*, 62, p. 6.

105 Atlantis, p. 6.

pollutants. The contaminated stormwater is filtered, purified, then stored in sub surface tanks and reused to irrigate the surrounding parkland.[106]

Another infiltration treatment involves swales. These are open, grass-lined channels that receive runoff from roads and other impervious surfaces. Small check dams can be added to slow velocities and increase pollutant removal.

Infiltration swale on the entrance boulevarde to the Lynbrook housing development, Melbourne, Victoria.

Bio-swales are grass swales with enhanced infiltration and pollution removal capabilities. Under the grass they usually incorporate coarse gravel, perforated sub-soil drainage pipes and geofabric (manufactured textile). The filtered water is collected and dispersed to the ground water table via sub-soil pipes. Excess water can be collected for reuse.

Permeable paving materials, such as porous asphalt or porous concrete, are surfaces that mimic natural infiltration. They can be particularly effective by allowing water infiltration close to the source of stormwater runoff.

Permeable surfaces can also be designed with reinforced turf and open-celled pavers, and concrete or plastic grids with voids that are filled with topsoil or aggregate.[107] Heavy metals are bound in the upper part of the soil and most of the pollution is held in the geotextile layer of the pavers.[108]

CASE STUDY: BIO-FILTRATION - MANLY STORMWATER TREATMENT AND REUSE PROJECT
Sydney, NSW

Manly has a high concentration of residents and visitors. Its extensive area of hard surfaces create large volumes of stormwater loaded with nutrients, hydrocarbons, heavy metals, toxicants and litter. These discharge to the surf zone at Manly's famous beaches. Beach signage warns swimmers about the risks from this pollution up to three days after rain.

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[106] Atlantis, p. 6.

[107] U.S. Green Building Council, U.S. Department of Energy, Public Technology (Inc.) & U.S. Environmental Protection Agency (1996). *Sustainable building technical manual: green building design, construction and operation*. Annapolis Junction, Md.: USA.

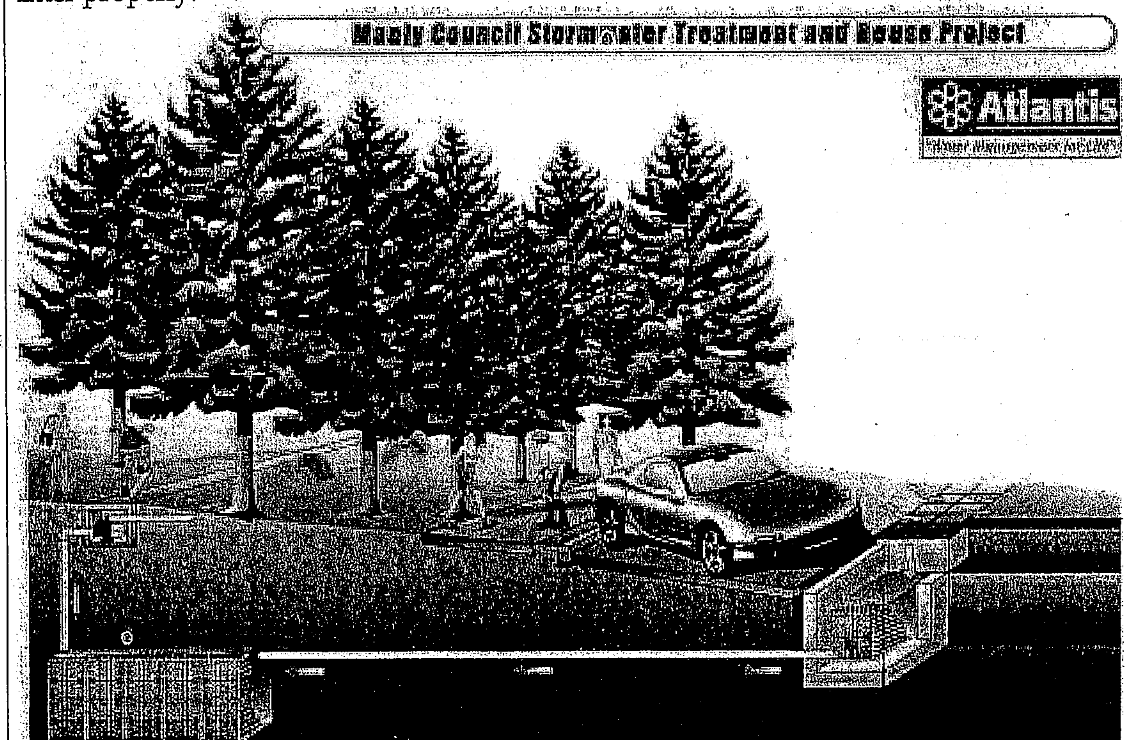
[108] Dowsett, Brigid (1994). The management of stormwater: from a problem to a resource, Sydney Water Project, p. 24.

To improve stormwater quality, interception devices are fitted inside and outside existing stormwater drains to prevent litter and sediment from entering. Oils, fine sediments and grease are also filtered from the stormwater. Vacuum street sweeping is being increased to suck up many of the pollutants that have been stopped from entering the drainage system.

A section of road has been paved with Rocla ecopavers as used at the Olympic Stadium. This is part of a trial of a range of infiltration techniques.

At the beach carpark, Atlantis porous paving has been placed along the road verge to reduce stormwater flow and to provide filtration through a special material called bio-soil. The stormwater is stored and treated in Atlantis tanks underneath the beach parkland. It is then irrigated onto the heritage Norfolk Island Pines lining the beachfront.

A public education campaign supports the pollution control infrastructure, and emphasises the role residents and the 7 million visitors a year can play in handling their litter properly.



The whole project is being used as a demonstration of innovation and best practice by the Commonwealth Urban Stormwater Initiative that provided catalytic funding of $545,000 for the scheme.

WATER QUALITY CONTROL PONDS

Constructed pollution control ponds, or wet detention basins, are largely open water bodies of several metres depth. They have relatively cheap capital and operating costs, although they do require a large area of suitable land.[109] Water quality ponds can suffer from either pollutant or storm overload. Mosquitoes may become a problem if not factored into the design.

CONSTRUCTED WETLANDS

Usually wetlands are developed with one or more of the following objectives in mind:
To improve downstream water quality.
To improve landscape amenity.
To provide recreational opportunities, usually passive.
To create fauna and flora habitat.
To provide opportunities for stormwater harvesting, sometimes combined with aquifer storage and recovery.
To provide a degree of flood retention.

As a general rule, the more constructed wetlands resemble local natural wetlands, the higher the probability that they will develop into healthy ecosystems that are productive diverse and resilient. When an ecosystem is productive, it means that there is a significant biomass of plants and microscopic algae, that take up nutrients and provide habitat and food for animals. When an ecosystem is diverse it has a large range of animal, plant and microbial species, that promote materials transfer and decomposition of organic material.

Constructed Wetland near an industrial estate in Townsville, Queensland.

Wetland ecosystems that are resilient are able to accommodate seasonal variability in inflows and water level changes.[110]

Once established, constructed wetlands should be able to maintain themselves indefinitely through growth and reproduction of all species of plants and animals with minimal on-

[109] Cullen, Peter (1995). The Cinderella resource: urban stormwater in a dry country, p. 11.
[110] Natural Heritage Trust Waters and Rivers Commission. Techniques to Improve Urban Stormwater Quality: workshop notes, The Institution of Engineers Australia, p. 62.

going maintenance. Ongoing maintenance of constructed wetlands may need to include some level of litter removal, weed control, fire control and mosquito control to ensure that their aesthetic and amenity functions are not diminished.[111]

WETLAND PERFORMANCE

Water quality improvement in wetlands or basins primarily relies on suitable design, moderate loadings, and adequate residence time.[112] Although stormwater pollution control ponds and wetlands both have value in intercepting and treating stormwater, wetlands have proved to be a superior treatment option on the basis of pollutant removal, lower removal time and a smaller footprint area.

Constructed wetlands are suited to removing fine particles and soluble contaminants. Wetland plants can take up nutrients, use them for growth and release chemicals such as nitrogen into the atmosphere. They can treat heavy metals and break down organic pesticides or kill disease-producing organisms.

CASE STUDY: STORMWATER QUALITY IMPROVEMENT WITH WETLANDS
Port Phillip, Melbourne, Victoria.

The rapid growth of south east Melbourne is leading to increased runoff and deterioration in the health of urban waterways. The Victorian Government has set a target of reducing stormwater discharges of nitrogen across Melbourne into Port Phillip Bay by 500 tonnes by 2010. CSIRO research shows that stormwater is the major source of toxicants, pathogens, litter and sediments discharged into the Bay.

Assisted by $3.5m funding from the Commonwealth's Clean Seas Program, Melbourne Water is constructing a series of 10 wetlands within the Cities of Casey, Kingston and Greater Dandenong. Innovative water sensitive urban design is also being employed in some housing estates and freeway developments.

The wetlands treat the base flows of catchments by bringing the urban runoff back towards the profile of rural runoff. The stormwater is directed through substantial areas of ephemeral, shallow and deep marshes.

The sites will work as part of a treatment train. Primary treatment of sediment and litter is being conducted at source through education campaigns, installation of traps at strategic locations and detention and stilling ponds and carbon filters in front of the pool and riffle and constructed marsh features.

Some 635,000 plants are being established in the wetlands to filter stormwater and create havens for native wildlife and provide an attractive location for recreation in the urban corridors.

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[111] Natural Heritage Trust Waters, p. 62.
[112] Dillon, P.J. & Pavelic, P. (1996). Guidelines on the quality of stormwater and treated wastewater for injection into aquifers for storage and reuse. Urban Water Research Association of Australia, p. 13.

Large scale constructed wetlands in Melbourne, Victoria.

Constructed wetlands need to be supported by strong source control measures focused on land management and pollution control. Farmers on the rural urban fringe can contain and treat runoff through detention and reuse ponds. Builders can protect topsoil from erosion by the use of silt fences. Education campaigns with urban residents, industry, and road authorities can prevent wastes and sediment washing into stormwater systems.

Constructed wetlands have become popular with developers as they add an aesthetic element to residential and industrial estates while treating stormwater runoff. However, care needs to be taken that they don't become a site for the establishment and spread of noxious weeds.

Constructed wetlands need to be designed with safety provisions to minimise the risk of children drowning and avoid stagnant pools that may become mosquito breeding grounds. Care also needs to be taken that constructed wetlands do not become a haven for rats and snakes and even crocodiles in tropical urban areas.

These challenges are surmountable with intelligent wetland design. This is occurring in harmony with the move to multiple use corridors in new housing or industrial estates as part of water sensitive urban design (WSUD). Using this approach, wetlands are sometimes located on small sites to treat runoff from a cluster of houses or effluent or stormwater from industrial sites for recycling.

Many people have been attracted to constructed wetlands because they see them as a 'natural' solution to water quality threats to coastal waterways. However, the wetland will require human intervention to protect and maintain it in a highly urbanised environment that has significant differences to a 'natural' catchment. Placement of sediment and litter traps in front of wetlands can increase their effectiveness and reduce maintenance requirements.

Occasionally, complete wetland reconstruction may be required due to siltation from urban runoff. When the time comes it can cause angst for local residents. They frequently forget that this was not a natural feature even though the constructed wetland may have attracted a diversity of bird and animal life.

CASE STUDY: WETLANDS AND TREATMENT PONDS
Cleveland Bay, Townsville, Qld

Improving stormwater quality from tropical catchments draining into the Great Barrier Reef is a major challenge. The 1998 Reefs at Risk Report identified Cleveland Bay as a "high risk" location. It is the only part of the Great Barrier Reef Marine Park where urban development is the major source of pollution. Ross and Louisa Creek discharge to the Bay, part of the Great Barrier Reef World Heritage Area and a dugong protection zone.

The Commonwealth Government has provided $962,500 to a consortium led by Townsville City Council to undertake water quality improvement works on Ross and Louisa Creek.

A lake system located in the upper Ross Creek catchment has recorded the highest levels of Anabaena algal density in Australia. The Creek is being polluted by leachate from contaminated sites, residential and industrial stormwater, litter from the Central Business District and sediment from high intensity rainfall. To manage the problem, low to medium stormwater flows will be treated in stormwater ponds. The ponds will remove heavy metals, organic matter, bacteria and nutrients. Nettech Gross Pollutant Interceptor Traps, permanent water monitoring stations and sediment remediation techniques will be trialed. If successful, they may be used as pollution control measures in other tropical localities.

In Louisa Creek, Townsville City Council is constructing small treatment wetlands, each tailored to specific design constraints, including:

A long dry season.
Low lying catchment.
Limited ground or surface water storage.
Narrow residential and industrial drainage corridors.
Tropical monsoon events.
The need to avoid attracting crocodiles in urban areas.
The need to avoid attracting large waterbirds to the wetlands as it is close to an air force base flight path.

Wetlands are being spaced along the watercourse to split the contaminant load and enhance fisheries habitat values. They also have major bypass channels to cope with tropical storms.

FLOW DISTRIBUTION

One of the more challenging hydraulic and engineering aspects of constructed wetlands is to achieve a distributed flow through macrophyte plant beds. Channels can easily form, particularly as a result of occasionally high flows. Short-circuiting of the flows within the system can destroy the pollutant removal effectiveness.

WATER HARVESTING

The feasibility of water harvesting from urban stormwater wetlands rests upon three conditions:

1. The water must be of sufficiently high quality for users.
2. The water supply must have sufficient reliability and volume to justify the expense of extraction infrastructure.
3. Water extraction must not adversely affect the water quality improvement function of the wetland. Water quality improvement rests, to a large degree, on the health of the aquatic vegetation and aquatic plants are sensitive to water level fluctuations.

CASE STUDY; WATERWAYS NURSERY REUSE

Adelaide, South Australia

Commercial plant nurseries are high users of water. Wastewater containing high levels of nutrients and chemicals often drains into stormwater collection systems. At the Waterways Nursery, a closed loop system will trap rainwater and recycle stormwater and wastewater after treatment in a small on-site wetland and sand filter. A monitoring system will control irrigation to maximise the use of rainwater and reclaimed water. The Commonwealth's Cleaning Our Waterways Industry Partnership Program is providing over $44,000 to develop this nursery into a demonstration project for the industry.

Just Parks and Gardens Waterway Nursery, South Australia.

IN-LAKE TREATMENTS

AERATION

Tertiary treatment of stormwater can be undertaken by artificial means, by aeration, where particularly high nutrient loads may cause algal blooms. Oxygeneration is a form of treatment, which has been developed from techniques used in sewage treatment processes. This approach has been used successfully in Western Australia to treat toxic algal blooms in combination with a clay (CSIRO's phoslock) that seals nutrient rich sediment into the riverbed to impede nutrient cycling through the water column.

CASE STUDY: CANNING RIVER OXYGENATION
Perth, WA

Oxygenation trials have been focused on sections of the Canning River where several major stormwater drains flow into the River's system. The chief water quality problems of these reaches of the River are:

Toxic blue green algae which can close the River to all recreational use.
Algae and thermal stratification causing oxygen depletion.
High nutrient concentrations in the water column and sediments.
River flow in the Canning in summer is minimal and wind mixing is not sufficient to return oxygen to the water column faster than it is being used. As a result, dissolved oxygen concentrations, especially close to the bottom, drop to almost zero.

The oxygenation and phoslock trials have been conducted with 2 plants based on the river bank with assistance of $319,000 from the Commonwealth Government's Clean Seas Program, While trials are proceeding, initial results show favourable control of the effects of phosphorous and nitrogen.

FLOCCULATION

The removal of fine colloidal suspended pollutants can be difficult with current stormwater settling techniques. A flocculating agent can be introduced to combine the particles so they settle out. There are a number of commercially available flocculants, however, they all leave a trace residue that can be a pollutant requiring management.

Electro-flocculation techniques have been developed which overcome many of these problems. They are of particular value on construction sites, where treatment of retention water is necessary prior to discharge to the stormwater system.

PURIFICATION

Stormwater may be required to be purified to potable water quality for health reasons. While expensive, it can undergo micro-filtration and ultra violet treatment to this standard.

ROOF GARDENS

In cities, roofs cover 40-80% of the surface.[113] This prevents infiltration and increases stormwater runoff.

A number of countries in Europe have acknowledged this problem and have legislated that all public buildings should be covered with a roof garden. The German Government, contributes 50% to the cost of building a roof garden on either private or public buildings.[114] Roof gardens absorb about 76 litres of water per square metre of garden area.[115] Super-imposed loads on the roof structure, plus retained rainwater, means that the roof needs to be designed to the extra loading.

[113] Urriola, Humberto (1999). Roof gardens: an environmental asset. In Wood, J.A. (ed.) (1999). Water sensitive design & stormwater re-use: seminar proceedings, 31 March 1999. Stormwater Industry Association: Sydney, p. 1.
[114] Urriola, Humberto, p. 1.
[115] Urriola, Humberto, p. 1.

CHAPTER 8

SEDIMENT AND EROSION CONTROL

INTRODUCTION

SOIL CONSERVATION

SOIL LOSS

SEDIMENT TRAPS

WIND EROSION

VEGETATION STABILISATION
Brush and Straw Mulches
Erosion Blankets and Geo-Textiles

SUB-SOIL DRAINAGE

STREET SWEEPING / VACUUM CLEANING

INTRODUCTION

There are two parts to an effective water quality management strategy for an urban development. The first phase involves the installation of erosion and sediment control measures during construction, when the sediment export potential is at its greatest. The second phase of a management strategy involves the construction of treatment trains to improve the quality of post development runoff.[116]

Sediment research, points to the following water quality and ecological processes in Australian waters:

- Systems heavy in suspended solids, with adsorption of nutrients, metals and pesticides attached to surfaces of suspended solids.
- Turbidity associated with suspended solids blocking light and adsorbing solar radiation that exacerbates temperature stratification in water bodies.
- Low organic carbon levels and a high proportion of refractory carbon, limiting microbial-driven nutrient release.

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[116] Sharpin, M.G. & Morrison, A.J. (1995). Towards ecologically sensitive drainage systems. In *Preprints of papers: the second international symposium on urban stormwater management 1995: integrated management of urban environments, Melbourne, 11-13 July 1995.* Institution of Engineers: Canberra, p. 40.

- Highly variable flows, with significant events driving major exports of pollutants, followed by extended period of low flows.
- Sediments as the major store of pollutants, and the moderator of water quality in the water column.
- Poor mixing of water caused by periods of low flow and high temperatures, creating sharp temperature gradients.
- Poor mixing conditions depressing oxygen transfer, exacerbating sediment nutrient release processes.
- Time-based interception, storage and remobilisation of flow constituents, often associated with land use and management practices.
- Trophic systems, affected by sunlight extinction limiting photosynthesis, and variable flows (water levels) limiting plant habitats (biomass).

Large civil works and building sites in fully developed inner city areas can provide challenges in controlling stormwater pollution. There is increased risk of sediment pollution where building materials such as sand, fill material and topsoil are delivered and temporarily stored on pavements and roadsides.

Other threats arise when concrete conveying pumps, delivery tubes, hoses, trucks and delivery bins are washed out. This acidic, heavily polluted, sediment causes severe problems in stormwater systems and kills aquatic organisms. Litter, pesticides, acid washes, paints, solvents and construction adhesives also pose risks.

Clearing and earthmoving increases erosion by as much as 40,000 times the rate occurring in undisturbed sites. Many states and regions have legal requirements for erosion and sediment control. These laws have been supplemented by national stormwater guidelines.

SOIL CONSERVATION

The key protector of soils is vegetation. Erosion is generally high wherever the vegetation has been disturbed and rainwater is concentrated. The problem increases as 'marginal' lands are developed as urban centres grow. Most land degradation associated with urban development results from erosion by water, salinity and acid sulphate soils. Wind is a factor on sandy soils in exposed coastal zones.

The damage from poor conservation practices is easily recognisable. However, environmental damage tends to accumulate slowly. It is often only after scientific evidence brings to light the loss of flora and fauna species, that community concern is raised and action is taken.

Soil erosion has particular consequences for aquatic environments, causing:

- Degradation of marine habitats.
- Increased turbidity in streams and water bodies.
- Increased salinity on land and in water bodies.
- Increased frequency and damage caused by flooding.

- Reduced aesthetic values of bushland and water bodies.

SOIL LOSS

Stormwater managers and designers can calculate the anticipated soil loss which is likely to occur during development, and use this information to take protective measures to contain the problem. These calculations can assist in assessing the erosion risk, selecting controls, sizing of sediment and retarding basins, and provide comparative catchment analysis.

SEDIMENT TRAPS

Sediment traps are temporary control measures used to retain coarse suspended particles. Finer particles and soluble materials pass through them. Sediment traps are easy to construct, relatively inexpensive and easily moved as construction work proceeds. The most common forms of sediment traps are straw bales and sediment fences using geotextile fabrics.

WIND EROSION

Wind erosion can cause soil particles to become airborne and then settle out as dust where it will be washed into stormwater systems in the next downpour. In Australia, intense rainfall immediately after bushfires can result in the flow of large sediment and organic ash loads into water bodies.

VEGETATION STABILISATION

Vegetation stabilisation can reduce potential soil loss by reducing raindrop impact, storm run-off velocity and wind erosion. Techniques include:

BRUSH AND STRAW MULCHES

A variety of innovative proprietary methods have been developed by organisations specialising in soil erosion protection. Commonly these systems are spray applied, use organic materials, and are bound with emulsions which slowly degrade. These systems generally use brush or straw, and can be applied at controlled thicknesses, depending upon the slope and erodibility of the soil.

EROSION BLANKETS AND GEO-TEXTILES

Soil protection can be 'rolled out' in the form of organic blankets and synthetic woven geo-textiles. These are generally installed to allow permanent establishment of vegetation using prepared tube stock and semi advanced tree cover. This form of soil erosion control is generally used where there is possible high velocity flows, such as creek and stream bank protection.

SUB-SOIL DRAINAGE

Sub-soil drainage systems can take a variety of forms. Common types are:

- Rubble drains.
- Perforated or slotted pipes.
- Strip drains with a cellular core wrapped in a geo-textile filter fabric.

Sub-soil drainage can be used to assist with stormwater surface flow management and infiltration control. It can improve the environment for growing protective vegetation and improve soil stability on steep slopes. Sub-soil drainage is increasingly being used in Water Sensitive Urban Design to underlay grassed swales in streetscapes and carry stormwater to settling and reuse treatment ponds and wetlands.

STREET SWEEPING / VACUUM CLEANING

Traditionally, street sweeping as a treatment-based control measure for removing litter and reducing overall heavy metal loads and coarse sediments, has not been a very cost efficient management system. However, recent technical advances in vacuum suction cleaning have made it more competitive. In the future, pollution on some high use freeway and road systems may require vacuum cleaning to protect sensitive local water bodies, if other measures cannot be designed in or retrofitted.

Stormwater runoff from road surfaces is one of the many contributors to the non-point source pollution load. Tiny particles are proving difficult to capture in current stormwater pollution devices. The stormwater load contains significant quantities of heavy metals, which are a threat to aquatic environments.

Recent monitoring in California indicates that automotive disk brake pad wear is one of the major sources of copper metal loading being washed down stormwater drains into San Francisco Bay. Diesel exhaust from buses and trucks is also a significant source of heavy metal pollution.[117]

Gross pollution is typically, gathered into the stormwater system from the street during bursts of rain or wind, or both. It is suggested that unless street sweeping is conducted just prior to or during these 'deposition' periods, the bulk of pollution will not be collected. It follows that very short sweeping and vacuuming cycles are required in order to ensure that street sweeping is effective, as a 'source' method for pollution control.[118]

[117] James, R. & Whitman, K. (1995). Stormwater and watershed management in the Santa Clara Valley. In *Preprints of papers: the second international symposium on urban stormwater management 1995: integrated management of urban environments*, p. 103.
[118] *Nilson B., Silby, N., Argue, J.R. (1995). An investigation into source control of gross pollution. In* Eighth national local government engineering conference: "Local government engineers: serving the community", Gold Coast, 27 August to 1 September 1995: conference papers. *Institute of Municipal Engineering: Melbourne.*

CHAPTER 9

STORMWATER RE-USE

INTRODUCTION
WATER TANKS
WATER HARVESTING AND IRRIGATION
AQUIFER STORAGE AND RECOVERY

INTRODUCTION

Stormwater runoff from Australian cities is about equal to the amount of high quality imported water they use.[119] As more than 50% of high quality water piped to urban areas is used for lower quality purposes, such as garden watering and toilet flushing, there is potential for expanded collection, storage and reuse of stormwater for non-drinking purposes.[120]

RESEARCH EXAMPLE: MEAN ANNUAL RUNOFF, DEVELOPED SURFACE AND GROUNDWATER RESOURCES AND GROSS WATER CONSUMPTION IN AUSTRALIA'S METROPOLITAN REGIONS, (GIGALITRES).	
CITY	***WATER REGION MEAN ANNUAL RUNOFF AVERAGE YIELD OF DEVELOPED SURFACE SOURCES GROUNDWATER PRODUCTION GROSS WATER CONSUMPTION***
Brisbane	1860 555 60 331
Sydney	3900 581 11 620
Melbourne	1650 548 19 479
Adelaide	441 109 44 251

[119] Commonwealth Environment Protection Agency (1993). *Urban stormwater: a resource too valuable to waste*. Canberra. EPA, Feb 1993. p. 2.
[120] *Urban stormwater: a resource too valuable to waste*, p. 2.

Perth	1260 213 226 369

Source: CSIRO and NSW Department of Land and Water Conservation. Wastewater Re-Use, Stormwater and the National Water Reform Agenda, 1997, p. ii.

Optimum use of all water requires a single, integrated resource management framework.[121] While stormwater is an obvious alternative source of water it has not been exploited to any large extent in Australia, where only 3% is reused compared to 11% of municipal wastewater. Treated sewage effluent is considered a more reliable source of reclaimed water than urban stormwater, which occurs in varying volumes and frequency. Nevertheless, urban stormwater offers a large potential resource, securing environmental and economic benefits through storage and reclamation. The technique can prevent water pollution and minimise the need to dam natural watercourses to supply increased potable water supplies for non-potable purposes.

In urban areas, improvements in landscaping, better flow regulation and new treatment technologies are increasing the scope for reclamation and stormwater management. Relative costs of these options are falling, benchmarked against the increasing environmental and economic costs of doing nothing i.e. increases in potable water supplies or demand management. A more sophisticated water market in urban areas is providing demand for water qualities for different uses.

Without increased water reclamation, growing demands for water resources by urban users require increasing volumes to be imported from water harvesting catchments, or extracted from groundwater aquifers. The marginal costs for imported water rise as less accessible catchments are exploited, sometimes with severe disruption to non-urban communities. Yet the resource potential of stormwater is only just beginning to be recognised.[122]

Stormwater recycling can be encouraged at minimum cost to government. Rainwater tanks connected to roofs provide a valuable source of water for gardens, toilet flushing, washing and hot water. Stormwater storage underground, which could form part of an on-site stormwater retention/detention system, can also be incorporated into buildings. Incentives can be promoted to developers and home owners to store and recycle stormwater, by providing rebates on their current water and sewer charges. Local Government can play a major role in encouraging the use of reclaimed stormwater. Development consents can require stormwater storage for toilet, garden, washing and hot water use.

121 *Urban stormwater: a resource too valuable to waste*, p. 3.
122 *Urban stormwater: a resource too valuable to waste*, p. 3.

WATER TANKS

Water tanks connected to roofs in urban areas can significantly reduce the volume of stormwater entering the drainage system, if applied across catchments. If the collected water is used for non-drinking purposes, it can reduce the demand upon the public reticulation system. Already more than 1 in 5 Australians depend on tank water for their drinking supply, often using first flush filters.

Recent research by the University of Newcastle, commissioned by the Upper Parramatta River Catchment Trust (UPRCT), has resulted in modelling of water tanks to provide on-site stormwater detention (OSD) capacity, as well as retention qualities. By providing both stormwater retention for reuse purposes, and detention capacity to reduce peak flow from storm events, tanks are an effective source control tool in managing stormwater at the household scale.

Other studies by the University of Newcastle have demonstrated that stormwater held in tanks improves the quality of stormwater discharges, eliminating contamination by metals and chemicals. This result supports the assumption that flocculation, settlement and bio-reaction processes operate within rainwater tanks.

Recent innovations in rainwater tank design, both in the use of plastics and cost effective manufacturing processes, have seen new tank shapes become commercially available. One recent example is the Freewater Modular System that provides interconnected tank panels which are 200 mm wide, allowing use as fencing panels, screen walls or building wall panels, giving space saving and design flexibility domestic water storage.

In field testing, the use of rainwater tanks for household garden watering and toilet flushing, reduced the stormwater export from a Canberra catchment by 20%.[123] An increased role for tanks as part of the existing potable water distribution system, combined with stormwater reclamation has been demonstrated by the CSIRO Urban Water Program.

A new approach for roof water retention, is to provide storage gutters at the eaves, acting as a linear tank. This assists distribution by providing supply take-off from any point in the perimeter gutter for low-pressure water for toilet flushing and irrigation. In Sydney the storage gutter system saves 27% of the potable water supply to an average household, and when used in new building construction is cost neutral. Being part of the roofline, there is little need for pumping and there is no need for tank stands and reduction of precious yard space. The system can be applied to existing homes, as a replacement gutter system. The storage gutter is an Australian patented system called Rainsaver.[124]

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[123] McAlister, Tony (1999). Stormwater reuse: a balanced assessment. In *Stormwater 2000: the green with the gold: conference proceedings 26-28 April 1999*, ed. J.A. Wood. Stormwater Industry Association.
[124] Smith, Frank (1999). Stormwater recycling and OSR – Rainsaver. In *Water sensitive design & stormwater re-use: seminar proceedings, 31 March 1999*, ed. J.A. Wood. Stormwater Industry Association: Sydney, p. 1.

Testing and monitoring in selected development projects to date, has shown that rainwater used in hot water systems for temperatures between 55 degrees C and 63 degrees C was compliant with the Australian Drinking Water Guidelines (1996). Hot water systems pasteurise rainwater to produce acceptable water quality.

Research by the University of Newcastle, has shown that rainwater tanks when used with toilets, garden irrigation and hot water use, reduce the reliance upon mains supply by up to 65%.[125] Many industrial processes, including general wash down requirements, can use stored rainwater and/or treated stormwater.

WATER HARVESTING AND IRRIGATION

Past studies suggest that as long as the focus is on the cost of stormwater or the current price of reticulated water supply, then stormwater reuse will be apparently uneconomical, due to the heavily subsidised nature of the reticulated supply. This comes about because there are costs that are often not included in the charged price for reticulated mains water, such as:

Land developer capital costs.
Inadequate expenditure on asset replacement.
Ongoing environmental impact costs, levies and expenses.[126]

When the complete range of other issues are factored into costing considerations, stormwater reuse becomes economically attractive.127 These other factors are:

The savings that are gained through the reduction in non-point source pollutants, especially sediment loads, and the reductions in peak stormwater flows, achieved by stormwater reuse. These savings occur firstly through the need for reduced water supply reticulation and stormwater drainage infrastructure if extensive on-site stormwater reuse is practiced. There are also likely to be considerable savings due to the removal of the requirement to 'clean up' waterways of sediment, nutrients and debris that accumulate downstream of urban developments.

The cost of maintaining environmental flows in rivers that are impacted by dam storage's.

The financial benefits, often of an intangible nature, gained by the multi-use of waterway corridors for recreation, environmental enhancement and stormwater storage and reclamation purposes. These benefits are typically manifest in greater property values in areas where such management practices are applied.[128]

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[125] Coombes, P.J., Kuczera, G., Argue, J.R., Cosgrove, F., Arthur, D., Bridgeman, H.A., & Enright, K. (1999). Design, monitoring and performance of the water sensitive urban redevelopment at Figtree Place in Newcastle. In *Proceedings of the 8th international conference on urban storm drainage, Sydney Hilton Hotel, Sydney, Australia, 30 August - 3 September 1999*, eds. Ian B. Joliffe & James E. Ball. Institution of Engineers, p. 1326.

[126] McAlister, Tony.

[127] McAlister, Tony.

[128] McAlister, Tony.

CASE STUDY: STORMWATER HARVESTING AND TREATMENT
St. Kilda, Melbourne, Victoria

A $12m CSIRO study of the water quality in Port Phillip Bay revealed that stormwater is the primary threat to its biodiversity. An estimated 7,000 tonnes of waterborne and dissolved nitrogen compounds enter Port Phillip Bay in stormwater each year. At St Kilda, local Waterwatch groups have identified high levels of nitrates and low levels of oxygen in the stormwater inflow as a major threat to a local colony of fairy penguins.

As a first for Victoria, a system designed by Integrated Eco-Villages will result in stormwater and greywater being recycled using an aeration tank and wetlands. The first flush stormwater from a new housing development of 236 units ('The Inkerman Oasis') will be trapped, treated, filtered and cleaned by a 400 square metre subsurface flow wetlands and 100 square metre sand filter. It will be combined with the recycled, domestic greywater and used for garden irrigation and toilet flushing. A roof garden on top of the sub-basement car park will contribute to reducing greenhouse emissions, provide insulation, minimise stormwater runoff and receive nutrient rich recycled water. Garden beds, grassed areas and subsurface wetlands will remove nutrients from stormwater, preventing their entry into urban waterways and Port Phillip Bay.

Compared to current building designs, the reuse of first flush stormwater will reduce the amount of potable water required in the development by up to 45%. It is estimated that stormwater catchment, treatment and reuse will directly prevent nearly 7 tonnes each of nitrogen and phosphates entering Port Phillip Bay each year. The project is a partnership between Inkerman Development Pty Ltd, the City of Port Phillip, applied research organisations and the community.

AQUIFER STORAGE AND RECOVERY

Aquifer Storage & Recovery (ASR) involves the harvesting of surplus stormwater from a variety of sources. It is temporarily stored in a suitable aquifer, and then retrieved for potable, irrigation or industrial applications.[129] ASR provides a viable alternative to reservoirs in areas where land values and evaporation rates are high, catchment areas are intensively developed. In urban areas of semi-arid regions disposal of treated wastewater and urban stormwater runoff is considered wasteful, and some form of treatment and storage is required to tap these potential resources. Artificial recharge of aquifers using infiltration basins has been practised for many years where soils are permeable and aquifers are unconfined.[130]

A confined aquifer can be a water body with limited additional capacity, due to pressure. Research and development in Australia over the past few years has focused on the injection, storage and recovery of stormwater and treated domestic water into shallow

[129] Gerges, N.Z. *Aquifer storage and recovery: type and selection of aquifer.* Primary Industry and Resources.
[130] Dillon, P.J. & Pavelic, P. (1996). *Guidelines on the quality of stormwater and treated wastewater for injection into aquifers for storage and reuse.* Urban Water Research Association of Australia. p. 1.

unconfined and deep confined aquifer systems, using injection wells and infiltration trench methods.[131] Usually the input water is pre-treated in a wetland.[132]

Stormwater is often of lower salinity than the natural groundwater. When injected into an aquifer, treated stormwater forms a 'bubble' or 'lens' around the base of the injection pipe. There is generally some mixing of the two waters at the margins of the lens. Because migration of groundwater is small, and generally only in the order of a few metres per year, the bubble will usually be retained around the injection well.

Confined aquifers are generally a stable and predictable environment for storage.[133] Aquifers targeted for recharge are usually sedimentary (carbonate, gravel and sand), with various degrees of consolidation, but may also include fractured rock.[134] Monitoring is an integral part of recharge operation, and it may be undertaken to better understand processes or for regulatory control. It is normal for each site to have several observation wells, and for injected waters and ground waters to be sampled regularly.[135] The longest operating site for stormwater re-charge into an aquifer is at Mount Gambier, South Australia, which has been recharging the groundwater via drainage wells for over 100 years. The rate at which new sites have been established in South Australia has been accelerating.[136]

CASE STUDY: COMMERCIAL REUSE
PARAFIELD PARTNERSHIPS URBAN STORMWATER INITIATIVE SALISBURY, SOUTH AUSTRALIA

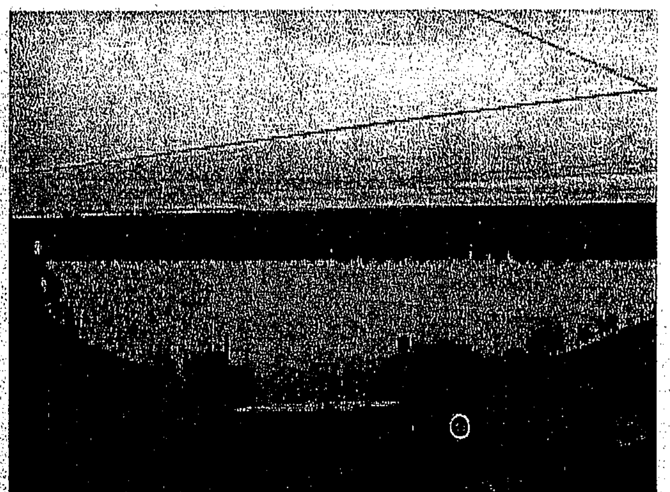
Urbanisation has contributed to the discharge of an estimated 5000 megalitres per annum of polluted stormwater into the Barker Inlet. The Barker Inlet is a sensitive marine ecosystem. It is a fish breeding ground and nursery for much of South Australia's marine fisheries. Residential and industrial growth in the Barker Inlet catchment, particularly from the City of Salisbury, is placing pressure on the water quality of the Inlet and the Gulf of St Vincent. It is also placing increasing demands on potable water supplies from the Murray River.

This project captures and treats urban stormwater for reuse in G.H. Michell & Sons Woolscour, local industry and horticultural irrigation. Up to 1.5 billion litres per annum of Adelaide mains water, mostly from the Murray River, will be replaced by high quality stormwater runoff from the urban area will be harvested and treated in bird-proofed reed bed ponds on the Parafield Airport - a world first for an aviation facility.

The cleaned stormwater will be supplied direct from the treatment ponds to users during operating periods. Surplus water will be injected into underground aquifers for storage. It can be recovered during dry periods for use in the wool processing operation and by other

131 Gerges, N.Z.
132 Gerges, N.Z.
133 Gerges, N.Z.
134 Dillon & Pavelic, p. 3.
135 Dillon & Pavelic, p. 3.
136 Dillon & Pavelic, p. 3.

users in the Salisbury area. Aims of the project include a 90% reduction in both the volume and nutrient pollution loads of stormwater entering the Barker Inlet, and a reduction of 1000 million litres of water extracted from the River Murray annually.



Large netted wetland at Parafield Airport, Adelaide, South Australia.

CHAPTER 10

SOME FUTURE STORMWATER MANAGEMENT OPTIONS

INTEGRATED CATCHMENT MANAGEMENT
STORMWATER INFRASTRUCTURE FUNDING
ENVIRONMENTAL MANAGEMENT BONDS
GREEN FIELD DEVELOPMENT
PRIVATE PROPERTY PIPE CERTIFICATION
INNOVATIVE MANAGEMENT APPROACHES
Demand Management
Porous Pavements
Bio-Basins
EDUCATION
Mass Media
Industry Programs
Community Education
POLICY CONSIDERATIONS
State of Environment Reporting

INTEGRATED CATCHMENT MANAGEMENT

Stormwater management is one aspect of natural resource management. It focuses on catchments and sub-catchments, straddles local government boundaries and even States, e.g. the Murray Darling Basin. Establishing responsibilities for stormwater, and linking that responsibility to planning and management varies from state to state and city to city. Generally local government is responsible. In some regions catchment authorities/boards/trusts develop policies and strategies and then go on to construct and monitor treatment infrastructure and source control measures.

The regional catchment management planning process provides a mechanism for ensuring that all funding for natural resource management is directed to key areas. This avoids dissipating resources through fragmented structures and piecemeal investment in uncoordinated projects.[137] Bringing the stakeholders together, including the existing water utilities, is an important role of catchment organisations.

STORMWATER INFRASTRUCTURE FUNDING

To be fully effective, catchment organisations need access to secure funding, e.g. the Catchment Water Management Boards in South Australia have an annual levy. It enables the community to plan long-term strategies and the capacity to enter into partnerships

[137] State of Victoria (2000). *Unpublished submission to House of Representatives Standing Committee on Environment and Heritage Inquiry into catchment management*, p. 10.

with industry and local government and to maximise the opportunities provided by Commonwealth and State Government funding e.g. projects funded by the NSW Government's Urban Stormwater Program have stopped an estimated 4300 truckloads of pollution entering waterways each year.[138]

ENVIRONMENTAL MANAGEMENT BONDS

Environmental Management Bonds are regularly applied by environmental agencies and local government, when approving development. While constructing new housing estates the developer may be responsible for environmental performance (staged land releases), prior to completion and handover to the local council. For example, the developers of the Harrington Park Estate in Sydney, places a $500 bond on each home site purchaser to ensure that their builders do not breach Environment Protection Authority pollution control guidelines. In turn, the owners pass this bond condition on to their builders, who also then place this condition upon their subcontractors. This means that the polluter pays the penalty.

GREEN FIELD DEVELOPMENT

The primary aims of stormwater management in new subdivisions is to reduce peak flows, minimise pollution and provide opportunities for stormwater reuse.[139] It is now accepted that a well-engineered residential suburb is one in which:

The risk of flooding is low.
Recreational waterways are healthy.
Stormwater replaces some mains water uses.[140]

However any attempt to develop a common practice for stormwater management in Australian residential subdivisions needs to recognise the great diversity of environmental, economic, social and political climates across regions. These include:

- Rainfall and evaporation that is highly variable.
- Wide range of soil types and terrain.
- Variety of relevant geological conditions, including presence or absence of groundwater.
- Variety of housing forms.
- Variety in water available for gardens and other water-dependent amenities.
- Water price and policy differences.
- Differences in types and levels of pollution generated in urban areas.
- Different community environmental values.[141]

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[138] State of Victoria. *Unpublished submission*, p. 10.
[139] Argue, J.R. (1995). Stormwater management in Australian residential development: towards a common practice. In *Preprints of papers: the second international symposium on urban stormwater management 1995: integrated management of urban environments, Melbourne, 11-13 July 1995*, Institution of Engineers. Canberra, p. 425.
[140] Argue, p. 425.
[141] Argue, p. 425.

A goal for new development is to ensure that the post-development peak discharge rate, volume, timing and pollutant load does not exceed pre-development levels. However, best management practices (BMPs) are not 100 percent effective in removing stormwater pollutants. For this reason, government agencies in each region have set performance standards that are based on risk analysis and feasibility of implementation.[142] Some of the performance standards are based on achieving water quality targets in regional waterways.

CASE STUDY: "LYNBROOK" WSUD HOUSING ESTATE
South East Melbourne, Victoria

Lynbrook Estate is a greenfield residential development 35 kms from the centre of Melbourne. The Urban & Regional Land Corporation, Melbourne Water and the CRC for Catchment Hydrology are implementing a range of water sensitive urban design (WSUD) techniques here to protect the waters of Port Phillip Bay. A feature of the stormwater system is the use of swales and an underground gravel trench system to collect, infiltrate and convey runoff to a treatment wetland.

Initial performance figures indicate excellent water quality results, cost neutral construction and double the sales rate compared to commensurate estates with traditional stormwater treatment.

PRIVATE PROPERTY PIPE CERTIFICATION

Stormwater pollution of waterways as a result of sewer overflows is mainly caused by cracked and leaking pipes and illegal cross connection with stormwater drains on private property. It has been suggested that requiring all urban household sewer and stormwater pipe systems to be certified as being fault free upon sale of property would address this problem. It would put the onus on the household drainage system being maintained by the property owner.

INNOVATIVE MANAGEMENT APPROACHES

The CSIRO has launched a collaborative research project aimed at devising better water, wastewater and stormwater services in urban environments.[143] The program involves

Reviewing the existing system, starting with an analysis of contaminant and nutrient flow in water, stormwater and wastewater. A detailed audit has been conducted of domestic water use that accounts for 70% of urban water use, and an analysis of the life cycle costs of assets.

142 *Evangelisti & Associates, Landvision & V.& C. Semeniuk Research Group (1995).* Water resources management study: Middle Canning catchment (stage 1, volume 1). *Perth, p. 98.*
143 CSIRO develops urban water systems program. *SIA Bulletin*, 62, February 1999, p. 1.

Developing scenarios of the way in which urban water systems might be provided in future. An industry reference group of water company representatives, pipeline manufacturers, environmentalists, regulators, academics and water resource managers works alongside CSIRO scientists to 'reality check' the alternatives, to ensure they are feasible and cost effective. A test site and water model is used to help model theoretical concepts and constraints.[144]

DEMAND MANAGEMENT

Demand management has the advantage of reducing water consumption and hence discharges to waterways. Demand management techniques can include:

- Allowances for stormwater retention & reuse.
- Water saving household appliances.
- Electronic controlled, soil moisture meter sensing irrigation systems.
- Electronic metering & householder information systems.
- Reduction in reticulation water supply pressure/leakage controls.
- Reduction in wastewater generation.

POROUS PAVEMENTS

Using porous paving to increase infiltration in carparks, shopping centres, housing clusters, sports grounds, commercial zones and industrial complexes, can have beneficial effects in the uptake of heavy metals as well as reducing runoff. Extensive testing and field trials in Germany has found that heavy metal concentrations are caught and locked into the upper crevices of the porous pavers, with no impacts from heavy metals causing soil contamination at levels below the prepared sub-grade material.

BIO-BASINS

Bio-Basins are planted and shaded infiltration basins which trap polluted stormwater. The basin surface appears 'dry' as its surface is gravel and there are no ponds for mosquitos to breed. The Bio-basin contains specialised wetland plants that act upon the water pollutants in much the same way they do in natural wetlands. Larger detained pollutant particles settle out to allow the natural bacteria processes to occur.

Bio-Basins are easier to maintain and manage than constructed wetlands, but must be protected from fine sediment loads which could eventually clog the system. The Bio-Basins concept is new, and until some long term monitoring of performance is available, it should be treated as experimental. They could be developed as a hybrid system of infiltration, detention, treatment and reuse storage. Bio-Basins could be placed under car-parks, parklands and garden nature strips, and in dense urban areas, particularly in urban renewal projects where site restrictions limit other water quality management techniques.

[144] *SIA Bulletin*, p. 1.

EDUCATION

MASS MEDIA

A combination of mass media approaches is being used in a number of States to achieve long term behavioral change. Techniques include the use of community advocates, media releases, the Internet, radio talk back, community events and seminars. The needs of regional and ethnic communities are being addressed, as are schools through awareness-raising campaigns on stormwater management.

INDUSTRY PROGRAMS

The key industry targets include:

- Motor vehicle servicing.
- Construction.
- Horticulture.
- Landscaping.
- Painting and decorating.
- Manufacturing.

CASE STUDY: HOLDEN RECYCLED STORMWATER PROJECT
Elizabeth, Adelaide, South Australia

The Holden car plant is part of a project to reduce polluted urban stormwater flowing into the Little Para River, one of South Australia's most stressed waterways. The catchment surrounding the River releases about 300 million litres of untreated stormwater into the Barker Inlet and Gulf St Vincent every year. Barker Inlet is listed under Australia's Directory of Important Wetlands. It is an essential breeding ground for dolphins, fish and shellfish.

The stormwater is being diverted to the City of Salisbury's Karuna Park constructed wetlands for filtration. Clean water will be piped back to Holden and other industries for reuse. Surplus recycled water will be injected into aquifers to meet bore water demand during dry spells.

The Commonwealth is providing $629,000 towards this $3m project under the Cleaning Our Waterways Industry partnership Program in partnership with Holden, the City of Salisbury, the SA Dept of Industry & Trade, and the Northern Adelaide and Barossa Catchment Water Management Board.

The Holden car plant, Adelaide, South Australia.

COMMUNITY EDUCATION

There are a number of examples of successful campaigns that link community action with reducing stormwater pollution. This is in addition to litter reduction programs by the Keep Australia Beautiful Foundation, Tidy Towns, and Clean-Up Australia. Examples are:

- Drain Marking - stencilling messages and symbols on drains as a reminder that pollutants flowing down stormwater systems end up in natural waterways eg. the 'Yellow Fish Road' drain marking program.[145]
- Adopting a creek or waterway - these programs work to link residents of a catchment with business and local government in taking unified protection measures eg. 'Kids, Companies & Creeks' in Sydney.
- Sub-catchment Audits - voluntary participation by businesses in council or water authority audits assists managers identify cleaner production techniques.
- Mass media campaigns - the NSW Stormwater Trust "Drain is Just for Rain" education campaign reports that 9 out of 10 people could now nominate something they could do to prevent stormwater pollution.
- Stormwater pollution monitors - display boards are placed in catchment "hot spots" to indicate storm drain water quality. They can also indicate the amount of pollutants removed from drains by treatment trains.

POLICY CONSIDERATIONS

In its report to the Sustainable Land and Water Resources Management Committee and the Council of Australian Governments (COAG) National Water Reform Taskforce, the CSIRO recommends a range of policy instruments to address the stormwater management problem, including:

[145] McAlister, Tony (1999). Stormwater reuse - a balanced assessment. In *Stormwater 2000: the green with the gold: conference proceedings 26-28 April 1999*, ed. J.A. Wood. Stormwater Industry Association.

- There should be reform of drainage rating systems so that charges more accurately reflect the costs of stormwater management programs.
- Extensive reform of the institutional structures for stormwater management to complement the corporatisation of water utilities and to create explicit roles for State and Local Government.
- In all jurisdictions, responsibilities at State level for setting the broad water resource and environmental policies affecting the rural-urban fringe, such as environmental quality targets, need to be separated from those of detailed stormwater catchment planning and management undertaken by urban catchment management bodies.
- Stormwater management programs should be established for all major urban catchments. There is a need for stormwater management to be undertaken at either the metropolitan scale or at the major urban catchment scale.
- Urban catchment bodies should have the power to obtain revenue either from local government or though direct charges on the private and public sectors, employ staff and commission works.
- Stormwater targets should be set with reference to the National State of the Environment Reporting System.
- A water quality strategy should identify environmental values and complementary integrated catchment management activities and stormwater infrastructure.
- Among the roles of the Commonwealth should be the provision of grants for capital works that demonstrate methods for integrated stormwater management.

STATE OF ENVIRONMENT REPORTING

National, State and Local Environment Reports can influence stormwater management by targeting the need for integrated planning and monitoring, priority on-ground works, regulatory changes and source control activities.

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Ventura County's Hillside Development Standards

"Hillside" means property located in an area with known erosive soil conditions, where the development contemplates grading on any natural slope that is **xx%** or greater and where grading contemplates cut or fill slopes.

Jurisdiction	**Slope%**
1. CAMARILLO	20%
2. FILLMORE	?
3. MOORPARK	20%
4. OJAI	15%
5. OXNARD	0%
6. PORT HUENEME	0%
7. SAN BUENAVENTURA	?
8. SANTA PAULA	?
9. SIMI VALLEY	20%
10. THOUSAND OAKS	25%
11. VENTURA COUNTY	25%

ATTACHMENT A

VENTURA COUNTYWIDE STORMWATER QUALITY URBAN IMPACT MITIGATION PLAN (SQUIMP)

BACKGROUND

The Ventura Countywide Stormwater Quality Management Program (Program) was established pursuant to Section 402(p) of the Federal Clean Water Act, which requires that all point source discharges of pollutants into waters of the United States, including discharges from municipal storm drain systems, be regulated by a National Pollutant Discharge Elimination System (NPDES) permit. The requirement to implement a program for development planning is based on, federal and state statutes including: Section 402(p) of the Clean Water Act, Section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990 ("CZARA") and the California Water Code. The Clean Water Act amendments of 1987 established a framework for regulating storm water discharges from municipal, industrial, and construction activities under the NPDES program. The primary objectives of the municipal storm water program requirements are to:

1. Effectively prohibit non-storm water discharges; and
2. Reduce the discharge of pollutants from storm water conveyance systems to the Maximum Extent Practicable (MEP statutory standard)

The SQUIMP was developed as part of the municipal storm water program to address storm water pollution from new development and redevelopment by the private sector. This SQUIMP contains a list of the minimum required Best Management Practices (BMPs) that shall be used for a designated project. Additional BMPs may be required by ordinance or code adopted by the Co-permittees and applied generally or on a case-by-case basis. The Co-permittees are required to implement the requirements set herein in their own jurisdiction. Developers shall incorporate appropriate SQUIMP requirements into the project plans for the projects covered by the SQUIMP requirements. Each Co-permittee will approve the project plan as part of the development plan approval process.

All projects that fall into one of eight categories are identified in the Ventura Countywide Municipal Permit as requiring SQUIMPs. These categories are:

- Single-Family Hillside Residences
- 100,000 Square Foot Commercial Developments
- Automotive Repair Shops
- Retail Gasoline Outlets
- Restaurants
- Home Subdivisions with 10 or more housing units
- Location within or directly adjacent to or discharging directly to an environmentally sensitive area
- Parking lots with 5,000 square feet or more impervious parking or access surfaces or with 25 or more parking spaces and potentially exposed to storm water runoff

DEFINITIONS

"100,000 Square Foot Commercial Development" means any commercial development that creates at least 100,000 square feet or impermeable area, including parking areas.

"Automotive Repair Shop" means a facility that is categorized in any one of the following Standard Industrial Classification (SIC) codes: 5013, 5014, 5541, 7532-7534, or 7536-7539.

"Best Management Practice (BMP)" means any program, technology, process, siting criteria, operational methods or measures or engineered systems, which when implemented prevent, control, remove or reduce pollution.

"Commercial Development" means any development on private land that is not heavy industrial or residential. The category includes, but is not limited to: hospitals, laboratories and other medical facilities, educational institutes, recreational facilities, plant nurseries, multi-apartment buildings, car wash facilities, mini-malls and other business complexes, shopping malls, hotels, office buildings, public warehouses, and other light industrial complexes.

"Designated Public Access Points" means any pedestrian, bicycle, equestrian or vehicular point of access to jurisdictional channels in the area of Ventura County subject to permit requirements.

"Directly Adjacent" means situated within 200 feet of the contiguous zone required for the continued maintenance, function, and structural stability of the environmentally sensitive area.

"Directly Connected Impervious Area (DCIA)" means the area covered by a building, impermeable pavement, and/or other impervious surfaces, which drains directly into the storm drain without first flowing across permeable land area (e.g. lawns).

"Directly Discharging" means outflow from a drainage conveyance system that is composed entirely or predominately of flows from the subject, property, development, subdivision, or industrial facility and not commingled with the flows from adjacent lands.

"Environmentally Sensitive Area" means an areas "in which plant or animal life or their habitats are either rare or especially valuable because of their special nature or role in an ecosystem and which would be easily disturbed or degraded by human activities and developments" (California Public Resources Code §30107.5)

Areas subject to storm water mitigation requirements area: areas designated as an Area of Special Biological Significance (ASBS) by the State Water Resources Control Board, an area designated as a significant natural resource by the California Resources Agency, or an area identified by the discharger as environmentally sensitive for water quality purposes, based on the Regional Board Basin Plan and Clean Water Act Section 303(d) Impaired Water-bodies List for the County of Ventura.

"Hillside" means property located in an areas with known erosive soil conditions, where the development contemplates grading on any natural slope that is twenty-five percent or greater.

"Infiltration" means the downward entry of water into the surface of the soil.

"New Development" means land disturbing activities; structural development, including construction or installation of a building or structure, creation of impervious surface; and land subdivision.

"Parking Lot" means land area or facility for the temporary parking or storage of motor vehicles used personally, for business or for commerce with an impervious surface area of 5,000 square feet or more, or with 25 or more parking spaces.

"Redevelopment" means, but is not limited to, the expansion of a building footprint or addition or replacement of a structure; structural development including an increase in gross floor area and/or exterior construction or remodeling; replacement of impervious surface that is not part of a routing maintenance activity; land disturbing activities related with structural or impervious surfaces. Redevelopment of one of the eight identified SQUIMP categories that result in the creation or addition of 5,000 square feet or more of impervious surfaces is subject to the requirements for storm water mitigation. If the creation or addition of impervious surfaces is fifty percent or more of the existing impervious surface area, then storm water runoff from the entire areas (existing and additions) must be considered for purposed of storm water mitigation. If the creation or additions is less than fifty percent of the impervious areas, then storm water runoff from only the addition areas needs mitigation.

"Restaurant" means a stand-alone facility that sells prepared foods and drinks for consumption, including stationary lunch counters and refreshment stands selling prepared foods and drinks for immediate consumption (SIC Code 5812).

"Retail Gasoline Outlet" means any facility engaged in selling gasoline and lubricating oils.

"Source Control BMP" means any schedules of activities, structural devices, prohibitions of practices, maintenance procedures, managerial practices or operational practices that aim to prevent storm water pollution by reducing the potential for contamination at the source of pollution.

"Storm Event" means a rainfall event that produces more than 0.1 inch of precipitation and that, which is separated from the previous storm event by at least 72 hours of dry weather.

"Structural BMP" means any structural facility designed and constructed to mitigate the adverse impacts of storm water and urban runoff pollution (e.g. canopy, structural enclosure). The category may include both Treatment Control BMPs and Source Control BMPs.

"Treatment" means the application of engineered systems that use physical, chemical or biological processes to remove pollutants. Such processes include, but are not limited to, filtration, gravity settling, media absorption, biodegradation, biological uptake, chemical oxidation and UV radiation.

"Treatment Control BMP" means any engineered system designed to remove pollutants by simple gravity settling of particulate pollutants, filtration, biological uptake, media absorption or any other physical, biological or chemical process.

CONFLICTS WITH LOCAL PRACTICES

Where provisions of the SQUIMP requirements conflict with established local codes, (e.g., specific language of signage used on storm drain stenciling), the Co-permittees may continue the local practice and modify the SQUIMP to be consistent with the code, except that to the extent that the standards in the SQUIMP are more stringent than those under local codes, such more stringent standards shall apply.

SQUIMP PROVISIONS APPLICABLE TO ALL CATEGORIES AS APPROPRIATE

<u>REQUIREMENTS</u>

1. PEAK STORM WATER RUNOFF DISCHARGE RATES

The discharger shall control the post-development peak storm water runoff discharge rates to maintain or reduce pre-development downstream erosion, and to protect stream habitat.

SQUIMP category projects, excluding single-family hillside residences that directly discharge to unlined receiving streams shall implement the following design criteria:

a. 2-year post development discharge rates shall not exceed the predeveloped discharge rates for the 2-year frequency storm event.
b. Peak flows shall be determined using the procedures set forth in the latest edition of the *Hydrology Manual* and Direct Runoff curves produced by Ventura County Public Works Agency, Watershed Protection District. Additional information is provided in the Ventura Countywide Stormwater Quality Management Program's Technical Guidance Manual for Stormwater Quality Control Measures.

2. CONSERVE NATURAL AREAS

If applicable, the following items are required and shall be implemented in the site layout during the subdivision design and approval process, consistent with applicable General Plan and Local Area Plan policies:

- Concentrate or cluster Development on portions of a site while leaving the remaining land in a natural undisturbed condition
- Limit clearing and grading of native vegetation at a site to the minimum amount needed to build lots, allow access, and provide fire protection
- Maximize trees and other vegetation at each site by planting additional vegetation, clustering tree areas, and promoting the use of native and/or drought tolerant plants

- Promote natural vegetation by using parking lot islands and other landscaped areas
- Preserve riparian areas and wetlands

3. MINIMIZE STORM WATER POLLUTANTS OF CONCERN

Storm water runoff from a site has the potential to contribute oil and grease, suspended solids, metals, gasoline, pesticides, and pathogens to the storm water conveyance system. The development shall be designed so as to minimize, to the maximum extent practicable, the introduction of pollutants of concern that may result in significant impacts, generated from site runoff of directly connected impervious areas (DCIA), to the storm water conveyance system. Pollutants of concern consist of any pollutants that exhibit one or more of the following characteristic: current loadings or historic deposits of the pollutant are impacting the beneficial uses of a receiving water, elevated levels of the pollutant are found in sediments of a receiving water and/or have the potential to bioaccumulate in organisms therein, or the detectable inputs of the pollutant are at concentrations or loads considered potentially toxic to humans and/or flora and fauna. The storm water pollutants of concern currently identified by the Program are total and fecal coliform, mercury, PAHs. DDT and byproducts, diazinon, sediment/TSS, chlorpyrifos, copper, lead, thallium, bis(2-ethylhexyl)phthalate and phosphorous. The program may amend the list of pollutants of concern as additional information becomes available.

In meeting this specific requirement, "minimization of the pollutants of concern" will require the incorporation of a BMP or combination of BMPs best suited to maximize the reduction of pollutant loadings in that runoff to the Maximum Extent Practicable (MEP). Those BMPs best suited for that purpose are those listed in the *Ventura County Technical Guidance Manual for Stormwater Quality Control Measures*.

Examples of BMPs that can be used for minimizing the introduction of pollutants of concern generated from site runoff are identified in Table 2.

4. PROTECT SLOPES AND CHANNELS

Project plans shall include BMPs consistent with local codes and ordinances and the SQUIMP to decrease the potential of slopes and/or channels from eroding and impacting storm water runoff.

- Convey runoff safely from the tops of slopes and stabilize disturbed slopes
- Utilize natural drainage systems to the Maximum Extent Practicable
- Control or reduce or eliminate flow to natural drainage systems to the Maximum Extent Practicable
- Stabilize permanent channel crossings
- Vegetate slopes with first consideration given to native or drought tolerant species
- Install energy dissipaters, such as riprap at the outlets of new storm drains, culverts, conduits, or channels that enter unlined channels in accordance with applicable specifications to minimize erosion, with the approval of all agencies with jurisdiction, e.g., the U.S. Army Corps of Engineers and the California Department of Fish and Game.

5. PROVIDE STORM DRAIN SYSTEM STENCILING AND SIGNAGE

Storm drain stencils are highly visible source controls that are typically placed directly adjacent to storm drain inlets. The stencil contains a brief statement that prohibits the dumping of improper materials into the storm water conveyance system. Graphical icons, either illustrating anti-dumping symbols or images of receiving water fauna, are effective supplements to the anti-dumping message.

- All storm drain inlets and catch basins within the project area shall be stenciled with prohibitive language (such as: "DON'T DUMP! DRAINS TO OCEAN")
- Signs and prohibitive language and/or graphical icons, which prohibit illegal dumping, shall be posted at designated public access points along channels and creeks within the project area
- Legibility of stencils and signs shall be maintained

6. PROPERLY DESIGN OUTDOOR MATERIAL STORAGE AREAS

Outdoor material storage areas refer to storage areas or storage facilities solely for the storage of materials. Improper storage of materials outdoors may provide an opportunity for toxic compounds, oil and grease, heavy metals, nutrients, suspended solids, and other pollutants to enter the storm water conveyance system. Where proposed project plans include outdoor areas for permanent storage of materials that may contribute pollutants to the storm water conveyance system, the following Structural or Treatment BMPs are required:

- Materials with the potential to contaminate storm water shall be (1) placed in an enclosure such as, but not limited to, a cabinet, shed, or similar structure that prevents contact with runoff or spillage to the storm water conveyance system; or (2) protected by secondary containment structures such as berms, dikes, or curbs.
- The storage area shall be paved and sufficiently impervious to contain leaks and spills.
- The storage area shall have a roof or awning to minimize collection of storm water within the secondary containment area.

7. PROPERLY DESIGN TRASH STORAGE AREAS

A trash storage area refers to an area where a trash receptacle or receptacles are located for use as a repository for solid wastes. Loose trash and debris can be easily transported by the forces of water or wind into nearby storm drain inlets, channels and/or creeks. All trash container areas shall meet the following Structural or Treatment Control BMP requirements (individual single-family residences are exempt from these requirements):

- Trash container areas shall have drainage from adjoining roofs and pavement diverted around the area(s)
- Trash container areas shall be screened or walled to prevent off-site transport of trash

8. PROVIDE PROOF OF ONGOING BMP MAINTENANCE

Improper maintenance is one of the most common reasons why water quality controls will not function as designed or systems to fail entirely. It is important to consider who will be responsible for maintenance of a permanent BMP and what equipment is required to perform the maintenance properly. As part of project review, if a project applicant has included or is required to include, Structural or Treatment Control BMPs in project plans, the Co-permittee shall require that the applicant provide verification of maintenance provisions through such means as may be appropriate, including, but not limited to legal agreements, covenants, CEQ mitigation requirements and/or Conditional Use Permits.

For all properties, the verification will include the developer's signed statement, as part of the project application, accepting responsibility for all structural and treatment control BMP maintenance until the time the property is transferred and, where applicable, a signed agreement from the public or private entity assuming responsibility for Structural or Treatment Control BMP maintenance. The transfer of property to a private or public owner shall have conditions requiring the recipient to assume responsibility for maintenance of any Structural or Treatment Control BMP included in the sales or lease agreement for that property. The condition of transfer shall include a provision that the property owners conduct maintenance inspection of all Structural or Treatment Control BMPs at least once a year and retain proof of inspection. For residential properties where the Structural or Treatment Control BMPs are located within a common area, which will be maintained by a homeowner's association, language regarding the responsibility for maintenance shall be included in the project's conditions, covenants and restrictions (CC&Rs). Printed educational materials will be required to accompany the first deed transfer to highlight the existence of the requirement and to provide information on what storm water management facilities are present, signs that maintenance is needed, how the necessary maintenance can be performed, and assistance that the Co-permittee can provide. The transfer of this information shall also be required with any subsequent sale of the property.

If Structural or Treatment Control BMPs are located within a public area proposed for transfer, they will be the responsibility of the developer until they are accepted for transfer by the appropriate public agency. Structural or Treatment Control BMPs proposed fro transfer shall meet design standards adopted by the public entity for the CMP installed and should be approved by the appropriate public agency prior to installation.

9. DESIGN STANDARDS FOR STRUCTURAL OR TREATMENT CONTROL BMPs

Structural or Treatment Control BMPs selected for use at any project covered by this SQUIMP shall meet the design standards of this Section unless specifically exempted.

Volume-based and flow-based design standards may be used separately or in combination to equivalent treatment of storm water discharges. Volume-based criteria should be used in the sizing of detention/retention or infiltration structures; flow-based criteria should be used on swales, catch basin devices, or wetlands. Other, BMP-specific criteria may be applicable. Project applicants should refer to the *Ventura County Technical Guidance Manual for Stormwater Quality Control Measures* for further information.

> Volume-based BMPs shall be designed to mitigate (infiltrate, filter or treat) the volume necessary to capture and treat 80 percent or more of the average annual runoff volume from the site at the design drawdown period specified in the *Ventura County Technical Guidance Manual for Stormwater Quality Control Measures* Fact Sheet for the proposed treatment control measures.
>
> Flow-based BMPs shall be designed to mitigate (infiltrate, filter or treat) 10% of the 50-year design flow rate.

Limited Exclusion

Where the land area for development or redevelopment is less than 5,000 square feet, restaurants are excluded from the numerical Structural or Treatment Control BMP design standard requirement only.

10. PROVISIONS APPLICABLE TO INDIVIDUAL PRIORITY PROJECT CATEGORIES

REQUIREMENTS

A. <u>100,000 SQUARE FOOT COMMERCIAL DEVELOPMENTS</u>

1. PROPERLY DESIGN LOADING/UNLOADING DOCK AREAS
   Loading/unloading dock areas have the potential for material spills to be quickly transported to the storm water conveyance system. To minimize this potential, the following design criteria are required:
   - Cover loading dock areas or design drainage to minimize run-on and runoff of storm water
   - Direct connections to storm drains from depressed loading decks (truck wells) are prohibited

2. PROPERLY DESIGN REPAIR/MAINTENANCE BAYS
   Oil and grease, solvents, car battery acid, coolant and gasoline from the repair/maintenance bays can negatively impact storm water if allowed to come into contact with storm water runoff. Therefore, design plans for repair bays shall include the following:

   - Repair/maintenance bays shall be indoors or designed in such a way that does not allow storm water run-on or contact with storm water runoff.
   - Design a repair/maintenance bay drainage system to capture all washwater, leaks and spills. Connect drains to a sump for collection and disposal. Direct connection of the repair/maintenance bays to the storm drain system is prohibited. If required by local jurisdiction, obtain an Industrial Waste Discharge Permit.

3. PROPERLY DESIGN VEHICLE/EQUIPMENT WASH AREAS
   The activity of vehicle/equipment washing/steam cleaning has the potential to contribute metals, oil and grease, solvents, phosphates and suspended solids to the storm water conveyance system. Include in the project plans, an area for washing/steam cleaning of vehicles and equipment. The area in the site design shall be:

A017243

- Self-contained and/or covered, equipped with a clarifier, or other pretreatment facility and properly connected to a sanitary sewer

B. RESTAURANTS

1. PROPERLY DESIGN EQUIPMENT/ACCESSORY WASH AREAS

   The activity of outdoor equipment/accessory washing/steam cleaning has the potential to contribute metals, oil and grease, solvents, phosphates and suspended solids to the storm water conveyance system. Include in the project plans an area for the washing/steam cleaning of equipment and accessories. This area shall be:

   - Self-contained, connected to a grease interceptor, and properly connected to a sanitary sewer
   - If the wash area is to be located outdoors, it shall be covered, paved, have secondary containment, be connected to a grease interceptor and be connected to the sanitary sewer.

C. RETAIL GASOLINE OUTLETS

1. PROPERLY DESIGN FUELING AREA

   Fueling areas have the potential to contribute oil and grease, solvents, car battery acid, coolant and gasoline to the storm water conveyance system. The project plans shall include the following BMPs:

   - The fuel dispensing area shall be covered with an overhanging roof structure or canopy. The canopy's minimum dimensions shall be equal to or greater than the area within the grade break. The canopy shall not drain onto the fuel dispensing area, and the canopy downspouts shall be routed to prevent drainage across the fueling area.
   - The fueling dispensing area shall be paved with Portland cement concrete (or equivalent smooth impervious surface) and the use of asphalt concrete shall be prohibited.
   - The fuel dispensing area shall have a 2% to 4% slope to prevent ponding and shall be separated from the rest of the site by a grade break that prevents run-on of storm water to the extent practicable.
   - At a minimum, the concrete fuel dispensing area shall extend 6.5 feet (2.0 meters) from the corner of each fuel dispenser, or the length at which the hose and nozzle assembly may be operated plus 1 foot (0.3 meters), whichever is less.

D. AUTOMOTIVE REPAIR SHOPS

1. PROPERLY DESIGN FUELING AREA

   Fueling areas have the potential to contribute oil and grease, solvents, car battery acid, coolant and gasoline to the storm water conveyance system. Therefore, design plans, which include fueling areas, shall contain the following:

   - The fuel dispensing area shall be covered with an overhanging roof structure or canopy. The canopy's minimum dimensions shall be equal to or greater than the area within the grade break. The canopy shall not drain onto the fuel dispensing area, and the canopy downspouts shall be routed to prevent drainage across the fueling area.
   - The fueling dispensing area shall be paved with Portland cement concrete (or equivalent smooth impervious surface) and the use of asphalt concrete shall be prohibited.
   - The fuel dispensing area shall have a 2% to 4% slope to prevent ponding and shall be separated from the rest of the site by a grade break that prevents run-on of storm water to the extent practicable.
   - At a minimum, the concrete fuel dispensing area shall extend 6.5 feet (2.0 meters) from the corner of each fuel dispenser, or the length at which the hose and nozzle assembly may be operated plus 1 foot (0.3 meters), whichever is less.

2. PROPERLY DESIGN REPAIR/MAINTENANCE BAYS

Oil and grease, solvents, car battery acid, coolant and gasoline from the repair/maintenance bays can negatively impact storm water if allowed to come into contact with storm water runoff. Therefore, design plans for repair bays shall include the following:

- Repair/maintenance bays shall be indoors or designed in such a way that does not allow storm water run-on or contact with storm water runoff.
- Design a repair/maintenance bay drainage system to capture all wash-water, leaks and spills. Connect drains to a sump for collection and disposal. Direct connection of the repair/maintenance bays to the storm drain system is prohibited. If required by local jurisdiction, an Industrial Waste Discharge Permit should be obtained.

3. PROPERLY DESIGN VEHICLE/EQUIPMENT WASH AREAS

The activity of vehicle/equipment washing/steam cleaning has the potential to contribute metals, oil and grease, solvents, phosphates and suspended solids to the storm water conveyance system. Include in the project plans, an area for washing/steam cleaning of vehicles and equipment. The area in the site design shall be:

- Self-contained and/or covered, equipped with a clarifier, or other pretreatment facility and properly connected to a sanitary sewer

4. PROPERLY DESIGN LOADING/UNLOADING DOCK AREAS

Loading/unloading dock areas have the potential for material spills to be quickly transported to the storm water conveyance system. To minimize this potential, the following design criteria are required:

- Cover loading dock areas or design drainage to minimize run-on and runoff of storm water
- Direct connections to storm drains from depressed loading docks (truck wells) are prohibited

E. <u>PARKING LOTS</u>

1. PROPERLY DESIGN PARKING AREA

Parking lots contain pollutants such as heavy metals, oil and grease, and polycyclic aromatic hydrocarbons that are deposited on parking lot surfaces by motor vehicles. These pollutants are directly transported to surface waters. To minimize the offsite transport of pollutants, the following design criteria are required:

- Reduce impervious land coverage of parking areas
- Infiltrate runoff before it reaches the storm drain system
- Treat runoff before it reaches the storm drain system

2. PROPERLY DESIGN TO LIMIT OIL CONTAMINATION AND PERFORM MAINTENANCE

Parking lots may accumulate oil, grease and water insoluble hydrocarbons from vehicle drippings and engine system leaks.

- Treat to remove oil and petroleum hydrocarbons at parking lots that are heavily used (e.g., fast food outlets, lots with 25 or more parking spaces, sports event parking lots, shopping malls, grocery stores, discount warehouse stores)
- Ensure adequate operation and maintenance of treatment systems, particularly sludge and oil removal, and system fouling/plugging prevention control

11. WAIVER

A Co-permittee may, through adoption of an ordinance or code incorporating the treatment requirements of the SQUIMP, provide for a waiver from the requirement if impracticability for a specific property can be established. A waiver for impracticability shall be granted only when all other Structural or Treatment Control BMPs have been considered and rejected as infeasible. Recognized situations of impracticability include, (i) extreme limitations of space for treatment on a redevelopment project, (ii) unfavorable or unstable soil conditions at a site to attempt infiltration, and (iii) risk of ground water contamination because a known unconfined aquifer lies beneath the land surface or an existing or potential underground source of drinking water is less than 10 feet from the soil surface. Any jurisdiction for impracticability shall be separately petitioned by the Co-permittee and submitted to the Regional Board for consideration. The Regional Board may consider approval of the waiver justification or may delegate the authority to approve a class of waiver justifications to the Regional Board Executive Officer. The supplementary waiver justification becomes recognized and effective only after approval by the Regional Board or the Regional Board Executive Officer. A waiver granted by a Co-permittee to any development or redevelopment project may be revoked by the Regional Board Executive Officer for cause and with proper notice upon petition.

If a waiver is granted for impracticability, the Co-permittee shall require the project proponent to transfer the savings in cost, as determined by the Co-permittee, to a storm water mitigation fund operated by a public agency or a non-profit entity to be used to promote regional or alternative solutions for storm water pollution in the watershed.

12. LIMITATION ON USE OF UNFILTRATION BMPs

Three factors significantly influence the potential for storm water to contaminate ground water. They are (i) pollutant mobility, (ii) pollutant abundance in storm water, (iii) and soluble fraction of pollutant. The risk of contamination of groundwater may be reduced by pretreatment of storm water. A discussion of limitations and guidance for infiltration practices is contained in, *Potential Groundwater Contamination from Intentional and Non-Intentional Storm Water Infiltration, Report No. EPA/600/R-94/051, USEPA (1994).*

The distance of the groundwater table from the infiltration BMP may also be a factor in determining the risk of contamination. A historic high water table distance separation of ten feet depth in California presumptively poses negligible risk for storm water not associated with industrial activity or high vehicular traffic except in cases where groundwater basins are unconfined. Unconfined groundwater basins and vulnerable unconfined aquifers are areas that have been identified by the County of Ventura Public Works Agency, Water Resources Division and the Regional Board as areas where the application of infiltration BMPs should be limited to those that provide pre-treatment to ensure groundwater is protected from pollutants of concern.

Infiltration BMP are not recommended for areas of industrial activity or areas subject to high vehicular traffic (25,000 or greater average daily traffic (ADT) on main roadway or 15,000 or more ADT on any intersecting roadway) unless appropriate pretreatment is provided to ensure groundwater is protected and the infiltration BMP is not rendered ineffective by overload.

13. ALTERNATIVE CERTIFICATION FOR STORM WATER TREATMENT MITIGATION

In lieu of conducting detailed BMP review to verify Structural or Treatment Control BMPs adequacy, a Co-permittee may elect to accept a signed certification from a Civil Engineer or a Licensed Architect registered in the State of California, that the plan meets the criteria established herein. The Co-permittee is encouraged to verify that certifying person(s) have been trained on BMP design for water quality, not more than two years prior to the signature date. Training conducted by an organization with storm water BMP design expertise (e.g., University, American Society of Civil Engineers, American Society of Landscape

Architects, American Public Works Association, or the California Water Environment Association) may be considered qualifying.

Equestrian-Related
Water Quality Best Management Practices

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To TRACY WOODS	From PAUL TANTET	
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Fax # 213-576-5777	Fax #	

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How Do Horse Waste and Equestrian Activities Impair Water Quality?

Although horse wastes (manure, urine and soiled bedding) are organic, biodegradable materials, many of their physical, biological and chemical properties (such as sediment, phosphorous, nutrients, and bacteria) can be detrimental to water quality and can adversely affect human health and aquatic life in water bodies. Many of the nutrients ingested by horses return to the environment in feces and urine. When carried by runoff to streams and lakes, excessive amounts of these same nutrients can stimulate unwanted algae blooms in creeks and streams, causing a decrease in dissolved oxygen in water, which stifles aquatic life.[1]

Some activities, such as heavy grazing or pasture use, remove the soil's vegetative cover and can expose the soil surface. Exposed soil is easily transported by runoff to streams and creeks, and excessive sediment can fill pools, smother aquatic habitats, and cover food supplies.[1]

Bacteria, such as fecal coliform, are present in horse manure. As previously discussed, the Regional Boards have listed fecal coliform as a pollutant of concern because it is an indicator of potential viruses and pathogens that cause swimmer-associated sickness in water bodies.

Chemicals used during horse grooming and shelter/living area maintenance may cause adverse health effects to humans and are toxic to aquatic life.

[1]Paraphrased from *Horse Owners Guide to Water Quality Protection* published by the Council of Bay Area Resource Conservation Districts

Expectations from the Equestrian Community

The Permittees have been charged with the challenging task by the Regional Boards of preventing pollutants to the maximum extent practicable from reaching local water bodies. In response to this challenge, the Permittees worked with equestrian community representatives, the environmental community and the public to develop BMPs that may be implemented while not inhibiting the public's ability to conduct business, curtail recreational use of horses or the enjoyment of land uses. Therefore, the Permittees expect that the equestrian community will implement the suggested minimum BMPs to the maximum extent practicable taking into consideration time, monetary, and other direct and indirect costs associated with improving water quality. Many of the suggested BMPs require little or no monetary expenditures, such as following the directions on horse grooming products to prevent chemicals from reaching waterways, while others will require monetary expenditures, such as drainage control improvements. The Permittees recognize that existing facilities, which have been operating for many years, will require a longer period of time to implement some of the suggested BMPs that require monetary expenditures, compared to newly proposed equestrian facilities that are expected to incorporate necessary and appropriate BMPs into the designs of their facilities.

Therefore, in recognition of the fundamental difference between existing and proposed equestrian facilities in their abilities to implement BMPs to the maximum extent practicable, the Permittees suggest two different paths for evaluating BMPs to be implemented at existing versus newly proposed facilities.

For existing facilities, such as commercial stables, residential properties with a stable, or individuals owning horses on residential properties, owners should perform the following tasks in order to analyze what BMPs should be implemented.

> *Task 1: Inventory and map your resources.* Draw a map of the site and note natural water features (including drainage flow characteristics), property improvements (e.g. corral fences, wash areas, buildings associated with care and stabling, access roads, etc.), vegetation, slopes, bare areas, and other characteristics that affect water drainage and water quality.
>
> *Task 2: Identify, assess, and prioritize potential problem areas.* Take a walk around the facility, preferably during or immediately after a heavy rainfall. Use the site map developed and take notes. For example, draw arrows on the site map to show runoff and drainage patterns. Assess situations and prioritize areas in need of attention like manure storage problems such as rain water coming into contact with stockpiled manure and washing downhill into streams or creeks. Prioritize the areas needing attention. Those areas or activities that are directly contributing to pollution must receive the highest priority. As a guidance, the BMPs within this document highlight situations of concern to the Permittees.

Task 3: Develop solutions. Use the BMPs within this document to address problem areas and activities.

Task 4: Schedule and properly install BMPs. Write down a work plan and stick to it. Document current and past practices that help to curtail pollution into creeks and streams.

Task 5: Maintain BMPs. A mismanaged or unmaintained BMP will not work.

Existing facility owners are encouraged to develop a Water Quality Management Plan as a mechanism by which to document to the local jurisdiction that the facility is progressing toward compliance with the applicable local NPDES Program.

For proposed facilities, owners must develop a Water Quality Management Plan (WQMP) for review and approval by the governing Permittee. A WQMP should describe commitments to installation and maintenance of site design, source control and treatment control BMPs listed below that can be readily incorporated for use on the project or other BMPs, which have been demonstrated to work equally well. The WQMP should also reflect language that the above tasks were completed and information from the tasks was taken into account in the WQMP.

Runoff Best Management Practices

The goal of runoff management is to prevent the transport of pollutants into receiving waters to the maximum extent practicable by separating "clean water" from "contaminated water" and reducing erosion caused by runoff. Below is a list of examples that could be used to reach these objectives, whenever practical or feasible. Some of these BMPs are more applicable to existing facilities, while others are applicable to new facilities. If a stable operator (commercial or residential) chooses to use other techniques or methods, he/she is required to demonstrate the efficacy of the alternative technique or method to the local jurisdiction in charge of the storm water program.

A. Roof Runoff Related BMPs

Direct roof runoff away from high-use, bare, un-vegetated and manure storage areas. This could include the use of gutters and downspouts, subsurface drains to collect water and divert from buildings, or any other available technology.

B. Facility Runoff Related BMPs

Runoff from areas containing manure, bedding, or feed debris represents the most significant source of pollutants from equestrian facilities. Preventative measures could include some of the below listed examples. Generally these serve to prevent and minimize the runoff that comes into contact with manure, bedding, or feed debris being carried off the facility and into a storm drain.

1. Separate barnyards, paddocks, and manure storage areas from any waterways with buffer strips of vegetation to filter sediments and absorb nutrients in runoff.
2. Divert surface runoff around areas with pollutants by constructing berms, ditches, underground pipelines or other methods.
3. Locate NEW buildings and confinement areas away from creeks, steep slopes, and floodplains. Check with the local jurisdiction regarding zoning or flood plain issues.
4. Maintain vegetation and replant bare areas to reduce erosion.
5. Control potential runoff from water troughs with automatic waterers or other means.
6. Improve infiltration and drainage, in and around arenas, paddocks, turnouts and service roads by using base rock and sand or other appropriate measures.
7. If water basins and waste ponds are used, water should not remain for more than 72 hours because of the likelihood of attracting mosquitoes that may carry the West Nile Virus or other diseases.

The additional benefits of runoff management for water quality include a drier barnyard, a healthier horse environment, and better working conditions.

Erosion Control-Related Best Management Practices

When considering drainage or slope stabilization BMPs, facility operator should seek professional assistance.

A. Horse-Specific Related BMPs

1. Restrict horse access and human activities at horse facilities in wetlands, creeks, creek banks, meadows, and steep hillsides.
2. Keep areas well vegetated and restore bare areas with vegetation.
3. Manage pastures to prevent heavy grazing such as rotating the use of pastures to allow grasses to regrow.
4. Maintain a strip of vegetation downslope of bare areas such as paddocks and turnouts to help trap sediment.

B. Site Drainage Related BMPs

1. Maintain culverts and ditches. Control upslope erosion sources to prevent sediment from filling culverts. Use measures such as fiber rolls to capture sediments upstream of culverts and maintain regularly. Vegetate whenever possible.
2. Keep ditches vegetated with grass to help maintain stability and capture sediments. Longitudinal slopes should not exceed 2.5%. Regularly maintain ditches by clearing sediments and debris. For chronic sediment problems, address the erosion source.
3. Keep inlets clear. Remove debris before the rainy season (October 15 to April 14 each year) and check during and after storms.
4. Properly construct and maintain roads, trails, and parking lots in accordance with local construction requirements. Maintain road and trail surfaces.
5. Regrade roads to smooth the surface and prevent rills from expanding.
6. During construction install and maintain silt fences or straw bale sediment barriers to trap sediment.

C. Slope Stabilization Related BMPs

1. Watch for accelerated erosion on steep slopes, pastures, gullies, and intensively used horse areas.
2. Stabilize slopes with vegetation or other applicable erosion control measures, such as erosion control blankets. Do not plant any invasive species. You may be able to obtain a list of invasive plant species from your local fire department, or your City or County Hazard Reduction Program coordinator.

Bacteria / Nutrient Transportation Prevention Best Management Practices

A. Manure Management

1. Remove manure regularly, daily is best, or keep manure under cover such that runoff does not come into contact with manure stockpiles.
   a. Stalls, corrals and wash areas should be cleaned and manure removed on a daily basis.
   b. Paddocks shall be cleaned according to the following schedules:
      i. During the summer dry season (April 15 to October 14 each year): paddocks shall be cleaned at least once every week.
      ii. During the winter rainy season (October 15 to April 14 each year): paddocks shall be cleaned at least twice every week.
2. Provide temporary storage for manure that cannot be disposed of daily – about 15 cubic feet of storage per horse per week. Manure shall not be stored for more than a week on site. See #7 below for composting information.
3. Grade the area surrounding the manure storage area to prevent surface water from reaching the storage area.
4. Store horse waste on an impervious surface (a concrete pad or plastic tarp) and under cover (a roof or tarp) during rains to prevent leaching or runoff of pollutants.
5. Locate manure storage areas away from waterways so that floods or runoff will not wash away waste.
6. Do not dump horse waste on the edge of, or directly into waterways.
7. Consider composting if conditions are suitable. Composting might require permits from various agencies, so ensure to check for local requirements. One of the best manure management practices is to compost manure, although the practice requires space, good setup and operation to have good results. For more information, visit the US Composting Council website http://compostingcouncil.org or other available resources to determine if composting is a good solution for your stable.

B. Building & Site Design

1. Site layout should ensure that structures are placed where adverse effects are minimized and the natural topography, drainage patterns and vegetation remain undisturbed.
2. If no pastures are on site, filter strips should be used to separate riding rings and manure collection from waterways.
3. Set buildings, covered areas, high-use arenas, horse wash racks, manure storage areas, roads, and trails back away from waterways.
4. It is recommended to place gravel below the sand in corrals to percolate wastes and extra water. If bedding is used in corrals, cleaning it up regularly will help prevent it from being collected in rainwater or surface runoff.
5. It is recommended that paddocks have gravel or sand bottom for percolation of water and pollutants, and not be built in areas with a greater than 10% slope.

6. Keep paddocks and corrals as dry as possible during the winter rainy season.

Prior to building and site design, contact your local agency for setback requirements from property lines and other restrictions.

C. Wash Rack Design

1. Do not allow water from horse wash areas to flow into storm drains, creeks, ponds or seasonal drainages.
2. Connect wash racks to the sanitary sewer system, if permitted and possible. Infiltration of wash rack water, if possible, is an acceptable means of disposal. Verify that soil conditions do allow percolation prior to construction.
3. Elevate the wash area from the surrounding ground.
4. Wash water should drain away from the area to a filter strip or other vegetated area. Check to make sure wash water does not cause drainage problems on neighboring properties.
5. Use a shut-off nozzle or low-flow nozzle at the end of the hose.
6. Use horse grooming and health products properly. Follow instructions and use recommended amounts, and clean up spills. Even biodegradable horse grooming and health care products can have a negative effect on water quality.
7. Use plain water to rinse horses - avoid using soap as much as possible.

General Housekeeping Best Management Practices

A. Integrated Pest Management (IPM) BMPs for Horse Facilities and Surrounding Landscape

Integrated Pest Management is an ecologically based pest control strategy that focuses on long-term prevention and control of pests and their damage. A combination of techniques are used such as inspecting and identifying the pest, learning the pest and host life cycles and biology, removing or reducing the pest habitat when possible, using natural enemies, using resistant plant varieties, using mechanical control for weed removal, monitoring frequently, establishing a threshold for damage, choosing the control tactic and then evaluating the results. Pesticides can be used in an IPM system, but should only be used when all other factors in an IPM strategy are met. Some pesticides are designed to be toxic only to the target pest and will not harm desirable insects.

1. Stabilize bare slopes, use native vegetation whenever possible because native vegetation doesn't require fertilizer.
2. Use IPM techniques to reduce the amount of chemicals, pesticides, fertilizers and herbicides placed on landscaping that may wash away.

Additional information can be found on the University of California, Davis web site at www.ipm.ucdavis.edu

B. Trash / Debris
1. Collect and dispose of trash and debris.
2. Do not allow trash or debris to enter creeks, seasonal streams, storm drains, or ponds.

C. Chemicals
1. Follow directions for all chemical applications.
2. Dispose of unused chemicals at a household hazardous waste (HHW) facility. Call your local jurisdiction for the location of your nearest HHW facility.

Trails and Access to Waterbodies Best Management Practices

A. Access to Waterbodies

1. Restrict horse access and human activities in wetlands, creeks, creek banks, meadows, and steep hillsides, if possible.
2. Provide bridges over waterbodies, if practical.
3. Designate access points to creeks by using a designated creek crossing point to reduce and control contaminants from entering the creek and to prevent bank erosion.
4. Select a crossing location that will least impact stream banks and riparian vegetation.

B. Trail Signage and Design

1. Use designated trails for horse riding.
2. The grade on any new trail should not exceed 10 percent and trails should be avoided at all costs on slopes steeper than 20 percent.
3. If a trail must be built on a steep slope, the trail should switch back and forth down the slope. On steep grades, there is a greater chance that erosion will occur.
4. Consider drainage patterns when building new trails. To reduce the potential erosion of the trail from rainwater and runoff, trails should be built so that water sheet flows across the trail. Trails parallel to the flow increases erosion of the trail, and the water will create deep treads in the trail that may render it unusable.
5. Berms should be constructed as appropriate to direct storm water away from the trail.
6. Whenever possible, provide a buffer area between trails and waterways.

Other Permits Issued by the Environmental Protection Agency and State Water Resources Control Board

In December 2002, the Environmental Protection Agency revised the Clean Water Act regulation for Concentrated Animal Feeding Operations, or CAFOs changing the thresholds at which a horse stable operation becomes a CAFO. CAFO designations are assigned ONLY by the Regional Boards and not by the Permittees. Consequently, the Regional Boards enforce CAFO regulations. The information presented herein is for information only to stable owners. The EPA updates its rules frequently; therefore, contact your Regional Board for the latest CAFO rules and for answers to any questions regarding CAFO regulations.

A horse stable operation can be classified a "Large CAFO," a "Medium CAFO," or a "Designated CAFO" if the following requirements are met:

- "Large CAFO"
  - It is an animal feeding operation; and
  - Has at least 500 horses.
- "Medium CAFO"
  - It is an animal feeding operation; and
  - Has at least 150 horses; and
  - Has a manmade ditch or pipe that carries manure or wastewater from your operation, or the horses come into contact with surface water running through the area where they're confined.

Additionally, any size operation can be a "Designated CAFO" if the Regional Board inspects the operation and determines that it's adding pollutants to surface waters.

The requirements for all horse CAFO Permits may include:

- Implementing a nutrient management plan;
- Submitting annual reports to the Regional Board;
- Keeping the permit current until the operation is closed and all manure is removed; and
- Keeping records of the nutrient management practices for at least five years.

Nutrient management plans for all horse CAFOs may include provisions for:

- Assuring adequate manure storage capacity;
- Proper handling of dead animals and chemicals;
- Diverting clean water from the production area;
- Keeping animals out of surface water;
- Using site specific conservation practices;
- Developing ways to test manure and soil;
- Assuring appropriate use of nutrients when spreading manure; and
- Keeping records of nutrient management practices.

Additional information can be found by accessing the EPA web site at **www.epa.gov/npdes/caforule** or the USDA web site at **www.usda.gov**

Ventura Countywide Stormwater Quality Management Program

Report

Stormwater Quality Management Plan

November 2001 (Revision 2)
January 2001 (Revision 1)
February 1999

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Appendix G *Monitoring*

Executive Summary

The Ventura County Stormwater Quality Management Plan, referred to as the SMP throughout this document, represents and defines the requirements of the Ventura County Municipal Storm Water National Pollutant Discharge Elimination System (NPDES) Permit (Board Order No. 00-108; NPDES Permit No. CAS004002) (Permit) adopted on July 27, 2000 by the California Regional Water Quality Control Board (RWCQB), Los Angeles Region, pursuant to Division 7 of the California Water Code.

The Permit applies to Ventura County Flood Control District (VCFCD), the County of Ventura, and the Cities of Camarillo, Fillmore, Moorpark, Ojai, Oxnard, Port Hueneme, San Buenaventura, Santa Paula, Simi Valley, and Thousand Oaks (hereinafter referred to separately as Co-permittees and collectively as the Discharger). VCFCD is the Principal Co-permittee for Permit implementation while the remaining entities, including the County of Ventura and the ten cities, are designated as Co-permittees.
As the Principal Co-permittee, VCFCD:

- Coordinates Permit activities;
- Establishes uniform data submittal format;
- Sets time schedules;
- Prepares regulatory reports;
- Forwards information to the Co-permittees;
- Arranges for public review;
- Secures services of consultants as necessary;
- Implements activities of common interest;
- Develops/prepares/generates all materials and data common to all Co-permittees;
- Updates Co-permittees on RWQCB and US Environmental Protection Agency (USEPA) regulations;
- Arranges for collection and payment of annual Permit renewal fee;
- Convenes all Management Committee and Subcommittee meetings;
- Manages the countywide educational program; and
- Manages the countywide stormwater quality monitoring program.

The Permit and the SMP are intended to develop, achieve, and implement a timely, comprehensive, cost-effective stormwater pollution control program to reduce pollutants to the maximum extent practicable (MEP). The Permit is in effect for discharges of stormwater and urban runoff from municipal storm drain systems within the urban areas of Ventura County and will expire on July 27, 2005.

As stated in the Permit, PART 3.B.1,

The Discharger shall modify the Ventura County SMP adopted with this Order to make it consistent with the requirements herein. The revised Ventura County SMP will be submitted to the Regional Board Executive Officer for approval no later than January 27, 2001

The following SMP has been modified to be consistent with the requirements of the Permit. There are nine sections to the SMP organized as follows:

- Section 1 – Program Management
- Section 2 – Programs for Residents
- Section 3 – Programs for Industrial/Commercial Businesses
- Section 4 – Programs for Planning and Land Development
- Section 5 – Programs for Construction Sites
- Section 6 – Programs for Public Agency Activities
- Section 7 – Programs for Illicit Connections/Illegal Discharges
- Section 8 – Program Evaluation
- Section 9 – Monitoring Program

Sections 1 through 7 contain the programs as specified in the Permit. Each section begins with a list of program elements, a description of each program element, Permit requirements, annual reporting requirements, and performance criteria. Direct quotes from the Permit are in italics with headings in bold. General guidance material is included as appendices.

Section 8 describes the evaluation program used to support and redefine the SMP in terms of program elements and performance criteria. Program evaluation of the SMP focuses on the accomplishments of the Co-permittees in implementing program elements and summarizes storm water quality results from the *Storm Water Monitoring Report* (see below). Results from this program evaluation and recommended modifications to the SMP are presented in the *Annual Storm Water Report and Assessment*, which is submitted, to the RWQCB on October 1 of each Permit year.

Section 9 describes the monitoring program used to support and redefine the SMP in terms of water quality. Results from water quality monitoring are presented in the *Storm Water Monitoring Report* and submitted on July 15 of each Permit year. This report covers results of water quality monitoring from the previous wet season, presents the status of the monitoring program implementation, and provides a general interpretation of the monitoring results, to the extent that data allows.

Acronyms are used throughout the SMP for brevity. For clarity, the acronyms used in the SMP are defined below.

BMP	Best Management Practice
CWA	Clean Water Act
MEP	Maximum Extent Practicable
NOI	Notice of Intent
NOV	Notice of Violation
NPDES	National Pollutant Discharge Elimination System
Permit	Ventura County re-issued NPDES Permit CAS004002
RWQCB	Regional Water Quality Control Board
SMP	Ventura Countywide Stormwater Quality Management Plan
SWPCP	Stormwater Pollution Control Plan
SWPPP	Stormwater Pollution Prevention Plan
TMDL	Total Maximum Daily Load
USEPA	United State Environmental Protection Agency
VCFCD	Ventura County Flood Control District

Section 1
Program Management

1.1 Stormwater Management Program

This section defines and discusses the program management aspects of the Ventura County Stormwater Quality Management Plan (SMP). Program management elements include:

- Permit Coverage/Provisions;
- Institutional Arrangements;
- Program Structure;
- Monitoring and Reporting;
- Fiscal Resources; and
- Legal Authority.

1.2 Permit Coverage/Provisions

Program Description

The Ventura County Flood Control District (VCFCD), the County of Ventura, and the Cities of Camarillo, Fillmore, Moorpark, Ojai, Oxnard, Port Hueneme, San Buenaventura, Santa Paula, Simi Valley, and Thousand Oaks (hereinafter referred to separately as Co-permittees) have joined together to form the Ventura Countywide Stormwater Quality Management Program to control the discharge of stormwater and urban runoff from municipal separate storm sewer systems (MS4). Order No. 94-082 adopted by the California Regional Water Quality Control Board (RWQCB), Los Angeles Region, on August 22, 1994, issued the first National Pollutant Discharge Elimination System (NPDES) Permit to the Ventura County Co-permittees. Order No. 00-108, adopted by the RWQCB on July 27, 2000, re-issued the NPDES Permit, and is hereafter referred to as the Permit.

The Ventura Countywide Stormwater Quality Management Program (the Program) was established pursuant to Section 402(p) of the Federal Clean Water Act (CWA), which requires that all point source discharges of pollutants into Waters of the United States, including discharges from municipal separate storm sewer systems (MS4s), be regulated by a NPDES Permit. The NPDES Permit for the Ventura County Co-permittees covers the urban areas of the county and regulates discharges from municipal storm drain systems in Ventura County. Figure 1-1, located on page 1-4, shows the area covered by the Ventura County Stormwater Management Plan (SMP).

The County and City Co-permittees each own, operate, and maintain a MS4 within their respective jurisdiction. VCFCD is a regional agency that owns, operates, and maintains a MS4 countywide, with facilities located within the jurisdictional boundaries of the Co-permittees. These MS4s are regulated by the Permit and are covered by this SMP.

The MS4s in the permitted area of Ventura County, hereinafter referred to as a storm drain system, is defined as:

"...the conveyance or system of conveyance (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains) owned or operated by a Co-permittee, that is designed or used for collecting or conveying storm water, which is not a combined sewer, and which is not part of a Publicly Owned Treatment Works (POTW) as defined at 40 CFR 122.2."

For the purposes of each Co-permittee, the length of their storm drain system is the total length of all storm drain systems owned and operated by the Co-permittee. The length of each storm drain system is the centerline distance, in linear feet, between the downstream end and upstream end of each storm drain system. The downstream end is defined as the point of discharge to the waters of the United States, or to a MS4 that is not owned or operated by the Co-permittee. The upstream end is defined as the point of entry to any storm drain system.

Table 1-1 (shown below) summarizes the length of the storm drain facilities owned, operated, and maintained by each Co-permittee.

Table 1-1

Co-permittee Agencies	Storm Drain System - Length in Linear Feet							
	Open Channel Soft Side AND Bottom	*Open Channel Hard Side OR Bottom*	*Open Channels Hard Side AND Bottom*	*Underground Storm Drains*	*Ditches*	*Gutters*	*Other Storm Drain*	*Total Length*
Principal Co-permittee								
VCFCD								0
Co-permittees								
City of Camarillo								0
County of Ventura								0
City of Fillmore								0
City of Moorpark								0
City of Ojai								0
City of Oxnard	12 miles	3 miles	5 miles	40 miles	*	400 miles		0
City of Port Hueneme								0
City of San Buenaventura								0
City of Santa Paula								0
City of Simi Valley								0
City of Thousand Oaks								0

* Included in Open Channel/Soft Side and Bottom

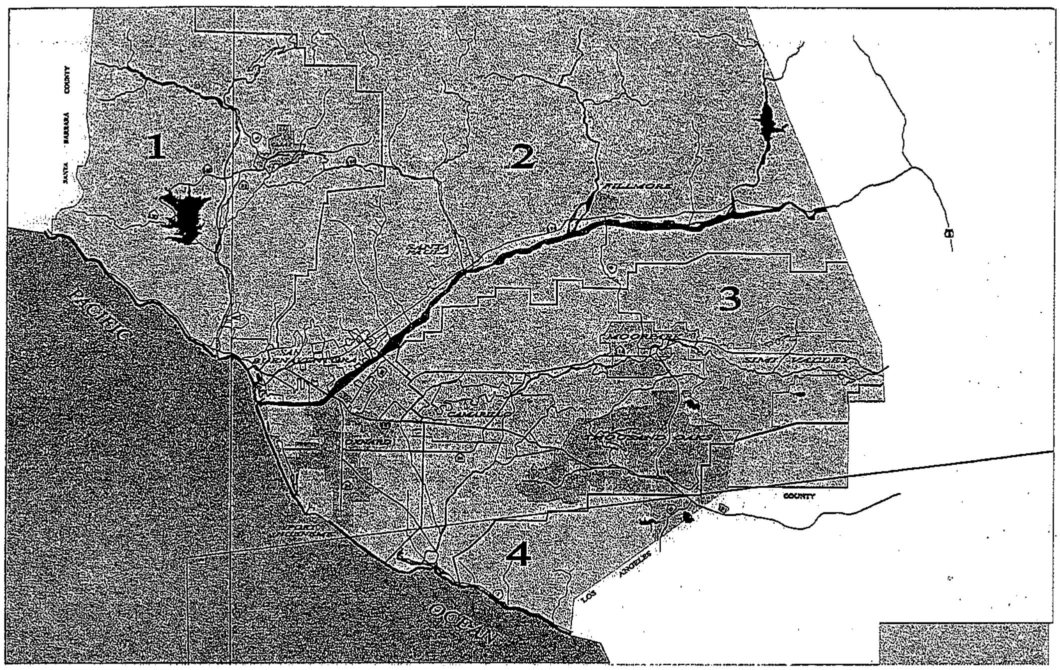

Figure 1-1
Area Covered by the Stormwater Management Plan

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1.2 Permit Coverage/Provisions

1.2.1 Provisions

Program Description

The Ventura County Co-permittees filed a Report of Waste Discharge (ROWD) in February 1999. The February 1999 ROWD contained an application for renewal of waste discharge requirements and an application for a NPDES Permit to discharge stormwater and urban runoff from MS4s to surface waters. The February 1999 ROWD included the Ventura Countywide Stormwater Quality Management Plan (SMP), which described in detail all group activities and entity-specific activities. The SMP was revised in January 2001 to reflect the re-issued NPDES Permit requirements dated July 27, 2000, and again revised in November 2001 to reflect RWQCB comments on the January 27, 2001 revisions. This revised SMP, dated November 1, 2001, describes program details, the tasks required to accomplish permit requirements, the schedule for implementation of permit requirements, and performance criteria. The schedule and tasks are projected for the 5-year Permit period of July 27, 2000 through July 27, 2005 as shown in Table 1-2 (on page 1-24).

The implementation component of the SMP consists of the following elements:

- Program management
- Programs for residents
- Programs for industrial/commercial businesses
- Programs for land development
- Programs for constructions sites
- Public agency activities, and
- Programs for illicit discharge control

The SMP is specifically designed to develop, achieve, and implement a timely, comprehensive, and cost-effective stormwater pollution control program. The ultimate goal of the SMP is to reduce pollutants in Ventura County stormwater discharges to the maximum extent practicable (MEP).

The SMP is an enforceable component of the Permit and has been modified to be consistent with the Permit. This SMP covers activities for all areas within the boundaries of the cities as well as urbanized unincorporated areas of Ventura County, as depicted in Figure 1-1 (on page 1-4) and is organized as specified in the Permit as follows:

- Section 1 describes the overall program management activities.
- Sections 2 through 7 describe implementation activities for various management programs.
- Section 8 discusses methods that will be used to evaluate the overall program.
- Section 9 discusses the monitoring program.

Sections 1 through 7 describe proposed management programs and program elements that are consistent with Permit requirements. Each section includes:

- Program Description– a detailed account of each program element,
- Permit Requirements – citations from the Permit for the program element,
- Annual Reporting requirements – quotes from the Permit Program CI 7388, and
- Performance Criteria– identified actions for Co-permittees, as specified in the Permit.

General guidance material for each program is included as Appendices.

Section 8 describes the requirements to evaluate and assess the effectiveness of the SMP. Results of this process and stormwater quality results taken from the *Storm Water Monitoring Report* are used to generate proposed program modifications. Program evaluation and assessment, a general summary of stormwater quality, and proposed modifications to the SMP are presented in the *Annual Storm Water Report and Assessment*. Section 9 outlines the monitoring program for collecting stormwater quality samples and is the basis for the *Storm Water Monitoring Report.*

NPDES Permit CAS004002 Requirement(s)

Findings – 1.
Ventura County Flood Control District (VCFCD), the County of Ventura, and the Cities of Camarillo, Fillmore, Moorpark, Ojai, Oxnard, Port Hueneme, San Buenaventura, Santa Paula, Simi Valley, and Thousand Oaks (hereinafter referred to separately as Co-permittees and jointly as the Discharger) have joined together to form the Ventura Countywide Storm Water Quality Management Program to discharge wastes under waste discharge requirements contained in Order No. 94-082, adopted by this Board on July 27, 2000. The Discharger discharges or contributes to discharges of storm water and urban runoff from municipal separate storm sewer systems (MS4s), also called storm drain systems, into receiving waters of the Santa Clara River, Ventura River, Calleguas Creek, and other coastal watersheds within Ventura County.

Findings – 6
The Discharger has filed a report of waste discharge (ROWD) and has applied for renewal of its waste discharge requirements and an NPDES permit to discharge wastes to surface waters. The ROWD includes the Ventura Countywide Storm Water Quality Management Plan (hereinafter called Ventura County SMP) which describes in detail all group activities and entity-specific activities. The Ventura County SMP also describes management measures that are included and how they are organized; it lists tasks required to accomplish the measure, the schedule for implementation, and specific goals. The schedule and tasks are projected for the 5-year permit period.

Findings – 12
This permit is intended to develop, achieve, and implement a timely, comprehensive, cost-effective storm water pollution control program to minimize pollutants to the maximum extent practicable in storm water discharges from the permitted area in Ventura County to the waters of the United States.

PART 3.B.1
The Discharger shall modify the Ventura County SMP adopted with this Order to make it consistent with the requirements herein. The revised Ventura County SMP will be submitted to the Regional Board Executive Officer for approval no later than January 27, 2001.

Annual Reporting

None Specified.

Performance Criteria

- Submit the new, revised SMP to RWQCB Executive Officer for approval by January 27, 2001.
- Comply with all requirements and criteria relative to this Program as set forth in the Permit and the SMP.

1.3 Institutional Arrangements

Program Description

The Co-permittees are separate legal entities who have entered into an implementation agreement, naming VCFCD as Principal Co-permittee. The division of responsibilities under the Permit will be in accordance with the implementation agreement (current edition described), which can be modified by the Management Committee. The responsibilities of the Principal Co-permittee and Co-permittees are identified below.

Principal Co-permittee (VCFCD) responsibilities:

- Comply with the requirements of the Permit within its own jurisdictional boundaries (including the review of projects connected to VCFCD storm drain systems).
- Operate and maintain those storm drains owned and operated by VCFCD, including those located within the jurisdiction of the Co-permittees.
- Coordinate Permit activities (see Table 1, on page 1-23, for the schedule of Permit milestones).
- Serve as liaison between the Co-permittees and the RWQCB. This includes:
  - Set time schedules for the performance of activities.
  - Prepare regulatory reports and seek Co-permittee review.
  - Forward Co-permittee information to the RWQCB.
  - Arrange for public review, when needed.
  - Update Co-permittees on RWQCB and EPA regulations.
  - Arrange for collection and payment of Permit renewal fee.
- Secure services of consultants with concurrence of Co-permittees.
- Manage the stormwater quality monitoring program.
- Convene the Management Committee and subcommittee meetings.
- Assign Co-permittees to subcommittees.
- Attend subcommittee meetings.
- Manage the countywide educational and outreach program.

Co-permittee responsibilities:

- Comply with the requirements of the Permit within their own jurisdictional boundaries.
- Provide Permit submittals to the Principal Co-permittee.
- Prepare Permit-required submittals in the format specified by the Principal Co-permittee.
- Develop a program to address the following within its jurisdictional boundaries:
  - Implementation of controls to reduce pollution from industrial/commercial and residential areas.
  - Implementation of structural/nonstructural controls on land development and construction sites.
  - Implementation of controls to reduce pollution from maintenance activities.
  - Elimination of illegal connections and improper disposal of hazardous materials or wastes.
  - Inspection, monitoring and control programs for industrial facilities.
  - Implementation of public awareness and training programs.

VCFCD, as Principal Co-permittee, will provide the overall program management and coordination with the RWQCB. To oversee program development and provide guidance, senior staff from all Co-permittee agencies will attend a Management Committee, chaired by VCFCD. The Management Committee will review materials developed by the subcommittees, provide comments, and approve or reject program activities. Approved program materials will be distributed to all Co-permittees for their use in implementing local stormwater program activities.

Five subcommittees, composed of Co-permittee staff from various departments or contracted representatives will meet as needed to discuss program implementation activities, develop program materials, and advise and make recommendations to the Management Committee.

Each Co-permittee will serve on one or more subcommittees. Subcommittee assignments are based on city population. The subcommittees currently include the following:

- Programs for Residents
- Programs for Industrial and Commercial/Illicit Discharges (one subcommittee covers two program areas)
- Programs for Planning and Land Development
- Programs for Construction Sites
- Programs for Public Agency Activities

Because of the importance of these committees to the implementation of the SMP, performance standards will be applied to meeting attendance as follows:

- Co-permittees will be represented at 100% of all Management Committee meetings.
- Co-permittees will be represented at 100% of all assigned subcommittee meetings. The Management Committee has assigned subcommittee attendance requirements as follows:
    - Oxnard, Thousand Oaks, Ventura, Simi Valley, and Camarillo will be represented at 5 out of 5 meetings.
    - Moorpark, Santa Paula, and Fillmore will be represented at 4 out of 5 meetings.
    - Ojai and Port Hueneme will be represented at 3 out of 5 meetings.

NPDES Permit CAS004002 Requirement(s)

Findings – 10
The Co-permittees are separate legal entities and have the authority to develop, administer, implement, and enforce storm water quality management programs within their own jurisdiction. The Ventura County SMP defines certain storm water discharge requirements that apply to the Discharger, and others that apply to specific Co-permittees. Each Co-permittee is responsible for compliance with relevant portions of this permit with their jurisdiction.

Finding - 11
VCFCD is the Principal Co-permittee for permit implementation while the remaining entities, including the County of Ventura and the ten cities, are designated as Co-permittees. The following Implementation Agreement exists between the Principal Co-permittee and the Co-permittees:

As the Principal Co-permittee, VCFCD will:

a. Coordinate permit activities;

b. Establish uniform data submittal format;

c. Set time schedules;

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d. Prepare regulatory reports;

e. Forward information to the Co-permittees;

f. Arrange for public review;

g. Secure services of consultants as necessary;

h. Implement activities of common interest;

i. Develop/prepare/generate all materials and data common to all Co-permittees;

j. Update Co-permittees on Regional Board and US Environmental Protection Agency (USEPA) regulations;

k. Arrange for collection and payment of annual permit renewal fee; and

l. The Principal Co-permittee shall convene all Management Committee and Subcommittee meetings.

All Co-permittees will:

a. Comply with the requirements of the permit within their own jurisdictional boundaries;

b. Prepare and provide to the Principal Co-permittee permit-required submittals;

c. Develop programs to address:

- *Implementation of controls to reduce pollution from commercial, industrial, and residential areas;*
- *Implementation of structural/non-structural controls on land development and construction sites;*
- *Implementation of controls to reduce pollution from maintenance activities;*
- *Elimination of illegal connections, including discouragement of improper disposal, encouragement of spill prevention and containment, and implementation of appropriate spill response;*
- *Inspection monitoring and control programs for industrial facilities; and,*
- *Implementation of public awareness and training programs.*

d. Co-permittees shall be represented at Management Committee Meetings;

e. There are currently five subcommittees which were developed during the first permit cycle: Residents, Businesses/Illicit Discharges, Planning and Land Development, Construction and Co-permittee Facilities Maintenance. The Management Committee will assign subcommittee attendance requirements in proportion to Co-permittee population. Co-permittees shall be represented at all assigned subcommittee meetings, and,

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f. Within its own jurisdiction, each Co-permittee is responsible for adoption and enforcement of storm water pollution prevention ordinances, implementation of self-monitoring programs and Best Management Practices (BMPs), and conducting applicable inspections. Based upon a countywide model, each Co-permittee, except the City of Simi Valley, has adopted a Storm Water quality Ordinance applicable to their jurisdiction. This is in addition to the 'Control of Water Quality, Soil, Erosion, and Sedimentation of New Agricultural Hillside Developments' adopted by the Board of Supervisors of the county of Ventura on March 20, 1984. The Principal Co-permittee is responsible for the preparation and submittal of progress and annual reports to the Regional Board.

Annual Reporting

None Specified.

Performance Criteria

- Principal Co-permittee will fulfill the responsibilities described above.
- Co-permittees will fulfill the responsibilities described above.
- Co-permittees will be represented at 100% of the Management Committee meetings.
- Co-permittees, Oxnard, Thousand Oaks, Ventura, Simi Valley, and Camarillo will be represented at 100% of subcommittee meetings.
- Co-permittees, Moorpark, Santa Paula, and Fillmore will be represented at 80% of subcommittee meetings.
- Co-permittees, Ojai and Port Hueneme will be represented at 60% of subcommittee meetings.
- Comply with all requirements and criteria relative to this Program as set forth in the Permit and the SMP.

1.4 Program Structure

Program Description

The SMP was prepared and updated to be consistent with the requirements as specified in the Permit (CAS004002). The current NPDES Permit will expire on July 27, 2005. The Permit provides program requirements that will be implemented by all Co-permittees during the five-year Permit term and is organized into six Parts:

- Part 1 – Permit Requirements
- Part 2 – Receiving Water Limitations
- Part 3 – Storm Water Quality Management Plan Implementation, Monitoring, and Reporting
- Part 4 – Special Provisions
- Part 5 – Definitions
- Part 6 – Standard Provisions

These six Parts of the Permit are the basis for the SMP. The SMP is an enforceable document as referenced in the Permit. Due to the evolving nature of science and technology related to stormwater quality management, the SMP may need to be modified in the future. Modifications to the SMP may be approved by the RWQCB after providing the opportunity for public comment:

a. By petition of the Co-permittee or of interested parties, after the submittal of the Annual Monitoring Program Report. Such a petition shall be filed no later than 60 days after the Annual Monitoring Report submittal date, or

b. As deemed necessary by the RWQCB Executive Officer following notice to the Co-permittee.

Such direction may include watershed-specific requirements for watersheds shared by Ventura County and other MS4 programs. The SMP will be modified to address Total Daily Maximum Loads (TMDLs) for specific water bodies, when the request is received from the RWQCB. The typical process for modifying the SMP starts with an issued directive from the RWQCB whereby the Co-permittees will assess what changes are needed. Those changes are submitted back to the RWQCB for approval.

NPDES Permit CAS004002 Requirement(s)

IT IS HEREBY ORDERED that the Ventura County Flood Control District, the County of Ventura, and the Cities of Camarillo, Fillmore, Moorpoark, Ojai, Oxnard, Port Hueneme, San Buenaventura, Santa Paula, Simi Valley, and Thousand Oaks, in order to meet the provisions contained in Division 7 or the California Water Code and regulations adopted thereunder, and the provisions of the Clean Water Act, as amended, and regulations and guidelines adopted thereunder, shall comply with the following:

PART 1
Discharge Prohibitions

PART 2
Receiving Water Limitations

PART 3
Storm Water Quality Management Plan Implementation, Monitoring, and Reporting

PART 4
Special Provisions

The Ventura County SMP submitted by the Discharger is an integral and enforceable component of the permit.

PART 4.G.1
The Permittee shall modify the Ventura County SMP to comply with the waste load allocations developed and approved pursuant to the process for the designation and implementation of Total Daily Maximum Loads (TMDLs) for impaired water bodies

PART 5
Definitions

PART 6
Standard Provisions

Annual Reporting

Co-permittees will provide a comparison of program implementation results to performance standards established in the SMP annually as part of the *Annual Storm Water Report and Assessment.*

Co-permittees will provide the status of compliance for permit requirements including implementation dates for all time-specific deadlines. If permit deadlines are not met, the Discharger shall report the reasons why the requirement was not met, how the requirements will be met in the future, and include projected implementation date as part of the *Annual Storm Water Report and Assessment.*

Co-permittees will assess the effectiveness of the SMP requirements to reduce storm water pollution. This assessment will be based upon the specific record-keeping information requirement in each major section of the permit, monitoring data, and any other data the Discharger has, or is aware of that provides information on program effectiveness. Beginning in the Year 2003, to the extent data collected in monitoring requirements included herein allows, the Discharger shall include an analysis of trends, land use contributions, pollutant source identifications, BMP effectiveness, and impacts on beneficial uses as part of the *Annual Storm Water Report and Assessment.*

Co-permittees will provide an analysis of the data to identify areas of the Program coverage which cause or contribute to exceedances of water quality standards or objectives, predominate land uses in these areas, and potential sources of pollutants in those areas annually as part of the *Annual Storm Water Report and Assessment.*

Co-permittees will discuss the compliance record and the corrective actions taken or planned that may be needed to bring the discharge into full compliance with the waste discharge requirements annually as part of the *Annual Storm Water Report and Assessment.*

Performance Criteria

- Submit the *Annual Storm Water Report and Assessment* by October 1 of each Permit year.
- Comply with all requirements and criteria relative to this Program as set forth in the Permit and the SMP.

1.5 Monitoring and Reporting

Program Description

The SMP includes program and reporting requirements as specified in the Permit. The Permit lists milestone-reporting requirements by program. The reporting schedule is summarized in Table 1-2 (located on page 1-24). Additionally, the Monitoring and Reporting Program, CI-7388, lists reporting requirements for each program (Part I), monitoring requirements (Part II), and program evaluation requirements (Part III). Co-permittees will collect information to fulfill the monitoring and reporting requirements listed in the SMP. The Co-permittees will provide program evaluation results reported in the standardized format, using Annual Report Forms, to the Principal Co-permittee by August 1 of each Permit year. As part of the program evaluation, Co-permittees will also provide an annual self-audit to verify the implementation of the SMP through January 1 of each Permit year. The Principal Co-permittee will provide the self-audit form for the Co-permittees to complete and return to the Principal Co-permittee by February 1 of each Permit year.

Stormwater quality monitoring and Co-permittee information will be used to generate the two reports required by the Permit. The first report is *The Storm Water Monitoring Report*. The *Storm Water Monitoring Report* will be submitted on July 15, 2001 and annually on July 15 thereafter. The report will include status of implementation of the monitoring program, results of the monitoring program; and a general interpretation of the significance of the results, to the extent that data allows, to guide future stormwater monitoring efforts.

The second report, the *Annual Storm Water Report and Assessment* covers each fiscal year from July 1 through June 30 and is due on October 1, 2001 and annually thereafter. The *Annual Storm Water Report and Assessment* includes program information necessary to assess the compliance status of the Ventura Countywide Stormwater Quality Management Program relative to the Permit and the effectiveness of implementation of Permit requirements on stormwater quality. The *Annual Storm Water Report and Assessment* incorporates a general summary of the *Storm Water Monitoring Report* to generate proposed modifications to the stormwater quality monitoring program.

NPDES Permit CAS004002 Requirement(s)

Findings – 7
The Ventura Countywide Storm Water Quality Management Program also includes the Storm Water Monitoring Plan. To date, the monitoring program has consisted of land-use based monitoring combined with receiving water monitoring and modeling. The Discharger intends to sign an agreement to participate in the Regional Monitoring Program established for Southern California municipal programs under the guidance of the Southern California Coastal Water Research Project.

PART 3.D Annual Storm Water Report and Assessment

1. The Discharger shall submit, by October 1 of each year beginning the Year 2001, An Annual Storm Water Report and Assessment documenting the status of the general program and individual tasks contained in the Ventura County SMP, as well as results of analyses from the monitoring and reporting program CI 7388. The Annual Storm Water Report and Assessment shall cover each fiscal year from July 1 through June 30, and shall include the information necessary to assess the Discharger's compliance status relative to this Order, and the effectiveness of implementation of permit requirements on storm water quality. The Annual Storm Water Report and Assessment shall include any proposed changes to the Ventura County SMP as approved by the Management Committee.

PART 3.E Storm Water Monitoring Report

1. The Discharger shall submit a Storm Water Monitoring Report on July 15, 2001 and annually on July 15 thereafter. The report shall include:

a. Status of implementation of the monitoring program as described in the attached Monitoring and Reporting Program, CI-7388.

b. Results of the monitoring program; and

c. A general interpretation of the significance of the results, to the extent that data allows.

Annual Reporting

All Co-permittees shall perform a self-audit to verify implementation of the SMP through January 1 of each year and report the results of the self-audit to the Principal Co-permittee by February 1, 2001, and annually thereafter.

All Co-permittees shall submit program evaluation results, in a standardized format, to the Principal Co-permittee by August 1, 2001, and annually thereafter.

Performance Criteria

- Submit the *Storm Water Monitoring Report* on July 15, 2001 and annually on July 15 of each Permit year.
- Submit the *Annual Storm Water Report and Assessment* by October 1, 2001 and annually on October 1 of each Permit year.
- Annually, each Co-permittee will submit a self-audit, verifying the implementation of the SMP through January 1 of each year and report the results to the Principal Co-permittee by February 1 of each Permit year.
- Annually, each Co-permittee will submit program evaluation results, in a standardized format, to the Principal Co-permittee by August 1 of each Permit year.
- Comply with all requirements and criteria relative to this Program as set forth in the Permit and the SMP.

1.6 Fiscal Resources

Program Description

Co-permittees will prepare an annual stormwater budget update on resources applied to the stormwater program. The budget report will include an annual update identifying the stormwater budget for the following year. Budget amounts are designated as percentages of the total budget. Co-permittees vary in size, accounting systems, and specific stormwater budgets.

Comparison of Co-permittee budget information will consider the size of the Co-permittee, ability to track detailed budgets and account for activities that may not be a part of all budgets. Estimated percentages of the budget proposed per program and written explanations will be used, as necessary, when programs may share a stormwater budget, be covered elsewhere, or have the potential for unforeseen requirements. The following nine budget reporting categories will be used, whenever possible:

1. Program management
2. Illicit connections/illicit discharge
3. Development planning/development construction
4. Construction inspection activities
5. Public Agency Activities
   - Operation and Maintenance
   - Municipal Street Sweeping
   - Fleet and Public Agency Facilities
   - Landscape and Recreational Facilities
6. Capital Costs
7. Public Information and Participation
8. Monitoring Program
9. Other

To fund program activities, Co-permittees will draw on a number of sources:

- VCFCD will use a portion of the Flood Control Benefit Assessment Program to fund its Permit activities. VCFCD is responsible for the cost of program implementation dealing with storm drains and flood control facilities it owns and operates, and the cost of Principal Co-permittee activities specified in the implementation agreement.
- Co-permittees, responsible for the cost of program implementation within their own jurisdictional boundaries, may use the Benefit Assessment Program to supplement funds from other sources.

NPDES Permit CAS004002 Requirement(s)

Findings – 6
...The Ventura County SMP is implemented by the Co-permittees with general funds, and/or Benefit Assessment Program funds.

PART 3.D.2 Storm Water Management Program Budget

a. The Discharger shall prepare annually a storm water budget update on resources applied to the storm water program. This budget report shall include an annual update identifying the storm water budget for the following year using estimated percentages and written explanations where necessary], for the specific categories noted below:

- *i.* *Program management*
- *ii.* *Illicit connections/illicit discharge*
- *iii.* *Development planning/development construction*
- *iv.* *Construction inspection activities*
- *v.* *Public Agency Activities*
    - *Operation and Maintenance*
    - *Municipal Street Sweeping*
    - *Fleet and Public Agency Facilities*
    - *Landscape and Recreational Facilities*
- *vi.* *Capital Costs*
- *vii.* *Public Information and Participation*
- *viii.* *Monitoring Program*
- *ix.* *Other*

Co-permittees, in addition to the Benefit Assessment budget, shall report any supplemental dedicated budgets, if any, for the same categories.

Annual Reporting None Specified.

Performance Criteria

- Co-permittees will update the stormwater program budget report annually as part of the *Annual Storm Water Report and Assessment.*
- Comply with all requirements and criteria relative to this Program as set forth in the Permit and the SMP.

1.7 Legal Authority

Program Description

The Co-permittees are separate legal entities with broad authority to develop, administer, implement, and enforce stormwater management programs within their respective jurisdictions. Although specific stormwater ordinances exist throughout the County, Co-permittees may also use legal authority derived from wastewater, solid and hazardous materials regulations, and various public nuisance ordinances to address stormwater quality issues.

Co-permittees will possess the necessary legal authority required by the Permit to prohibit non-stormwater discharges and control the contribution of pollutants to the storm drain system from stormwater discharges including, but not limited to:

- A prohibition on illicit discharges and illicit connections and a requirement for removal of illicit connections.
- A prohibition on spills, dumping, or disposal of materials other than stormwater.
- A mechanism to control, through interagency agreement, the contribution of pollutants from one portion of the municipal separate sewer system to another portion of the municipal separate storm sewer system.
- A requirement for compliance with conditions in ordinances, permits, contracts or orders.
- The ability to carry out all inspections, surveillance, and monitoring procedures necessary to determine compliance with the Permit, including the prohibition on illicit discharges to the municipal separate storm sewer system.

In 1997, a working group of Co-permittees developed a model stormwater ordinance to specifically and cooperatively addresses stormwater quality issues. VCFCD finalized the document and made it available to all Co-permittees. A copy of the model stormwater ordinance is included as Appendix A.

With the re-issuance of the NPDES Permit, each Co-permittee will review their existing legal authority to implement the stormwater management program set forth in the Permit and the SMP, and if necessary, adopt or amend their legal authority to meet the requirements of the Permit by July, 2001. If existing legal authority is broad enough, Co-permittees may choose to implement program details by establishing policy or programs rather than modifying ordinances.

The following indicates the status of stormwater ordinance adoption.

Co-Permittee	Adopted Date
County of Ventura	July 22, 1997
Moorpark	December 3, 1997
Camarillo	March 25, 1998
Port Hueneme	April 1, 1998
Oxnard	April 24, 1998
Santa Paula	December 16, 1998
San Buenaventura	January 11, 1999
Ojai	February 9, 1999
Thousand Oaks	September 14, 1999
Fillmore	December 27, 1998
Simi Valley	July 23, 2001

NPDES Permit CAS004002 Requirement(s)

PART 3.C Legal Authority

1. *Co-permittees shall possess the necessary legal authority to prohibit non-storm water discharges and control the contribution of pollutants to the storm drain system from storm water discharges, including, but not limited to:*

   a. *A prohibition on illicit discharges and illicit connections and a requirement for removal of illicit connections;*

      i. *Prohibit the discharge of wash waters to the MS4 when gas stations, auto repair garages, or other types of automotive service facilities are cleaned;*

      ii. *Prohibit the discharge of runoff to the MS4 from mobile auto washing, steam cleaning, mobile carpet cleaning, and other such mobile commercial and industrial operations;*

      iii. *Prohibit the discharges of runoff to the MS4 from areas where, repair of machinery and equipment which are visibly leaking oil, fluid or antifreeze, is undertaken;*

      iv. *Prohibit the discharge of runoff to the MS4 from storage areas of materials, containing grease, oil, or other hazardous substances, and uncovered receptacles containing hazardous materials;*

      v. *Prohibit the discharge of chlorinated swimming pool water and filter backwash to the MS4;*

vi. *Prohibit the discharge of untreated runoff from the washing of toxic materials from paved or unpaved areas to the MS4;*

vii. *Prohibit washing impervious surfaces in industrial/commercial areas which results in a discharge of untreated runoff to the MS4, unless specifically required by State or local health and safety codes; and*

viii. *Prohibit the discharge from washing out of concrete trucks, pumps, tools, and equipment to the MS4.*

b. *A prohibition on spills, dumping, or disposal of materials other than storm water;*

i. *Litter, landscape debris and construction debris;*

ii. *Any state or federally banned pesticide, fungicide or herbicide;*

iii. *Food wastes; and*

iv. *Fuel and chemical wastes, animal wastes, garbage, batteries, and other materials which have potential adverse impacts on water quality.*

c. *A mechanism to control, through interagency agreement, the contribution of pollutants from one portion of the MS4 to another portion of the MS4;*

d. *A requirement for compliance with conditions in ordinances, permits, contracts or orders; and,*

e. *The ability to carry out all inspections, surveillance and monitoring procedures necessary to determine compliance and non-compliance with permit conditions, including the prohibition on illicit discharges to the MS4.*

f. *Each Co-permittee shall adopt, no later than July 27, 2001, an agency-specific storm water and urban runoff ordinance or amend an existing one if necessary, based on the countywide model (Appendix A of the Ventura County SMP) to be able to enforce all requirements of the permit.*

Annual Reporting

None Specified.

Performance Criteria

- Each Co-permittee will review their existing legal authority to implement the stormwater management plan set forth in the Permit and the SMP, and if necessary, adopt or amend their legal authority to meet the requirements of the Permit by July 27, 2001.
- Comply with all requirements and criteria relative to this Program as set forth in the Permit and the SMP.

Section 2
Residents

2.1 Overview

This section discusses the following programs for residents:

- Public Reporting
- Stencil Program
- Education and Outreach Program

2.2 Public Reporting

Program Description

Each Co-permittee will identify staff that is to serve as the contact(s) person for public reporting in their jurisdiction. Identification of staff will be complete within six (6) months of Permit issuance (January 27, 2001) and updated as necessary. Updates or confirmation of contact person(s) will be included in the *Annual Storm Water Report and Assessment,* as well as listed on the Ventura Countywide Stormwater Program website (www.vcstormwater.org).

In addition, the telephone number of contact staff will be publicized, by each Co-permittee independently and collectively through countywide projects. Publication of contact information will include listing in the government pages of the phone book, which will clarify to residents how to reach or be directed to the appropriate party.

Designated contact staff will be provided with relevant stormwater quality information. This will include current resident program activities, preventative stormwater pollution control information and contact information for responding to illicit discharge/illegal dumping activities.

Current contact information is listed below:

Public Reporting Contact Information	
Principal Co-permittee	
Ventura County Flood Control District	805.654.3179
Co-permittees	
City of Camarillo	805.388.5380
County of Ventura	805.654.3179
City of Fillmore	805.524.3701
City of Moorpark	805.529.6864
City of Ojai	805.646.5581
City of Oxnard	805.488.3517
City of Port Hueneme	805.986.6564
City of San Buenaventura	805.652.4515
City of Santa Paula	805.933.4212
City of Simi Valley	805.583.6462
City of Thousand Oaks	805.449.2400

NPDES Permit CAS004002 Requirement(s)

PART 4.A.1:
Co-permittees shall identify staff who will serve as the public reporting contact person(s) for reporting clogged catch basin inlets and illicit discharges/dumping, and general storm water management information within 6 months of permit issuance, and thereafter include this information, updated when necessary, in public information, the government pages of the telephone book and the Annual Report as they are developed/published.

The designated contact staff will be provided with relevant storm water quality information including current resident program activities, preventative stormwater pollution control information and contact information for responding to illicit discharges/illegal dumping.

Annual Reporting

Co-permittees will update program contact information as defined above in outreach materials, the government pages of the telephone book (as they are developed/published) and annually as part of the *Annual Storm Water Report and Assessment.*

Performance Criteria

- Co-permittees will report to the Principal Co-permittee relevant program contact information as defined above by January 27, 2001 and update the information as needed. This information will be available in outreach materials, the government pages of the telephone book (as they are developed/published), and the Program's website.
- Comply with all requirements and criteria relative to this Program as set forth in the Permit and the SMP.

2.3 Stencil Program

Program Description

Each Co-permittee will clearly mark storm drain inlets within their jurisdiction with a legible and visible "no dumping" message. This message is intended to inform and educate the public that the storm drain systems flow to the ocean and that contaminated stormwater receives no treatment prior to discharge. The message will consist of a brief, single-line phrase using prohibitive language that clearly discourages illegal dumping. Once labeled, drain inlets will be maintained and re-label when necessary.

In addition, Co-permittees will post signs with prohibitive language to discourage illegal dumping at designated public access point to creeks and other relevant water bodies by July 27, 2002. Posted signs will be maintained and replaced as needed.

NPDES Permit CAS004002 Requirement(s)

PART 4.A.2:
Co-permittees shall mark storm drain inlets with a legible "no dumping" message. In addition, signs with prohibitive language discouraging illegal dumping must be posted at designated public access points to creeks, other relevant water bodies, and channels by July 27, 2002.

Annual Reporting

Co-permittees will provide the number and percentage of the total system of storm drain inlets marked with a "no dumping" message annually as part of the *Annual Storm Water Report and Assessment.*

Performance Criteria

- Co-permittees will mark and maintain 90% of the storm drains with a "no dumping" message.
- Co-permittees will post and maintain signs with prohibitive language discouraging illegal dumping at 90% of the designated public access points to creeks and channels by July 27, 2002.
- Comply with all requirements and criteria relative to this Program as set forth in the Permit and the SMP.

2.4 Education and Outreach Program

Program Description

Each Co-permittee will organize outreach events, training and other activities on stormwater quality within their jurisdiction. Co-permittees will emphasize the importance of using environmentally safe practices at home and work to prevent stormwater pollution. Outreach efforts will include one-on-one, small group learning activities, and other media to deliver a stormwater message that educates and informs the public.

Co-permittee utilize a variety of outreach methods, including:

- Presentations at schools, community groups, etc.
- Contests
- Staffed and non-staffed displays
- Newspaper articles/advertisements
- Brochures
- Utility bill inserts/mailers
- Countywide stormwater website (www.vcstormwater.org)
- Movie/slide presentations
- Television/Radio announcements

For countywide events, the Principal Co-permittee will coordinate Co-permittees' efforts and provide the Co-permittees with information on staffing and supply needs. The Ventura County Fair is an example of a countywide event where the Principal Co-permittee schedules Co-permittee staffing levels as required for effective distribution of educational material and personal contact.

Collectively, the Co-permittees will reach a minimum of 2.1 million contacts per permit year. These contacts will provide the public with information about stormwater quality management by utilizing published material, local TV and radio, and other appropriate media or methods listed above.

NPDES Permit CAS004002 Requirement(s)

PART 4.A.3:
Conduct educational activities within each Co-permittee jurisdiction and participate in countywide events.

PART 4.A.4:
Each Co-permittee shall distribute outreach materials to the general public and school children at appropriate public counters and events. Outreach material shall include information such as proper disposal of litter, green waste, pet waste, proper vehicle maintenance, lawn care, and water conservation practices.

PART 4.A.5:
The Discharge shall insure a minimum of 2.1 million impressions per year are made on the general public about stormwater quality via print, local TV access, local radio, or other appropriate media.

Annual Reporting

Co-permittees will provide a description of program activities including: distributing brochures; community outreach efforts; public communication efforts; and educational programs in schools annually as part of the *Annual Storm Water Report and Assessment.*

Co-permittees will provide the number of impressions per year made on the general public about storm water quality via print, local TV and radio, and meetings or other appropriate media annually as part of the *Annual Storm Water Report and Assessment.*

Performance Criteria

- Each Co-permittee will conduct educational activities within its jurisdiction and participate in countywide events.
- Each Co-permittee shall distribute outreach material that includes information such as, the proper disposal of litter, green waste, and pet waste, proper vehicle maintenance, and lawn care practices. In addition, outreach materials will emphasize water conservation methods and practices.
- Collectively, the Co-permittees will make a minimum of 2.1 million contacts per Permit year using the media types listed above.
- Comply with all requirements and criteria relative to this Program as set forth in the Permit and the SMP.

Section 3
Industrial/Commercial Businesses

3.1 Overview

This section discusses the following programs for industrial and commercial businesses:

- Site Education/Inspection
- Targeted Businesses/POCs
- General Industrial Permit Facility Visits
- Stormwater Quality Staff Training

3.2 Site Education/Inspection

Program Description

Co-permittees will implement an educational site inspection program for industrial and commercial businesses within their jurisdictions. Automotive and food service facilities will be visited once every two years. During site visits, Co-permittees will:

- Consult with a representative of the facility to explain applicable stormwater regulations;
- Distribute and discuss applicable BMP and educational materials; and
- Conduct a site walk-through to inspect for, at a minimum, evidence of illicit discharges, prevention BMPs, and stormwater quality management education programs for employees.

Inspection staff shall meet with the business owner, manager, or designated responsible individual to review the objectives of the inspection, and then walk through the facility. Inspection results shall then be discussed with the business owner or manager. Suggested BMPs are included as Appendix B (Appendices are provided as guidance that may be updated as needed).

Businesses will be scheduled for a follow-up visit whenever evidence of an illicit discharge is found, within six months of the inspection. If during the follow-up inspection evidence still indicates non-compliance, another revisit may be scheduled or enforcement actions may be initiated. Enforcement actions including Notice of Violations (NOVs), Cease and Desist Orders, Administrative Civil Liability actions, and monetary fines, will be used when no action is observed to address, resolve or remove the illicit discharge. As each Co-permittee has adopted their own version of the model ordinance, they have included enforcement provisions to facilitate the site education/inspection program and foster permit compliance.

Co-permittees will develop a database of inspected automotive and food service facilities that includes; facility name, site address, applicable SIC code(s), and NPDES storm water permit coverage. This database will be submitted to the RWQCB and updated annually.

NPDES Permit CAS004002 Requirement(s)

PART 4.B.1
Each Co-permittee shall implement an industrial/commercial educational site inspection program.

PART 4.B.2
Co-permittees shall inspect automotive service and food service facilities in its jurisdiction once every two years. During site visits, Co-permittees shall:

a. Consult with a representative of the facility to explain applicable storm water regulations;

b. Distribute and discuss applicable BMP and educational materials; and

c. Conduct a site visit walk-through to inspect for, at a minimum, evidence of illicit discharges and storm water educational programs for employees

PART 4.B.3
Co-permittees shall revisit automotive and food service facilities where evidence of illicit discharges is found within six months of the inspection. If necessary, Co-permittees will begin enforcement action to remove sources of illicit discharges.

PART 4.B.6
Co-permittees shall provide an annual update of the inspected automotive service, food service ... facilities to this Regional Board in the annual report. The database shall include at a minimum; facility name, site address, applicable SIC code(s), and NPDES storm water permit coverage.

Annual Reporting

Co-permittees shall provide the number of automotive and food service facilities targeted, the number of visits conducted, and the number of outreach contacts made annually as part of the *Annual Storm Water Report and Assessment.*

Co-permittees will develop a database of inspected automotive, and food service facilities which includes the facility name, site address, applicable SIC(s) and NPDES storm water permit coverage by July 27, 2002. This database will be updated annually as part of the *Annual Storm Water Report and Assessment.*

Performance Criteria

- Each Co-permittee will conduct site education/inspections of 90% of automotive, food service, and other targeted businesses in their jurisdiction every two years.
- Businesses will be scheduled for a follow-up visit whenever evidence of an illicit discharge is found, within six months of the education site inspection.
- Comply with all requirements and criteria relative to this Program as set forth in the Permit and the SMP.

3.3 Targeted Businesses/POCs

Program Description

Co-permittees will target additional businesses based on Pollutants of Concern (POCs) for inclusion in the site education/inspection program. Co-permittees may contact these targeted businesses in a manner appropriate to the type of business. Co-permittees shall provide appropriate educational outreach materials.

NPDES Permit CAS004002 Requirement(s)

PART 4.B.4
Based on Pollutants of Concern source identification, additional target businesses may be identified to be included in the inspection program. Co-permittees shall report on the types and proposed actions to be taken in regard to the additional target businesses in annual reports.

PART 4.B.6
Co-permittees shall provide an annual update of ...other targeted facilities to this Regional Board in the annual report. The database shall include at a minimum; facility name, site address, applicable SIC code(s), and NPDES storm water permit coverage.

Annual Reporting

Co-permittees will report the types and proposed actions taken in regard to businesses targeted based on POCs annually as part of the *Annual Storm Water Report and Assessment.*

Co-permittees will develop a database of targeted facilities, which includes the facility name, site address, applicable SIC(s) and NPDES storm water permit coverage by July 27, 2002. This database will be updated annually as part of the *Annual Storm Water Report and Assessment.*

Performance Criteria

- Co-permittees will target additional businesses based on POCs as appropriate.
- Comply with all requirements and criteria relative to this Program as set forth in the Permit and the SMP.

3.4 General Industrial Permit Facility Visits

Program Description

Co-permittees will attempt to identify facilities subject to the State General Industrial Activities NPDES Permit (General Industrial Permit) in their respective jurisdiction. Resources that co-permittees may use to facilitate identifying Phase I industries include:

- State Water Resources Control Board (SWRCB) database of facilities covered by the General Industrial Permit
- Hazardous materials inventories maintained by fire or environmental health departments
- Lists of facilities subject to local wastewater utility's industrial pretreatment program
- City business license records
- Commercially available business listings (e.g., the Dun & Bradstreet database)
- Telephone book business listings
- Non-filers database
- Letters/Use surveys/Mailer with response requested/checklist, etc.

Once facilities are identified, the Co-permittees will visit the targeted facilities by July 27, 2002. During site visits the Co-permittees will complete a site visit checklist developed by the Principal Co-permittee and approved by the RWQCB. The checklist is provided in Appendix B as guidance. This checklist is for guidance only and may be modified by the Co-permittees as needed to incorporate with pre-existing inspection programs. The checklist will indicate the facility name, site address, applicable SIC code(s), whether or not a SWPPP was on site, indication as to whether or not a NOI was submitted, and confirm that educational materials were distributed.

Co-permittees will distribute stormwater pollution prevention information every two years to identified industrial businesses subject to the General Industrial Permit. Educational materials and BMP handouts will be adapted from the *NPDES Storm Water Multi-Sector General Permit for Industrial Activities* (USEPA, 1995). The information will be provided as guidance to help facility owners develop their own programs to reduce potential pollutants to the storm drain system and receiving waters.

Educational materials will include the following specific requirements of the General Industrial Permit:

- Facilities subject to the General Industrial Permit must file an Notice of Intent (NOI) with the State Board
- A Storm Water Pollution Prevention Plan (SWPPP) must be available on site

Educational materials will also include information describing illicit discharges. Emphasis will be placed on prohibited discharges, preventative methods for illicit discharges, what to do in the event of an illicit discharge, and penalties that can be assessed for non-compliance.

Co-permittees who determine that a facility may not be in compliance with the General Industrial Permit may choose to refer a facility to the RWQCB for further action. Follow-up inspections and enforcement of the General Industrial Permit will be accomplished by the permitting agency, the State or the RWQCB.

Co-permittees will develop a database of businesses identified as Phase I industrial facilities that includes; facility name, site address, applicable SIC code(s), and NPDES storm water permit coverage, if applicable. This database will be updated annually or as needed.

NPDES Permit CAS004002 Requirement(s)

PART 4.B.5
No later than July 27, 2002, each Co-permittee shall conduct a site visit and complete a site visit checklist provided by the Regional Board, and distribute educational program materials to facilities identified as subject to the State Board General Industrial Permit. Thereafter, material will be redistributed once every two years. These industrial facilities shall be notified of specific requirements contained in the Statewide Industrial General Permit including: that such facilities must file a Notice of Intent (NOI) with the State Board, and that a Storm Water Pollution Prevention Plan (SWPPP) must be available on the site. Educational materials shall also include information describing illicit discharges. The information shall include: types of discharges prohibited, how to prevent illicit discharges, what to do in the event of an illicit discharge, and the array of enforcement actions the facility may be subject to, including penalties that can be assessed. The Co-permittee shall note on the site-visit checklist if an NOI has been submitted and if a SWPPP is available on site.

PART 4.B6
Co-permittees shall provide an annual update of ... facilities identified as Phase I industrial facilities to this Regional Board in the annual report. The database shall include at a minimum; facility name, site address, applicable SIC code(s), and NPDES storm water permit coverage.

Annual Reporting

Co-permittees shall provide the number of industrial facilities potentially subject to the General Industrial Permit, the number of visits conducted, the number of outreach contacts made, and the number of facilities that have failed to file a Notice of Intent (NOI) annually as part of the *Annual Storm Water Report and Assessment.*

Co-permittees will develop a database of businesses identified as Phase I industrial facilities, and include the facility name, site address, applicable SIC(s) and NPDES storm water permit coverage by July 27, 2002. This database will be updated annually as part of the *Annual Storm Water Report and Assessment.*

Performance Criteria

- Co-permittees will distribute educational materials to 90% of facilities identified as potentially subject to the General Industrial Permit and perform site visits as locally determined necessary to complete a checklist. The checklist will list the SIC code of the industrial users, indicate whether an identified site has obtained coverage under the State General Industrial Permit, and if a SWPPP is available on site.
- Comply with all requirements and criteria relative to this Program as set forth in the Permit and the SMP.

3.5 Stormwater Quality Staff Training

Program Description

Each Co-permittee will identify inspection staff and other personnel based on the type of stormwater quality and pollution issues that they may encounter during the performance of their regular inspections or daily activities. Training may target staff members who perform inspection activities as part of the HAZMAT, Environmental Health, and Wastewater Pretreatment Programs as well as staff who may respond to questions from the public or industrial/commercial businesses.

Staff will be trained in a manner that will provide adequate knowledge for effective business inspections, enforcement, and answering questions from the public or industrial/commercial operators who contact Co-permittees. Training may consist of informal "tailgate" meetings, formal classroom training, or self-guided training methods. All employees in targeted positions shall be trained regarding the requirements of the storm water quality management program by January 27, 2001 and annually thereafter.

Co-permittee industrial/commercial staff training will include appropriate information on the prevention, detection, and investigation of illicit discharges and illegal connections (ID/IC). See Section 7 for more information regarding ID/IC training.

NPDES Permit CAS004002 Requirement(s)

PART 4.B.7
Co-permittees shall train their employees in targeted positions (whose jobs or activities directly affect storm water quality, or those who respond to questions from the public), including inspection staff, regarding the requirements of the storm water management program by January 27, 2001, and annually thereafter.

Annual Reporting

Co-permittees will provide the percentage of targeted staff trained annually as part of the *Annual Storm Water Report and Assessment.*

Performance Criteria

- Co-permittees will train 90% of targeted employees by January 27, 2001 and annually thereafter.
- Comply with all requirements and criteria relative to this Program as set forth in the Permit and the SMP.

Section 4
Planning and Land Development

4.1 Overview

This section discusses the following programs for planning and land development:

- Land Use Planning and Environmental Review
- Development Standards – Technical Manual
- Environmentally Sensitive Areas
- Development Community Outreach
- Stormwater Quality Staff Training

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4.2 Land Use Planning and Environmental Review

4.2.1 Project Review and Conditioning

Program Description

Development and redevelopment projects can potentially discharge pollutants to stormwater. By recognizing this potential and addressing it throughout the development process, these impacts can be controlled. Co-permittees approach stormwater concerns early in the project development process when the options of pollution control are greatest and the cost to incorporate these controls into new development and redevelopment projects are least.

Co-permittees will implement the Stormwater Quality Urban Impact Mitigation Plan (SQUIMP) for new private development projects that fall into one or more of the following categories:

- Single-family hillside residences;
- 100,000 square foot commercial development;
- Automotive repair shops;
- Retail gasoline outlets;
- Restaurants;
- Home subdivisions with 10 or more housing units;
- Locations within, or directly adjacent to or discharging to a SQUIMP Environmentally Sensitive Area; and,
- Parking lots of 5,000 square feet or more or with 25 or more parking spaces and potentially exposed to stormwater runoff.

Private redevelopment projects that result in the creation or addition of 5,000 square feet or more of impervious surfaces are subject to the requirements of the SQUIMP. If a redevelopment project creates or adds 50% or more impervious surface area to the existing impervious surfaces, then stormwater runoff from the entire area (existing and additions) must be conditioned for stormwater quality mitigation. Otherwise, only the additional area of redevelopment project requires mitigation.

The SQUIMP lists the minimum required Best Management Practices (BMPs) that must be implemented for new private development and private redevelopment projects subject to SQUIMP.

The minimum requirements include the following BMPs:

- Control peak stormwater runoff discharge rates;
- Conserve natural areas;
- Minimize stormwater pollutants of concern;

- Protect slopes and channels;
- Provide storm drain stenciling and signage;
- Properly design outdoor material storage areas;
- Properly design trash storage areas;
- Provide proof of ongoing BMP maintenance;
- Meet design standards for structural or treatment control BMPs; and
- Comply with provisions applicable to individual priority project categories, which include the following:
  - 100,000 square foot commercial developments;
  - Restaurants;
  - Retail gasoline outlets;
  - Automotive repair shops; and
  - Parking lots.

The SQUIMP provides a Co-permittee, through adoption of an ordinance or code incorporating requirements of the SQUIMP, the ability to provide a waiver from SQUIMP requirement(s) if impracticability for a specific property can be established. This waiver may only be granted when all other structural or treatment control BMPs have been considered and rejected as infeasible. Details on the specific requirements for granting waivers are included in the SQUIMP.

The SQUIMP also contains provisions that provide suggested limitations and restrictions on infiltration BMPs. Areas identified in Ventura County where the application of infiltration BMPs should be limited are identified on a map contained in the SQUIMP. Use of infiltration BMPs in those identified areas should provide pretreatment to ensure groundwater protection from pollutants of concern.

During the development review process, the Co-permittees will identify development and redevelopment projects that fall into one or more of the categories covered in the SQUIMP. These projects will be conditioned to comply with all applicable provisions of the SQUIMP. Examples of project conditions are contained in Appendix C. These example conditions are for guidance only and may be modified by the Principal Co-permittee as needed to implement the requirements of the SQUIMP and the SMP, Land Use Planning and Development Program. Co-permittees are encouraged to identify applicable projects early, so that projects can be conditioned when the options for incorporation of SQUIMP requirements are greatest and the cost are least. This is also a good opportunity to conduct educational outreach to project participants regarding the requirements of the Program for Planning and Land Development (see Section 4.5).

In addition to complying with the requirements in the SQUIMP, projects should be conditioned to comply with the Ventura Countywide Stormwater Quality Management Program Land Development Guidelines and the SMP Construction Program (see Section 5). The Development Guidelines are contained in Appendix C. These guidelines may be modified by the Principal Co-permittee as needed to implement the requirements of the SQUIMP and the SMP.

Water quality control BMPs must be adequately maintained if they are to provide long-term water quality protection. Co-permittees will condition projects subject to the SQUIMP to develop and implement a long-term operation and maintenance plan for water quality protection BMPs included in the project.

The operation and maintenance plans will contain:

- Operation procedures
- Procedures for routine maintenance (such as debris removal, vegetation clearing, maintenance frequency);
- Procedures for corrective maintenance (such as parts replacement);
- Maintenance performance levels;
- Identification of the party responsible for operation and maintenance; and
- Inspection and reporting requirements.

When a non-public agency (e.g., the landowner, homeowners' associations, etc.) is responsible for the long-term operation and maintenance, the Co-permittees will require formal designations of responsibility. This can be done through deed restrictions or other formal mechanisms that inform all future owners of the requirements for the continuous operation and maintenance of the stormwater quality control BMPs on site. All operation and maintenance plans will include a written and executed statement from the responsible party accepting operation and maintenance responsibilities.

After a project is initially conditioned, Co-permittees will need to verify in subsequent project reviews that stormwater quality protection conditions are being adequately incorporated. In lieu of conducting detailed reviews of BMP designs, the Co-permittees may accept a certification from a Civil Engineer or a licensed Architect registered in California, that the plan meets the requirements of this program. Details on the certification process are included in the SQUIMP.

Once it has been determined, through detailed review or by certification, that a project will fully comply with stormwater quality protection conditions required by this program, the project may be deemed complete for further processing. Issuance of building and grading permits will not occur until full compliance is achieved.

4.2.2 Environmental Review

Program Description

The California Environmental Quality Act (CEQA) sets forth requirements for the processing and environmental review of many projects. CEQA processing and review provide excellent opportunities to address stormwater quality issues related to proposed projects early in the planning stages. The National Environmental Quality Act (NEPA) comes into play less often than CEQA, but may surface on projects involving Federal funding. Like CEQA, NEPA processing and review provide excellent opportunities to address stormwater quality issues related to proposed projects early in the planning stages.

Each Co-permittee will review their internal planning procedures for preparing and reviewing CEQA (and NEPA when applicable) documents, and for linking stormwater quality mitigation conditions (including those required to protect sensitive areas) to legal discretionary project approvals. If necessary to comply with the requirements of the SMP, the Land Use Planning and Development Program, or the Permit, the Co-permittee will make appropriate revisions to the procedures.

The Co-permittees will consider stormwater quality issues during processing of environmental checklists, initial studies, or environmental impact reports required by CEQA, and during processing of similar documents where NEPA applies. This process will include consideration of SQUIMP Environmentally Sensitive Areas based on state designations no later than January 27, 2001, and based on the list developed by the Principal Co-permittee no later than July 27, 2001.

4.2.3 General Plan Revisions

Program Description

The Co-permittees' General Plans provide the foundation and the framework for land use planning and development. Therefore, the General Plans reflect overall policies for protection of stormwater quality.

Each Co-permittee will include watershed and stormwater management considerations in the appropriate elements of their General Plans whenever these elements are significantly rewritten.

NPDES Permit CAS004002 Requirement(s)

PART 4.C.1
The Discharger shall implement the approved Ventura Countywide Stormwater Quality Urban Impact Mitigation Plan (SQUIMP) (Attachment A) no later than January 27, 2001. The SQUIMP shall address conditions and requirements for new development and significant redevelopment. At a minimum, appropriate elements of the SQUIMP will be included as project requirements for the following development categories:

a. *Single-family hillside residences;*
b. *100,000 square foot commercial developments;*
c. *Automotive repair shops;*
d. *Retail gasoline outlets;*
e. *Restaurants;*
f. *Home subdivisions with 10 or more housing units;*
g. *Locations within, or directly adjacent to or discharging directly to an environmentally sensitive area; and,*
h. *Parking lots of 5,000 square feet or more or with 25 or more parking spaces and potentially exposed to storm water runoff.*

PART 4.C.4
Co-permittees shall make appropriate modifications to their internal planning procedures for preparing/reviewing CEQA documents, and for linking storm water quality mitigation conditions to legal discretionary project approvals.

PART 4.C.6
The Permittee shall include watershed and storm water management considerations in the appropriate elements of the Permittee's General Plan whenever said elements are significantly rewritten. Appropriate elements include, but are not limited to, water quality protection, development goals and policies, open space goals and policies, preservation of and integration with natural features, and water conservation policies.

Board Order No. 00-108 Stormwater Quality Urban Impact Mitigation Plan

...This SQUIMP contains a list of the minimum required Best Management Practices (BMPs) that shall be used for a designated project. Additional BMPs may be required by ordinance or code adopted by the Co-permittees and applied generally or on a case by case basis. The Co-permittees are required to implement the requirements set herein in their own jurisdictions. Developers shall incorporate appropriate SQUIMP requirements into the project plans for the projects covered by the SQUIMP requirements. Each Co-permittee will approve the project plan as part of the development plan approval process.

All projects that fall into one of eight categories are identified in the Ventura Countywide Municipal Permit are requiring SQUIMPs.

These categories are:

a. Single-Family Hillside Residences
b. 100,000 Square Foot Commercial Developments
c. Automotive Repair Shops
d. Retail Gasoline Outlets
e. Restaurants
f. Home subdivisions with 10 or more housing units
g. Location within or directly adjacent to or discharging directly to an environmentally sensitive area
h. Parking lots with 5,000 square feet or more impervious parking or access surfaces or with 25 or more parking spaces and potentially exposed to storm water runoff

The SQUIMP requirements shall take effect not later than January 27, 2001 for projects identified herein that have not received development/ planning permit approval or been deemed complete for processing prior to July 27, 2000.

SQUIMP PROVISIONS APPLICABLE TO ALL CATEGORIES:

1. *[Control] Peak Storm Water Runoff Discharge Rates...*
2. *Conserve Natural Areas...*
3. *Minimize Storm Water Pollutants of Concern...*
4. *Protect Slopes and Channels...*
5. *Provide Storm Drain Stenciling and Signage...*
6. *Properly Design Outdoor Material Storage Areas...*
7. *Properly Design Trash Storage Areas...*
8. *Provide Proof of Ongoing BMP Maintenance...*
9. *[Meet] Design Standards for Structural or Treatment Control BMPs*
10. *[Comply with] Provision Applicable to Individual Priority Project Categories...*
11. *[Comply with Provision for] Waiver[s]*
12. *[Comply with] Limitation on Use of Infiltration BMPs*
13. *[Comply with Provisions for] Alternative Certification for Storm Water Treatment Mitigation*

Annual Reporting

Co-permittees will provide the percentage of the total development projects reviewed for storm water and conditioned to meet SQUIMP requirements annually as part of the *Annual Storm Water Report and Assessment.*

Co-permittees will provide the scheduled date of a significant rewrite of the Co-permittees' General Plan annually as part of the *Annual Storm Water Report and Assessment.*

Performance Criteria

- Co-permittees will review 90% of all private development and redevelopment projects, falling into one or more of the categories specified above and condition these projects to comply with appropriate elements of the SQUIMP. Projects that received development planning permit approvals or were deemed complete for processing prior to July 27, 2000 do not need to be conditioned to comply with the SQUIMP.
- Each Co-permittee shall review internal planning procedures for preparing and reviewing CEQA documents and for linking stormwater quality mitigation conditions (including those required to protect SQUIMP Environmentally Sensitive Areas) to legal discretionary project approvals.
- If necessary to comply with the requirements of the SMP, or the Permit, planning procedures shall be modified.
- Co-permittees will consider stormwater quality during processing of environmental checklists, initial studies, or environmental impact reports required by CEQA, and during processing of similar documents where NEPA applies.
- Co-permittees will include watershed and stormwater management considerations in the appropriate elements of the Co-permittee's General Plan whenever these elements are significantly rewritten.
- Comply with all requirements and criteria relative to this Program as set forth in the Permit and the SMP.

4.3 Development Standards – Technical Manual

Program Description

Protection of water quality requires that Best Management Practices (BMPs) be designed in accordance with criteria sufficient to meet the requirements of the stormwater quality management program, without causing collateral, negative impacts elsewhere in the environment. In addition, the science and technology of stormwater quality management continues to evolve. Therefore, it is necessary to develop BMP design criteria and then to periodically update the criteria to reflect the current state of knowledge and available technologies.

The Principal Co-permittee will prepare a technical manual by July 27, 2002, which includes the following:

- Specifications for treatment control BMPs and structural BMPs based on the flow-based and volume-based water quality design criteria in the SQUIMP;
- Criteria that can be implemented consistently throughout the permit area; and
- Criteria for the control of discharge rates and duration for the purposes of maintaining or reducing pre-development downstream erosion, and for protecting stream habitat.

The technical manual will be consistent with and no less stringent than the design criteria in the SQUIMP, and will be submitted to the RWQCB Executive Officer for approval.

NPDES Permit CAS004002 Requirement(s)

PART 4.C.2
The Discharger shall no later than July 27, 2002, prepare a technical manual, which shall include:

a. specifications for treatment control BMPs and structural BMPs based on the flow-based and volume-based water quality design criteria for the purposes of countywide consistency, and

b. criteria for the control of discharge rates and duration.

Notwithstanding the requirement that the BMP design criteria be incorporated into a technical manual, the criteria shall be effective as of July 27, 2000. The technical manual criteria shall be consistent with, and must not be less stringent than the design criteria in the SQUIMP, and shall be subject to approval by the Regional Board Executive Officer.

Annual Reporting

None Specified.

Performance Criteria

- The Principal Co-permittee will prepare the technical manual specified above and submit it to the RWQCB Executive Officer for approval by July 27, 2002.
- Comply with all requirements and criteria relative to this Program as set forth in the Permit and the SMP.

4.4 Environmentally Sensitive Areas

Program Description

Some areas, due to their plant or animal life or their habitats, could be degraded by water quality changes caused by human activities, and may require special consideration in the SMP, Land Use Planning and Development Program. For the purposes of the SMP, the SQUIMP, and the Permit, these areas are referred to as Environmentally Sensitive Areas (ESA).

The Co-permittees shall consider ESAs in the development planning and conditioning process in accordance with the following schedule:

- State ESAs will be considered as of January 27, 2001
- ESAs defined in this section will be considered as of July 27, 2001

The Principal Co-permittee developed the following description to identify ESAs. This description in included in the SMP to comply with permit requirements to identify ESAs by January 27, 2001, and is suitable for use in the Land Use Planning and Development Program and the conditioning of projects for the application of SQUIMP requirements.

ESAs are defined as follows:

Areas of Special Biological Significance (ASBS) by the State Water Resources Control Board, areas designated as a significant natural resource by the California Resources Agency, and the bed and banks of 303(d) listed waters (map on page 4-12) that are also unimproved channels. Projects that are exempt from this definition include:

- Single Family Residences (except those that meet Permit definition of Hillside Residences)
- Commercial developments less than 100,000 square feet except:
    - Automotive repair shops;
    - Retail Gasoline Outlets; and
    - Restaurants, where the land area available for development or redevelopment is greater than 5000 sq. ft.
- Parking lots with less than 5000 sq. ft. of impervious surface or with less than 25 parking spaces that are exposed to stormwater runoff;
- Home subdivisions with less than 10 housing units; and
- Any project that does not have the potential to discharge any listed pollutant/stressor of the 303(d) listed waterbody.

The Principal Co-permittee may provide narrative or graphical depictions of ESAs to the Co-permittees to aid in their application of the ESA definition, if determined by the Principal Co-permittee to be needed or necessary.

NPDES Permit CAS004002 Requirement(s)

PART 4.C.3.
The Discharger shall identify no later than January 27, 2001, specific environmentally sensitive areas in Ventura County for the application of SQUIMP requirements, based on the Regional Board's Basin Plan and CWA Section 303 (d) Impaired Water-bodies List, and submit the list to the Regional Board Executive Officer for approval. Once approved, this list will supplement the state designations included in the definition of "Environmentally Sensitive Areas".

PART 4.H.2.
Requirements for new development and significant redevelopment in environmentally sensitive areas shall be incorporated into enforceable documents such as land development guidelines and city ordinances no later than July 27, 2001.

a. Requirements of the SQUIMP as they relate to the supplemental list of "Environmentally Sensitive Areas" identified based on the Regional Board's Basin Plan and the CWA Section 303 (d) Impaired Water-bodies List shall take effect no later than July 27, 2001.

b. Requirements of the Stormwater Quality Urban Impact Mitigation Plan for state designations of "Environmentally Sensitive Areas" shall take effect no later than January 27, 2001.

Annual Reporting

None Specified.

Performance Criteria

- ESAs were to be identified by January 27, 2001, and the requirements for new development and redevelopment in ESAs were to be included in land development guidelines and ordinances. The Principal Co-permittee submitted the above ESA definition to the RWQCB by the permit required date. However, due to the significance of ESAs and the RWQCB's desire for additional clarification and delineation of ESAs, further action on an ESA definition has been delayed until the L.A. Permit is re-issued and the definition of an ESA is clarified.
- Each Co-permittee shall review internal planning procedures for preparing and reviewing CEQA documents and for linking stormwater quality mitigation conditions (including those required to protect Environmentally Sensitive Areas) to legal discretionary project approvals. If necessary to comply with the requirements of SMP or the Permit, the planning procedures shall be modified. Consideration of Environmentally Sensitive Areas based on state designations shall take effect no later than January 27, 2001, and based on the ESA definition provided in this section no later than July 27, 2001. However, due to the significance of ESAs and the RWQCB's desire for additional clarification and delineation of ESAs, further action on an ESA definition has been delayed until the L.A. Permit is re-issued and the definition of an ESA is clarified.
- Comply with all requirements and criteria relative to this Program as set forth in the Permit and the SMP.

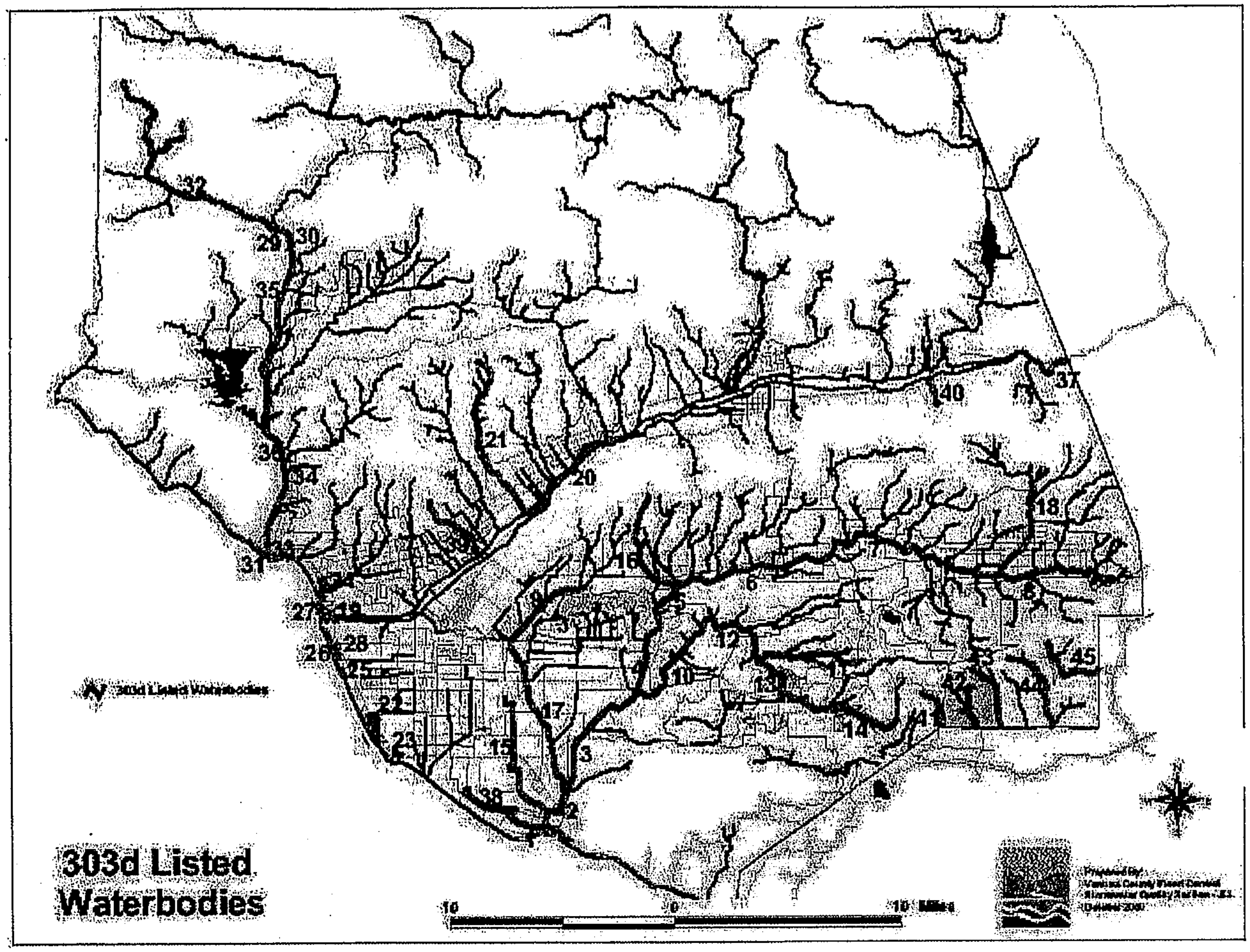

Figure 4-1
303d Listed Waterbodies

4.5 Development Community Outreach

Program Description

The Co-permittees will discuss stormwater quality management program requirements and concerns with developers, engineers, planners, architects, builders, and others, when relevant, and will emphasize requirements of the Stormwater Quality Urban Impact Mitigation Plan (SQUIMP).

Appropriate materials will be made available to educate the land use planning and development community. Suitable materials include those previously developed by the Ventura Countywide Stormwater Quality Management Program. Other materials may be developed, as needed.

The Co-permittees will track their outreach efforts to the land use planning and development community and coordinate the results of their efforts with the education and outreach program discussed in Section 2.

NPDES Permit CAS004002 Requirement(s)

None Specified.

Annual Reporting

Co-permittees will provide a description of activities of distributing brochures, community outreach efforts, public communication efforts, and include an estimate of the number of contacts made to the land development community about storm water quality via print, meetings, or other appropriate venues annually as part of the *Annual Storm Water Report and Assessment.*

Performance Criteria

- During meetings involving developers, engineers, planners, architects, builders, and others involved in land use planning and development, the Co-permittees will discuss stormwater quality controls as appropriate.
- Comply with all requirements and criteria relative to this Program as set forth in the Permit and the SMP.

4.6 Stormwater Quality Staff Training

Program Description

Each Co-permittee will identify employees who are involved in planning and land development. Identified staff will be targeted for training regarding the requirements of the Program for Planning and Land Development, including requirements for the Stormwater Quality Urban Impact Mitigation Plan (SQUIMP). Targeted employees may include staff involved with planning, review, conditioning, or permitting of development projects or in administration of departments that conduct these activities.

Staff will be trained in a manner that will provide adequate knowledge of the Program for Planning and Land Development, including SQUIMP. Training may be done using informal meetings, formal classroom training, or self-guided training methods. All employees in targeted positions will be trained by January 27, 2001, and annually thereafter.

Co-permittee planning and land development staff training will include appropriate information on the prevention, detection, and investigation of illicit discharges and illegal connections (ID/IC). See Section 7 for more information on the ID/IC training program.

NPDES Permit CAS004002 Requirement(s)

PART 4.C.5
Co-permittees shall train their employees in targeted positions (whose jobs or activities are engaged in development planning) regarding the requirements of the SQUIMP no later than January 27, 2001, and annually thereafter.

Annual Reporting

Co-permittees will provide the percentage of targeted staff trained annually as part of the *Annual Storm Water Report and Assessment.*

Performance Criteria

- Co-permittees will train 90% of targeted employees by January 27, 2001 and annually thereafter. Training shall include coverage of SQUIMP requirements.
- Comply with all requirements and criteria relative to this Program as set forth in the Permit and the SMP.

Section 5
Construction Sites

5.1 Overview

This section discusses the following programs for construction sites:

- SWPCP Preparation, Certification, and Implementation
- Incorporating Best Management Practices
- Notice of Intent Requirement
- Construction Site Inspection Program
- Construction Community Outreach
- Stormwater Quality Staff Training

5.2 SWPCP Preparation, Certification, and Implementation

Program Description

Each Co-permittee will require that Storm Water Pollution Control Plans (SWPCPs) be prepared for appropriate construction projects and then implemented throughout the duration of construction and remain in effect until the construction site is stabilized and all construction activity is complete. The SWPCP will identify potential pollutant sources that may affect the quality of discharges to stormwater and will include the design, placement, and maintenance of appropriate Best Management Practices (BMPs) to effectively prevent the entry of pollutants from the construction site into the storm drain system. At a minimum, the preparation, certification, and implementation of the SWPCP must ensure that the following minimum requirements are met to the MEP.

- Sediments generated on the project site shall be retained using structural drainage controls.
- No construction-related materials, wastes, spills, or residues shall be discharged from the project site to streets, drainage facilities or adjacent properties by wind or runoff.
- Non-stormwater runoff from equipment and vehicle washing and any other activity shall be contained at the project site.
- Erosion from slopes and channels will be eliminated, by implementing BMPs, including, but not limited to, limiting of grading scheduled during the wet season, inspecting graded areas during rain events, planting and maintenance of vegetation on slopes, and covering erosion susceptible slopes.

SWPCPs will be developed consistent with guidance prepared by the Ventura Countywide Stormwater Quality Management Program. Current guidance for SWPCP preparation is contained in Appendix D. This guidance is subject to modification and revision as determined by the Principal Co-permittee for consistency with the Permit and to conform to conditions in Ventura County.

Storm Water Pollution Prevention Plans (SWPPPs) prepared for projects subject to the General Construction Activities Storm Water Permit – NPDES Permit No. CAS000002 (General Permit) may be accepted as the SWPCP for a project if the SWPPP meets all requirements in the General Permit and the minimum requirements noted below.

Each Co-permittee will require that a properly certified SWPCP be submitted prior to issuance of a grading permit for projects that are located in a hillside area, or will result in soil disturbance of one acre or more, or is within or discharging directly to or directly adjacent to an environmentally sensitive area (ESA).

Each Co-permittee will review their grading permit process to determine appropriate procedures for requiring the submittal of SWPCPs for candidate projects prior to issuance of grading permits, and modify procedures if needed.

Each Co-permittee will incorporate SWPCP provisions in Co-permittee construction projects, which result in soil disturbance of one acre of more, is located in a hillside area, or is directly discharging to an ESA. Provisions will set forth contractor responsibilities for SWPCP preparation, implementation, and for performance of the work and ancillary activities in accordance with the SWPCP approved by the Co-permittee for the project.

When a pre-construction meeting between the Co-permittee and contractor is held, the SWPCP and/or stormwater quality controls and management practices appropriate for the construction activity will be discussed. If a pre-construction meeting is not held, Co-permittee staff will discuss the SWPCP and/or stormwater quality controls and management practices with the contractor throughout the course of construction.

NPDES Permit CAS004002 Requirement(s)

PART 4.D.1.
Co-permittees shall require the preparation, submittal, and implementation of a Storm Water Pollution Control Plan (SWPCP) prior to issuance of a grading permit for construction projects that meet one of the following criteria:

a. *Will result in soil disturbance of one acre or more in size;*

b. *Is within or discharging directly adjacent to an environmentally sensitive area or,*

c. *Is located in a hillside area.*

PART 4.D.2.
Co-permittees shall prepare and implement a SWPCP on Co-permittee construction projects, as required above.

PART 4.D.3
The SWPCP shall include appropriate construction site BMPs selected from documents such as the California Storm Water BMP Handbook, the Caltrans Storm Water Handbook, Ventura County Stormwater Quality Standard Sheet, EPA database and American Society of Civil Engineers (ASCE) database. In addition, Co-permittees shall ensure the following minimum requirements are met, to the maximum extent practicable, at construction sites regardless of size:

a. *Sediments generated on the project site shall be retained using structural drainage controls;*

b. *No construction-related materials, wastes, spills, or residues shall be discharged from the project site to streets, drainage facilities or adjacent properties by wind or runoff;*

c. *Non-storm water runoff from equipment and vehicle washing and any other activity shall be contained at the project site;*

d. *Erosion from slopes and channels will be eliminated, by implementing BMPs, including, but not limited to, limiting of grading scheduled during the wet season, inspecting graded areas during rain events, planting and maintenance of vegetation on slopes, and covering erosion susceptible slopes.*

PART 4.D.4

The SWPCP must include the rationale used for selecting or rejecting BMPs. The project architect, or engineer of record, or authorized qualified designee, must sign a statement on the SWPCP to the effect:

"As the architect/engineer of record, I have selected appropriate BMPs to effectively minimize the negative impacts of this project's construction activities on storm water quality. The project owner and contractor are aware that the selected BMPs must be installed, monitored, and maintained to ensure their effectiveness. The BMPs not selected for implementation are redundant or deemed not applicable to the proposed construction activity."

The Landowner shall sign a statement to the effect:

"I certify that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, to the best of my knowledge and belief, the information submitted is true, accurate, and complete. I am aware that submitting false and/or inaccurate information, failing to update the SWPCP to reflect current conditions, or failing to properly and/or adequately implement the SWPCP may result in revocation of grading and/or other permits or other sanctions provided by law."

The SWPCP certification shall be signed by the landowner as follows:

(1) For a corporation: by a responsible corporate officer which means (a) a president, secretary, treasurer, or vice president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision-making functions for the corporation, or (b) the manager of the construction activity if authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures;

(2) For a partnership or sole proprietorship: by a general partner of the proprietor; or

For a municipality or other public agency: by an elected official, a ranking management official (e.g., County Administrative Officer, City Manager, Director of Public Works, City Engineer, District Manager), or the manager of the construction activity if authority to sign SWPCPs has been assigned or delegated to the manager in accordance with established agency policy.

Annual Reporting

Co-permittees will provide the number of construction projects requiring SWPCPs and the percentage of projects in categories requiring submittal of a SWPCP for which SWPCPs were completed annually as part of the *Annual Storm Water Report and Assessment.*

Performance Criteria

- Co-permittees will require 90% of construction projects that meet the criteria specified above, to submit a SWPCP that meets the criteria also specified above, prior to issuance of a grading permit.
- For construction projects that prepare a SWPCP under this program, require implementation of the SWPCP during the entire course of construction.
- Comply with all requirements and criteria relative to this Program as set forth in the Permit and the SMP.

5.3 Incorporating Best Management Practices

Program Description

Each Co-permittee will require that SWPCPs for construction sites incorporate appropriate BMPs, including both control measures and management practices. The BMPs are to be selected from documents such as the Ventura Countywide Stormwater Quality Management Program standard sheet, the California Storm Water BMP Handbooks, the Caltrans Storm Water Quality Handbooks, EPA database, and ASCE database. The BMPs to be included in the SWPCP must be appropriate for use in Ventura County and must be acceptable to the permitting Co-permittee.

The SWPCP must include the rational for selecting or rejecting BMPs. The project architect, or engineer of record, or authorized qualified designee, must sign and include in the SWPCP the statement set forth in Permit Part 4.D.4 indicating the BMPs are appropriate to minimize the negative impacts from the project's construction activities on stormwater quality and that the project owner and contractor are aware that the selected BMPs must be installed, monitored, and maintained.

NPDES Permit CAS004002 Requirement(s)

PART 4.D.3.

The SWPCP shall include appropriate construction site BMPs selected from documents such as the California Storm Water BMP Handbook, the Caltrans Storm Water Handbook, Ventura County Stormwater Quality Standard Sheet, EPA database and American Society of Civil Engineers (ASCE) database. In addition, Co-permittees shall ensure the following minimum requirements are met, to the maximum extent practicable, at construction sites regardless of size:

a. *Sediments generated on the project site shall be retained using structural drainage controls;*

b. *No construction-related materials, wastes, spills, or residues shall be discharged from the project site to streets, drainage facilities or adjacent properties by wind or runoff;*

c. *Non-storm water runoff from equipment and vehicle washing and any other activity shall be contained at the project site;*

d. *Erosion from slopes and channels will be eliminated, by implementing BMPs, including, but not limited to, limiting of grading scheduled during the wet season, inspecting graded areas during rain events, planting and maintenance of vegetation on slopes, and covering erosion susceptible slopes.*

PART 4.D.4

The SWPCP must include the rationale used for selecting or rejecting BMPs. The project architect, or engineer of record, or authorized qualified designee, must sign a statement on the SWPCP to the effect:

"As the architect/engineer of record, I have selected appropriate BMPs to effectively minimize the negative impacts of this project's construction activities on storm water quality. The project owner and contractor are aware that the selected BMPs must be installed, monitored, and maintained to ensure their effectiveness. The BMPs not selected for implementation are redundant or deemed not applicable to the proposed construction activity."

The Landowner shall sign a statement to the effect:

"I certify that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, to the best of my knowledge and belief, the information submitted is true, accurate, and complete. I am aware that submitting false and/or inaccurate information, failing to update the SWPCP to reflect current conditions, or failing to properly and/or adequately implement the SWPCP may result in revocation of grading and/or other permits or other sanctions provided by law."

The SWPCP certification shall be signed by the landowner as follows:

(1) For a corporation: by a responsible corporate officer which means (a) a president, secretary, treasurer, or vice president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision-making functions for the corporation, or (b) the manager of the construction activity if authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures;

(2) For a partnership or sole proprietorship: by a general partner of the proprietor; or

(3) For a municipality or other public agency: by an elected official, a ranking management official (e.g., County Administrative Officer, City Manager, Director of Public Works, City Engineer, District Manager), or the manager of the construction activity if authority to sign SWPCPs has been assigned or delegated to the manager in accordance with established agency policy.

Annual Reporting

None Specified.

Performance Criteria

- For construction projects that require a SWPCP, Co-permittees will require the inclusion of the statement specified above from the project architect, or engineer of record, or authorized qualified designee, and the certification specified above from the landowner.
- For Co-permittee construction projects that require a SWPCP, Co-permittees will include the statement specified above from the project architect, or engineer of record, or authorized qualified designee, and the Co-permittees certification specified above from an elected official, ranking management official or the manager of the construction activity.
- Comply with all requirements and criteria relative to this Program as set forth in the Permit and the SMP.

5.4 Notice of Intent Requirement

Program Description

Each Co-permittee will require projects subject to the General Construction Activities Storm Water Permit – NPDES Permit No. CAS000002 (General Permit) submit proof of filing a Notice of Intent (NOI) to obtain coverage under the General Permit prior to issuance of a grading permit. Proof of filing the NOI may include a copy of the completed NOI form and a copy of the check sent to the State Board, or a copy of the letter from the State Board with the Waste Discharge Identification Number (WDID) for the project.

Co-permittees will file a NOI with the State Board, and pay the appropriate fee, for all Co-permittee construction projects subject to the General Permit. The NOI and appropriate fee will be filed prior to the commencement of any construction activity covered by the General Permit. A copy of the NOI filed with the State Board will be kept in project files and in the SWPCP or SWPPP for the project, and will be supplemented with a copy of the letter providing the WDID number when it is received from the State Board (note that there may be delays in receiving the WDID from the State Board).

Projects subject to the requirements of the General Permit currently include those that involve clearing, grading, or excavation resulting in soil disturbances of at least five acres of total land (if applicable acreage is reduced, then projects of that size will be required to submit); or construction activity that results in soil disturbances of less than five acres if it is part of a larger common plan of development or sale. Co-permittee emergency work and routine Co-permittee maintenance projects may not require the preparation of a SWPCP, but shall instead performed in accordance with Section 6 – Programs for Public Agency Activities.

NPDES Permit CAS004002 Requirement(s)

PART 4.D.5.
Co-permittees shall require proof of filing a Notice of Intent for coverage under the State General Construction Activity Storm Water Permit prior to issuing a grading permit for all projects requiring coverage under the state general permit.

Annual Reporting

None Specified.

Performance Criteria

- For construction projects subject to the General Permit, Co-permittees will require proof that a NOI has been filed prior to issuance of a grading permit for 90% of all such projects.
- Comply with all requirements and criteria relative to this Program as set forth in the Permit and the SMP.

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5.5 Construction Site Inspection Program

Program Description

Each Co-permittee will inspect construction sites with SWPCPs, a minimum of once during the wet season to determine if the SWPCP is being adequately implemented. During this SWPCP inspection, a stormwater quality control site inspection checklist, developed by the Co-permittees, will be completed to document inspection results. A guidance stormwater quality control site inspection checklist is included in Appendix D. This guidance is subject to modification and revision as determined by the Principal Co-permittee for consistency with the Permit and to conform to local conditions and policies in Ventura County.

The SWPCP inspection will seek to make a determination regarding the adequacy of implementation of the SWPCP and can be accomplished as a single purpose inspection, or as part of a routine inspection. If it is determined that the SWPCP is not being adequately implemented or where there is evidence of or a reasonable potential for sediment, construction materials or wastes, or non-stormwater runoff to be discharged from the project site, then a follow up inspection will be scheduled to take place within two weeks. If compliance is not achieved before the follow up inspection, and the site is subject to the General Construction Activities Storm Water Permit (General Permit), the RWQCB will be notified. For all other sites, a written notice shall be delivered to the owner or person responsible for implementing the SWPCP. This process will be repeated at least every two weeks until the site comes into compliance with the SWPCP.

Each Co-permittee will review their construction project inspection procedures to determine how to incorporate the minimum requirements set forth in Part 4.D.3 of the Permit into all routine inspections of construction sites, year round, and then incorporate these procedures.

When construction sites fail to comply with the SWPCP or where there is evidence of or a reasonable potential for sediment, construction materials or wastes, or non-stormwater runoff to be discharged from the project site, the inspector will implement appropriate notification and enforcement procedures. For specific instruction relating to notification and enforcement procedures, each Co-permittee will refer to their Stormwater Quality Management Ordinance. The five general levels of notification and enforcement appropriate for handling most stormwater related problems for construction projects are discussed below in increasing level of severity. The decision to use any level of control will be based upon the severity of the violation(s).

Verbal Notification. This is the first level of notification to the owner/contractor. This notification is generally limited to problems that are relatively minor and will be resolved immediately and cooperatively upon notification. All Verbal Notifications will be documented in the Inspector's Job Log. Notifying the RWQCB is usually not required when a Verbal Notification is made. In addition, Verbal Notifications may be used for more severe conditions when immediate action by the owner/contractor is required. Under this condition, the Verbal Notification is documented in the Inspector's Job Log and followed immediately with a written notification in accordance with the procedures below.

Job Memorandum. This is the first level of written notification to the owner/contractor. This notification is generally limited to problems that are relatively minor and will be resolved immediately and cooperatively upon notification and when needed to more formally follow up a Verbal Notification where the inspector determines that a written notification is required to prevent misunderstandings. The Job Memorandum may be handed to or mailed to the owner/contractor. The issuance of the Job Memorandum will be documented in the Inspector's Job Log and a copy placed in the project file. Notifying the RWQCB is usually not required when a Job Memorandum is issued.

Notice of Violation. This is the second level of written notification to the owner/contractor. This notification is used when Verbal Notifications and/or Job Memorandums fail to achieve compliance for minor problems that are repeated, and for moderate level problems that will be resolved cooperatively but may require an extended period of time to achieve desired compliance. The issuance of the Notice of Violation will be documented in the Inspector's Job Log and a copy placed in the project file.

The Notice of Violation will identify the objectives that are not being met and/or the local requirements that have not been achieved and will indicate that continued noncompliance may result in additional enforcement actions. The Notice of Violation will provide the owner/contractor with a compliance date.

Administrative Compliance Order. This is the third level of written notification to the owner/contractor. This notification is used when Notices of Violation fail to achieve compliance for moderate problems that are repeated, and for major problems that will be resolved cooperatively but may require an extended period of time to achieve desired compliance or specific direction on their resolution. The issuance of an Administrative Compliance Order will be documented in the Inspector's Job Log and a copy placed in the project file.

The Administrative Compliance Order may include any of the following: specific steps and time schedules for compliance as reasonably necessary to prevent threatened or future discharge of pollutants to stormwater; specific steps and time schedules for compliance as reasonably necessary to discontinue any illicit connection; specific requirements for containment, cleanup, removal, storage, installation of controls, or proper management of any pollutant having potential contact to stormwater; any other terms or requirements reasonably calculated to achieve full compliance with the SWPCP and/or permits.

Cease and Desist Order or **"Stop Work" Order**. This is the fourth level of written notification to the owner/contractor. This notification is used when Administrative Compliance Orders fail to achieve compliance for major problems that are repeated, for any violation that may pose an immediate and/or significant threat to the public or to the environment, or when problems are the result of deliberate, intentional, and/or criminal acts or failures to act. The issuance of the Cease and Desist Order will be documented in the Inspector's Job Log and a copy placed in the project file.

The Cease and Desist Order may direct the owner/contractor to: immediately cease and desist any construction site discharge that contains or is likely to contain pollutants that may enter the stormwater drainage system; immediately contain or divert any flow of water off the property; immediately discontinue any violation of the SWPCP and/or local requirements for construction sites; and clean up any area affected by the violation(s).

Regional Board (RWQCB) Referrals. While the Co-permittees generally have sufficient authority to enforce requirements for stormwater pollution controls at construction sites, notifying the RWQCB of stormwater program violation sites may provide the Co-permittees with additional leverage for resolving on-going or severe violations. Notifying the RWQCB is required when a follow up stormwater quality inspection determines that a site subject to the General Permit is not in compliance with the SWPCP/SWPPP.

NPDES Permit CAS004002 Requirement(s)

PART 4.D.6.
Co-permittees shall inspect sites with SWPCPs for storm water quality requirements during routine inspections a minimum of once during the wet season. For inspected sites that have not adequately implemented their SWPCP, a follow-up inspection to ensure compliance will take place within 2 weeks. If compliance has not been achieved, and the site is covered under the State General Construction Activity Storm Water Permit, the Regional Board shall be notified. Co-permittees shall develop and implement a checklist for inspecting storm water quality control measures at construction sites by January 27, 2001.

Annual Reporting

Co-permittees will provide an update of the number and type of enforcement actions, applicable to storm water enforcement, taken at construction sites annually as part of the *Annual Storm Water Report and Assessment.*

Performance Criteria

- Develop and implement a checklist for inspecting stormwater quality control measures at construction sites by January 27, 2001.
- For construction projects that require a SWPCP, inspect sites a minimum of once during the wet season for stormwater quality requirements and complete a stormwater quality control site inspection checklist.
- For sites that have not adequately implemented the SWPCP or where there is evidence of or a reasonable potential for sediment, construction materials or wastes, or non-stormwater runoff to be discharged from the project site, a written notice (Job Memorandum, Notice of Violation, Administrative Compliance Order, Cease and Desist Order) shall be prepared and delivered to the owner or person responsible for implementing the SWPCP.
- For sites that have not adequately implemented the SWPCP, conduct a follow up inspection within two weeks to ensure compliance and complete a stormwater quality control site inspection checklist.
- For sites that have not achieved compliance after the follow-up inspection, and are covered by the State General Construction Permit, Co-permittees will notify the RWQCB.
- Comply with all requirements and criteria relative to this Program as set forth in the Permit and the SMP.

5.6 Construction Community Outreach

Program Description

The Co-permittees will discuss stormwater quality requirements and concerns with developers, contractors, and the trades during meetings and inspections, when relevant, and will emphasize complying with stormwater quality requirements and properly implementing the project's SWPCP.

The Principal Co-permittee will assess the need for workshops and seminars as a means of outreach to the construction community. When workshops are deemed necessary, the Principal Co-permittee may either organize the seminars/workshops or possibly co-sponsor events being planned by others.

Appropriate materials will be made available to educate the construction community. Suitable materials include those previously developed by the Ventura Countywide Stormwater Quality Management Program. Other materials may be developed, as needed. A handout of stormwater pollution control guidelines for construction sites is included in Appendix D (Appendices are provided as guidance that may be updated as necessary).

The Co-permittees will make efforts to inform the construction community that the developer is responsible for all discharges from the project site, including discharges from streets and storm drains, until final acceptance of the project by the Co-permittee. It will be emphasized that this responsibility includes discharges that result from activities at owner occupied facilities (e.g., landscaping, block wall construction, etc.) conducted by the new owner and/or individuals or companies hired by the new owner.

The Co-permittees will develop a "New Owner" brochure and upon request provide these to developers, Home Owner Associations (HOAs), and residents to assist them with their efforts to prevent discharges from owner occupied portions of the project site. Developers will be encouraged to prepare their own brochures and to incorporate notices and warnings regarding stormwater pollution prevention requirements into purchase contracts, CC&Rs, and other new owner documents.

NPDES Permit CAS004002 Requirement(s)

PART 4.D.7.
Co-permittees shall discuss storm water controls at construction sites and distribute educational materials targeted to the construction community during meetings, inspections, and as appropriate.

Annual Reporting

Co-permittees will provide a description of the outreach program to the construction community and assess its effectiveness annually as part of the *Annual Storm Water Report and Assessment.* This assessment will include a discussion of the number of inspections, site visits, or other meetings conducted.

Performance Criteria

- During meetings and inspections involving developers, contractors, construction workers, and others involved in construction projects and activities, discuss stormwater quality controls as appropriate.
- Notify developers of their responsibility for all discharges from the project site, including dischargers from streets and storm drains, until final acceptance of the project by the Co-permittee.
- Notify developers that their responsibility includes discharges that result from activities at owner occupied facilities.
- Co-permittees will develop a "New Owner" brochure and upon request provide these to developers, Home Owner Associations (HOAs), and residents to assist them with their efforts to prevent discharges from owner occupied portions of the project site.
- Comply with all requirements and criteria relative to this Program as set forth in the Permit and the SMP.

5.7 Stormwater Quality Staff Training

Program Description

Each Co-permittee will identify employees who are involved with construction and development projects. Staff will be targeted for training regarding the requirements of the stormwater quality management program for construction projects. Targeted employees may include staff involved in administration, inspection, and enforcement of building and grading permits, as well as staff involved in Co-permittee construction, which may include engineers, inspectors, and superintendents.

Staff will be trained in a manner that will provide adequate knowledge of effective implementation of stormwater pollution prevention and control at construction, and will include site inspection and enforcement procedures. Training may be done using informal "tailgate" meetings, formal classroom training, or self-guided training methods. All employees in targeted positions regarding the requirements of the stormwater management program shall be trained by January 27, 2001, and annually thereafter.

Co-permittee construction staff training will include appropriate information on the prevention, detection, and investigation of illicit discharges and illegal connections (ID/IC). See Section 7 for more information on the ID/IC training program.

NPDES Permit CAS004002 Requirement(s)

PART 4.D.8.
Co-permittees shall train employees in targeted positions (whose jobs or activities are engaged in construction activities including construction inspection staff) regarding the requirements of the storm water management program by January 27, 2001, and annually thereafter.

Annual Reporting

Co-permittees will provide the percentage of targeted staff trained annually as part of the *Annual Storm Water Report and Assessment.*

Performance Criteria

- Co-permittees will train 90% of targeted employees by January 27, 2001 and annually thereafter.
- Comply with all requirements and criteria relative to this Program as set forth in the Permit and the SMP.

Section 6
Public Agency Activities

6.1 Overview

This section discusses the following programs for Co-permittee facilities maintenance:

- Corporation Yards
- Other Facilities
  - Drainage System Operation and Maintenance
  - Roadway Operation and Maintenance
  - Pesticide, Herbicide, and Fertilizer Application and Use
  - Stormwater Quality Staff Training

6.2 Corporation Yards

Program Description

The Co-permittees utilize corporation yards to support operations and maintenance activities within their jurisdiction. Corporation yards are operated and maintained by the Co-permittees for the following activities or facilities: vehicle and equipment storage, parking, or maintenance; vehicle and equipment fueling and fueling facilities; wash racks for cleaning vehicles and equipment; material storage areas; workshops; garages; and employee support facilities, such as offices, locker rooms, and meeting rooms. The following table lists the Co-permittee designated corporation yards. Any changes to this list will be reported in the *Annual Storm Water Report and Assessment*.

Co-Permittee Corporation Yards		
Co-Permittee	***Corporation Yard Name***	***Location***
Camarillo	Corporation Yard	283 South Glenn Drive, Camarillo
County of Ventura	El Rio* Moorpark* Gov. Center (GSA Maint. Area)	630 El Rio Drive, Oxnard 7150 Walnut Canyon Rd. Moorpark 800 S. Victoria Avenue, Ventura
Moorpark	Moorpark Materials Yard	675 Moorpark Avenue, Moorpark
Fillmore	PWA Corporate Yard	743 Sespe Place, Fillmore
Ojai	PWA Corporation Yard	405 South Signal Street, Ojai
Oxnard	City Yard Regional Recycling Center City Water Division Yard	1060 Pacific Avenue, Building 1, Oxnard 111 South Del Norte Boulevard, Oxnard 251 South Hayes Avenue , Oxnard
Port Hueneme	Corporate Yards	250 N. Ventura Road, Port Hueneme 700 E. Hueneme Road, Port Hueneme
San Buenaventura	Wastewater Plant Maintenance Yard Water Treatment Plant	1400 Spinnaker Drive, San Buenaventura 336 SanJon Road, San Buenaventura 5895 N. Ventura Road, San Buenaventura
Santa Paula		903 Corporation Street, Santa Paula 180 S. Palm Avenue, Santa Paula
Simi Valley		490 West Los Angeles Avenue, Simi Valley
Thousand Oaks	Municipal Service Center	1993 Rancho Conejo Rd., Thousand Oaks
Ventura County Flood Control District	*Co-located within County of Ventura Facilities	*Co-located within County of Ventura Facilities

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The facilities and activities common to corporation yards can be a source of pollutant discharges to the storm drain system if not adequately controlled. Therefore, a Storm Water Pollution Control Plan (SWPCP) will be developed for each Co-permittee designated corporation yard. The purpose of the SWPCP will be to identify potential sources of pollutants at a corporation yard that may affect the quality of stormwater discharges from the facility, and to set forth a plan that identifies best management practices (BMPs) for control of these pollutant discharges to the maximum extent practicable (MEP).

The Principal Co-permittee has developed a model corporation yard SWPCP and has made the model available to the Co-permittees. The model SWPCP is contained in Appendix E. The Co-permittees will utilize the model SWPCP as guidance for development of site-specific SWPCPs for each of their corporation yards. The model SWPCP, and the Co-permittees' site-specific SWPCPs, will include the following requirements:

- Prohibit the discharge of untreated stormwater runoff to the storm drain system from the following areas at a corporation yard: toxic or hazardous material storage areas by January 27, 2001; and fueling areas, vehicle maintenance and repair areas, and temporary street maintenance material and waste areas by July 27, 2001.

- Require that all vehicle and equipment wash areas meet one or more of the following three requirements:
  - Be fully self-contained. This means the facility must be designed so that no surface runoff (including rainfall runoff) from potentially contaminated areas within the facility, wash area runoff, or sump will discharge to a storm drain or receiving water.
  - Be self contained and covered. This means the facility must incorporate a cover to protect potentially contaminated areas within the facility and wash areas from contact with rainfall, and must be designed so that no surface runoff (including rainfall runoff) from potentially contaminated areas within the facility, wash area runoff, or sump will discharge to a storm drain or receiving water. Uncontaminated runoff from the cover may be discharged to the storm drain system provided that appropriate BMPs are implemented.
  - Be equipped with a clarifier or other pretreatment facility, and properly connected to a sanitary sewer. This means that the facility must be designed so that all surface runoff (including rainfall runoff) from potentially contaminated areas within the facility, wash area runoff, and sumps will be discharged to the sanitary sewer after pretreatment in a clarifier or other pretreatment facility acceptable to the sewering agency. If the facility incorporates a cover, uncontaminated runoff from the cover may be discharged to the storm drain system provided that appropriate BMPs are implemented.

The model SWPCP may designate other minimum requirements to be incorporated by the Co-permittees into the site-specific SWPCPs.
The site-specific SWPCPs will be implemented by the Co-permittees at corporation yards by July 27, 2002. In addition, the Co-permittees will implement the prohibitions with Permit-specified deadlines by the designated deadlines. A copy of the site-specific SPWPC will be kept at each corporation yard.

Periodic inspections of corporation yards will be conducted by the Co-permittees annually after July 27, 2002 to determine if the site-specific SWPCP is being implemented and is effective. To standardize corporation yard inspections, Co-permittees will use a standardized BMP checklist. An example corporation yard checklist is included in Appendix E. This inspection checklist may be updated by the Principal Co-permittee for consistency with the model SWPCP, and periodically to meet the needs and the objectives of the corporation yard inspection program.

The results of each corporation yard inspection will be brought to the attention of the appropriate staff who will determine whether operation and maintenance activities or facility BMPs require changes in order to comply with the SWPCP or if the SWPCP needs to be revised to be more effective. Revised operational and maintenance activities and facility BMPs will be prioritized and implemented as soon as practicable, and the SWPCP will be revised if necessary. If changes in activities or BMPs are needed, or if the SWPCP is revised, a follow-up inspection will be conducted before the next annual inspection to verify that the revised activities and BMPs are being implemented.

NPDES Permit CAS004002 Requirement(s)

PART 4.E.1
The Principal Co-permittee shall develop a model SWPCP for corporation yards and the Co-permittees shall implement the minimum requirements of the SWPCP in all corporation yards by July 27, 2002. Thereafter, Co-permittees shall inspect corporation yards on an annual basis.

PART 4.E.2
Co-permittees shall prohibit the discharge of untreated storm water runoff to the storm drain system from toxic or hazardous material storage areas no later than January 27, 2001.

PART 4.E.3
Co-permittees shall prohibit the discharge of untreated storm water runoff to the storm drain system from fueling areas, and repair/maintenance areas for vehicle maintenance and repair facilities no later than July 27, 2001.

PART 4.E.4
Co-permittees shall require that all vehicle/equipment wash areas must be self-contained, or covered, or equipped with a clarifier, or other pretreatment facility, and properly connected to a sanitary sewer. This provision does not apply to fire fighting vehicles.

Annual Reporting

None Specified.

Performance Criteria

- Co-permittees will develop a model Storm Water Pollution Control Plan (SWPCP) for corporation yards and make the model available to the Co-permittees.
- Co-permittees will develop and implement a site-specific SWPCP at Co-permittee corporation yards by July 27, 2002.
- Co-permittees will inspect Co-permittee corporation yards on an annual basis after July 27, 2002 to determine if the site specific SWPCP is being adequately implemented.
- At corporation yards, Co-permittees will require that all vehicle and equipment wash areas meet one or more of the following requirements: 1) be fully self contained; or 2) be self contained and covered; or 3) be equipped with a clarifier or other pretreatment facility and properly connected to a sanitary sewer.
- At corporation yards, Co-permittees will prohibit the discharge of untreated stormwater runoff to the storm drain system from toxic or hazardous material storage areas by January 27, 2001.
- At corporation yards, Co-permittees will prohibit the discharge of untreated stormwater runoff to the storm drain system from fueling areas, and vehicle maintenance and repair areas by July 27, 2001.
- Comply with all requirements and criteria relative to this Program as set forth in the Permit and the SMP.

6.3 Public Agency Activities – Other Facilities

6.3.1 Drainage System Operation and Maintenance

Program Description

Catch basins, open drainage facilities, detention/retention basins, and reinforced concrete open channels are important features of the drainage system that if appropriately operated and maintained, may control the discharge of pollutants in stormwater runoff.

The Co-permittees will inspect catch basins, open drainage facilities, detention/retention basins, and reinforced concrete open channels that are part of their drainage system. These inspections do not apply to facilities that are under private ownership. Inspections will be scheduled and completed at least once each year before the wet season (Permit-defined wet season begins on October 1). Inspections will include at a minimum, the visual observation of each catch basin, open drainage facility, detention/retention basin, and concrete open channel in the system to determine if the facility has accumulations of trash, sediment, or debris that need to be removed to protect water quality or to maintain hydraulic capacity or function of the facility.

The Co-permittees will routinely clean catch basins, open drainage facilities, detention/retention basins, and reinforced concrete open channels at least once each year prior to the wet season. For catch basins, open drainage facilities, improved open channels, and reinforced concrete open channels, "routine cleaning" for these facilities means the removal of accumulations of trash, sediment, or debris that would likely be washed down stream with the next runoff event.

The Co-permittees will clean catch basins on an as-needed basis. For catch basins, "as-needed cleaning" will occur whenever trash, sediment, or debris accumulation in the catch basin is at least 40% of capacity. Because the design of detention and retention basins includes the accommodation of multi-year accumulations of debris and sediment, "routine cleaning" of these facilities means the removal of barriers from the inlet/outlet of the facility to restore the operational design of the facility. The debris/sediment will be cleaned whenever the accumulation in the basin has filled the basin to target levels established in the facility design or subsequently adopted operation and maintenance protocols for the facility. Debris basins designed to capture debris in flows from upstream of urban areas are not considered to be detention or retention basins. Debris basins will be inspected and maintained in accordance with applicable local policies and procedures appropriate for these facilities.

During all routine and as-needed drainage facility cleaning, the Co-permittees will implement appropriate BMPs to reduce to the MEP materials in the drainage facility from being washed downstream.

The Co-permittees will encourage the establishment of voluntary programs for the collection of trash in natural stream channels. It is recognized that private property rights and liability issues may significantly impact the ability of the Co-permittees to extensively implement these programs. However, where practicable, these programs will be established in coordination with the residential outreach and education program.

The Co-permittees will undertake a program to inventory and map their storm drain system facilities. The inventory and mapping process will begin with the Co-permittees developing countywide standards for use during inventory and mapping activities in their respective jurisdictions. Each Co-permittee will be responsible for providing the mapping and inventory data in conformance with the standards developed by the Co-permittees for the program. Once inventory and mapping data are provided, the information database will be updated as needed.

NPDES Permit CAS004002 Requirement(s)

PART 4.E.5
Co-permittees shall inspect and clean the catch basins, open drainage facilities, and detention/retention basins at least one time each year prior to the wet season. At any time, any catch basin that is at least 40% full of trash and debris shall be cleaned out. All reinforced concrete open channels shall be cleaned at least once each year prior to the wet season.

PART 4.E.11
Co-permittees shall routinely conduct trash collection along, or in improved open channels within their jurisdiction.

PART 4.E.12
The Discharger shall encourage the establishment of voluntary programs for the collection of trash in natural stream channels.

Annual Reporting

Co-permittees will provide a summary, which at a minimum includes the quantity, predominant types and likely sources of trash removed from catch basin inlets annually as part of the *Annual Storm Water Report and Assessment.*

Performance Goals

- Co-permittees will inspect and clean 90% of all catch basins, open drainage facilities, detention/retention basins, and reinforced concrete open channels at least once each year prior to the wet season (Permit-defined wet season begins October 1).
- Co-permittees will clean catch basins whenever they are 40% or more full of trash and debris.
- Co-permittees will routinely remove trash from improved open channels.
- Co-permittees will encourage establishment of voluntary programs for collection of trash in natural stream channels.
- Co-permittees will develop countywide standards for the inventory and mapping of storm drain facilities, as needed.
- Comply with all requirements and criteria relative to this Program as set forth in the Permit and the SMP.

6.3.2 Roadway Operation and Maintenance

Program Description

Street sweeping has been identified as a program that may help reduce the discharge of street and roadway pollutants to the storm drain system. While the Co-permittees may sweep streets for many other reasons, this program implements a baseline program geared towards protection of stormwater quality. The Co-permittees are encouraged, but are not required, to continue more intensive street sweeping programs that may be implemented in their communities for other reasons.

The Co-permittees will identify curbed streets placed in the following categories within their jurisdiction, and will implement a sweeping program for these streets. The identified streets will be swept by the Co-permittee, at a minimum, in accordance with the following requirements:

- High traffic downtown areas: sweep at least four times per month;
- Moderate traffic collector streets and residential areas: sweep at least six times per year; and
- Other continuously bermed public streets: sweep at least one time per year prior to the rainy season.

For the purpose of streets in the "other" category, "prior to the rainy season" will mean sweeping the street at least once during the three month period (July, August, September) immediately prior to the wet season (Permit-defined wet season begins October 1). "Continuously bermed" will mean a street in the permitted area where a berm exists on both sides of the street without breaks. These streets are usually in more rural areas of the permitted area.

To increase the efficiency of the street sweeping, Co-permittees should make an effort to encourage voluntary relocation of street-parked vehicles on scheduled sweeping days. This may be achieved by placing temporary "no stopping" and "no parking" signs, posting permanent street sweeping signs or distributing street sweeping schedules to residents and businesses.

Street maintenance activities may potentially result in pollutants being discharged to the storm drain system if appropriate protective measures are not implemented. The Co-permittees will require that roadway maintenance staff, roadway maintenance contractors, and others implement BMPs to control the discharge of pollutants to the storm drain system as a result of roadway maintenance activities.

At a minimum, these BMPs will include the following minimum requirements:

- Prohibit saw-cutting during a storm event of 0.25 inches or greater; and
- Prohibit the discharge of untreated runoff from temporary or permanent street maintenance material and waste storage areas from entering the storm drain system.

Some Co-permittees may contract for street maintenance work and most Co-permittees issue street cut or similar permits. The Co-permittees will address work under these contracts or permits by including contract provisions and/or permit conditions that require that street maintenance or repair work comply with the minimum requirements shown above, and other BMPs required for protection of water quality.

A list of BMPs that may be required to protect water quality during street maintenance activities in addition to meeting the minimum requirements, are included in Appendix E (Appendices are provided as guidance that may be updated as necessary).

Sometimes roadway maintenance work must be conducted immediately in order to protect lives or property. The co-permittees will endeavor to conduct emergency roadway work in a manner protective of water quality; however, the minimum requirements above are not intended to apply to emergency work.

NPDES Permit CAS004002 Requirement(s)

PART 4.E.6
Co-permittees shall conduct street sweeping on curbed public streets in their permitted area according to the following schedule:

a. *A monthly average not less than 4 times per month in high traffic downtown areas;*

b. *A yearly average of not less than 6 times per year in moderate traffic collector streets, and residential areas;*

c. *In addition, Co-permittees will sweep continuously bermed public streets once per year prior to the rainy season.*

PART 4.E.7
Co-permittees shall prohibit street saw cutting and paving during a storm event of 0.25 inches or greater (except during emergency conditions).

PART 4.E.8
Co-permittees shall prohibit discharge of untreated runoff from temporary or permanent street maintenance material and waste storage areas.

Annual Reporting

Co-permittees will provide a summary of the total curb miles of streets swept annually, and the percentage of total curb miles swept annually, as a function of total curb miles annually as part of the *Annual Storm Water Report and Assessment.*

Performance Criteria

- Co-permittees will conduct street sweeping on 80% of curbed and continuously bermed public streets in the permitted areas according to the schedule specified above in PART 4.E.6 of the Permit.
- Co-permittee will prohibit street saw cutting and paving during a storm event of 0.25 inches or greater (except during emergency conditions).
- Co-permittee will prohibit the discharge of untreated runoff from temporary or permanent street maintenance material and waste storage areas.
- Comply with all requirements and criteria relative to this Program as set forth in the Permit and the SMP.

6.3.3 Pesticide, Herbicide, and Fertilizer Application and Use

Program Description

Pesticide, herbicide, and fertilizer application and use may potentially result in pollutants being discharged to the storm drain system if appropriate protective measures are not implemented.

The Principal Co-permittee has developed a standardized protocol for routine and non-routine application of pesticides, herbicides (including preemergents), and fertilizers. The standardized protocol was completed and distributed to the Co-permittees by July 27, 2001, and is included in Appendix E. The standardized protocol includes the following minimum requirements to control the discharge of pollutants to stormwater as a result of pesticide, herbicide, and fertilizer applications:

- Prohibit the application of pesticides, herbicides, and fertilizers during rain events;
- Prohibit the application of pesticides, herbicides, and fertilizers within one day of a rain event forecasted to be greater than 0.25 inches except for application of pre-emergent herbicides;
- Prohibit the application of pesticides, herbicides, and fertilizers after a rain event where water is leaching or running from the application area; or
- Prohibit the application of pesticides, herbicides, and fertilizers when water is running off-site from the application area.

Co-permittees will require that all staff applying pesticides are either certified by the California Department of Food and Agriculture, or are under the direct on site supervision of a certified pesticide applicator, as defined in the protocol. Co-permittees will restrict the purchase and use of pesticides and herbicides to certified staff. If purchasing is done by a purchasing agent, the purchasing agent will restrict the distribution of pesticides and herbicides to certified staff.

Co-permittees that contract out for pesticide applications will include contract provisions that require the contract applicator meet all requirements of this program, including compliance with the standardized protocol, the prohibitions, and requirements for certification and supervision of pesticide applicators.

NPDES Permit CAS004002 Requirement(s)

PART 4.E.9
The Discharger shall develop a standardized protocol for the routine and non-routine application of pesticides, herbicides (including preemergents), and fertilizers within one year after permit adoption.

There shall be no application of pesticides or fertilizers during the following conditions:

a. During rain events;

b. Within one day of a rain event forecasted too be greater than 0.25 inches except for application of preemergent herbicides;

c. After a rain event where water is leaching or running or,

d. When water is running off-site.

The Discharger shall ensure that staff applying pesticides are either certified by California Department of Food and Agriculture, or are under the direct supervision on-site of a certified pesticide applicator.

Annual Reporting

None Specified.

Performance Criteria

- Co-permittees will develop a standardized protocol for the routine and non-routine application of pesticides, herbicides (including preemergents), and fertilizers by July 27, 2001.
- Comply with all requirements and criteria relative to this Program as set forth in the Permit and the SMP.

6.3.4 Stormwater Quality Staff Training

Program Description

Each Co-permittee will target staff based on the type of stormwater quality and pollution issues that they could encounter during the performance of their regular maintenance activities. Training may target staff who perform activities in the following areas: stormwater maintenance; drainage and flood control systems; streets and roads; parks and public landscaping; and corporation yards.

Staff will be trained in a manner that will provide adequate knowledge for effective facility maintenance activities. Training may be done using informal "tailgate" meetings, formal classroom training, or self-guided training methods. All employees in targeted positions regarding the requirements of the stormwater management program shall be trained by January 27, 2001 and annually thereafter.

Co-permittee facilities maintenance staff training will include appropriate information on the prevention, detection, and investigation of illicit discharges and illegal connections (ID/IC). See Section 7 for more information on the ID/IC training program.

NPDES Permit CAS004002 Requirement(s)

PART 4.E.10
Co-permittees shall train their employees in targeted positions (whose jobs and activities affect storm water quality) regarding the requirements of the storm water management program no later than January 27, 2001, and annually thereafter.

Annual Reporting

Co-permittees will provide the percentage of targeted staff trained annually as part of the *Annual Storm Water Report and Assessment.*

Performance Criteria

- Co-permittees will train 90% of targeted employees by January 27, 2001 and annually thereafter.
- Comply with all requirements and criteria relative to this Program as set forth in the Permit and the SMP.

Section 7
Illicit Discharges/Illegal Connections

7.1 Overview

This section discusses the following programs for illicit discharges and new connections:

- Incident Response
- Education
- Illicit Discharges/Illegal Connections Staff Training

7.2 Incident Response

Program Description

Co-permittees will investigate the cause, determine the nature, and estimate the number of legitimate illicit discharge/dumping incidents supported by the documented information collected at the time of each potential illicit discharge/dumping report. Reports of illicit discharge/dumping may come in from the general public, as discussed in Section 2.2 Public Reporting, or may come from Co-permittee staff. Co-permittees will notify the appropriate department/agency to investigate reports of illicit discharges depending on the location of the incident and the type of material initially reported. These departments/agencies will determine the nature of the material and the extent of the spill. This may include:

- Storm drain maintenance, if the spill reaches the storm drain system.
- Street and road maintenance, if the spill is in the public right-of-way.
- Sewer system maintenance, if the material is from the sewage system.
- Industrial waste inspection, if the material is from industrial facilities.
- Fire Departments/"first responders," if the material may be hazardous.
- Contractors for hazardous materials, if the material is hazardous

All non-storm water discharges into municipal separate storm sewer systems (MS4s) and watercourses are prohibited except where such discharges are: (a) not identified as a source of pollutants; or (b) not identified as a source of pollutants, subject to conditions. The non-storm water discharges in Table 7-1 (on page 7-3) are not identified as sources of pollutants, subject to conditions.

Non-stormwater discharges are prohibited from entering the storm drain system, with the following exceptions:

Table 7-1
Discharges Not Identified as a Source of Pollutants, Subject to Conditions
▪ Discharges in compliance with a separate NPDES permit/waste discharge requirement (WDR) or granted a discharge exemption by the RWQCB, the Executive Officer, or the State Water Resources Control Board.
▪ Flows from riparian habitats or wetlands
▪ Diverted stream flows
▪ Natural springs
▪ Rising ground waters
▪ Uncontaminated groundwater infiltration
▪ Water line flushing
▪ Discharges from potable water sources
▪ Foundation drains
▪ Footing drains
▪ Air conditioning condensate
▪ Water from crawl space pumps
▪ Reclaimed and potable irrigation water
▪ De-chlorinated swimming pool discharges
▪ Individual residential car washing
▪ Sidewalk washing
▪ Discharges or flows from emergency fire fighting activities

Each of the aforementioned non-storm water discharges must meet the following conditions in order to presume that the discharge will not be a source of pollutants.

1. The discharge must not be known to contain any pollutants or containments that will cause a condition of pollution, contamination, or nuisance in the receiving water.
2. The source of the discharges is not from a site: under clean up and/or abatement orders; where previous water or soil testing has indicated the presence of contaminants or pollutants; where toxic or hazardous chemicals, substances, or wastes are or have been treated, stored, or disposed; or that is known as a result of past investigative or exploratory work to be a source or potential source of contaminants or pollutants of concern.

3. The discharge must not contain any visible sediment.

4. The chlorine level/residual must be below 0.1 ppm (mg/L).

5. The pH must be between 6.0 and 9.0.

6. The discharge is exempt from conditions (1) – (6) if it results from fire fighting activities that are related to emergencies or discharges from potable water sources during emergencies.

The Co-permittees may presume that the non-storm water discharges listed in Table 7-1 (on page 7-3) and that meet the conditions above may be discharged to the storm drain system. However, the Co-permittee may prohibit these discharges at any time and shall prohibit these discharges if it becomes evident that conditions are not being met or that pollutants or contaminants harmful or potentially harmful to receiving waters are or may be discharged.

If any of the above non-storm water discharges are determined to be a source of pollutants, the discharge need not be prohibited if the Co-permittee implements or requires the discharger to implement appropriate best management practices (BMPs) to ensure that the discharge will meet the conditions noted above before entering the storm drain system.

The following are examples of candidate BMPs (Numbered BMPs are from the California Storm Water Best Management Practice Handbooks) for non-storm water discharges that are identified as pollutant sources. The Co-permittees may identify alternative BMPs or additional BMPs to bring discharges into compliance with conditions.

BMPs	Applicable BMPs
Dechlorination	5
pH increasers or decreasers	6
Public Education/Participation (SC0)	1, 2, 3, 4, 5, 6
Non-Storm Water Discharges to Drains (SC1)	1, 2, 3, 4, 5, 6, 7
Vehicle and Equipment Washing and Steam Cleaning (SC3)	1, 2, 4, 6
Contaminated or Erodible Surface Areas (SC10)	1, 2, 3, 4
Outlet Protection (ESC40)	3, 4
Storm Drain Inlet Protection (ESC54)	3, 4
Sediment Trap (ESC55)	3, 4

7.2 Incident Response

7.2.1 Source Determination

Program Description

To help determine whether or not the material is an illicit discharge/dumping; Co-permittees will attempt to determine the source. This investigation will generally be a visual observation of the storm drain system and/or activities on the surface. A field inspection crew will investigate the surface drainage system in the vicinity of suspected illicit discharges. This may include accessible areas in the public right-of-way adjacent to residences and businesses, catch basins, open channels near known points of discharge, and upstream manholes. A form that may be used to document illicit discharge investigations is included in Appendix F (Appendices are provided as guidance that may be updated as necessary).

If the source is determined, voluntary cleanup/termination or enforcement procedures will be initiated, and steps will be taken to prevent its recurrence. If the source is not determined, or if the Co-permittee so chooses, the appropriate Co-permittee departments or contractors will be notified to contain and clean up the material. Because the situations and materials will vary widely, procedures will vary as well. The following are the steps that will generally be taken to determine the source:

- Verify the location of the spill/discharge.
- Investigate the cause (look for the origin).
- Determine the nature and estimate the amount of illicit discharged/dumped material.
- Containment and cleanup.
- When appropriate, Co-permittees will refer documented non-stormwater discharges/connections or dumping to an appropriate agency for investigation.
- When appropriate, Co-permittees will issue an enforcement order that will result in cessation of the illicit discharge and/or elimination of the illicit connection (to occur within six months after the Co-permittee gains knowledge of the discharge/connection).
- If appropriate, Co-permittees will notify the RWQCB.

7.2.2 Illicit Connections

Program Description

The Principal Co-permittee will take a pro-active approach to eliminate illicit connections. Proposed projects requiring new connections to VCFCD jurisdictional channels will be reviewed and conditioned for stormwater quality during permit issuance procedures. Staff involved in reviewing proposed projects will be trained as described in Section 7.4.

7.2.3 Enforcement

Program Description

Enforcement procedures will be implemented to eliminate illicit discharges/disposal and illegal connections. The procedures will be followed when the source and nature of the discharge is known. Enforcement procedures will be consistent with the Co-permittees' legal authority stipulated in their respective ordinances. While legal authority for Co-permittees varies, most enforcement processes follow a common sequence.

Typically they include:

- Verbal or written warnings for minor violations.
- Formal notice of violation or non-compliance with specific actions and time frames for compliance.
- Cease and desist or similar order to comply.
- Specific remedies such as civil penalties (e.g., infraction), non-voluntary termination with cost recovery, or referral for criminal penalties or further legal action.

Enforcement activity will begin at the appropriate level as determined by the Co-permittee's authorized representative. It need not necessarily be imposed sequentially. For incidents that are more severe or threatening at the outset, enforcement will start at an increased level. Enforcement steps will be accelerated if there is evidence of a clear failure to act, or an increasing severity of the discharge. Enforcement actions for violating any of the provisions of the Co-permittees' ordinances may include any of the following or a combination thereof, at the discretion of the prosecuting authority:

- Criminal Penalties
  - Monetary punishment
  - Imprisonment
- Civil Penalties
  - Monetary punishment

As staff members are conducting their regular activities, they will take note of evidence of non-stormwater discharges and/or connections to the storm drain system. This may include items such as flows, stains, deposited materials, and pipes or hoses. Evidence will be documented in writing.

The incident will be reported to the appropriate Co-permittee and will be investigated as described in Section 7.2.1, Source Determination.

NPDES Permit CAS004002 Requirement(s)

PART 4.F.1
Co-permittees shall investigate the cause, determine the nature and estimated amount of reported illicit discharge/dumping incidents, and refer documented non-storm water discharges/connections or dumping to an appropriate agency for investigation, containment and cleanup. Appropriate action including issuance of an enforcement order that will result in cessation of the illicit discharge, and/or elimination of the illicit connection, shall take place within six months after the Co-permittee gains knowledge of the discharge/connection.

Annual Reporting

Co-permittees will provide the number of reports of illicit discharges that Co-permittees responded to, percentage that were identified as actual illicit discharges, and percentage of the actual illicit discharges where the incident was either cleaned up, referred to another responsible agency and/or follow up/education with the discharger was conducted annually as part of the *Annual Storm Water Report and Assessment.*

For groups of identified illicit discharge types where the probable causes for the discharge can be identified, Co-permittees will report probable causes and the actions taken to prevent similar discharges from occurring annually as part of the *Annual Storm Water Report and Assessment.*

Co-permittees will provide the number of illicit connections identified and eliminated annually as part of the *Annual Storm Water Report and Assessment.*

Co-permittees will provide number and type of enforcement actions for storm water illicit discharges and/or illicit connections annually as part of the *Annual Storm Water Report and Assessment.*

Co-permittees will provide a summary from records on illicit discharges and connections which includes type of material, type of source, date of initial inspection, enforcement action taken, date of follow-up inspection, date of conclusion/clean up/removal/follow up/education annually as part of the *Annual Storm Water Report and Assessment.*

Performance Criteria

- Co-permittees will investigate 90% of reported illicit discharge/dumping incidents.
- When appropriate or necessary, Co-permittees will refer documented non-stormwater discharges/connections or dumping to the appropriate agency for investigation, containment, and cleanup.
- Comply with all requirements and criteria relative to this Program as set forth in the Permit and the SMP.

7.3 Education

Program Description

Automotive, food, and construction site inspection visits will include distribution of educational material that describes illicit discharges and provides a staff contact number for reporting illicit discharges. Educational components from Programs for Residents, Programs for Industrial/Commercial Businesses, Programs for Construction Sites, and Programs for Illicit Connections/Illegal Discharges will be developed with a common goal:

- Instruct special groups on elements of stormwater quality, tools available, where to find assistance/reference materials and where efforts from the public/private sectors are best focused to be most effective.

New information developed for industrial facility educational materials will include information describing illicit discharges. Contacts from this educational effort will count towards the overall outreaching effort as specified in Section 2 of this SMP. The educational information will include:

- Types of discharges prohibited,
- How to prevent illicit discharges,
- What to do in the event of an illicit discharge, and
- Enforcement actions the facility may be subject to, including penalties that can be assessed.

NPDES Permit CAS004002 Requirement(s)

PART 4.F.3
Automotive, food facility, construction and Co-permittee facility site inspection visits shall include distribution of educational material that describes illicit discharges and provides a contact number for reporting illicit discharges.

PART 4.F.4
New information developed for Phase I industrial facility educational material shall include information describing illicit discharges. The information shall include: types of discharges prohibited, how to prevent illicit discharges, what to do in the event of an illicit discharge, and the array of enforcement actions the facility may be subject to, including penalties that can be assessed.

Annual Reporting

None Specified.

Performance Criteria

- Comply with all requirements and criteria relative to this Program as set forth in the Permit and the SMP.

7.4 Illicit Discharges/Illegal Connections Staff Training

Program Description

Each Co-permittee will target its staff based on the type of stormwater quality and pollution issues that they could encounter. Training may target drainage, roadway, landscape and facilities staff, industrial pretreatment inspectors, and code enforcement officers. Training of these staff may be incorporated with existing drainage, roadway, and business inspection programs discussed in Sections 3 and 6.

The goal of training staff is to raise the level of awareness of illicit connections and illegal discharges. When members of this training are conducting their regular activities, the likelihood is increased that non-stormwater discharges and/or connections to the storm drain system will be caught. This may include observed items such as flows, stains, deposited materials, and pipes or hoses. Evidence will be documented in writing to support the estimated number of illicit discharges/illegal connections reported.

Staff will be trained in a manner that will provide adequate knowledge for effective illicit discharge identification, investigation, reporting, and/or clean up. Training may be done using informal "tailgate" meetings, formal classroom training, or self-guided training methods. All employees in targeted positions regarding the requirements of illicit discharges will be trained by January 27, 2001 and annually thereafter. ID/IC training has been incorporated into the training proposed for staff in other programs where training is a Permit requirement.

NPDES Permit CAS004002 Requirement(s)

PART 4.F.2
Each Co-permittee shall train its employees in targeted positions, as defined by the Ventura County SMP, on how to identify and report illicit discharges by January 27, 2001, and annually thereafter.

Annual Reporting

None Specified.

Performance Criteria

- Co-permittees will train 90% of targeted employees by January 27, 2001 and annually thereafter. Training will include education in illicit discharge/dumping and illegal connections identification, investigation, reporting and/or clean up.
- Comply with all requirements and criteria relative to this Program as set forth in the Permit and the SMP.

Section 8
Program Evaluation

8.1 Overview

The programs developed under this SMP will be evaluated for their effectiveness at regular intervals. The following subsections outline several measures that will be used to collect data, compare and evaluate information, report results, and modify the program as needed.

Generally, program evaluation is conducted by evaluating implementation of program elements which are likely to lead to stormwater quality. The nature of water quality monitoring is such that the program is not likely within this Permit term to see measurable changes in water quality. As a result, program evaluation techniques must use non-water quality parameters.

8.2 Performance Criteria

Programs described in the SMP have a list of implementation activities that Co-permittees will follow, and most have associated performance criteria. While the permit standard will continue to be the MEP, the performance criteria are to be considered the minimum level of implementation that each Co-permittee must achieve to conduct an effective program.

The performance criteria are generally items that are quantifiable, and can be reported with some consistency between Co-permittees. Although many activities will be implemented by the Co-permittees, the performance criteria are established for only those activities that can be used to monitor program implementation and ultimately serve as indicators of program effectiveness.

8.3 Internal Reporting

Several methods will be used to facilitate internal reporting:

- Forms for collecting program data;
- An electronic database to compile data from all Co-permittees; and
- A program structure to facilitate an inter-agency/intra-agency exchange of information.

Co-permittees will keep track of program data internally in sufficient detail to implement and document Co-permittee activity and to help track information required for the SMP. This information will be kept at the Co-permittee level and may go beyond the summary information that is reported to the Principal Co-permittee. Co-permittees may choose to share data forms and develop standards as part of the subcommittee process described below.

To compile data on a countywide level, Co-permittees will use an electronic Data Management and Reporting System. The Co-permittees will use the database to report program data to the Principal Co-permittee by August 1, 2001 and annually thereafter.

As discussed in Section 1.4, the program management structure is an integral part of internal reporting among Co-permittees, departments, and agencies. At Subcommittee and Management Committee meetings, Co-permittees will discuss the progress of program implementation, including challenges, opportunities for improvement, ideas, and questions. This process will keep Co-permittees informed of the overall program implementation status.

8.4 Annual Reports

The Permit identifies two annual reports to be submitted to the RWQCB, the *Storm Water Monitoring Report* and the *Annual Storm Water Report and Assessment.* The requirements for these are reports are contained within the Permit and the Monitoring and Reporting Program, CI7388. CI7388 sets forth program reporting requirements (Part I), stormwater quality monitoring requirements (Part II), and program evaluation schedules (Part III).

The *Storm Water Monitoring Report* contains monitoring data available and is prepared by the Principal Co-permittee for submittal to the RWQCB by July 15 of each Permit year. The *Annual Storm Water Report and Assessment* is prepared by the Principal Co-permittee and submitted to the RWQCB by October 1 of each Permit year.

Additionally, each Co-permittee will perform a self-audit of their program through January 1 of each Permit year, and will report the results to the Principal Co-permittee by February 1 of that same Permit year.

8.4.1 Storm Water Monitoring Report

The *Storm Water Monitoring Report* contains the details of stormwater quality sample collection and available analytical results of samples collected during the wet weather. Analytical results from the previous wet season are the main focus of this report.

8.4.2 Annual Storm Water Report and Assessment

Information for generating the *Annual Storm Water Report and Assessment* will be collected by Co-permittees in the electronic Data Management and Reporting System for the period July 1 through June 30 and submitted to the Principal Co-permittee by August 1 of each Permit year. The *Annual Storm Water Report and Assessment* contains the summarized program data and a general summary of the stormwater quality monitoring information. The *Annual Storm Water Report and Assessment* also includes any recommended or required changes to the SMP resulting from SMP evaluation.

8.5 Stormwater Management Plan Revisions

The Management Committee and subcommittees will use information from the above activities to revise the programs as needed to better address the quality of stormwater runoff. Activities may include reviewing: illicit discharge reports to determine the most useful education techniques and topics for pursuit; outreach methods to assess the most effective process to reach the general public; businesses to determine any additional types that should be targeted for the business inspection program; and pollutants of concern, discussed in Section 9.4, to further determine their source. Programs may be modified to include best management practices most likely to control the sources of the pollutants.

Proposed changes discussed in subcommittee meetings will be taken to the Management Committee for final approval. Only proposed program changes to the SMP will be listed in the *Annual Storm Water Report and Assessment.*

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Section 9
Monitoring

9.1 Proposed Structure of Monitoring Program

This monitoring program is designed to provide water quality monitoring data to be used to assess the effectiveness of and provide direction to the management programs discussed in Sections 2 through 7. To provide this information, the monitoring program consists of four types of monitoring activities:

- Discharge Characterization/Outfall Monitoring
- Receiving Water Quality Impacts and Watershed Activities
- Pollutant Source Identification
- Management Program Effectiveness

These types of monitoring activities address five major objectives:

- Characterize and determine long term trends in stormwater discharges by monitoring sites representative of different land uses.
- Establish the impact of stormwater discharges on receiving waters by conducting receiving water quality monitoring.
- Identify pollutant sources based on analysis of monitoring data, inspection of businesses, and investigation of illicit discharges.
- Define management plan effectiveness using data collected before and after implementation of pollution prevention programs.
- Develop methodology to refine estimates of annual pollutant loads to receiving waters.

During the five years of the first permit term (August 25, 2994 – July 27, 2000), the Program achieved these objectives by:

- Conducting discharge characterization monitoring at three to six outfall monitoring sites for two to five storms per year, to characterize stormwater discharges in the permit area. Discharges from each outfall monitoring site primarily represent a single land use in the permit area: commercial, industrial, residential, and agricultural.
- Conducting receiving water monitoring at two to three sites for two to five storms per year to assess impacts from stormwater discharges on receiving waters in the permit area.
- Conducting a special study of receiving water quality in tributaries to Malibu Creek during dry and wet weather to assess impacts of Ventura County discharges on the Malibu Creek Watershed.
  - Analyzing monitoring data to develop pollutant loads and models to identify long term trends in stormwater pollutant loadings and evaluate effectiveness of the management programs.
  - Evaluating the results of discharge characterization and receiving water monitoring, the illicit discharge program, and regulatory requirements to determine a prioritized list of Pollutants of Concern (POCs) for the management program.

During the next five-year permit term (July 27, 2000 – 2005), the key elements of the proposed Plan are as follows:

- Continued limited discharge characterization monitoring at one residential, one industrial, and one agricultural discharge site.
- Toxicity monitoring at three outfall monitoring sites until baseline information has been established.
- Continued receiving water monitoring at two receiving water monitoring sites.
- Develop and conduct an instream bioassessment monitoring program for the Ventura River.
- Develop and conduct a mass emission monitoring program to establish baseline conditions and load estimates for the Ventura River, Calleguas Creek, and Santa Clara River.
- Participate as part of the Federal 205(j) non-point source grant study in the Calleguas Creek Watershed, in meetings of the Santa Clara River Enhancement and Management Plan, the Calleguas Creek Watershed Management Plan, and the Steelhead Restoration and Recovery Plan, and in storm water studies with the Southern California Coastal Water Research Project.
- Participate in the development and implementation of volunteer monitoring programs.
- Identify and investigate general sources of prioritized POCs. Investigate and implement control measures to reduce the discharge of POCs from identified significant sources.
- Refine Watershed Management Model (WMM) to estimate pollutant loads and long term trends in stormwater pollutant loadings if needed for TMDL development.

9.2 Discharge Characterization and Outfall Monitoring

The discharge characterization and outfall monitoring during the first permit term consisted of wet weather sample collection and analysis from land use characterization monitoring sites. This section summarizes the monitoring site locations, storm events captured, water quality results, and the proposed monitoring program for the discharge characterization sites.

9.2.1 Monitoring Site Descriptions

The discharge characterization monitoring sites were chosen to represent typical, single land use watersheds within the permit area. Two residential, two industrial, one commercial, and one agricultural monitoring sites were selected and monitored during the first permit term using automated sampling equipment. Table 9-1 (shown below) provides a summary of the monitoring sites and descriptions of site characteristics.

Table 9 - 1
Discharge Characterization Monitoring Location Characteristics

Station Code	Location	Land Uses	Drainage Basin Area (acres)	Rain Gauge Location
R-1	Swan Street and Macaw Avenue (San Buenaventura)	Residential	65	County Government Center
R-2	Lawrence Way and Hill Street (Oxnard)	Residential	121	Oxnard Airport
C-1	Via del Norte and Los Olivos (Oxnard)	Commercial	62	Oxnard Airport
I-1	Via Pescador and Avenida Acaso (Camarillo)	Industrial	30	Camarillo
I-2	Ortega Street (San Buenaventura)	Industrial	189	County Government Center
A-1	Wood Road at Revolon Slough	Agricultural	350 (estimated)	Oxnard Airport

The locations of the discharge characterization sites are shown in Figure 9-1 (on page 9-4). The Swan Street (R-1) site receives runoff from a relatively new (15 to 20 year old) residential neighborhood containing single-family dwellings, churches, parks, and a recreation center. The Lawrence Way (R-2) site receives runoff from an older area that contains single-family and multi-family dwellings. The Via del Norte (C-1) site receives runoff from a new area of mixed commercial use. Auto dealerships and a warehouse shopping club/store are the primary businesses in the basin. The Via Pescador (I-1) site is located in an industrial park (approximately 10-15 years old) typical of newer industrial parks throughout the county. A mixed industrial area containing older manufacturing facilities, newer industrial parks, and a few undeveloped lots was selected as the other industrial site on Ortega Street (I-2). The Wood Road (A-1) site drains a basin comprised almost entirely of agricultural land, except for a small number of farm residences and associated facilities for equipment maintenance and storage.

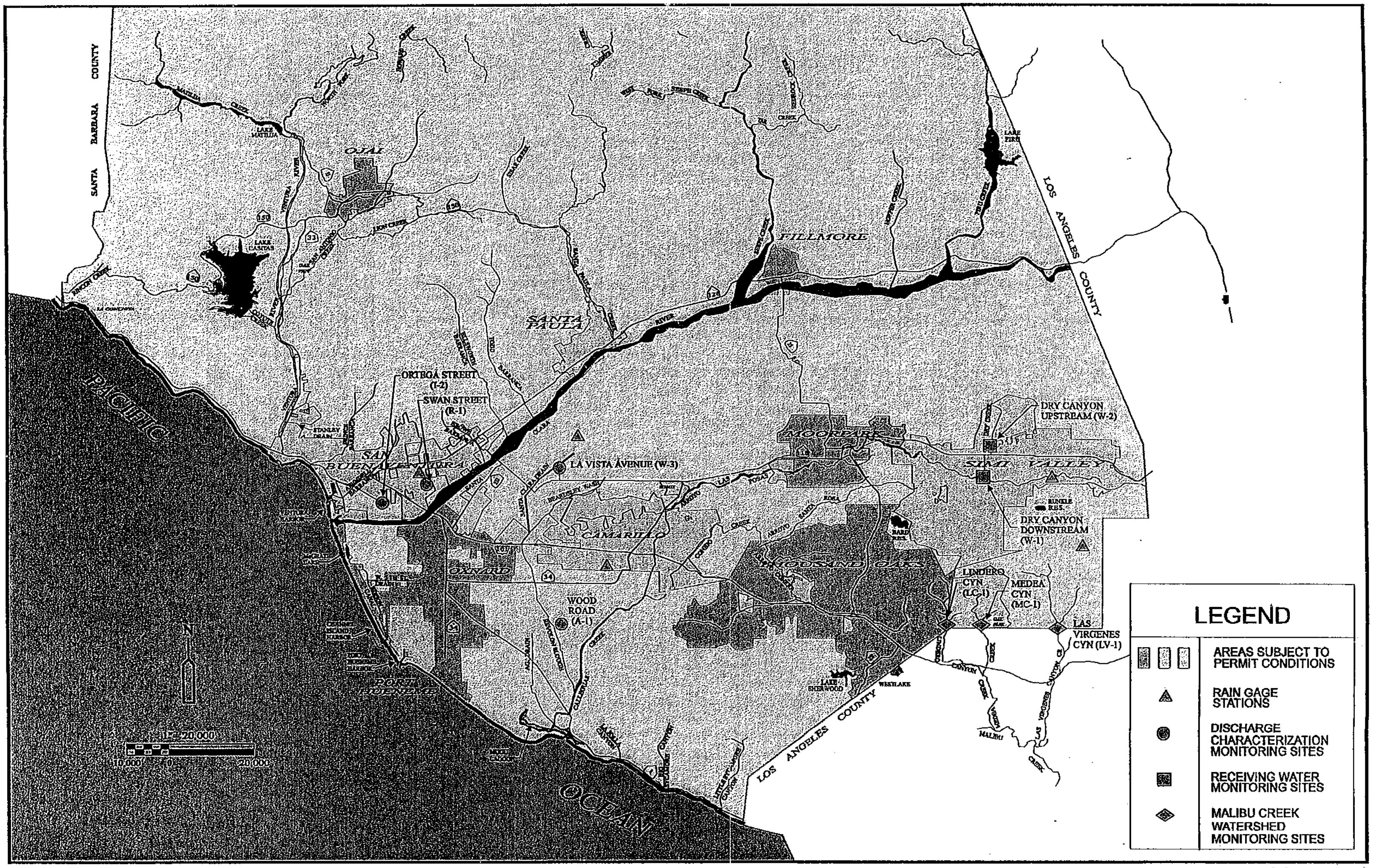

Figure 9-1
Ventura County
Locations of Rain Gages and Monitoring Stations

9.2.2 Storm Events Monitored

The monitoring events captured at each discharge characterization site are listed in Table 9-2 (shown below).

Table 9 - 2
Summary of Discharge Characterization Monitoring Dates

Monitoring Station	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98
A-1, Wood Rd.	NS	NS	2/13/95 3/21/95	1/31/96 2/19/96 3/4/96	10/29/96 11/20/96 11/26/96	11/26/97 12/5/97 1/9/98 1/29/98 3/24/98
C-1, Via del Norte	2/7/93 2/18/93 3/25/93	11/29/93 1/24/94 2/17/94 3/24/94	10/5/94 11/10/94 12/24/94 2/13/95	12/12/95 1/21/96 1/31/96 2/19/96	NS	NS
I-1, Via Pescador	2/7/93 2/18/93 3/25/93	11/29/93 1/24/94 2/17/94 3/24/94	10/5/94 12/24/94 2/13/95 3/21/95	12/12/95 1/21/96 1/31/96 2/19/96	NS	NS
I-2, Ortega St.	1/7/93 2/7/93 2/18/93 3/25/93	11/29/93 1/24/94 2/17/94 3/24/94	10/5/94 11/10/94 12/24/94 2/13/95	12/12/95 1/21/96 1/31/96 2/19/96	10/29/96 11/20/96	11/10/97 3/24/98
R-1, Swan St.	2/7/93 2/18/93 3/25/93	11/29/93 1/24/94 2/17/94 3/24/94	10/5/94 11/10/94 12/24/94 2/13/95	12/12/95 1/21/96 1/31/96 2/19/96	10/29/96 11/20/96 1/20/97	11/10/97 3/24/98
R-2, Lawrence Way	1/7/93 2/7/93 2/18/93 3/25/93	11/29/93 1/24/94 2/17/94 3/24/94	10/5/94 11/10/94 12/24/94 2/13/95	12/12/95 1/21/96 1/31/96 2/19/96	NS	NS

NS Monitoring location not sampled during the permit year.

Monitoring at R-2, C-1, and I-1 was discontinued after the 1995/96 monitoring year as R-2 and I-1 were determined to be of similar quality to R-1 and I-2 respectively. The discharges from both residential and industrial sites were determined to be of similar quality to other regional and national urban runoff databases, and sufficient data had been collected at each site to adequately define baseline conditions. C-1 was eliminated because the site had a backflow condition that appeared to be affecting the quality of the stormwater samples. Efforts to improve the flow conditions at the site and thereby improve the integrity of the samples were not successful and monitoring was discontinued. An agricultural discharge characterization site (A-1) was added during 1994/95.

9.2.3 Monitoring Results

9.2.3.1 Water Quality Results

Stormwater monitoring data collected during the events listed in Section 9.2.2 were compiled and summary statistics developed for each site. Tables 9-3 through 9-8 (on pages 9-6 through 9-15) list the means, medians, and coefficients of variation for detected constituents for each discharge characterization site.

Table 9 - 3
Summary Statistics for Detected Constituents at A-1, Wood Rd. (1994-1998)[1]

Parameter	Units	# Samples	% Detected	Mean	Median	Coefficient of Variation
Conventionals						
BOD	mg/L	9	100%	51	15	1.6
COD	mg/L	6	100%	188	165	0.55
Oil and Grease	mg/L	10	40%	0.93	0.33	1.92
TRPH	mg/L	8	38%	0.85	0.4	1.09
Total Organic Carbon	mg/L	9	100%	18	7.6	1.2
Conductivity	umho/cm	11	100%	891	696	0.76
pH	pH units	11	100%	7.5	7.4	0.03
Total Dissolved Solids	mg/L	9	100%	530	528	0.48
Total Suspended Solids	mg/L	9	100%	1144	1160	0.29
Hardness	mg/L	9	100%	278	255	0.44
Chloride	mg/L	3	100%	16.6	18	0.25
Nutrients						
Ammonia-Nitrogen	mg/L	10	100%	2.3	1.8	0.99
Kjeldahl-Nitrogen	mg/L	9	100%	8.1	7.8	0.43
Nitrate Nitrogen	mg/L	9	100%	13.8	12.5	0.57
Orthophosphate-P	mg/L	4	100%	0.64	0.68	0.22
Phosphorus, Total	mg/L	10	100%	3.3	3.0	0.49
Phosphorus, Dissolved	mg/L	10	100%	1.9	1.1	1.1
Bacteriological[2]						
Total Coliform	MPN/100ml	11	100%	261,800	160,000	1.2
Fecal Coliform	MPN/100ml	11	100%	32,700	13,000	1.6
Fecal Streptococcus	MPN/100ml	11	100%	82,800	50,000	1.1
Metals[3]						
Arsenic, Total	µg/L	9	100%	15.6	16	0.28
Arsenic, Dissolved	µg/L	9	100%	4.9	4.9	0.52
Cadmium, Total	µg/L	9	100%	4.6	4.5	0.46
Cadmium, Dissolved	µg/L	9	100%	1.6	1.9	0.54
Chromium, Total	µg/L	9	100%	131	84	1.2
Chromium, Dissolved	µg/L	9	100%	11.8	12	0.50
Copper, Total	µg/L	9	100%	92.6	92	0.23
Copper, Dissolved	µg/L	9	100%	24.4	26	0.45
Lead, Total	µg/L	9	100%	32.3	22.6	0.74
Lead, Dissolved	µg/L	9	78%	11.4	6.1	1.5
Mercury, Total	µg/L	10	50%	0.11	0.046	1.6
Mercury, Dissolved	µg/L	4	100%	0.0021	0.0015	0.71
Nickel, Total	µg/L	9	100%	95.1	93	0.26
Nickel, Dissolved	µg/L	9	100%	35.5	33	0.82
Selenium, Total	µg/L	9	100%	1.36	1.1	0.37
Selenium, Dissolved	µg/L	9	56%	0.82	0.75	0.18
Silver, Total	µg/L	9	44%	0.96	0.31	1.1

Table 9 - 3
Summary Statistics for Detected Constituents at A-1, Wood Rd. (1994-1998)[1]

Parameter	Units	# Samples	% Detected	Mean	Median	Coefficient of Variation
Silver, Dissolved	µg/L	9	33%	0.26	0.19	0.45
Zinc, Total	µg/L	9	100%	272	304	0.44
Zinc, Dissolved	µg/L	9	100%	63	45	0.75
EPA 625[4]						
2,3,5-Trimethlynaphthalene	ng/L	3	33%	ID	ID	ID
Chrysene	ng/L	10	10%	ID	ID	ID
Fluoranthene	ng/L	10	20%	ID	ID	ID
Phenanthrene	ng/L	10	30%	36.9	35.9	0.26
Pyrene	ng/L	10	20%	ID	ID	ID
bis(2-ethylhexyl)phthalate	ng/L	10	30%	290	289	0.11
Butyl benzyl phthalate	ng/L	10	20%	ID	ID	ID
Di-n-octyl phthalate	ng/L	10	30%	19.2	19.2	0.06
Dibutyl phthalate	ng/L	10	30%	104	104	0.08
Diethyl phthalate	ng/L	10	30%	156	152	0.27
Dimethyl phthalate	ng/L	10	20%	ID	ID	ID
EPA 8080						
Aroclor 1242	ng/L	10	10%	ID	ID	ID
2,4'-DDD	ng/L	10	40%	39.8	12.5	2.1
2,4'-DDE	ng/L	10	30%	ID	ID	ID
2,4'-DDT	ng/L	10	60%	96.4	18.6	1.9
4,4' - DDD	ng/L	10	30%	ID	ID	ID
4,4' - DDE	ng/L	10	70%	251	180	0.92
4,4' - DDT	ng/L	10	90%	259	218	0.82
Aldrin	ng/L	10	10%	ID	ID	ID
beta-BHC	ng/L	10	10%	ID	ID	ID
delta-BHC	ng/L	10	10%	ID	ID	ID
gamma-BHC	ng/L	10	30%	10.2	2.7	1.8
Endosulfan II	ng/L	10	20%	ID	ID	ID
Endrin	ng/L	10	20%	ID	ID	ID
Heptachlor	ng/L	10	10%	ID	ID	ID
EPA 8140						
Chlorpyrifos	µg/L	11	18%	ID	ID	ID
Dichlorvos	µg/L	11	9%	ID	ID	ID

1 The Helsel Method (1990) was used to assign concentrations to non-detected samples.
2 In cases where microbiological counts were reported as greater than 160,000 MPN/mL, 160,000 MPN/mL was used as the count value for statistical purposes.
3 The 1996/97 metals data that were censored due to data quality problems were not included in the calculations.
4 Variations in number of sample results from differences in constituents reported by the various laboratories used during the permit term.
ID Insufficient data available for analysis. For the non-detect analysis, at least 3 detected values were required and at least 20% of the samples had to be detected. If all samples were detected, there had to be at least 2 sample results for statistics to be generated.

Table 9 - 4
Summary Statistics for Detected Constituents at C-1, Via Del Norte (1993-1996)[1]

Parameter	Units	# Samples	% Detected	Mean	Median	Coefficient of Variation
Conventionals						
BOD	mg/L	14	79%	40.1	17	1.8
COD	mg/L	14	100%	154	115	0.85
Oil and Grease	mg/L	15	80%	5.7	5	0.75
TRPH	mg/L	8	75%	1.7	1.4	0.82
Total Organic Carbon	mg/L	7	100%	25.1	17	1.2
Conductivity	umho/cm	10	100%	126	89	0.99
pH	pH units	13	100%	6.8	6.8	0.05
Total Dissolved Solids	mg/L	14	100%	75.0	53	1.1
Total Suspended Solids	mg/L	14	100%	403	161	1.5
Hardness	mg/L	14	100%	40.4	24.5	1.2
Nutrients						
Ammonia-Nitrogen	mg/L	14	86%	0.47	0.25	1.1
Kjeldahl-Nitrogen	mg/L	14	100%	4.3	2.4	1.00
Nitrate Nitrogen	mg/L	14	100%	0.43	0.42	0.62
Nitrite Nitrogen	mg/L	4	100%	0.12	0.026	1.7
Nitrogen	mg/L	1	100%	ID	ID	ID
Phosphorus, Total	mg/L	14	100%	0.71	0.45	0.93
Phosphorus, Dissolved	mg/L	14	100%	0.38	0.30	0.78
Bacteriological[2]						
Total Coliform	MPN/100ml	8	100%	107,000	160,000	0.68
Fecal Coliform	MPN/100ml	15	100%	4530	1300	1.4
Fecal Streptococcus	MPN/100ml	15	100%	32,530	16,000	1.6
Metals						
Antimony, Total	µg/L	3	67%	ID	ID	ID
Beryllium	µg/L	3	33%	ID	ID	ID
Arsenic, Total	µg/L	13	92%	3.9	3	0.96
Arsenic, Dissolved	µg/L	10	70%	1.1	1	0.67
Cadmium, Total	µg/L	14	86%	1.9	1.7	0.89
Cadmium, Dissolved	µg/L	11	82%	0.62	0.5	0.96
Chromium, Total	µg/L	14	100%	15.8	4.8	1.5
Chromium, Dissolved	µg/L	11	100%	2.9	1.7	0.89
Copper, Total	µg/L	14	100%	59.6	29.5	1.2
Copper, Dissolved	µg/L	11	100%	10.8	9	0.52
Lead, Total	µg/L	14	100%	29.1	10.5	1.5
Lead, Dissolved	µg/L	11	91%	4.9	3.4	0.89
Mercury, Total	µg/L	14	14%	ID	ID	ID
Nickel, Total	µg/L	14	86%	26.2	17	1.1
Nickel, Dissolved	µg/L	11	91%	15.9	18	0.60
Selenium, Total	µg/L	13	31%	0.55	0.31	0.93
Selenium, Dissolved	µg/L	10	10%	ID	ID	ID
Silver, Total	µg/L	13	62%	0.71	0.2	1.5
Silver, Dissolved	µg/L	10	30%	0.21	0.11	1.0
Zinc, Total	µg/L	14	100%	332	164	1.1
Zinc, Dissolved	µg/L	11	100%	33.8	37	0.50
EPA 625						
Bis(2-ethylhexyl)phthalate	ng/L	13	23%	7297	2196	1.6

1 The Helsel Method (1990) was used to assign concentrations to non-detected samples.
2 For microbiological counts reported as greater than 160,000 MPN/mL, 160,000 MPN/mL was used as the count value for statistical purposes.
ID Insufficient data available for analysis. For the non-detect analysis, at least 3 detected values were required and at least 20% of the samples had to be detected. If all samples were detected, at least 2 sample results were needed for statistics to be generated.

Table 9 - 5
Summary Statistics for Detected Constituents at R-1, Swan Street (1993-1998)1

Parameter	Units	# Samples	% Detected	Mean	Median	Coefficient of Variation
Conventionals						
BOD	mg/L	20	90%	27.7	15.5	0.94
COD	mg/L	18	100%	167	87.5	1.4
Oil and Grease	mg/L	17	76%	3.2	2.4	0.82
TRPH	mg/L	7	100%	1.7	1.4	0.63
Total Organic Carbon	mg/L	12	100%	55.7	15	1.8
Conductivity	umho/cm	14	100%	115	70.5	0.93
pH	pH units	17	100%	7.0	7.1	0.06
Total Dissolved Solids	mg/L	20	100%	122	72	0.98
Total Suspended Solids	mg/L	20	100%	156	130	0.67
Hardness	mg/L	20	100%	41.4	28	0.94
Chloride	mg/L	3	100%	20.3	12	1.1
Nutrients						
Ammonia-Nitrogen	mg/L	20	90%	0.68	0.4	1.1
Kjeldahl-Nitrogen	mg/L	20	100%	4.6	3.1	1.1
Nitrate Nitrogen	mg/L	20	100%	1.8	0.57	2.4
Nitrite Nitrogen	mg/L	4	100%	0.02	0.011	0.79
Nitrogen, Total	mg/L	1	100%	ID	ID	ID
Orthophosphate-P	mg/L	2	100%	0.69	0.69	1.1
Phosphorus, Total	mg/L	20	100%	0.78	0.59	0.82
Phosphorus, Dissolved	mg/L	20	100%	0.45	0.40	0.67
Bacteriological[2]						
Total Coliform	MPN/100ml	11	100%	65,800	50,000	0.66
Fecal Coliform	MPN/100ml	18	100%	17,200	6000	2.1
Fecal Streptococcus	MPN/100ml	18	100%	48,300	24,000	1.2
Metals[3]						
Antimony, Total	µg/L	3	67%	ID	ID	ID
Thallium, Total	µg/L	3	33%	ID	ID	ID
Arsenic, Total	µg/L	17	94%	2.5	2	0.84
Arsenic, Dissolved	µg/L	14	64%	1.3	1	1.2
Cadmium, Total	µg/L	18	89%	1.3	1	0.85
Cadmium, Dissolved	µg/L	15	73%	0.72	0.6	0.85
Chromium, Total	µg/L	18	100%	9.5	5	1.3
Chromium, Dissolved	µg/L	15	93%	3.1	2.3	0.68
Copper, Total	µg/L	18	100%	28.6	21.5	0.76
Copper, Dissolved	µg/L	15	100%	14.6	13	0.65
Lead, Total	µg/L	18	100%	25.8	23.5	0.78
Lead, Dissolved	µg/L	15	93%	10.7	9.7	1.1
Mercury, Total	µg/L	15	27%	0.14	0.049	1.9
Mercury, Dissolved	µg/L	5	40%	ID	ID	ID
Nickel, Total	µg/L	18	83%	20.3	20.5	0.70
Nickel, Dissolved	µg/L	15	93%	16.1	19	0.61
Selenium, Total	µg/L	17	47%	0.72	0.48	0.73
Selenium, Dissolved	µg/L	14	21%	0.68	0.57	0.43
Silver, Total	µg/L	17	59%	2.26	0.2	2.1
Silver, Dissolved	µg/L	14	43%	0.20	0.073	1.1
Zinc, Total	µg/L	18	100%	168	144	0.73
Zinc, Dissolved	µg/L	15	100%	55.6	40	0.73
EPA 625 [4]						
1-Methylnaphthalene	ng/L	3	33%	ID	ID	ID
1-Methylphenanthrene	ng/L	2	100%	151	151	1.3

Table 9 - 5
Summary Statistics for Detected Constituents at R-1, Swan Street (1993-1998)1

Parameter	Units	# Samples	% Detected	Mean	Median	Coefficient of Variation
2-Methylnaphthalene	ng/L	10	10%	ID	ID	ID
Acenaphthylene	ng/L	17	12%	ID	ID	ID
Benz(a)anthracene	ng/L	17	6%	ID	ID	ID
Benzo(a)pyrene	ng/L	17	6%	ID	ID	ID
Benzo(b)fluoranthene	ng/L	17	12%	ID	ID	ID
Benzo(e)pyrene	ng/L	2	100%	ID	ID	ID
Benzo(g,h,i)perylene	ng/L	17	6%	ID	ID	ID
Benzo(k)fluoranthene	ng/L	17	12%	ID	ID	ID
Chrysene	ng/L	17	12%	ID	ID	ID
Dibenzo(a,h)anthracene	ng/L	17	6%	ID	ID	ID
Fluoranthene	ng/L	17	12%	ID	ID	ID
Fluorene	ng/L	17	6%	ID	ID	ID
Indeno(1,2,3-c,d)pyrene	ng/L	17	12%	ID	ID	ID
Naphthalene	ng/L	17	6%	ID	ID	ID
Phenanthrene	ng/L	17	12%	ID	ID	ID
Pyrene	ng/L	17	12%	ID	ID	ID
bis(2-ethylhexyl)phthalate	ng/L	17	12%	ID	ID	ID
Butyl benzyl phthalate	ng/L	17	12%	ID	ID	ID
Di-n-octyl phthalate	ng/L	17	12%	ID	ID	ID
Dibutyl phthalate	ng/L	17	12%	ID	ID	ID
Diethyl phthalate	ng/L	17	12%	ID	ID	ID
Dimethyl phthalate	ng/L	17	12%	ID	ID	ID
EPA 8080[4]						
2,4'-DDE	ng/L	2	50%	ID	ID	ID
2,4'-DDT	ng/L	2	50%	ID	ID	ID
4,4' - DDD	ng/L	6	17%	ID	ID	ID
4,4' - DDE	ng/L	6	33%	ID	ID	ID
4,4' - DDT	ng/L	6	17%	ID	ID	ID
gamma-BHC	ng/L	6	17%	ID	ID	ID
EPA 8140						
Diazinon	µg/L	4	25%	ID	ID	ID

1 The Helsel Method (1990) was used to assign concentrations to non-detected samples.
2 In cases where microbiological counts were reported as greater than 160,000 MPN/mL, 160,000 MPN/mL was used as the count value for statistical purposes.
3 The 1996/97 metals data that were censored due to data quality problems were not included in the calculations.
4 Variations in number of sample results from differences in constituents reported by the various laboratories used during the permit term.
ID Insufficient data available for analysis. For the non-detect analysis, at least 3 detected values were required and at least 20% of the samples had to be detected. If all samples were detected, there had to be at least 2 sample results for statistics to be generated.

Table 9 - 6
Summary Statistics for Detected Constituents at R-2, Lawrence Way (1993-1996)[1]

Parameter	Units	# Samples	% Detected	Mean	Median	Coefficient of Variation
Conventionals						
BOD	mg/L	13	77%	17.8	9	1.1
COD	mg/L	12	100%	117	67	1.2
Oil and Grease	mg/L	13	62%	4.7	3	0.69
TRPH	mg/L	3	100%	3.0	2	0.68
Total Organic Carbon	mg/L	7	100%	36.3	13	1.2
Conductivity	umho/cm	8	100%	82.5	80	0.41
pH	pH units	11	100%	6.9	6.9	0.05
Total Dissolved Solids	mg/L	13	100%	66	48	0.79
Total Suspended Solids	mg/L	13	100%	89	81	0.54
Hardness	mg/L	13	100%	26.6	22	0.52
Nutrients						
Ammonia-Nitrogen	mg/L	12	83%	0.35	0.3	1.43
Kjeldahl-Nitrogen	mg/L	12	100%	3.0	2.4	0.58
Nitrate Nitrogen	mg/L	12	100%	0.76	0.44	1.1
Nitrite Nitrogen	mg/L	5	100%	0.03	0.018	1.1
Nitrogen, Total	mg/L	1	100%	ID	ID	ID
Phosphorus, Total	mg/L	12	100%	0.51	0.44	0.38
Phosphorus, Dissolved	mg/L	12	100%	0.42	0.36	0.37
Bacteriological[2]						
Total Coliform	MPN/100ml	7	100%	80,000	90,000	0.54
Fecal Coliform	MPN/100ml	13	100%	11,700	9000	0.84
Fecal Streptococcus	MPN/100ml	13	100%	43,700	17,000	1.1
Metals						
Antimony, Total	µg/L	4	75%	10.2	7.5	0.88
Beryllium	µg/L	4	25%	ID	ID	ID
Thallium, Total	µg/L	4	50%	ID	ID	ID
Arsenic, Total	µg/L	12	83%	1.6	1.7	0.45
Arsenic, Dissolved	µg/L	8	75%	0.97	1	0.14
Cadmium, Total	µg/L	13	85%	0.90	0.8	0.83
Cadmium, Dissolved	µg/L	9	89%	0.66	0.4	1.0
Chromium, Total	µg/L	13	100%	5.0	4	0.63
Chromium, Dissolved	µg/L	9	100%	3.0	2.7	0.76
Copper, Total	µg/L	13	100%	17.2	15	0.78
Copper, Dissolved	µg/L	9	100%	11.3	10	0.47
Lead, Total	µg/L	13	100%	13.8	11	0.91
Lead, Dissolved	µg/L	9	100%	6.6	3.3	0.95
Mercury, Total	µg/L	14	29%	0.36	0.21	0.78
Nickel, Total	µg/L	13	69%	14.0	16	0.89
Nickel, Dissolved	µg/L	9	89%	13.0	10	0.91
Selenium, Total	µg/L	12	17%	ID	ID	ID
Selenium, Dissolved	µg/L	8	13%	ID	ID	ID
Silver, Total	µg/L	12	50%	0.94	0.28	1.3
Silver, Dissolved	µg/L	8	25%	ID	ID	ID
Zinc, Total	µg/L	13	100%	88.0	79	0.73
Zinc, Dissolved	µg/L	9	100%	41.6	37	0.67

1 The Helsel Method (1990) was used to assign concentrations to non-detected samples.

2 In cases where microbiological counts were reported as greater than 160,000 MPN/mL, 160,000 MPN/mL was used as the count value for statistical purposes.

ID Insufficient data available for analysis. For the non-detect analysis, at least 3 detected values were required and at least 20% of the samples had to be detected. If all samples were detected, there had to be at least 2 sample results for statistics to be generated.

Table 9 - 7 Summary Statistics for Detected Constituents at I-1, Via Pescador (1993-1996) 1						
Parameter	**Units**	**# Samples**	**% Detected**	**Mean**	**Median**	**Coefficient of Variation**
Conventionals						
BOD	mg/L	14	86%	29.4	9.5	1.9
COD	mg/L	14	100%	111	73.5	1.4
Oil and Grease	mg/L	14	50%	2.5	2.1	0.47
TRPH	mg/L	9	44%	0.91	0.13	1.8
Total Organic Carbon	mg/L	7	86%	35.6	14	1.7
Conductivity	umho/cm	10	100%	119	66.5	1.2
pH	pH units	13	100%	6.9	6.9	0.07
Total Dissolved Solids	mg/L	14	100%	67.3	53	0.56
Total Suspended Solids	mg/L	14	100%	82.4	71.5	0.47
Hardness	mg/L	14	100%	26.2	18.5	0.81
Nutrients						
Ammonia-Nitrogen	mg/L	14	71%	0.38	0.2	0.96
Kjeldahl-Nitrogen	mg/L	14	100%	2.5	2.3	0.57
Nitrate Nitrogen	mg/L	14	100%	1.7	0.62	1.8
Nitrite Nitrogen	mg/L	4	100%	0.02	0.014	1.0
Nitrogen, Total	mg/L	1	100%	ID	ID	ID
Phosphorus, Total	mg/L	14	100%	0.40	0.39	0.59
Phosphorus, Dissolved	mg/L	14	100%	0.24	0.25	0.34
Bacteriological[2]						
Total Coliform	MPN/100ml	7	100%	11,600	8000	0.98
Fecal Coliform	MPN/100ml	14	93%	670	110	2.0
Fecal Streptococcus	MPN/100ml	14	100%	7890	2350	1.3
Metals						
Antimony, Total	µg/L	3	67%	ID	ID	ID
Thallium, Total	µg/L	3	33%	ID	ID	ID
Arsenic, Total	µg/L	13	92%	2.1	2	0.49
Arsenic, Dissolved	µg/L	10	70%	1.2	0.95	0.44
Cadmium, Total	µg/L	14	100%	1.2	1	0.81
Cadmium, Dissolved	µg/L	11	91%	0.81	0.6	0.77
Chromium, Total	µg/L	14	93%	8.4	7.7	0.66
Chromium, Dissolved	µg/L	14	93%	4.2	3.5	0.72
Copper, Total	µg/L	14	100%	16.4	14	0.65
Copper, Dissolved	µg/L	11	100%	10.5	11	0.38
Lead, Total	µg/L	14	100%	10.8	7.6	0.97
Lead, Dissolved	µg/L	11	91%	7.7	5	1.2
Mercury, Total	µg/L	13	15%	ID	ID	ID
Nickel, Total	µg/L	14	93%	17.1	18.5	0.66

Table 9 - 7
Summary Statistics for Detected Constituents at I-1, Via Pescador (1993-1996) 1

Parameter	Units	# Samples	% Detected	Mean	Median	Coefficient of Variation
Nickel, Dissolved	µg/L	11	91%	14.5	15	0.71
Selenium, Total	µg/L	13	8%	ID	ID	ID
Silver, Total	µg/L	13	62%	0.78	0.2	1.2
Silver, Total	µg/L	10	30%	0.27	0.11	1.3
Zinc, Total	µg/L	14	100%	101	100	0.55
Zinc, Dissolved	µg/L	11	100%	53.7	53	0.55
EPA 625						
Acenaphthylene	ng/L	13	8%	ID	ID	ID
Fluorene	ng/L	13	8%	ID	ID	ID
Phenanthrene	ng/L	13	8%	ID	ID	ID
Pyrene	ng/L	13	8%	ID	ID	ID
EPA 8150						
2,4,5-TP (Silvex)	µg/L	2	50%	ID	ID	ID

1 The Helsel Method (1990) was used to assign concentrations to non-detected samples.
2 For microbiological counts reported as greater than 160,000 MPN/mL, 160,000 MPN/mL was used as the count value for statistical purposes.
ID Insufficient data available for analysis. For the non-detect analysis, at least 3 detected values were required and at least 20% of the samples had to be detected. If all samples were detected, there had to be at least 2 sample results for statistics to be generated.

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Table 9 - 8
Summary Statistics for Detected Constituents at I-2, Ortega St. (1993-1998)1

Parameter	Units	# Samples	% Detected	Mean	Median	Coefficient of Variation
Conventionals						
BOD	mg/L	19	74%	18.0	9	1.5
COD	mg/L	16	100%	96.9	81.5	0.68
Oil and Grease	mg/L	17	76%	3.4	3	0.54
TRPH	mg/L	12	67%	0.91	0.7	0.71
Total Organic Carbon	mg/L	11	100%	24.7	11	0.94
Conductivity	umho/cm	13	100%	189	116	1.3
pH	pH units	17	100%	7.2	7.3	0.08
Total Dissolved Solids	mg/L	19	100%	148	92	0.88
Total Suspended Solids	mg/L	19	100%	436	249	1.4
Hardness	mg/L	19	100%	64.5	43	0.88
Chloride	mg/L	2	100%	23.5	23.5	1.2
Nutrients						
Ammonia-Nitrogen	mg/L	18	83%	0.53	0.35	0.89
Kjeldahl-Nitrogen	mg/L	18	100%	3.1	2.25	0.69
Nitrate Nitrogen	mg/L	18	100%	1.1	0.96	0.67
Nitrite Nitrogen	mg/L	5	100%	0.03	0.028	0.56
Nitrogen, Total	mg/L	1	100%	ID	ID	ID
Orthophosphate-P	mg/L	2	100%	0.33	0.33	0.76
Phosphorus, Total	mg/L	18	100%	0.63	0.50	0.61
Phosphorus, Dissolved	mg/L	18	100%	0.49	0.39	0.70
Bacteriological[2]						
Total Coliform	MPN/100ml	11	100%	39,300	24,000	1.1
Fecal Coliform	MPN/100ml	18	100%	13,500	2300	2.7
Fecal Streptococcus	MPN/100ml	18	100%	20,200	13,000	1.3
Metals[3]						
Antimony, Total	µg/L	4	75%	18.9	18	0.84
Thallium, Total	µg/L	4	75%	10.6	6	1.2
Arsenic, Total	µg/L	18	100%	5.6	4	0.75
Arsenic, Dissolved	µg/L	14	86%	2.1	2	0.40
Cadmium, Total	µg/L	19	95%	1.9	1.2	0.95
Cadmium, Dissolved	µg/L	15	80%	0.87	0.6	0.78
Chromium, Total	µg/L	19	100%	16.3	10.2	1.2
Chromium, Dissolved	µg/L	15	100%	4.8	3	0.84
Copper, Total	µg/L	19	100%	36.6	26	0.89
Copper, Dissolved	µg/L	15	100%	17.5	14	0.69
Lead, Total	µg/L	19	100%	17.2	12	0.96
Lead, Dissolved	µg/L	15	80%	7.3	5	1.0
Mercury, Total	µg/L	18	22%	0.24	0.1	1.8
Mercury, Dissolved	µg/L	5	40%	ID	ID	ID
Nickel, Total	µg/L	19	95%	31.8	28	0.84
Nickel, Dissolved	µg/L	15	93%	18.1	18	0.63
Selenium, Total	µg/L	18	56%	1.1	0.65	0.78
Selenium, Dissolved	µg/L	14	36%	0.82	0.5	0.71
Silver, Total	µg/L	18	67%	0.95	0.2	1.5
Silver, Dissolved	µg/L	14	43%	0.23	0.083	1.2
Zinc, Total	µg/L	19	100%	205	147	0.81
Zinc, Dissolved	µg/L	15	100%	67.3	45	0.93
EPA 625[4]						
1-Methylnaphthalene	ng/L	3	33%	ID	ID	ID
1-Methylphenanthrene	ng/L	2	50%	ID	ID	ID

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Table 9 - 8
Summary Statistics for Detected Constituents at I-2, Ortega St. (1993-1998)1

Parameter	Units	# Samples	% Detected	Mean	Median	Coefficient of Variation
2,6-Dimethylnaphthalene	ng/L	2	50%	ID	ID	ID
2-Methylnaphthalene	ng/L	10	10%	ID	ID	ID
Benz(a)anthracene	ng/L	17	12%	ID	ID	ID
Benzo(a)pyrene	ng/L	17	6%	ID	ID	ID
Benzo(b)fluoranthene	ng/L	17	12%	ID	ID	ID
Benzo(e)pyrene	ng/L	2	50%	ID	ID	ID
Benzo(g,h,i)perylene	ng/L	17	6%	ID	ID	ID
Benzo(k)fluoranthene	ng/L	17	6%	ID	ID	ID
Chrysene	ng/L	17	12%	ID	ID	ID
Dibenzo(a,h)anthracene	ng/L	17	6%	ID	ID	ID
Fluoranthene	ng/L	17	12%	ID	ID	ID
Fluorene	ng/L	17	6%	ID	ID	ID
Indeno(1,2,3-c,d)pyrene	ng/L	17	6%	ID	ID	ID
Naphthalene	ng/L	17	6%	ID	ID	ID
Perylene	ng/L	2	50%	ID	ID	ID
Phenanthrene	ng/L	17	12%	ID	ID	ID
Pyrene	ng/L	17	12%	ID	ID	ID
bis(2-ethylhexyl)phthalate	ng/L	17	12%	ID	ID	ID
Butyl benzyl phthalate	ng/L	17	12%	ID	ID	ID
Di-n-octyl phthalate	ng/L	17	12%	ID	ID	ID
Dibutyl phthalate	ng/L	17	12%	ID	ID	ID
Diethyl phthalate	ng/L	17	12%	ID	ID	ID
Dimethyl phthalate	ng/L	17	12%	ID	ID	ID
EPA 8080 [4]						
2,4'-DDD	ng/L	2	50%	ID	ID	ID
2,4'-DDE	ng/L	2	50%	ID	ID	ID
2,4'-DDT	ng/L	2	50%	ID	ID	ID
4,4' - DDD	ng/L	6	33%	ID	ID	ID
4,4' - DDE	ng/L	6	67%	58.2	40	0.80
4,4' - DDT	ng/L	6	17%	ID	ID	ID
gamma-BHC	ng/L	6	33%	ID	ID	ID
EPA 8140						
Dimethoate	µg/L	2	50%	ID	ID	ID
EPA 8150						
Methylene Chloride	µg/L	7	14%	ID	ID	ID
2,4,5-TP (Silvex)	µg/L	2	50%	ID	ID	ID

1 The Helsel Method (1990) was used to assign concentrations to non-detected samples.
2 In cases where microbiological counts were reported as greater than 160,000 MPN/mL, 160,000 MPN/mL was used as the count value for statistical purposes.
3 The 1996/97 metals data that were censored due to data quality problems were not included in the calculations.
4 Variations in number of sample results from differences in constituents reported by the various laboratories used during the permit term.
ID Insufficient data available for analysis. For the non-detect analysis, at least 3 detected values were required and at least 20% of the samples had to be detected. If all samples were detected, there had to be at least 2 sample results for statistics to be generated.

9.2.3.2 Bioassay Results

In addition to the chemical analyses summarized above, toxicity testing was conducted at the discharge characterization sites. Starting in 1997/98, when sufficient acute toxicity was observed in samples (less than 50% survival after 24 hours), a Toxicity Identification Evaluation (TIE) was initiated. Tables 9-9 through 9-10 (shown below) summarize the results of the *Ceriodaphnia* toxicity testing and TIEs conducted.

Table 9 - 9
Survival Rates of Ceriodaphnia for Discharge Characterization Monitoring Sites

	Percent Survival of Ceriodaphnia (LC50)					
Storm Event Date	**A-1**	**C-1**	**R-1**	**R-2**	**I-1**	**I-2**
1/31/96 [1]	NS	100%	NS	100%	20%	NS
2/19/96 [1]	NS	100%	NS	NS	NS	NS
11/20-22/96 [1]	0%	NS	0%	NS	NS	80%
11/10/97	NS	NS	75%	NS	NS	100%
11/26/97	25%	NS	NS	NS	NS	NS
12/5/97	25%	NS	NS	NS	NS	NS
3/24/98	12.5%	NS	100%	NS	NS	100%

1 Data reported as EC50 for these storm events.
NS Toxicity samples not collected at this site during the listed monitoring event.

TIEs were conducted on samples collected during the first event sampled in 1997/98. The primary toxicant classes identified as causing toxicity and any other classes contributing to the toxicity of each sample are summarized in Table 9-10 (shown below).

Table 9 - 10
Summary of TIE Results

Sample Site	Primary Toxicant Class	Classes Possibly Contributing to Toxicity
A-1 (11/26/97)	Non-polar organic compounds [1]	None identified
R-1 (11/10/97)	Organophosphate pesticides [1]	Non-polar organic compounds

1 Adjustment of the sample pH indicates that the toxicant is degraded under basic conditions.

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9.2.3.3 Comparison of Ventura County Mean Metals and Phosphorus Results to Other California Communities

Ventura County discharge characterization data were compared to runoff quality data reported in studies of other California communities and the Nationwide Urban Runoff Program (NURP). In previous annual reports median values from Ventura County were compared to values from Sacramento County, San Bernardino County, the City of Stockton, NURP, the Bay Area Stormwater Management Agencies Association (BASMAA, 1996), the Alameda County Flood Control and Water Conservation District (ACFCWCD, 1991), and the Santa Clara Valley Water District (SCVWD, 1991) (VCSQMP, 1997). In this report, updated median values for Ventura County were compared to the above data in Table 9-11 (on page 9-18) for industrial land use and Table 9-12 (on page 9-19) for residential land use.

In general, the Ventura County mean and median EMCs were similar or lower than values from other California communities and NURP. Total suspended solids and total and dissolved phosphorus were the only constituents found to have consistently higher EMCs than other communities. Ventura County's total cadmium, total copper, residential total lead, and industrial total nickel EMCs were higher than a few communities, but overall compared well with other communities.

Table 9 - 11
Comparison of Industrial Land Use EMCs: Ventura County (1993-98)[1] vs. California Communities

			Bay Area Community Mean EMCs					Other California Community Median EMCs		
CONSTITUENT	UNITS	Ventura County 1993-98 Mean EMC	BASMAA[2]	Alameda Loads Assessment	Santa Clara Loads Assessment	Ventura County 1993-98 Median EMC	NURP Median EMC	San Bernardino County[3]	Sacramento County[4]	City of Stockton[5]
Total Cadmium	µg/L	1.6	1.72	1.4	5.9	1.0	2.0[6]	NA	0.68	0.62
Total Chromium	µg/L	13.0	22*	20	39.1	9.3	NA	NA	NA	NA
Total Copper	µg/L	28.0	45*	44	52.9	20	29	33	18.8	15.7
Total Lead	µg/L	14.5	143	77	133.5	10	23[7]	22	25	13.5
Total Nickel	µg/L	25.5	34	13	54	22	NA	NA	NA	NA
Total Zinc	µg/L	161	358	367	1,471	119	226	210	191	139
Total Suspended Solids	mg/L	286	113	114	152	111	69	180	45.4	222
Total Phosphorus	mg/L	0.53	NA	NA	NA	0.44	0.20	0.48	0.22	0.43
Dissolved Phosphorus	mg/L	0.38	NA	NA	NA	0.31	0.08	0.14	NA	0.19

Notes:
1 Combined datasets for I-1 and I-2. Previous analysis has demonstrated that data from different sites of the same predominant land use category are compatible for combination into one data set (VCSQMP, 1996).
2 BASMAA values were calculated using a multiple variable linear regression to estimate land use-specific EMCs, while Ventura County means are averages calculated directly from the data (1993-98).
3 County of San Bernardino, et. al. "1997-98 Annual Report." Medians derived from 19 storm events between 2/94 and 3/98.
4 SCWA (1995), "Sacramento Stormwater Management Program, Report of Program Effectiveness." Medians derived from nine storm events monitored between 9/89 and 9/94.
5 CDM, et. al. (1993), "City of Stockton Part 2 NPDES Storm Water Permit Application." Medians derived from six storm events monitored between 10/92 and 9/94.
6 NURP EMC values not available. Representative values taken from WMM documentation (CDM, 1992).
7 Representative NURP Lead EMC not available for lead-free fuel time period. Median taken from Walker, 1990.
"NA" Indicates that value was not available from data source referenced.
* BASMAA results suggest that land use is not a significant factor in determining the concentration of this constituent in stormwater runoff. Instead, a station average-based "Urban area" value is used.

Table 9 - 12
Comparison of Residential Land Use EMCs: Ventura County (1993-98)[1] vs. California Communities

CONSTITUENT	UNITS	Ventura County 1993-98 Mean EMC	Bay Area Community Mean EMCs			Ventura County 1993-98 Median EMC	NURP Median EMC	Other California Community Median EMCs		
			BASMAA [2]	Alameda Loads Assessment	Santa Clara Loads Assessment			San Bernardino County Median[3]	Sacramento County Median[4]	City of Stockton Median[5]
Total Cadmium	µg/L	1.15	1.66	0.85	1.7	0.90	2.0[6]	NA	0.4	0.34
Total Chromium	µg/L	7.6	22*	14	21.1	5.0	NA	23	NA	NA
Total Copper	µg/L	25.0	45*	31	50.5	16.0	33	27	11	11.3
Total Lead	µg/L	23.8	51.7	73	60.8	14.0	23[7]	12	17	15
Total Nickel	µg/L	17.7	35.5	20	40.9	18.0	NA	NA	NA	NA
Total Zinc	µg/L	134	188	246	251	99	135	130	100	119
Total Suspended Solids	mg/L	129	85.9	192	76	118	101	120	40.4	53
Total Phosphorus	mg/L	0.68	NA	NA	NA	0.57	0.38	0.37	0.28	0.37
Dissolved Phosphorus	mg/L	0.44	NA	NA	NA	0.39	0.14	NA	NA	0.22

Notes:

1 Combined datasets for R-1 and R-2. Previous analysis has demonstrated that data from different sites of the same predominant land use category are compatible for combination into one data set (VCSQMP, 1996).

2 BASMAA values were calculated using a multiple variable linear regression to estimate land use-specific EMCs, while Ventura County means are averages calculated directly from the data (1993-98).

3 County of San Bernardino, et. al. "1997-98 Annual Report." Medians derived from 19 storm events between 2/94 and 3/98.

4 SCWA (1995), "Sacramento Stormwater Management Program, Report of Program Effectiveness." Medians derived from nine storm events monitored between 9/89 and 9/94.

5 CDM, et. al. (1993), "City of Stockton Part 2 NPDES Storm Water Permit Application." Medians derived from six storm events monitored between 10/92 and 9/94.

6 NURP EMC values not available. Representative values taken from WMM documentation (CDM, 1992).

7 Representative NURP Lead EMC not available for lead-free fuel time period. Median taken from Walker, 1990.

"NA" Indicates that value was not available from data source referenced.

* BASMAA results suggest that land use is not a significant factor in determining the concentration of this constituent in stormwater runoff. Instead, a station average-based "Urban area" value is used.

9.2.4 Proposed Monitoring Effort

The proposed discharge characterization and outfall monitoring effort reflects a shift from characterizing land use monitoring sites to focusing on sites where additional information is needed and continuing toxicity monitoring. Land use characterization for residential, industrial, and commercial areas has been conducted and sufficient data collected to adequately characterize the sites and to justify a reduction in monitoring at the remaining sites (R-1 and I-2). The proposed discharge characterization monitoring will include continued monitoring at the agricultural discharge characterization site on a yearly basis and monitoring at the residential and industrial characterization sites during three storms over the course of the permit term. Reduced discharge characterization monitoring will allow the management programs to redirect resources to other monitoring activities, with an emphasis on watershed monitoring.

Since 1993, over twenty storms have been captured at both the residential, Swan Street (R-1) and industrial, Via Ortega (I-2) characterization sites. Additionally, fourteen storms were captured at the other residential (R-2) and industrial (I-1) sites before monitoring was discontinued. Data from the monitoring sites with similar land uses were determined to be similar based on a statistical analysis conducted previously (VCSQMP, 1996). As a result, between 25 and 35 data points have been collected for most constituents (except toxicity) to characterize both residential and industrial discharges. Hence, the R-1 and R-2 sites will only be monitored for three storms during this permit term.

Toxicity samples have been collected at R-1 and I-2 during three events, and Toxicity Identification Evaluations (TIEs) were conducted on samples collected in 1997/98 and 1998/99. To confirm these toxicity results and sources of toxicity, toxicity samples will be collected from each of three discharge characterization sites during approximately one storm per year until baseline information has been collected. If toxicity is observed in the collected samples, TIEs will be conducted on the samples showing toxicity to identify potential toxicants in the sample. Additional investigation into the sources of the toxicity will be conducted if necessary to isolate the toxicant(s).

Discharge characterization monitoring will continue to be conducted at site (A-1) for a maximum of five more storms during the permit term to obtain a similar level of baseline data as obtained for the residential and industrial land use sites. The agricultural site was added during 1994/95, two years after monitoring began at R-1 and I-2. Monitoring this site during this permit term will ensure that sufficient data is collected to adequately characterize agricultural discharges from this site. At least one storm event will be monitored each year, and storm events will be selected to monitor an approximately equal number of first flush/early season storms, mid-season storms, and late season storms over the permit term.

The proposed discharge characterization monitoring is summarized in Table 9-13 (shown below).

Table 9-13
Proposed Discharge Characterization Monitoring[4]

Monitoring Station	Minimum Number Events (per year)	Sample Type	Constituents[1]
A-1, Wood Road	1[2]	Automated composite and grabs	Metals Organics Conventional Inorganics Microbiological Toxicity and TIEs[3]
R-1, Swan St.[3]	3 per Permit Term	Automated composite and grabs	Metals Organics Conventional Inorganics Microbiological Toxicity and TIEs[3]
I-2, Ortega St.[3]	3 per Permit Term	Automated composite and grabs	Metals Organics Conventional Inorganics Microbiological Toxicity and TIEs[3]

1 The list of specific constituents, analytical methods, detection limits, and holding times is included in Appendix G-1
2 A maximum of 5 events will be monitored during the permit term.
3 Toxicity monitoring will occur during at least one storm per year until baseline information has been collected, and then be discontinued. A Toxicity Identification Evaluation (TIE) shall be performed when acute toxicity results are greater than 1 TUa. Freshwater acute toxicity tests shall be conducted on the most sensitive of the two species - Fathead minnow and Ceriodaphnia.
4 Detailed monitoring procedures will be as described in the *Ventura Countywide Stormwater Monitoring Program: Standard Operating Procedures 2000-2005 Stormwater Monitoring* (SOPs), which is included as Appendix G of this report.

9.3 Receiving Water and Watershed Monitoring

Receiving water monitoring conducted during the first permit term consisted primarily of wet weather sample collection and analysis from receiving water sites. The following sections describe the monitoring site locations, storm events captured, water quality results, and the proposed receiving water monitoring plan.

9.3.1 Receiving Water Assessments

During the first permit term, the receiving water quality assessments conducted in Ventura County were compiled and evaluated to help direct the Program. Since then, updated assessments of receiving water quality conducted by Regional Water Quality Control Board (RWQCB) for the Los Angeles Region have been used as background information for monitoring activities and related work. Most recently, the 1998 Clean Water Act Section 303 (d) list was used in the identification and prioritization of pollutants of concern for the Program. Receiving water assessments are reviewed and used in the Program to help prioritize their activities.

9.3.2 Monitoring Site Descriptions

As part of the Ventura Countywide NPDES Stormwater Permit, stormwater monitoring of four receiving water sites, and three special study receiving water sites has occurred during various years of the permit term. The site locations and characteristics are described in the following sections.

9.3.2.1 Receiving Water Sites

Monitoring of receiving water was accomplished at four different receiving water sites (as shown in Figure 9-1, on page 9-4) over the course of the first permit term. The site characteristics for the four monitoring stations are summarized in Table 9-14 (shown below).

Table 9 - 14
Receiving Water Monitoring Location Characteristics

Station Code	Location (Waterbody)	Land Uses	Percent Developed	Watershed Area (acres)	Rain Gage
W-1	Heywood Street between Ettinger Road and Morley Street (Dry Canyon)	Residential (downstream)	43%	2,307	Santa Susana
W-2	Alamo Street between Wanda Avenue and Jasmine Glen Avenue (Dry Canyon)	Undeveloped (upstream)	4%	1,237	Santa Susana
W-3	La Vista Avenue south of Center Road (Revolon Slough)	Agricultural/ Open Space	<2%	752	Somis Deboni
W-4	Revolon Slough at Wood Road (Revolon Slough)	Mixed Use	20%	28,800	Oxnard Airport

The Alamo Street site (W-2) is near the northern city limits of Simi Valley at the Alamo Street overcrossing. The vast majority of the area above this monitoring site is undeveloped. The Heywood Street site (W-1) is just above the confluence of Dry Creek with Arroyo Simi at the Heywood Street overcrossing. Urban stormwater drains to this site from a primarily residential area containing some commercial land use area. This drainage basin composition is reflective of the community at large. The La Vista Avenue site (W-3) is in the upper Revolon Slough watershed, which consists primarily of agricultural and open space land uses. The W-1, W-2, and W-3 sites were equipped with automated monitoring equipment. The Revolon Slough site (W-4) is located in Revolon Slough at the Wood Road bridge in a large mixed use area. Samples are collected there as manual grab samples. This site is also monitored monthly by VCFCD in conjunction with the Calleguas Creek Watershed Coordinated Monitoring Program (CMP).

9.3.2.2 Malibu Creek Watershed Receiving Water Sites

During the 1996/97 and 1997/98 monitoring years, a two-year special study was conducted to investigate the quality of runoff entering Malibu Creek from drainage areas located in Ventura County. The upper Malibu Creek watershed monitoring stations are located on tributaries to Malibu Creek on the Ventura County side of the Ventura-Los Angeles County line as shown in Figure 9-1 on page 9-4. The monitoring locations and the watershed characteristics of the drainage areas to the creeks are summarized in Table 9-15 (shown below).

Table 9 - 15
Malibu Creek Watershed Monitoring Location Characteristics

Station Code	Location	Land Uses	Percent Developed	Watershed Area (acres)	Rain Gage
LC-1	Lindero Canyon Creek at Ventura-Los Angeles County Line	Undeveloped/ Residential	41.5 %	2,000	Simi Hills - #249
MC-1	Medea Canyon Creek at Ventura-Los Angeles County Line	Undeveloped/ Residential	40%	2,130	Simi Hills - #249
LV-1	Las Virgenes Creek at Ventura-Los Angeles County Line	Undeveloped	<2%	4,683	Simi Hills - #249

Two of the grab sample monitoring sites, Lindero Canyon Creek and Medea Canyon Creek, eventually flow to Malibu Lake and then to Malibu Creek in Los Angeles County. The land uses within these sub-basins are residential and undeveloped. The third grab sample monitoring site is located on Las Virgenes Canyon Creek in Ventura County, which joins Malibu Creek south of Malibu Lake. This watershed sub-basin is undeveloped and is significantly larger than the other two watershed areas.

9.3.3 Storm Events Monitored

This section summarizes the monitoring events captured at the receiving water monitoring sites since 1994 and describes the locations monitored during each year of the first permit.

9.3.3.1 Receiving Water Sites

Monitoring conducted at each of the four receiving water sites is summarized in Table 9-16 (shown below).

Table 9 - 16
Summary of Receiving Water Monitoring Dates

Monitoring Station	1994/95	1995/96	1996/97	1997/98
W-1, Heywood St.	2/13/95 3/21/95	1/21/96 1/31/96 2/19/96 3/4/96	10/29/96 11/20/96 12/9/96	NS
W-2, Alamo St.	2/13/95 3/21/95	1/21/96 1/31/96 2/19/96 3/4/96	10/29/96 11/20/96 12/9/96	NS
W-3, La Vista Rd.	NS	NS	1/14/97	11/26/97 12/5/97 1/9/98 1/29/98 3/24/98
W-4, Revolon Slough	NS	NS	NS	12/5/97 1/29/98 3/24/98

NS Monitoring location not sampled during the permit year.

During the 1996/97 monitoring season, it was concluded that low flow conditions at W-1 and W-2 necessitated moving the receiving water monitoring locations. Therefore, during 1996/97, two new receiving water sites were selected. Automated sampling equipment was installed at W-3, La Vista Rd., prior to the completion of the 1996/97 monitoring season and one storm was monitored. W-4, Revolon Slough at Wood Rd. was added during 1997/98 to coordinate with and in anticipation of the Calleguas Creek Watershed CMP.

9.3.3.2 Malibu Creek Watershed Monitoring Sites

The three Malibu Creek watershed sites were monitored as part of a two-year special study in 1996/97 and 1997/98. The storm events monitored are summarized in Table 9-17 (shown below).

Table 9 - 17
Summary of Malibu Creek Watershed Monitoring Dates

Monitoring Station	1996/97	1997/98
LC-1, Lindero Canyon	9/10/96 10/29/96 4/28/97 8/28/97	11/10/97 1/29/98 5/5/98 8/4/98
LV-1, Las Virgenes Creek	10/29/96 4/28/97	12/6/97 5/5/98
MC-1, Medea Canyon	9/10/96 10/29/96 4/28/97 8/28/97	11/10/97 1/29/98 5/5/98 8/4/98

9.3.4 Monitoring Results

Tables 9-18 through 9-21 (on pages 9-26 through 9-31) summarize the water quality results for detected constituents at the receiving water and Malibu Creek Watershed monitoring sites.

9.3.4.1 Receiving Water Sites

Table 9 - 18
Summary Statistics for Detected Constituents at W-1, Heywood St. (1994-1997)[1]

Parameter	Units	# Samples	% Detected	Mean	Median	Coefficient of Variation
Conventionals						
BOD	mg/L	5	100%	18.2	11	1.0
COD	mg/L	5	100%	91.8	87	0.39
Oil and Grease	mg/L	9	44%	1.7	0.92	1.1
TRPH	mg/L	7	100%	2.3	2.3	0.67
Total Organic Carbon	mg/L	4	100%	6.8	5.7	0.52
Conductivity	umho/cm	8	100%	105	111	0.25
pH	pH units	8	100%	6.96	6.95	0.02
Total Dissolved Solids	mg/L	5	100%	56.0	64	0.32
Total Suspended Solids	mg/L	5	100%	172	150	0.55
Hardness	mg/L	5	100%	28.4	28	0.23
Nutrients						
Ammonia-Nitrogen	mg/L	5	100%	0.54	0.4	0.52
Kjeldahl-Nitrogen	mg/L	5	100%	2.4	2	0.49
Nitrate Nitrogen	mg/L	5	100%	0.75	0.63	0.73
Phosphorus, Total	mg/L	5	100%	0.48	0.43	0.27
Phosphorus, Dissolved	mg/L	5	100%	0.32	0.32	0.27
Bacteriological[2]						
Total Coliform	MPN/100ml	8	100%	133,800	160,000	0.38
Fecal Coliform	MPN/100ml	8	100%	32,600	24,000	0.90
Fecal Streptococcus	MPN/100ml	7	100%	90,300	90,000	0.63
Metals[3]						
Arsenic, Total	µg/L	3	100%	2.2	2.1	0.14
Arsenic, Dissolved	µg/L	3	100%	1.8	2	0.26
Cadmium, Total	µg/L	3	100%	1.5	1.4	0.75
Cadmium, Dissolved	µg/L	3	67%	ID	ID	ID
Chromium, Total	µg/L	3	100%	10.8	10.9	0.53
Chromium, Dissolved	µg/L	3	100%	2.2	2.5	0.42
Copper, Total	µg/L	3	100%	32.7	30	0.49
Copper, Dissolved	µg/L	3	100%	10.3	10	0.06
Lead, Total	µg/L	3	100%	13.0	13	0.12
Lead, Dissolved	µg/L	3	100%	3.7	3.5	0.76
Mercury, Total	µg/L	6	17%	ID	ID	ID
Nickel, Total	µg/L	3	100%	39.3	38	0.36
Nickel, Dissolved	µg/L	3	100%	27.3	22	0.37
Selenium, Total	µg/L	3	33%	ID	ID	ID
Silver, Total	µg/L	3	33%	ID	ID	ID
Silver, Dissolved	µg/L	3	33%	ID	ID	ID
Zinc, Total	µg/L	3	100%	137	161	0.33
Zinc, Dissolved	µg/L	3	100%	46.0	39	0.26
EPA 625						
Bis(2-ethylhexyl)phthalate	ng/L	9	33%	7280	4260	0.74

1 The Helsel Method (1990) was used to assign concentrations to non-detected samples.
2 In cases where microbiological counts were reported as greater than 160,000 MPN/mL, 160,000 MPN/mL was used as the count value for statistical purposes.
3 The 1996/97 metals data that were censored due to data quality problems were not included in the calculations.
ID Insufficient data available for analysis. For the non-detect analysis, at least 3 detected values were required and at least 20% of the samples had to be detected. If all samples were detected, there had to be at least 2 sample results for statistics to be generated.

Table 9 - 19
Summary Statistics for Detected Constituents at W-2, Alamo St. (1994-1997)[1]

Parameter	Units	# Samples	% Detected	Mean	Median	Coefficient of Variation
Conventionals						
BOD	mg/L	4	75%	10.1	10	0.36
COD	mg/L	4	100%	73.0	71	0.33
Oil and Grease	mg/L	9	11%	ID	ID	ID
Total Organic Carbon	mg/L	3	100%	9.0	10	0.74
Conductivity	umho/cm	8	100%	198	196	0.33
pH	pH units	8	100%	7.2	7.3	0.03
Total Dissolved Solids	mg/L	4	100%	110	110	0.04
Total Suspended Solids	mg/L	4	100%	872	864	0.52
Hardness	mg/L	4	100%	79.3	79.5	0.06
Nutrients						
Ammonia-Nitrogen	mg/L	4	100%	0.35	0.3	0.55
Kjeldahl-Nitrogen	mg/L	4	100%	6.6	3.9	1.0
Nitrate Nitrogen	mg/L	4	100%	2.0	2.5	0.68
Phosphorus, Total	mg/L	4	100%	0.97	0.92	0.27
Phosphorus, Dissolved	mg/L	4	100%	0.34	0.34	0.32
Bacteriological[2]						
Total Coliform	MPN/100ml	8	100%	147,500	165,000	0.51
Fecal Coliform	MPN/100ml	8	100%	29,300	13,000	1.48
Fecal Streptococcus	MPN/100ml	7	100%	66,600	30,000	0.91
Metals[3]						
Arsenic, Total	µg/L	2	100%	8.7	8.7	0.01
Arsenic, Dissolved	µg/L	2	100%	5.2	5.2	0.40
Cadmium, Total	µg/L	2	100%	0.95	0.95	0.67
Cadmium, Dissolved	µg/L	2	100%	0.85	0.85	0.58
Chromium, Total	µg/L	2	100%	22.2	22.2	0.97
Chromium, Dissolved	µg/L	2	100%	6.8	6.8	0.97
Copper, Total	µg/L	2	100%	65.5	65.5	0.33
Copper, Dissolved	µg/L	2	100%	25.0	25.0	0.74
Lead, Total	µg/L	2	100%	20.3	20.3	0.83
Lead, Dissolved	µg/L	2	100%	8.0	8.0	0.83
Mercury, Total	µg/L	6	33%	ID	ID	ID
Nickel, Total	µg/L	2	100%	52.0	52.0	0.05
Nickel, Dissolved	µg/L	2	100%	35.5	35.5	0.10
Selenium, Total	µg/L	2	100%	0.75	0.75	0.47
Zinc, Total	µg/L	2	100%	164	164	0.11
Zinc, Dissolved	µg/L	2	100%	75.5	75.5	0.23
EPA 625						
Bis(2-ethylhexyl)phthalate	ng/L	9	11%	ID	ID	ID

1 The Helsel Method (1990) was used to assign concentrations to non-detected samples.
2 In cases where microbiological counts were reported as greater than 160,000 MPN/mL, 160,000 MPN/mL was used as the count value for statistical purposes.
3 The 1996/97 metals data that were censored due to data quality problems were not included in the calculations.
ID Insufficient data available for analysis. For the non-detect analysis, at least 3 detected values were required and at least 20% of the samples had to be detected. If all samples were detected, there had to be at least 2 sample results for statistics to be generated.

Table 9 - 20
Summary Statistics for Detected Constituents at W-3, La Vista Rd. (1997-1998)[1]

Parameter	Units	# Samples	% Detected	Mean	Median	Coefficient of Variation
Conventionals						
BOD	mg/L	5	100%	27.2	14	1.1
COD	mg/L	1	100%	ID	ID	ID
Oil and Grease	mg/L	3	67%	ID	ID	ID
TRPH	mg/L	3	67%	ID	ID	ID
Total Organic Carbon	mg/L	4	100%	16.9	8.8	1.0
Conductivity	umho/cm	4	100%	268	243	0.59
pH	pH units	4	100%	7.7	7.7	0.03
Total Dissolved Solids	mg/L	5	100%	256	242	0.31
Total Suspended Solids	mg/L	5	100%	3730	3240	0.78
Hardness	mg/L	5	100%	171	132	0.56
Chloride	mg/L	5	100%	16.8	14	0.51
Nutrients						
Ammonia-Nitrogen	mg/L	5	60%	0.95	0.6	0.90
Kjeldahl-Nitrogen	mg/L	5	100%	11.0	10.4	0.71
Nitrate Nitrogen	mg/L	5	100%	3.2	3.02	0.42
Orthophosphate-P	mg/L	4	100%	0.50	0.54	0.26
Phosphorus, Total	mg/L	5	100%	2.1	2.0	0.45
Phosphorus, Dissolved	mg/L	5	100%	0.47	0.5	0.30
Bacteriological[2]						
Total Coliform	MPN/100ml	4	100%	147,500	160,000	0.17
Fecal Coliform	MPN/100ml	4	100%	34,3000	37,000	0.55
Fecal Streptococcus	MPN/100ml	4	100%	180,000	160,000	0.22
Metals[3]						
Arsenic, Total	µg/L	4	100%	79.3	80	0.30
Arsenic, Dissolved	µg/L	4	100%	6.8	4.1	1.1
Cadmium, Total	µg/L	4	100%	5.2	4.4	0.61
Cadmium, Dissolved	µg/L	4	75%	2.5	1.7	0.95
Chromium, Total	µg/L	4	100%	220	230	0.13
Chromium, Dissolved	µg/L	4	100%	22.4	18.3	0.81
Copper, Total	µg/L	4	100%	527	547	0.38
Copper, Dissolved	µg/L	4	100%	85.0	55	0.81
Lead, Total	µg/L	4	100%	116	109	0.30
Lead, Dissolved	µg/L	4	100%	20.2	15	0.86
Mercury, Total	µg/L	4	100%	0.28	0.28	0.32
Mercury, Dissolved	µg/L	4	100%	0.01	0.005	0.26
Nickel, Total	µg/L	4	100%	183	176	0.23
Nickel, Dissolved	µg/L	4	75%	23.4	22	0.80
Selenium, Total	µg/L	4	100%	3.4	2.8	0.47
Selenium, Dissolved	µg/L	4	100%	1.1	0.95	0.42
Silver, Total	µg/L	4	50%	ID	ID	ID
Silver, Dissolved	µg/L	4	25%	ID	ID	ID
Zinc, Total	µg/L	4	100%	604	600	0.76
Zinc, Dissolved	µg/L	4	100%	85.5	58	0.79

Table 9 - 20
Summary Statistics for Detected Constituents at W-3, La Vista Rd. (1997-1998)[1]

Parameter	Units	# Samples	% Detected	Mean	Median	Coefficient of Variation
EPA 625						
1-Methylphenanthrene	ng/L	4	50%	ID	ID	ID
2,3,5-Trimethlynaphthalene	ng/L	4	25%	ID	ID	ID
Benz(a)anthracene	ng/L	4	25%	ID	ID	ID
Chrysene	ng/L	4	25%	ID	ID	ID
Fluoranthene	ng/L	4	50%	ID	ID	ID
Fluorene	ng/L	4	25%	ID	ID	ID
Phenanthrene	ng/L	4	75%	44.8	33.5	0.82
Pyrene	ng/L	4	25%	ID	ID	ID
1,3-Dichlorobenzene	ng/L	4	25%	ID	ID	ID
bis(2-ethylhexyl)phthalate	ng/L	4	75%	666	229	1.5
Butyl benzyl phthalate	ng/L	4	25%	ID	ID	ID
Di-n-octyl phthalate	ng/L	4	50%	ID	ID	ID
Dibutyl phthalate	ng/L	4	75%	56.5	58.5	0.52
Diethyl phthalate	ng/L	4	75%	68.7	49	1.1
Dimethyl phthalate	ng/L	4	50%	ID	ID	ID
EPA 8080						
2,4'-DDE	ng/L	4	50%	ID	ID	ID
2,4'-DDT	ng/L	4	50%	ID	ID	ID
4,4' - DDD	ng/L	4	100%	19.5	16.5	1.0
4,4' - DDE	ng/L	4	100%	197	176	0.68
4,4' - DDT	ng/L	4	100%	105	117	0.72
Aldrin	ng/L	4	25%	ID	ID	ID
beta-BHC	ng/L	4	25%	ID	ID	ID
gamma-BHC	ng/L	4	25%	ID	ID	ID
EPA 8140						
Chlorpyrifos	µg/L	4	50%	ID	ID	ID
Disulfoton	µg/L	4	25%	ID	ID	ID
EPA 8150						
2,4-D	µg/L	3	100%	9.5	5.6	1.1
Dinoseb (DNBP)	µg/L	3	100%	1.1	1.2	0.69

1 The Helsel Method (1990) was used to assign concentrations to non-detected samples.
2 In cases where microbiological counts were reported as greater than 160,000 MPN/mL, 160,000 MPN/mL was used as the count value for statistical purposes.
3 The 1996/97 metals data that were censored due to data quality problems were not included in the calculations.
ID Insufficient data available for analysis. For the non-detect analysis, at least 3 detected values were required and at least 20% of the samples had to be detected. If all samples were detected, there had to be at least 2 sample results for statistics to be generated.

Table 9 - 21
Summary Statistics for Detected Constituents at W-4, Revolon Slough (1997-1998)[1]

Parameter	Units	# Samples	% Detected	Mean	Median	Coefficient of Variation
Conventionals						
BOD	mg/L	2	100%	22.5	22.5	0.72
Total Organic Carbon	mg/L	1	100%	ID	ID	ID
Conductivity	umho/cm	2	100%	851	851	0.04
pH	pH units	2	100%	7.7	7.7	0
Total Dissolved Solids	mg/L	2	100%	566	566	0.13
Total Suspended Solids	mg/L	2	100%	1880	1880	1.2
Hardness	mg/L	2	100%	294	294	0.29
Chloride	mg/L	2	100%	35	35	0.12
Nutrients						
Ammonia-Nitrogen	mg/L	2	100%	0.8	0.8	0.18
Kjeldahl-Nitrogen	mg/L	2	100%	7.5	7.5	0.60
Nitrate Nitrogen	mg/L	2	100%	7.6	7.6	0.12
Orthophosphate-P	mg/L	2	100%	0.32	0.32	0.02
Phosphorus, Total	mg/L	2	100%	2.6	2.63	0.21
Phosphorus, Dissolved	mg/L	2	100%	0.4	0.35	0.08
Bacteriological[2]						
Total Coliform	MPN/100ml	2	100%	200,000	200,000	0.28
Fecal Coliform	MPN/100ml	2	100%	13,000	13,000	0
Fecal Streptococcus	MPN/100ml	2	100%	162,000	162,000	1.20
Metals						
Arsenic, Total	µg/L	2	100%	21.5	21.5	0.43
Arsenic, Dissolved	µg/L	2	100%	2.1	2.1	0.88
Cadmium, Total	µg/L	2	100%	2.6	2.6	0.27
Cadmium, Dissolved	µg/L	2	100%	0.5	0.45	0.79
Chromium, Total	µg/L	2	100%	83.5	83.5	0.77
Chromium, Dissolved	µg/L	2	100%	2.5	2.45	0.26
Copper, Total	µg/L	2	100%	92.5	92.5	0.45
Copper, Dissolved	µg/L	2	100%	12	12	0
Lead, Total	µg/L	2	100%	21	21	0.67
Mercury, Total	µg/L	2	100%	0.12	0.12	0.68
Mercury, Dissolved	µg/L	2	100%	0.0025	0.0025	0.73
Nickel, Total	µg/L	2	100%	72	72	0.63
Nickel, Dissolved	µg/L	2	100%	4.8	4.8	0.94
Selenium, Total	µg/L	2	100%	1.6	1.6	0.09
Silver, Total	µg/L	2	50%	ID	ID	ID
Silver, Dissolved	µg/L	2	50%	ID	ID	ID
Zinc, Total	µg/L	2	100%	267	267	0.60
Zinc, Dissolved	µg/L	2	100%	28.5	28.5	0.57
EPA 625						
1-Methylphenanthrene	ng/L	2	100%	16	16	0.18
Benzo(e)pyrene	ng/L	2	50%	ID	ID	ID
Chrysene	ng/L	2	50%	ID	ID	ID

Table 9 - 21
Summary Statistics for Detected Constituents at W-4, Revolon Slough (1997-1998)[1]

Parameter	Units	# Samples	% Detected	Mean	Median	Coefficient of Variation
Fluoranthene	ng/L	2	100%	77.5	77.5	0.05
Phenanthrene	ng/L	2	100%	86.5	86.5	0.14
Pyrene	ng/L	2	100%	59.5	59.5	0.01
bis(2-ethylhexyl)phthalate	ng/L	2	100%	306	306	1.2
Butyl benzyl phthalate	ng/L	2	50%	ID	ID	ID
Di-n-octyl phthalate	ng/L	2	100%	280	280	1.2
Dibutyl phthalate	ng/L	2	50%	ID	ID	ID
Diethyl phthalate	ng/L	2	100%	67.5	67.5	0.35
Dimethyl phthalate	ng/L	2	100%	22.5	22.5	0.28
EPA 8080						
2,4'-DDD	ng/L	2	100%	9.0	9.0	0.16
2,4'-DDE	ng/L	2	100%	9.5	9.5	0.52
2,4'-DDT	ng/L	2	100%	15.5	15.5	0.14
4,4' - DDD	ng/L	2	100%	23.5	23.5	0.39
4,4' - DDE	ng/L	2	100%	208	208	0.87
4,4' - DDT	ng/L	2	100%	140	140	1.1
gamma-BHC	ng/L	2	100%	7.0	7.0	0.61
alpha-Chlordane	ng/L	2	50%	ID	ID	ID
gamma-Chlordane	ng/L	2	50%	ID	ID	ID
EPA 8140						
Diazinon	µg/L	2	50%	ID	ID	ID

1 The Helsel Method (1990) was used to assign concentrations to non-detected samples.

2 In cases where microbiological counts were reported as greater than 160,000 MPN/mL, 160,000 MPN/mL was used as the count value for statistical purposes.

ID Insufficient data available for analysis. For the non-detect analysis, at least 3 detected values were required and at least 20% of the samples had to be detected. If all samples were detected, there had to be at least 2 sample results for statistics to be generated.

9.3.4.2 Bioassay Results

Toxicity samples were collected at three of the four sites during at least one storm and a TIE was conducted on samples collected in 1997/98. The results of toxicity samples collected at the receiving water sites are summarized in the Table 9-22 (shown below).

Table 9 - 22
Survival Rates of Ceriodaphnia for Receiving Water Monitoring Sites

	Percent Survival of Ceriodaphnia (LC50)		
Storm Event Date	**W-1**	**W-3**	**W-4**
1/31/96[1]	0%	NS	NS
2/19/96[1]	20%	NS	NS
12/10/96[1]	0%	NS	NS
11/26/97	NS	<6.25%	NS
12/5/97	NS	17%	17%
3/24/98	NS	76%	100%

1 Data reported as EC50 for these storm events.
NS Toxicity samples not collected at this site during the listed monitoring event.

A TIE was conducted on samples collected during two events sampled in 1997/98. The primary toxicant classes identified as causing toxicity and any other classes contributing to the toxicity of the receiving water samples are summarized in Table 9-23 (shown below).

Table 9 - 23
Summary of TIE Results

Sample Site	Primary Toxicant Class	Classes Possibly Contributing to Toxicity
W-3 (11/26/97)	Volatile compounds[1]	
W-3 (12/5/97)	Non-polar organic compounds [2]	Volatile or oxidizable compounds Particulate-bound toxins

1 Toxicity in samples dissipated before TIE manipulations could be conducted. Therefore, the toxicity was assumed to be due primarily to volatile compounds.
2 Adjustment of the sample pH indicates that the toxicant is probably not degraded under acidic or basic conditions.

Results of the 1997/98 TIEs are to be confirmed by toxicity samples collected in 1998/99.

9.3.4.3 Malibu Creek Watershed Receiving Water Sites

Water quality results obtained for the special receiving water study conducted in the Malibu Creek Watershed are summarized in Tables 9-24 through 9-26 (on pages 9-33 through 9-35).

Table 9 - 24
Summary Statistics for Detected Constituents at LC-1, Lindero Canyon (1996-1998)[1]

Parameter	Units	# Samples	% Detected	Mean	Median	Coefficient of Variation
Conventionals						
BOD	mg/L	5	40%	ID	ID	ID
COD	mg/L	3	33%	ID	ID	ID
Total Organic Carbon	mg/L	5	60%	15.7	5.3	1.1
Conductivity	umho/cm	5	100%	2580	2610	0.48
pH	pH units	5	100%	7.7	7.7	0.01
Total Dissolved Solids	mg/L	5	100%	2130	2060	0.53
Total Suspended Solids	mg/L	5	100%	102	26	1.4
Hardness	mg/L	3	100%	895	1040	0.59
Chloride	mg/L	2	100%	244	244	0.27
Nutrients						
Ammonia-Nitrogen	mg/L	5	60%	0.48	0.4	0.88
Kjeldahl-Nitrogen	mg/L	5	80%	2.4	1.4	1.1
Nitrate Nitrogen	mg/L	5	60%	0.65	0.32	1.6
Orthophosphate-P	mg/L	2	100%	0.17	0.17	0.08
Phosphorus, Total	mg/L	5	100%	0.37	0.24	0.87
Phosphorus, Dissolved	mg/L	5	100%	0.22	0.19	0.61
Bacteriological[2]						
Total Coliform	MPN/100ml	8	100%	30,800	8000	1.7
Fecal Coliform	MPN/100ml	8	100%	8440	1900	1.4
Fecal Streptococcus	MPN/100ml	8	100%	28,000	8000	1.9
Metals[3]						
Arsenic, Total	µg/L	4	75%	3.0	2.2	0.97
Arsenic, Dissolved	µg/L	2	100%	1.3	1.3	0.54
Cadmium, Total	µg/L	4	100%	4.1	2.9	1.0
Cadmium, Dissolved	µg/L	2	50%	ID	ID	ID
Chromium, Total	µg/L	4	100%	10.2	10.5	0.16
Chromium, Dissolved	µg/L	2	100%	3.0	3.5	0.61
Copper, Total	µg/L	4	100%	21.0	20.0	0.49
Copper, Dissolved	µg/L	2	100%	9.5	9.5	0.67
Lead, Total	µg/L	4	100%	26.3	15	1.2
Lead, Dissolved	µg/L	2	100%	8.0	8.0	1.2
Mercury, Total	µg/L	4	50%	ID	ID	ID
Mercury, Dissolved	µg/L	2	100%	0.0021	0.0021	0.26
Nickel, Total	µg/L	4	100%	34.0	37.0	0.52
Nickel, Dissolved	µg/L	2	50%	ID	ID	ID
Selenium, Total	µg/L	4	75%	2.9	2.7	0.47
Selenium, Dissolved	µg/L	2	50%	ID	ID	ID
Silver, Total	µg/L	4	75%	1.0	1	0.19
Silver, Dissolved	µg/L	2	50%	ID	ID	ID
Zinc, Total	µg/L	4	100%	43.5	23.5	1.1
Zinc, Dissolved	µg/L	2	100%	12.5	12.5	0.85

1 The Helsel Method (1990) was used to assign concentrations to non-detected samples.
2 In cases where microbiological counts were reported as greater than 160,000 MPN/mL, 160,000 MPN/mL was used as the count value for statistical purposes.
3 The 1996/97 metals data that were censored due to data quality problems were not included in the calculations.
ID Insufficient data available for analysis. For the non-detect analysis, at least 3 detected values were required and at least 20% of the samples had to be detected. If all samples were detected, there had to be at least 2 sample results for statistics to be generated.

Table 9 - 25
Summary Statistics for Detected Constituents at LV-1, Las Virgenes Creek (1996-1998)[1]

Parameter	Units	# Samples	% Detected	Mean	Median	Coefficient of Variation
Conventionals						
BOD	mg/L	4	50%	ID	ID	ID
COD	mg/L	2	50%	ID	ID	ID
Total Organic Carbon	mg/L	4	100%	15.1	12	0.64
Conductivity	umho/cm	4	100%	2600	2660	0.55
pH	pH units	4	100%	7.7	7.8	0.03
Total Dissolved Solids	mg/L	4	100%	2280	2270	0.59
Total Suspended Solids	mg/L	4	100%	54.3	25.5	1.3
Hardness	mg/L	3	100%	993	959	0.57
Chloride	mg/L	2	100%	85.0	85.0	0.82
Nutrients						
Ammonia-Nitrogen	mg/L	4	25%	ID	ID	ID
Kjeldahl-Nitrogen	mg/L	4	100%	2.3	1.9	0.73
Nitrate Nitrogen	mg/L	4	75%	1.0	0.67	1.1
Orthophosphate-P	mg/L	2	100%	0.47	0.47	0.87
Phosphorus, Total	mg/L	4	100%	0.49	0.36	0.82
Phosphorus, Dissolved	mg/L	4	100%	0.36	0.27	0.75
Bacteriological[2]						
Total Coliform	MPN/100ml	4	100%	13,800	15,500	0.72
Fecal Coliform	MPN/100ml	4	75%	8240	4400	1.4
Fecal Streptococcus	MPN/100ml	4	100%	31,100	17,000	1.3
Metals[3]						
Arsenic, Total	µg/L	3	67%	ID	ID	ID
Arsenic, Dissolved	µg/L	2	50%	ID	ID	ID
Cadmium, Total	µg/L	3	100%	5.1	6.4	0.71
Cadmium, Dissolved	µg/L	2	100%	2.7	2.7	1.3
Chromium, Total	µg/L	3	100%	14.8	6.3	1.1
Chromium, Dissolved	µg/L	2	100%	9.0	9.0	0.94
Copper, Total	µg/L	3	100%	14.3	15	0.28
Copper, Dissolved	µg/L	2	100%	13.5	13.5	0.37
Lead, Total	µg/L	3	67%	ID	ID	ID
Mercury, Total	µg/L	3	67%	ID	ID	ID
Mercury, Dissolved	µg/L	2	100%	0.0032	0.0032	0.90
Nickel, Total	µg/L	3	100%	32.7	39.0	0.42
Nickel, Dissolved	µg/L	2	100%	22.0	22.0	0.77
Selenium, Total	µg/L	3	100%	3.3	2.4	0.75
Selenium, Dissolved	µg/L	2	100%	2.9	2.9	0.88
Silver, Total	µg/L	3	100%	0.90	1.0	0.73
Silver, Dissolved	µg/L	2	50%	ID	ID	ID
Zinc, Total	µg/L	3	100%	28.0	37.0	0.68
Zinc, Dissolved	µg/L	2	100%	19.5	19.5	1.1

1 The Helsel Method (1990) was used to assign concentrations to non-detected samples.
2 In cases where microbiological counts were reported as greater than 160,000 MPN/mL, 160,000 MPN/mL was used as the count value for statistical purposes.
3 The 1996/97 metals data that were censored due to data quality problems were not included in the calculations.
ID Insufficient data available for analysis. For the non-detect analysis, at least 3 detected values were required and at least 20% of the samples had to be detected. If all samples were detected, there had to be at least 2 sample results for statistics to be generated.

Table 9 - 26
Summary Statistics for Detected Constituents at MC-1, Medea Canyon (1996-1998)[1]

Parameter	Units	# Samples	% Detected	Mean	Median	Coefficient of Variation
Conventionals						
BOD	mg/L	5	40%	ID	ID	ID
COD	mg/L	3	67%	ID	ID	ID
Total Organic Carbon	mg/L	5	60%	16.1	4.7	1.2
Conductivity	umho/cm	5	100%	2120	1590	0.54
pH	pH units	5	100%	7.8	7.8	0.02
Total Dissolved Solids	mg/L	5	100%	1690	1230	0.59
Total Suspended Solids	mg/L	5	100%	207	184	0.98
Hardness	mg/L	3	100%	616	712	0.34
Chloride	mg/L	2	100%	178	178	0.52
Nutrients						
Ammonia-Nitrogen	mg/L	5	60%	0.40	0.17	1.7
Kjeldahl-Nitrogen	mg/L	5	80%	4.1	1.2	1.2
Nitrate Nitrogen	mg/L	5	80%	1.1	0.57	1.4
Orthophosphate-P	mg/L	2	100%	0.20	0.20	0.40
Phosphorus, Total	mg/L	5	100%	0.59	0.36	0.96
Phosphorus, Dissolved	mg/L	5	100%	0.24	0.15	0.93
Bacteriological[2]						
Total Coliform	MPN/100ml	8	100%	42,800	18,500	1.3
Fecal Coliform	MPN/100ml	8	100%	17,800	7000	1.7
Fecal Streptococcus	MPN/100ml	8	100%	36,800	4000	1.6
Metals[3]						
Arsenic, Total	µg/L	4	75%	4.8	4.5	0.38
Arsenic, Dissolved	µg/L	2	100%	0.50	0.50	0
Cadmium, Total	µg/L	4	100%	2.6	2.5	0.69
Cadmium, Dissolved	µg/L	2	50%	ID	ID	ID
Chromium, Total	µg/L	4	100%	17.0	15.9	0.39
Chromium, Dissolved	µg/L	2	100%	5.0	5.0	0.57
Copper, Total	µg/L	4	100%	51.0	47.5	0.86
Copper, Dissolved	µg/L	2	100%	22.0	22	1.1
Lead, Total	µg/L	4	100%	26.3	16	1.2
Lead, Dissolved	µg/L	2	50%	ID	ID	ID
Mercury, Total	µg/L	4	50%	ID	ID	ID
Mercury, Dissolved	µg/L	2	100%	0.003	0.003	0.05
Nickel, Total	µg/L	4	100%	33.8	37.0	0.56
Nickel, Dissolved	µg/L	2	100%	18.0	18.0	1.2
Selenium, Total	µg/L	4	75%	1.5	1.5	0.42
Selenium, Dissolved	µg/L	2	50%	ID	ID	ID
Silver, Total	µg/L	4	100%	0.83	0.9	0.47
Silver, Dissolved	µg/L	2	50%	ID	ID	ID
Zinc, Total	µg/L	4	100%	118	111	0.88
Zinc, Dissolved	µg/L	2	100%	72.0	72.0	1.2

1 The Helsel Method (1990) was used to assign concentrations to non-detected samples.
2 In cases where microbiological counts were reported as greater than 160,000 MPN/mL, 160,000 MPN/mL was used as the count value for statistical purposes.
3 The 1996/97 metals data that were censored due to data quality problems were not included in the calculations.
ID Insufficient data available for analysis. For the non-detect analysis, at least 3 detected values were required and at least 20% of the samples had to be detected. If all samples were detected, there had to be at least 2 sample results for statistics to be generated.

9.3.5 Proposed Receiving Water and Watershed Monitoring

The proposed receiving water and watershed monitoring program includes monitoring in four watersheds: Revolon Slough, Ventura River, Calleguas Creek, and the Santa Clara River. The Revolon Slough monitoring will be continued at the La Vista Drain (W-3) and Wood Road (W-4) sites. Bioassessment monitoring on the Ventura River and mass emission monitoring on the Ventura River, Calleguas Creek and the Santa Clara River will be initiated during this permit term. In addition, participation in a number of watershed groups and activities will be pursued.

9.3.5.1 Revolon Slough Watershed

Due to the relocation of two of the original sites, only two years of data have been collected at La Vista Drain (W-3) and Revolon Slough at Wood Road (W-4). For this reason, monitoring of W-3 and W-4 will be continued during this permit term until five storms have been captured. Table 9-27 (shown below) summarizes the proposed Revolon Slough Watershed monitoring.

Table 9 - 27
Proposed Monitoring in Revolon Slough Watershed

Monitoring Station	Minimum Number of Events (per year)	Type of Sample	Constituents[1]
W-3, La Vista Drain	1[2]	Automated composite and grab samples	Metals Organics Conventional Inorganics Microbiological Toxicity and TIEs[3]
W-4, Revolon Slough @ Wood Road	1[2]	Composite and Grab	Metals Organics Conventional Inorganics Microbiological Toxicity and TIEs[3]

1 The list of specific constituents, analytical methods, detection limits, and holding times is included in Appendix G.
2 A maximum of five events will be monitored during the permit term.
3 Toxicity monitoring will occur during at least 1 storm event a year until baseline information has been collected, and then be discontinued. Toxicity Identification Evaluation (TIE) shall be performed when acute toxicity results are greater than 1 TUa. Freshwater acute toxicity tests shall be conducted on the most sensitive of the two species - Fathead minnow and Ceriodaphnia.

Samples will be collected in conjunction with sample collection at the discharge characterization sites whenever possible.

9.3.5.2 Bioassessment Monitoring in the Ventura River

To assess urban runoff impacts on the macroinvertebrate community structure in the Ventura River, a bioassessment monitoring program will be undertaken during this permit term. The bioassessment program will consist of aquatic macroinvertebrate monitoring at fourteen stations on the Ventura River. These stations will allow the assessment of a variety of impacts from urban and rural runoff. Two of the sites chosen have not been impacted by runoff or physical modifications and will be used as reference sites for comparison of the monitoring results from the other twelve locations. Table 9-28 (shown below) summarizes the proposed bioassessment monitoring locations.

Table 9-28.
Proposed Bioassessment Monitoring Stations

Stn. ID	Description	Impact Assessment
2*	Ventura – Shell Road	All land uses
3	Canada Larga -	Grazing
4	Canada Larga -	Reference for Canada Larga
5	Ventura - Foster Park	Urban, dam, quarry
6	San Antonio - near Vta conf	San Antonio Creek
7*	Lion Canyon - near San Antonio	San Antonio Creek, stables, grazing
8	Stewart Canyon - near San Antonio	San Antonio Creek, semi-rural development
10	Ventura - below Matilaja Dam	Matilija Dam, non-urban
11	North Fork Matilija - at gauging station	Non-impacted site
11b*	North Fork Matilija - u/s Ventura conf	Quarry
12	Matilija - @ gate at end of road	Non-impacted site
13	Matilija - below community	Matilija Creek above dam, development impact
14	Ventura - at Hwy 150	Development impact
15	Ventura - at Santa Ana Road	Development impact

* These sites require either clearance from private landowners or special needs for accessing the site.
Detailed monitoring procedures will be as described in the *Ventura Countywide Stormwater Monitoring Program: In-stream Bioassessment Monitoring Program, Ventura River*, which is included as Appendix G of this report.

Monitoring will be conducted once a year in the fall for a minimum of two years to establish baseline conditions. The sampling protocol will follow the procedures outlined in the California Stream Bioassessment Procedures developed by the California Department of Fish and Game, which is based on the Rapid Bioassessment Protocols, developed by the US EPA. Volunteer monitoring will be incorporated in the bioassessment monitoring program where possible.

9.3.5.3 Mass Emission Monitoring

Mass emission monitoring provides a mechanism for evaluating the amount of pollutants in a waterbody. The monitoring will include the collection of flow and water quality information at a specified location in a waterbody, which can then be used to estimate loadings at that point. Mass emission monitoring will be conducted during this permit term to establish baseline conditions and load estimates for the Ventura River, Calleguas Creek, and Santa Clara River. Monitoring on the Ventura River and Calleguas Creek will begin with the 2000-2001 monitoring season, and the Santa Clara River will be monitored starting with the 2001-2002 season. Samples will be collected during dry and wet weather for up to six events every year. At least two of the events monitored will be dry events.

One monitoring location will be established for each waterbody and sampled for a variety of water quality constituents. Each site will be equipped with automated monitoring equipment, which includes an automatic sampler, flow meter, and possibly a precipitation gauge. The proposed monitoring locations are described in the Table 9-29 (shown below).

Table 9 - 29.
Proposed Mass Emission Monitoring Locations and Requirements[4]

Site Code	Monitoring Station	Number of Events	Sample Type	Constituents[1]
ME-CC	Calleguas Creek – California State University at Channel Island bridge	Up to 6 per year (beginning with the 2000-01 season)[2]	Automated composite and grab samples	Metals, Organics, Conventional Inorganics, Microbiological Toxicity and TIEs[3]
ME-VR	Ventura River – Foster Park	Up to 6 per year (beginning with the 2000-01 season)[2]	Automated composite and grab samples	Metals, Organics, Conventional Inorganics, Microbiological Toxicity and TIEs[3]
ME-SCR	Santa Clara River – Freeman Diversion	Up to 6 per year (beginning with the 2001-02 season)[2]	Automated composite and grab samples	Metals, Organics, Conventional Inorganics, Microbiological Toxicity and TIEs[3]

1 The list of specific constituents, analytical methods, detection limits, and holding times is included in Appendix G-1.
2 Includes a minimum of two dry weather events per monitoring season.
3 Toxicity monitoring shall occur during two storm events per monitoring season (preferably the first significant storm and one other event) and one dry weather event per monitoring season. Chronic toxicity test shall be conducted using the most sensitive marine species. A Toxicity Identification Evaluation (TIE) shall be performed when toxicity manifests in two consecutive wet weather samples, or any dry weather flow sample.
4 Detailed monitoring procedures will be as described in the *Ventura Countywide Stormwater Monitoring Plan Standard Operating Procedures-2000-2005 Mass Emission Monitoring* (SOPs) included as Appendix G of this report.

Event and annual mass emission calculations will be developed using the water quality data obtained from the collected samples and flow information obtained from USGS/VCFCD depth and recording equipment present at both the Calleguas Creek and Ventura River monitoring locations.

9.3.5.4 Watershed Group and Regional Monitoring Participation

Recently, watershed management has become a large component of water quality and water resource activities throughout Ventura County. As such, participation in various watershed groups established in the County will be a component of the monitoring program. VCFCD will participate in appropriate water quality meetings of the Santa Clara River Enhancement and Management Plan, the Calleguas Creek Watershed Management Plan, and the Steelhead Restoration and Recovery Plan. Additionally, work is being conducted as part of a Federal 205(j) non-point source grant in the Calleguas Creek watershed. VCFCD monitored six sites during two dry weather and two wet weather events in 1998/99 as part of the grant study. Participation in additional activities and monitoring related to grant activities will be conducted as necessary.

In addition to the watershed management activities listed above, the Southern California Coastal Water Research Project (SCCWRP) has established a Regional Monitoring Program for Southern California municipal programs. Participation in the storm water studies with SCCWRP will be conducted as set out in the Memorandum of Agreement for the program.

Another activity that will be conducted related to watershed programs in the region is the promotion of volunteer monitoring programs in the coastal watersheds. Volunteer monitoring can be a useful source of many types of watershed information. A plan to identify appropriate volunteer monitoring projects will be developed and work will be done to help develop and implement volunteer monitoring programs for appropriate projects.

9.4 Pollutant Source Identification

An important part of the development and progression of the Program is the determination of pollutants of concern (POCs) and the identification of sources of those pollutants. The development of POCs, identification of sources of the POCs, and investigation of strategies to control POC discharges from those sources focuses the stormwater management program on control measures that provide the greatest environmental benefit. During the first permit term, the Program identified and prioritized POCs and started work on identifying general sources of the prioritized POCs. The focus of this permit term will be the identification and investigation of urban sources of POCs and investigation of methods to control discharges of POCs in urban runoff.

9.4.1 Pollutant of Concern Identification and Prioritization

During 1997/98, the Program identified and prioritized pollutants of concern (POCs) for stormwater and discussed, as part of the POC Working Group, general sources and best management practices (BMPs) for priority POCs.

Identifying POCs allows the program to focus efforts and resources on constituents that have the greatest impact on receiving waters. Monitoring data obtained through the stormwater monitoring program allowed a numeric and qualitative assessment of the constituents of most concern to the Program. The information gathered during the POC identification process was then used to prioritize (into Tier 1 and Tier 2) the pollutants of concern. Pollutants identified as Tier 1 POCs were targeted for investigation to determine general sources of the constituents and to develop BMPs to control the sources. The ranked POCs are listed in Table 9-30 (shown below).

Table 9 - 30
Tier 1 and Tier 2 Pollutants of Concern

Pollutant of Concern	Method/Class
Tier 1 Pollutants of Concern	
Coliform, Total	Bacteria
Mercury, Total	Metal
Coliform, Fecal	Bacteria
PAHs	PAH
DDT and by-products	OC Pesticide
Diazinon	OP Pesticide
Sediment/TSS	Conventional
Tier 2 Pollutants of Concern	
Chlorpyrifos	OP Pesticide
Copper [1]	Metal
Lead [1]	Metal
Thallium [2]	Metal
Bis(2-Ethylhexyl)Phthalate	Phthalate
Phosphorus	Conventional

Notes:
1) Water quality criterion comparison based on dissolved metal concentration.
2) Water quality criterion comparison based on total metal concentration.

Other stormwater programs and groups with similar pollutant issues have investigated sources of the Tier 1 POCs identified by the Program. A significant amount of information has been collected and is available for review and evaluation. The POC Workgroup conducted an initial review of the collected information and generated a preliminary list of potential general sources of the POCs. General sources of the Tier 1 POCs are listed in Table 9-31 (on page 9-42) based on source type.

9.4.2 Proposed POC Source Identification Plan

During this permit term, activities will be conducted to investigate the sources of the POCs identified during the first permit term and develop possible control measures to address the identified sources of POCs. Each year a progress report will be submitted to the Regional Board regarding the sources of POCs, BMPs proposed for control of POCs, and an assessment of the effectiveness of the BMPs as part of the *Annual Storm Water Report and Assessment.*

9.4.2.1 General Source Investigation

During this permit term, the general source information shown in Table 9-31 (on page 9-42) will be used as a starting point to investigate specific urban sources of POCs in the permit area.

Information collected under the illicit discharge program, discharge characterization monitoring data, inspection information, literature reviews and other available information will be used to identify areas where significant discharges of POCs could be occurring. During this review process, locations of the general sources of these constituents listed in Table 9-31 (on page 9-42) and other sources identified by literature reviews in the permit area will be identified. The located sources will be compared to other data gathered through the Program and proximity to receiving waters to create a prioritized list of areas and sources within the permit area, if any, where significant discharges may be occurring. This information will be used to identify potential control measures for the sources of POCs in urban areas of Ventura County.

Table 9 - 31
General Sources of Tier 1 POCs

POC	Source Category		
	Atmospheric	**Natural**	**Human Activities**
Coliform	▪ Dust/sediment Deposition	▪ Animals ▪ Birds ▪ Soils	▪ Sewage from leaks, spills and illicit connections ▪ Outdoor defecation ▪ Pet and livestock waste ▪ Diaper cleaning and disposal ▪ Landfills containing animal and human waste
Mercury	▪ Dust/sediment deposition ▪ Precipitation ▪ Smog	▪ Soil	▪ Use and improper disposal of: thermometers, barometers, electrical switches, fluorescent light bulbs, batteries, paints and fungicides that contain mercury, and miscellaneous household products ▪ Hospitals and dental offices ▪ Industrial manufacturing facilities[1] ▪ Leachate from decomposition of landfill material containing mercury ▪ Hazardous waste storage areas and collection facilities ▪ Automobile repair, salvage, and recycling services ▪ Battery recyclers ▪ Sewage from leaks, spills and illicit connections ▪
Diazinon	▪ Spraying ▪ Precipitation		▪ Pesticide applications ▪ Improper pesticide use and disposal ▪ Sewage from leaks, spills and illicit connections ▪ Landfill leachate from improper pesticide disposal ▪ Pesticide manufacturer, storage, and transport ▪ Household hazardous waste collection areas
DDT	▪ Dust/sediment deposition ▪ Precipitation	▪ Soil (from previous applications of DDT)	▪ Sewage from leaks, spills and illicit connections ▪ Erosion and sedimentation ▪ Use of chemicals containing DDT as a minor constituent ▪ Leachate from industrial landfills where products containing DDT decompose ▪ Hazardous waste storage areas and collection facilities
PAHs	▪ Dust/sediment deposition ▪ Precipitation ▪ Smog and stack emissions	▪ Soil ▪ Forest and brush fires ▪ Decaying organic matter	▪ Emissions from incinerators, furnaces, fireplaces, barbecues, and wood burning stoves ▪ Emissions from vehicles and other equipment or machinery ▪ Emissions from facilities or operations that use fossil fuel, wood or other organic matter as fuel source ▪ Emissions from restaurants ▪ Roofing and asphalt material ▪ Roadways and parking areas ▪ Building fires ▪ Food waste from barbecued food ▪ Sewage from spills, leaks, and illicit connections ▪ Industrial manufacturers[2] ▪ Wood materials preserved with creosote

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1 Industrial sources include: Adhesive Manufacturers, Battery Manufacturers, Electrical and Electronic Component Manufacturing, Electroplating/Metal Finishing, Inorganic and Organic Chemical Manufacturing, Non-ferrous metal Manufacturing, Paint and Ink Manufacturing, Pharmaceutical Manufacturing, Photographic Supply Manufacturing, Steam Electric Power, Textile Mills.

2 Industrial facilities include: Pharmaceutical Manufacturing, Biological and Chemical Research, Power Plants, Roofing Industry, Paving Industry, Coke Manufacturers, Incinerator Operations, Metal and Foundry Operations, Briquette Manufacturing, Dye Manufacturing, Railway Manufacturing and Repair, Automobile Repair, Petroleum Refining, Timber Products, Rubber Manufacturing, Pulp, Paper, Fiberboard Manufacturing, Paint and Ink Manufacturing, Battery Manufacturing, Electrical and Electronic Component Manufacturing.

Table 9 - 31
General Sources of Tier 1 POCs

POC	Source Category		
	Atmospheric	Natural	Human Activities
TSS/ Sediment	▪ Dust/sediment deposition ▪ Precipitation ▪ Smog	▪ Soil	▪ Construction sites and activities ▪ Roofs and other erodible housing material ▪ Landscaping activities ▪ Irrigation waters ▪ Rinse and wash waters from cleaning activities ▪ Emissions from fireplaces or other stacks ▪ Open spaces, exposed and disturbed land ▪ Illicit or approved connections from cooling towers or boiler operations ▪ Bulk storage areas ▪ Material handling, use, disposal, and cleanup procedures ▪ Streets, roads, parking lots, and other erodible surfaces ▪ Landfills

9.4.2.2 Control Measure Investigation

In coordination with the POC source identification, methods to control POC discharges will be investigated. Control measure investigation will identify source specific and general measures that have potential to cost-effectively control POC discharges.

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9.5 Management Program Effectiveness

9.5.1 Control Measure Effectiveness

Discharge characterization and receiving water monitoring provides the opportunity for the Program to demonstrate long-term effectiveness of the stormwater program. Control measure effectiveness evaluations are designed to assess a specific control measure or BMP to determine its ability to reduce discharges of pollutants in urban runoff or its applicability to certain applications. Monitoring efforts of the effectiveness of control measures are being conducted throughout the management program and are described in the performance standards for the other elements of the management program. Additionally, other agencies throughout the United States have conducted a number of studies to examine the effectiveness of control measures and a large amount of literature is available about public domain BMPs. As part of the monitoring program, control measure effectiveness will be evaluated through literature reviews, discussions with other agencies, and the gathering of available information where possible. If deemed necessary, special studies will be identified to help the stormwater management program evaluate and implement specific (generally structural) control measures to achieve the goals of the program.

9.5.2 Pollutant Loading

One important use of the collected discharge monitoring data is the determination of pollutant loads from the permitted area. During the first permit term, the Program developed a pollutant load model that provided a preliminary estimate of annual pollutant loads from urban discharges. The following sections describe the effort and the proposed activities to refine these pollutant loads over the next permit term.

9.5.2.1 Watershed Delineation/Land Use Specification

In general, southern Ventura County has three major watersheds: Ventura River, Santa Clara River, and Arroyo Simi/Calleguas Creek. Table 9-32 (shown below) summarizes the land uses within the three watersheds.

Table 9 - 32
Land Uses Within Ventura County

Land Use	Watersheds					
	Ventura River		Santa Clara River		Calleguas Creek	
	Area (acres)	% of Total	Area (acres)	% of Total	Area (acres)	% of Total
Urban	14,384	8	11,445	2	87,728	36
Agriculture	1,322	1	35,541	7	72,081	30
Open/Rural	162,854	91	482,934	91	73,978	31
State/Federal	0	0	0	0	7,493	3
TOTAL	178,560	100	529,920	100	241,280	100

Source: Ventura County General Plan Land Use Map
Note: National Forest Land is included in Open/Rural category.

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For the southern portion of Ventura County, including all the permitted areas, specific watershed and land use delineation was conducted. Using drainage master plans, VCFCD hydrology reports, and aerial photography, information was collected for 313 sub-areas that include the total acreage and land use percentage for undeveloped/open space, agricultural, residential, industrial, commercial, and open water/wetlands. The collected information was used in the development of the current pollutant load model. Since the model was developed, VCFCD has developed a GIS system that allows a more detailed delineation of land uses throughout the County.

9.5.2.2 Current Pollutant Load Estimates

During the 1996/97 monitoring year, a water quality/management model was developed to estimate pollutant loadings and assess the relative contribution of runoff from the permitted area to overall pollutant loadings in Ventura County runoff. The Watershed Management Model (WMM), as developed by Camp Dresser & McKee (CDM), was used as the basis for developing pollutant load estimates. This steady-state model combined constituent concentrations (as measured by EMCs) collected under the monitoring program for the years 1993-96 with watershed-specific rainfall totals, land use data, and runoff coefficient data to estimate annual pollutant loads. All calculations consider the land use distribution in the sub-areas and spatial differences in annual rainfall.

Ventura County constituent EMCs (1993-96) were used for input into the model whenever possible. When representative EMCs were not available directly from site-specific monitoring data, Nationwide Urban Runoff Program (NURP) data or WMM recommended values were used. Table 9-33 (shown below) contains all mean EMCs used for modeling and a reference to their source.

Table 9 - 33
Mean EMCs (1993-96) used in Modeling Pollutant Loads

	Oxygen Demand & Solids				Total Recoverable Metals				Nutrients			
	BOD	**COD**	**TDS**	**TSS**	**Cd**	**Cu**	**Pb**	**Zn**	**DP**	**TP**	**NO2/3**	**TKN**
Land Use	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L
Open [1]	8	51	100	216	2.0	0	9	234	0.06	0.23	0.73	1.36
Agriculture [2]	95	216	504	1,065	5.4	83	15	196	2.79	4.20	17.35	7.20
Residential [2]	20	146	79	131	1.1	22	20	124	0.40	0.54	1.49	3.08
Industrial [2]	23	99	91	278	1.4	25	13	143	0.37	0.50	1.36	2.42
Commercial [1]	10	61	100	91	2.4	37	24	331	0.10	0.24	0.63	1.28
Open Water [3]	3	22	100	26	0.0	0	0	110	0.01	0.03	0.60	0.60

Notes:
1. Calculated from NURP median values (EPA, 1983a; Table 6-12) except:
   - Pb suggested by more recent studies (Walker, 1990)
   - BOD and Cu [Undeveloped/Open only] from WMM Manual (CDM, 1992; Table 2-1)
   - Cd and TDS from WMM Manual (CDM, 1992; pg. 2-10).
2. Based on Ventura County monitoring data.
3. WMM Manual (CDM, 1992; Table 2-1).

Using the data inputs and the methodology described in the annual report for Permit Year 3 (VCSQMP, 1997), annual stormwater loadings of pollutants were estimated. Estimated annual stormwater loads are presented in Table 9-34 (on page 9-46) for permitted and non-permitted areas. The distribution of loads shown in this table generally reflects the ratio (4:1) of non-permitted to permitted land in the southern county.

Table 9 - 34
Estimated Mean Annual Loads for Southern Ventura County

Constituent		NPDES-Permitted	Non-permitted	Total
Conventional (tons/yr.)	BOD	1,921	7,010	8,931
	COD	9,763	26,143	35,905
	TDS	10,418	50,472	60,890
	TSS	20,505	106,732	127,237
Metals (tons/yr.)	Cd	0.15	0.76	0.92
	Cu	1.97	4.62	6.59
	Pb	1.39	3.38	4.77
	Zn	14.91	68.93	83.85
Nutrients (tons/yr.)	DP	41	158	199
	TP	62	269	331
	NO2/3	215	1,040	1,255
	TKN	234	748	982

Pollutant loadings from the permitted and non-permitted areas were proportionate to their respective areas with the exception of total recoverable copper and TKN, where the permitted area contributed 30 and 24 percent respectively of the pollutant load versus 19 percent of the land area.

The existing WMM model provides a good planning level estimate of stormwater runoff pollutant loads. The model was developed as a stormwater quality management tool and can be used to analyze the potential effect of best management practices (BMP) on pollutant loadings. Activities conducted during the upcoming permit term will expand upon these capabilities.

9.5.2.3 Proposed Activities to Improve Pollutant Load Estimates

The existing WMM model provides sufficient information for the planning and implementation of the stormwater management program. However, the development of Total Maximum Daily Loads (TMDLs) for the impaired waterbodies in Ventura County could require the use of more sophisticated models. If deemed necessary to assist with the development of TMDLs, the WMM model will be updated to meet the needs of the TMDL development.

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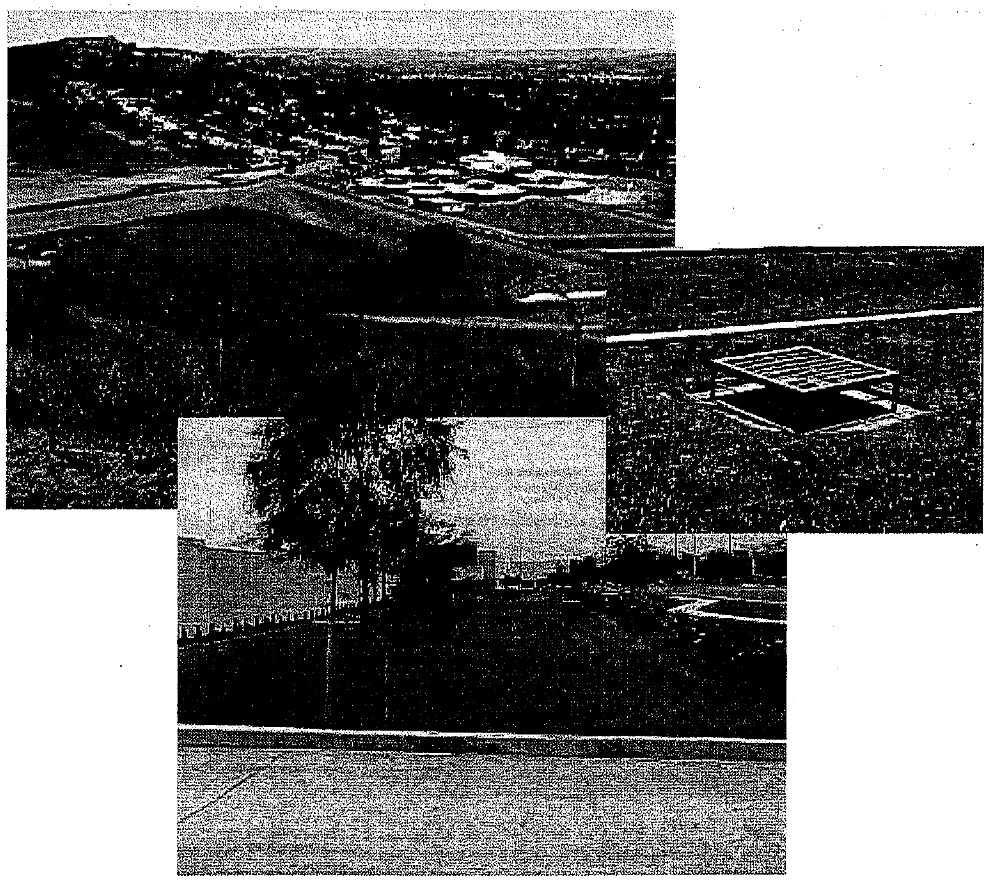

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SECTION 1
BACKGROUND AND GOALS

Background

In 1972, the Federal Water Pollution Control Act (also referred to as the Clean Water Act (CWA)) was amended to provide that the discharge of pollutants to waters of the United States from any point source be prohibited, unless the discharge is in compliance with a National Pollutant Discharge Elimination System (NPDES) permit. In 1987, further amendments to the CWA added Section 402(p) which established a framework for regulating municipal and industrial stormwater discharges under the NPDES program. The regulations require metropolitan areas with a population greater than one hundred thousand and specific categories of industrial facilities, to obtain an NPDES permit for stormwater discharges.

As principal permittee, the County of Ventura Flood Control District received a countywide municipal NPDES permit for stormwater discharges from the Los Angeles Regional Water Quality Control Board. The County of Ventura Flood Control District, County of Ventura and the Cities of Camarillo, Fillmore, Moorpark, Ojai, Oxnard, Port Hueneme, San Buenaventura, Santa Paula, Simi Valley, Thousand Oaks, are named as co-permittees under this permit. Under this permit, the permittees are required to develop, administer, implement, and enforce a Comprehensive Stormwater Management Program (CSWMP) to reduce pollutants in urban runoff to the maximum extent practicable (MEP). The CSWMP implemented by the co-permittees is a multi-faceted, dynamic program, which is designed to reduce stormwater pollution to the maximum extent practicable. The CSWMP emphasizes all aspects of pollution control including, but not limited to, public awareness and participation, source control, regulatory restrictions, water quality monitoring, and treatment control.

Controlling urban runoff pollution from new development during and after construction is critical to the success of the Comprehensive Stormwater Management Program. The New Development Management Program (NDMP) is an element of the Comprehensive Stormwater Management Program being implemented by the Permittees to specifically control post-construction urban runoff pollutants from new development and redeveloped areas. The goal of the NDMP is to minimize runoff pollution typically caused by land development and protect the beneficial uses of receiving waters by employing a sensible combination of pollutant source control and site-specific treatment control measures. The NDMP envisions reducing stormwater pollutants from new development by employing on-site control measures for commercial, industrial, multi-family, and single-family residential land uses

"Source Control Measures" and "Treatment Control Measures" as used in this manual refer to best management practices (BMPs) and features incorporated in the design of a land development or redevelopment project which prevent and/or reduce pollutants in stormwater runoff from the project. Source Control Measures limit the exposure of materials and activities so that potential sources of pollutants are prevented from contacting storm runoff. Treatment Control Measures are reasonable, engineered systems that provide a reduction of pollutants in runoff to be consistent with the MEP standards imposed by the Federal Clean Water Act on the City and County. This manual contains design guidance for on-site source and treatment controls for new development and redevelopment projects.

In addition to the countywide permit requirements, owners/developers of some of the sites in the County may also be subject to the State of California's general permit for stormwater discharge from industrial activities (Industrial General Permit) and general permit for stormwater from construction activities (Construction General Permit). The control measures provided in this manual may assist the owner/developer in meeting the requirements of the State's permit. The stormwater management staffs of the governing Permittee agencies are available to provide assistance regarding State permit requirements.

Goals

This manual has been prepared by the County of Ventura Co-permittees to accomplish the following goals:

- Ensure that new developments reduce urban runoff pollution to the "maximum extent practicable,"
- Ensure the implementation of measures in this manual are consistent with NPDES permit and other State requirements.
- Provide guidance to developers, design engineers, agency engineers, and planners on the selection and implementation of appropriate stormwater treatment and source control measures, and
- Provide maintenance procedures to ensure that the selected control measures will be maintained to provide effective, long-term pollution control.

SECTION 2
OVERVIEW AND
USE OF THE MANUAL

Introduction

The control measures, often termed Best Management Practices or BMPs, described in this manual were selected to optimize post-construction, on-site stormwater pollution control. On-site control measures, for the purposes of this Manual, apply to infill and new development project categories listed in the Ventura Countywide Storm Water Quality Urban Impact Mitigation Management Plan (SQUIMP – see Appendix H). Applicable SQUIMP project categories are listed in Table 2-1 along with the categories of pollutants likely to be present in stormwater runoff from project areas.

Table 2-1. SQUIMP Project Categories and Associated Pollutants of Concern

SQUIMP Project Category	Pollutant Category of Concern						
	Sediment	Nutrients	Metals	Trash and Debris	Oxygen Demand	Toxic Organics	Bacteria
Commercial Developments (≥ 100,000 SF)	X	X	X	X	X	X	X
Automotive Repair Shops	X		X	X	X	X	
Retail Gasoline Outlets	X		X	X	X	X	
Restaurants		X		X	X	X	X
Parking Lots (≥ 5,000 SF or 25 spaces)	X		X	X	X	X	
Hillside Single-family Residences	X	X	X	X	X	X	X
Home Subdivisions (≥ 10 units)	X	X	X	X	X	X	X
Projects Located Within or Directly Adjacent to, or Discharging Directly to Environmentally Sensitive Area (see Appendix I)	X	X	X	X	X	X	X

X = Pollutant likely to be present in stormwater runoff from project area

A design decision flowchart is presented in Figure 2-1 to aid the user of the manual in determining what steps need to be completed in the design process to comply with stormwater control requirements. A key step in the process is project assessment to determine expected pollutants (see Table 2-1), receiving water quality and hydraulic conditions, and site conditions (e.g. soils, groundwater, topography), as all these conditions will influence the selection of appropriate control measures. The selection of appropriate control measures should be a collaborative effort between the project proponent and the governing agency staff. It is recommended that discussions between project planners and engineers and agency stormwater staff regarding selection of controls measures occur early in the design process.

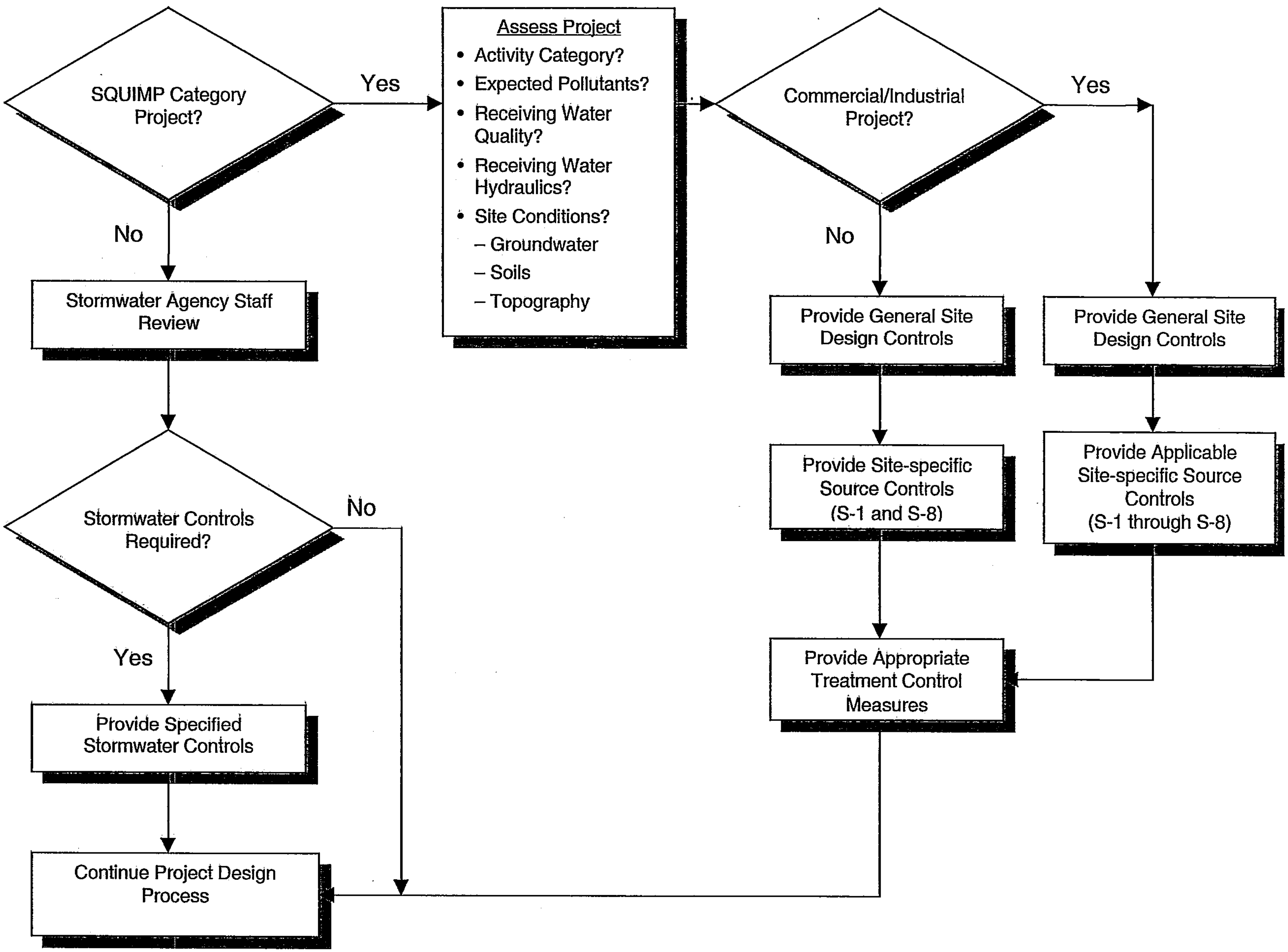


Figure 2-1. Stormwater Controls Design Decision Flowchart

If the project is determined by the governing stormwater agency to be a SQUIMP category project (see Table 2-1), the project must be designed to include the control measures specified in this Manual. Projects that are not SQUIMP category projects are still subject to stormwater agency review. Stormwater controls may be required by the governing agency for non-SQUIMP category projects, depending on the potential for discharge of pollutants in stormwater runoff.

Overview of Stormwater Pollution Control Measures

The categories of stormwater pollution controls measures specified in this Manual are summarized in Table 2-2 along with applicable projects and primary objectives of the control measures:

Table 2-2. Summary of Required Stormwater Pollution Controls Measures

Control Measure Category	Applicable Projects	Primary Objective
General Site Design Control Measures	All SQUIMP projects	Minimize the volume and rate of stormwater runoff discharge from the project site.
Site-specific Source Control Measures	Specific outdoor activities and development features: • Outdoor storage area • Trash storage area • Loading/unloading dock area • Repair/maintenance bay • Vehicle/equipment/accessory wash area • Fueling area	Prevent potential pollutants from contacting rainwater or stormwater runoff or to prevent discharge of contaminated runoff to the storm drain system or receiving water.
Treatment Control Measures	All SQUIMP projects – at least one approved treatment control measure required	Remove pollutants from stormwater runoff prior to discharge to the storm drain system or receiving water.

Site design and site-specific source controls are generally the most effective means to control urban runoff pollution because they minimize the need for treatment and are required for all applicable projects. Treatment controls are also required for all projects and may be selected from a list of approved methods. Alternative or proprietary treatment controls not described in this manual may be considered on a case-by-case basis provided the project proponent can demonstrate that treatment equivalent to approved methods is achievable. Alternative control measures are further discussed at the end of Section 5. Treatment controls are required in addition to source controls to meet the SQUIMP requirement to minimize, to the maximum extent practicable, discharge of pollutants to the stormwater conveyance system. A matrix of SQUIMP project categories and required stormwater pollution control measures is presented in Table 2-3 to aid the Manual user in determining what controls are required for various project categories. Detailed descriptions and design criteria and procedures for the three types of control measures are presented in fact sheet format in Sections 3, 4, and 5 of the Manual for General Site Design Controls, Site-specific Source Controls, and Treatment Controls, respectively.

Table 2-3. Control Measure Selection Matrix for SQUIMP Project Categories

SQUIMP Project Category	General Site Design Control Measures(a)					Site-Specific Source Control Measures(b)								Treatment Control Measures(c)
	Conserve Natural Areas (G-1)	Protect Slopes and Channels (G-2)	Control Peak Runoff Rates (G-3)	Minimize Impervious Area (G-4)	Minimize Effective Imperviousness (G-5) Turf Buffer (G-5.1) Grass-lined Channel (G-5.2)	Storm Drain Message and Signage (S-1)	Out door Storage Area Design (S-2)	Trash Storage Area Design (S-3)	Loading/unloading Dock Area Design (S-4)	Repair/maintenance Bay Design (S-5)	Vehicle/Equipment/ Accessory Washing Area Design (S-6)	Fueling Area Design (S-7)	Proof of Control Measure Maintenance (S-8)	Grass Strip Filter (T-1) Grass Swale Filter (T-2) Extended Detention Basin (T-3) Wet Detention Basin (T-4) Constructed Wetland (T-5) Detention Basin/Sand Filter (T-6) Porous Pavement Detention (T-7) Porous Landscape Detention (T-8) Infiltration Basin (T-9) Infiltration Trench (T-10) Media Filter (T-11) Proprietary Controls (T-12)(f)
Commercial Developments (≥ 100,000 SF)	R	R	R	R	R(e)	R	R(d)	R(d)	R(d)	R(d)	R(d)	R(d)	R	S
Automotive Repair Shops	R	R	R	R	R(e)	R	R(d)	R(d)	–	R(d)	R(d)	R(d)	R	S
Retail Gasoline Outlets	R	R	R	R	R(e)	R	R(d)	R(d)	–	R(d)	R(d)	R	R	S
Restaurants	R	R	R	R	R(e)	R	R(d)	R(d)	R(d)	–	R(d)	–	R	S
Parking Lots (≥ 5,000 SF or 25 spaces)	R	R	R	R	R(e)	R	R(d)	R(d)	–	–	–	–	R	S
Hillside Single-family Residences	R	R	R	R	R(e)	R	R(d)	–	–	–	–	–	R	S
Home Subdivisions (≥ 10 units)	R	R	R	R	R(e)	R	R(d)	–	–	–	–	–	R	S
Project Located Within or Directly Adjacent to, or Discharging directly to Environmentally Sensitive Area	R	R	R	R	R(e)	R	R(d)	R(d)	R(d)	R(d)	R(d)	R(d)	R	S

R = Required if applicable to project
R(d) = Required if activity area is included in the project
R(e) = Required unless shown to be infeasible based on site conditions. Select one or more applicable control measures
S = Select one or more applicable treatment control measures from list above.
(a) = Refer to Fact Sheets in Section 3 for detailed information and design criteria
(b) = Refer to Fact Sheets in Section 4 for detailed information and design criteria
(c) = Refer to Fact Sheets in Section 5 for detailed information and design criteria
(f) = Use only on a case-by-case basis with agency staff approval or in combination with other applicable treatment control measures

SECTION 3
GENERAL SITE DESIGN CONTROL MEASURES

Introduction

The principal objective of the General Site Design Control Measures specified in this Manual is to reduce stormwater runoff peak flows and volumes through appropriate site design. The benefits derived from this approach include:

- Reduced size of downstream treatment controls and conveyance systems;
- Reduced pollutant loading to treatment controls; and
- Reduced hydraulic impact on receiving streams.

General Site Design Control Measures include the following design features and considerations designated G-1 through G-5:

- G-1: Conserve Natural Areas
- G-2: Protect Slopes and Channels
- G-3: Control Peak Stormwater Runoff Discharge Rates
- G-4: Minimize Impervious Area
- G-5: Minimize Effective Imperviousness

The General Site Design Control Measures described in this section are required for all SQUIMP category projects unless the project proponent demonstrates to the satisfaction of the governing stormwater agency that the particular measures are not applicable to the proposed project, or the project site conditions make it infeasible to implement the design control measure in question.

Description

Detailed descriptions and design criteria for each of the General Site Design Control Measures are presented in this section in fact sheet format.

Conserve Natural Areas

Purpose

Each project site possesses unique topographic, hydrologic and vegetative features, some of which are more suitable for development than others. Locating development on the least sensitive portion of a site and conserving naturally vegetated areas can minimize environmental impacts in general and stormwater runoff impacts in particular.

Design Criteria

If applicable and feasible for the given site conditions, the following site design features or elements are required and should be included in the project site layout, consistent with applicable General Plan and Local Area Plan policies:

1. Concentrate or cluster development on least-sensitive portions of a site, while leaving the remaining land in a natural undisturbed state;
2. Limit clearing and grading of native vegetation at a site to the minimum amount needed to build lots, allow access, and provide fire protection;
3. Maximize trees and other vegetation at each site by planting additional vegetation, clustering tree areas, and promoting the use of native and/or drought-tolerant plants;
4. Promote natural vegetation by using parking lot islands and other landscaped areas;
5. Preserve riparian areas and wetlands.

Protect Slopes and Channels

Purpose

Erosion of slopes and channels can be a major source of sediment and associated pollutants, such as nutrients, if not properly protected and stabilized.

Design Criteria

Slope Protection

Slope protection practices must conform to design requirements or standards set forth by local agency erosion and sediment control standards and design standards. The design criteria described in this fact sheet are intended to enhance and be consistent with these local standards.

1. Slopes must be protected from erosion by safely conveying runoff from the tops of slopes.
2. Slopes must be vegetated (full-cover) with first consideration given to native or drought-tolerant species.

Channel Protection

Control measure G-3 is intended to limit peak flow to avoid erosive conditions in unlined receiving streams. The following measures should be implemented to provide additional erosion protection unlined receiving streams. Activities and structures must conform to applicable standards and specifications of agencies with jurisdiction (e.g. U.S. Army Corps of Engineers, California Department of Fish and Game).

1. Utilize natural drainage systems to the maximum extent practicable, but minimize runoff discharge to the maximum extent practicable.
2. Stabilize permanent channel crossings.
3. In cases where beds and/or banks of receiving streams are fragile and particularly susceptible to erosion, special stabilization may be required.
   a. Small grade control structure (e.g. drop structure) may be used to reduce the slope of the channel.
   b. Severe bends or cut banks may need to be hardened by lining with grass or rock.
   c. Rock-lined low-flow channels may be appropriate to protect fragile beds.
4. Install energy dissipaters, such as rock riprap, at the outlets of storm drains, culverts, conduits or channels that discharge into unlined channels.

Control Peak Stormwater Runoff Discharge Rates

Purpose

Unless controlled, peak stormwater runoff rates from developed areas are typically higher than those from previously undeveloped areas. Higher peak flows can change stream morphology and increase downstream erosion that can damage stream habitat and impact aesthetic value. In addition, higher flows convey larger pollutant loads to receiving waters. Control of peak stormwater discharge rates is thus required to protect stream habitat and aesthetic value by maintaining non-erosive hydraulic conditions in unlined receiving streams during stormwater runoff events.

Design Criteria

SQUIMP category projects, excluding single family hillside residences, that directly discharge to unlined receiving streams shall implement the following interim criteria:

1. 2-year post development discharge rates shall not exceed the predeveloped discharge rates for the 2-year frequency storm event.
2. Peak flows shall be determined using the procedures set forth in the latest edition of the *Hydrology Manual* and Direct Runoff curves produced by Ventura County Public Works Agency, Flood Control Department. The designer is specifically reminded to regard minimum subarea sizes required in the *Hydrology Manual.* Where jurisdictions within Ventura County have approved alternative hydrologic calculation methods, the alternative methods may be used if they have been approved by the jurisdiction for use in design of flow-based stormwater controls.

The Ventura County Public Works Agency, Flood Control Department is currently developing a modeling procedure to establish peak flow design criteria to avoid erosive conditions. A study in the upper reaches of the Arroyo Simi (Simi Valley) is currently underway to examine the relationship between runoff discharge rates and erosion. The results of the study will be used to revise/finalize the interim peak flow criteria presented in this manual upon approval of the co-permittee cities.

Minimize Impervious Area

Purpose

The potential for discharge of pollutants in stormwater runoff from a project site increases as the percentage of impervious area within the project site increases. Impervious areas increase the volume and rate of runoff flow. Pollutants deposited on impervious areas tend to be easily mobilized and transported by runoff flow. Minimizing impervious area through site design is an important means of minimizing stormwater pollutants of concern. In addition to the environmental and aesthetic benefits, a highly pervious site may allow reduction in the size of downstream conveyance and treatment systems, yielding savings in development costs.

Design Criteria

Some aspects of site design are directed by local agency building and fire codes and ordinances. The design strategies suggested in this fact sheet are intended to enhance and be consistent with these local codes and ordinances. Maximizing perviousness at every possible opportunity requires integration of many small strategies. Suggested strategies for minimizing imperviousness through site design include the following:

1. Reduce the foot prints of building and parking lots;
2. Cluster buildings and paved areas to maximize pervious area;
3. Use minimum allowable roadway and sidewalk cross sections and parking stall widths;
4. Include landscape islands in cul-de-sacs (where approved);
5. Use pervious pavement materials where appropriate, such as modular paving blocks, turf blocks, porous concrete and asphalt, brick, and gravel or cobbles. (Ref. BASMAA, 1999 for descriptions of pervious pavements options.)
6. Use grass-lined channels or surface swales to convey runoff instead of paved gutters. (See Fact Sheet G-5.2)

Purpose

Stormwater runoff flows from impervious areas typically contains higher concentrations of pollutant and higher peak flows than flows from equally-sized pervious areas. The impacts of flow from impervious areas can be reduced by employing a design strategy termed minimizing effective imperviousness. This approach involves routing runoff from impervious areas over grassy areas or other pervious areas prior to discharge to the storm drainage system or receiving water to reduce peak flows, reduce total runoff volume and provide some degree of pollutant removal. In addition to the environmental and aesthetic benefits, minimizing effective imperviousness may allow reduction in the size of downstream conveyance and treatment systems, yielding savings in development costs. Projects that employ the approaches described in this fact sheet in accordance with the specified design criteria will be allowed to reduce the value of the effective impervious ratio used later in this Manual to size treatment controls. Calculation of effective imperviousness is described later in this fact sheet.

Description and Design

Suggested design strategies to minimize effective imperviousness include G-5.1: Turf Buffer and G-5.2: Grass-lined Channel. Suggested uses of these design strategies are illustrated in Figure 3-1. These design control measures are described below along with associated design criteria. It is important to note that at least one of these control measures is required to be employed in the site design unless site conditions make it infeasible to do so. For this requirement to be waived, project proponents must demonstrate infeasibility to the satisfaction of the local stormwater agency review staff.

G-5.1: Turf Buffer

Description

Turf Buffers are uniformly graded and densely vegetated strips of turf grass. Runoff flow is distributed uniformly across the top width of the strip to achieve sheet flow down the length of the strip. Turf Buffers provide opportunity for infiltration, reduce peak flows from impervious areas and provide some degree of pollutant removal. Applications of Turf Buffers are illustrated in Figure 3-2. Turf Buffers differ from Grass-lined Channels, as they are designed to receive and maintain sheet flow as opposed to concentrated or channelized flow. Sheet flow application to the top of the Turf buffer may achieved by routing sheet flow from impervious areas, such as parking lots, directly to the top of the Turf Buffer or by redistributing concentrated flow across the top of the Turf Buffer by means of a level spreader. Turf Buffer strips, used for the purpose of minimizing effective imperviousness, are similar to Grass Strip Filters employed as a treatment control (see Section 5, Fact Sheet T-1), but differ in terms of the values used for the two principal design parameters – linear application rate (across the top width of the buffer) (cfs/ft width) and down-slope length.

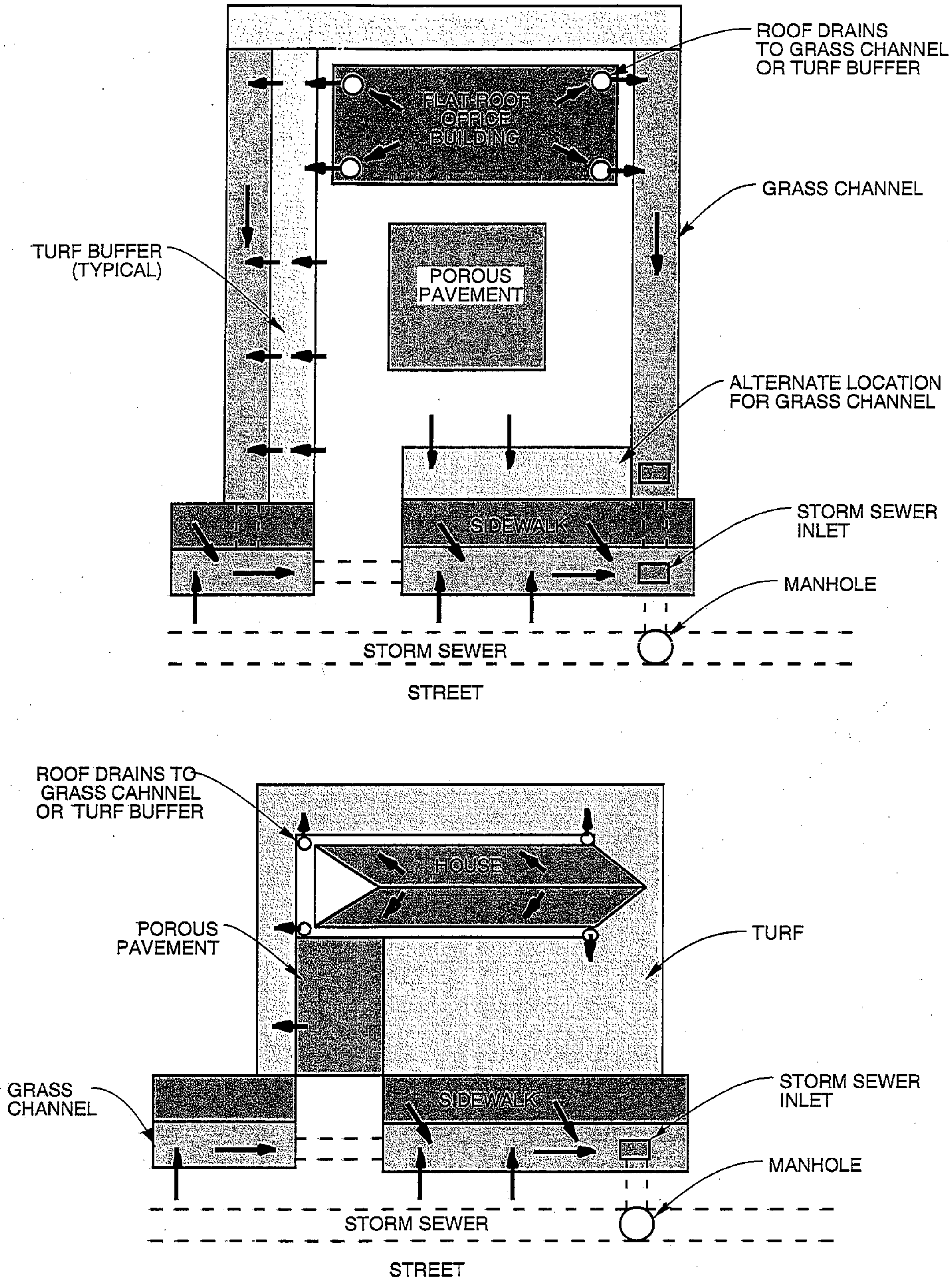


Figure 3-1 EXAMPLES OF MINIMIZING FLOW FROM IMPERVIOUS AREAS

General Application and Design Considerations

Turf Buffers are appropriate for use in residential, commercial, industrial and institutional settings as illustrated in Figure 3-1. They are typically located adjacent to impervious areas to be mitigated. Their use should be incorporated into the site and master drainage planning and their design should be performed in close coordination with the landscape architect. The contributing flow from impervious areas that can be accommodated by the Turf Buffer will be limited according to the design criteria in this fact sheet. Tributary areas are typically less than 5 acres. Several Turf Buffers may be used on a single site, each sized according to the impervious area from which it receives flow. Irrigation and regular mowing are required to maintain the turf grass cover. Turf Buffers should be located away from or protected from excessive pedestrian or vehicular traffic that can damage the grass cover and adversely affect achievement of sheet flow over the surface. Although Turf Buffers provide some degree of pollutant removal, they do not qualify as treatment controls and must be followed by at least one of the approved treatment controls described in Section 5.

Design Criteria and Procedure

Principal design criteria for Turf Buffers are summarized in Table 3-1. See Figure 3-2 for dimensional relationships.

Table 3-1. Turf Buffer Design Criteria

Design Parameter	Unit	Design Criteria
Design Flow (SQDF)	cfs	$0.1 \times Q_{P,\,50yr}$
Maximum linear application rate (q_a)	cfs/ft width	0.05
Minimum width (normal to flow) (W_{TB})	ft	(SQDF) / (q_a)
Minimum length (flow direction) (L_{TB})	ft	8 (minimum)
Maximum slope (flow direction)	%	4 (maximum)
Vegetation	–	Turf grass (irrigated)

Design procedure and application of design criteria are outlined in the following steps:

1. Design Flow — Determine Stormwater Quality Design Flow (SQDF) for impervious area to be mitigated.

   $Q_{P,\,SQDF} = 0.1 \times Q_{P,\,50yr}$ (see Calculation Fact Sheet, Section 5)

2. Minimum Width — Calculate minimum width of the Turf Buffer (W_{TB}) normal to flow direction.

   $W_{TB} = (SQDF) / (q_a)$

   $W_{TB} = (SQDF) / 0.05$ cfs/ft (minimum)

3. Minimum Length — Length of the Turf Buffer (L_{GB}) in the direction of flow shall not be less than 8 feet.

   $L_{TB} = 8$ feet (minimum)

4. Maximum Slope — Slope of the ground in the direction of flow shall not be greater than 4 percent.

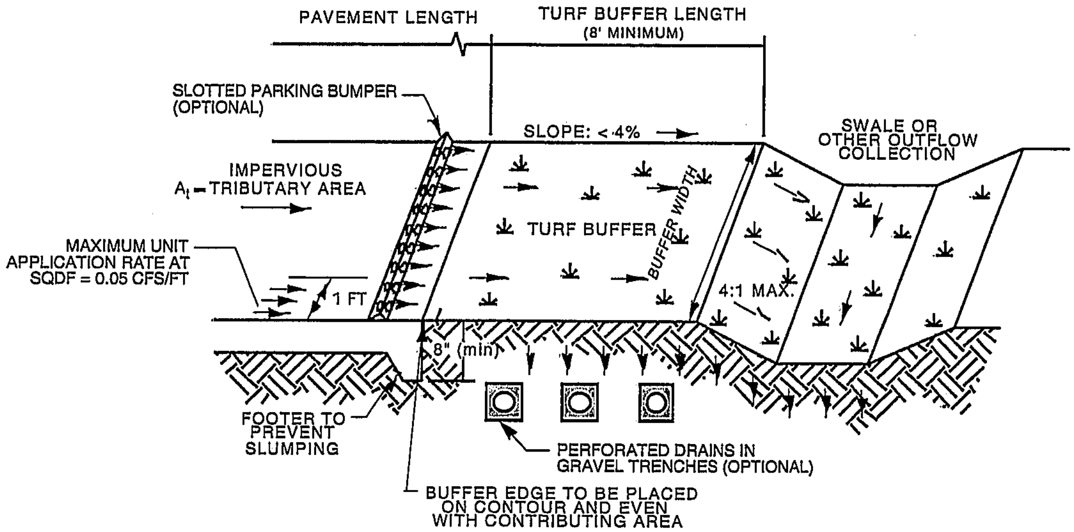
5. Flow Distribution — Incorporate a device at the upstream end of the Turf Buffer to evenly distribute flows along the top width, such as slotted curbing, modular block porous pavement, or other spreader devices. Concentrated flow delivered to the Turf Buffer must be distributed evenly by means of a level spreader of similar concept.

6. Vegetation — Provide irrigated perennial turf grass to yield full, dense cover (See Appendix F for suitable grasses).

7. Outflow Collection — Provide a means for outflow collection and conveyance (e.g. grass channel/swale, storm drain, street gutter)

<u>Design Example</u>

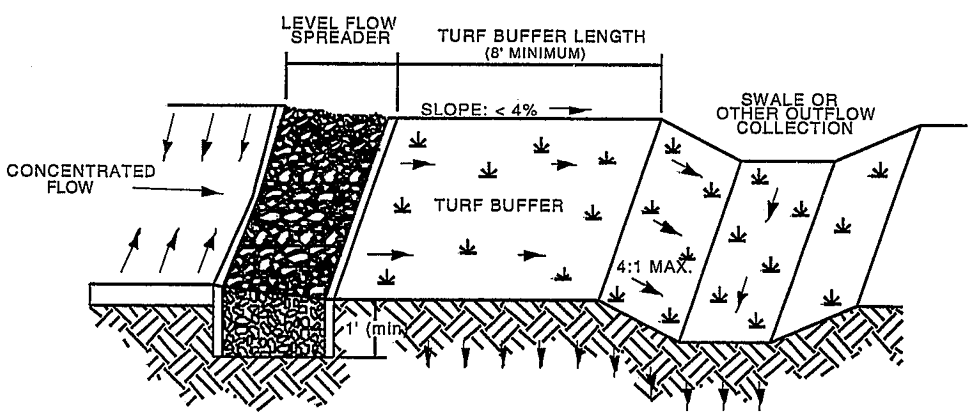
A completed design form follows as a design example. Blank design forms are provided in Appendix G.



SHEET FLOW CONTROL

NOT TO SCALE

ADAPTED FROM URBAN STORM DRAIN CRITERIA MANUAL VOL. 3 - BEST MANAGEMENT PRACTICES, URBAN DRAINAGE AND FLOOD CONTROL DISTRICT, 11/99



CONCENTRATED FLOW CONTROL

NOT TO SCALE

Figure 3-2 TURF BUFFER

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Design Procedure Form for G-5.1: Turf Buffer

Designer: ______________________________

Company: ______________________________

Date: ______________________________

Project: ______________________________

Location: ______________________________

1. Design Flow	$Q_{P, SQDF}$ = 1.0 cfs
2. Design Width W_{GB} = (SQDF) / 0.05 cfs/ft	W_{GB} = 20.0 ft.
3. Design Length (8 ft minimum)	L_{GB} = 8.0 ft.
4. Design Slope (4 percent maximum)	L_{GB} = 3.0 %
5. Flow Distribution (Check type used or describe "Other")	X Slotted curbing ___ Modular Block Porous Pavement ___ Level Spreader ___ Other ________
6. Vegetation (describe)	Tall Fescue
7. Outflow Collection (Check type used or describe "Other")	X Grass Channel/Swale ___ Street Gutter ___ Storm Sewer ___ Underdrain Used ___ Other ________

Notes ______________________________

A017431

G-5.2: Grass-lined Channels

Description

Grass-lined Channels are densely vegetated drainageways with gentle sideslopes and gradual longitudinal slopes in the direction of flow that collect and slowly convey runoff to downstream points of discharge. Grass-lined Channels provide an opportunity for infiltration, reduce peak flows from impervious areas and provide some degree of pollutant removal. Applications of Grass Swale are illustrated in Figure 3-3. Grass-lined Channels, used for the purpose of minimizing effective imperviousness, are similar to Grass Swale Filters employed as a treatment control (see Section 5, Fact Sheet T-1), but differ in terms of design depth of flow and minimum contact time.

General Application and Design Considerations

Grass-lined Channels are appropriate for use in residential, commercial, industrial and institutional settings as illustrated in Figure 3-1. They are typically used in conjunction with Turf Buffers and are located adjacent to impervious areas to be mitigated. Their use should be incorporated into the site and master drainage planning. The contributing flow from impervious areas that can be accommodated by the Grass-lined Channels will be limited according to the design criteria in this fact sheet. Tributary areas are typically less than 5 acres. Several Grass-lined Channels may be used on a single site, each sized according to the impervious area from which it receives flow. Irrigation and regular mowing are required to maintain the turf grass cover. Grass-lined Channels are not the same as Grass Swale Filters. Consequently, Grass-lined Channels do not qualify as treatment controls and must be followed by at least one of the approved treatment controls described in Section 5.

Design Criteria and Procedure

Principal design criteria for Grass-lined Channels are summarized in Table 3-2 (Ref. Figure 3-3).

Table 3-2 Grass-lined Channel Design Criteria

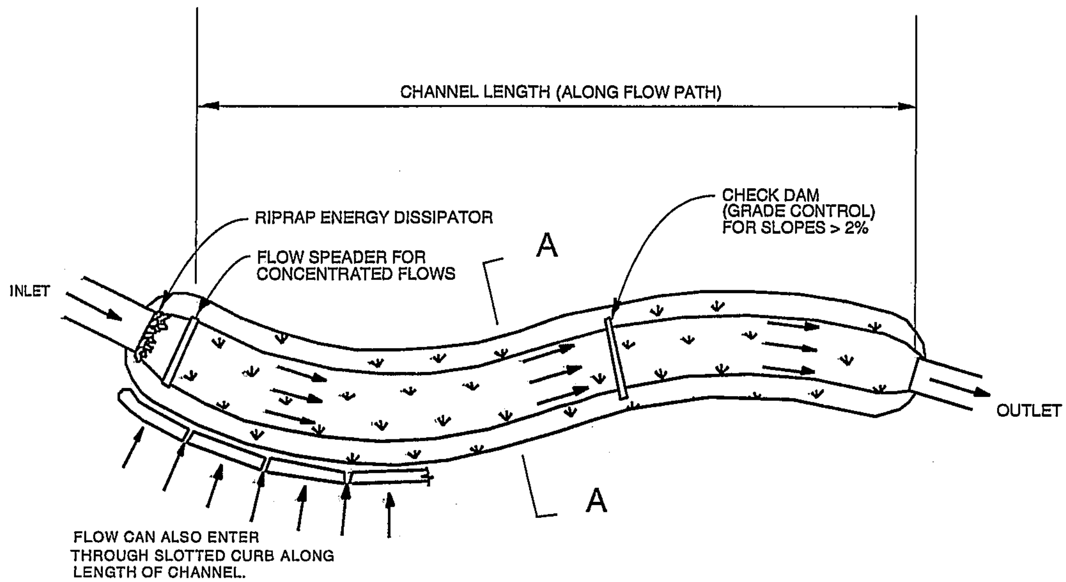
Design Parameter	Unit	Design Criteria
Design Flow (SQDF)	cfs	0.1 x $Q_{P,\ 50yr}$
Channel geometry	–	Trapezoidal or triangular
Maximum channel side slope	H:V	4 :1
Minimum slope in flow direction	%	0.2 (provide underdrains for slopes < 0.5)
Maximum slope in flow direction	%	2.0 (provide grade-control checks for slopes >2.0)
Maximum flow velocity	ft/sec	1.5 (based on Manning n = 0.05)
Maximum depth of slow at SQDF	ft.	2.0 (based on Manning n = 0.05)
Vegetation	–	Turf grass

Design procedure and application of design criteria are outlined in the following steps:

1.	Design Flow	Determine Stormwater Quality Design Flow (SQDF) for impervious area to be mitigated.
		$Q_{P, SQDF} = 0.1 \times Q_{P, 50yr}$ (see Fact Sheet, Section 5)
2.	Channel Geometry	Use trapezoidal or triangular cross section.
3.	Maximum Side Slope	Side slopes shall not be steeper than 4:1 (5:1 or flatter preferred).
4.	Minimum Slope	Slope of the channel in the direction of flow shall not be less than 0.2 percent. Channel with slopes less than 0.5 percent should be provided with underdrains (see Figure 3-3).
5.	Maximum Slope	Slope of the channel in the direction of flow shall not be greater than 2 percent. Provide grade control checks for slopes greater than 2.0 percent (see Figure 3-3).
6.	Flow Velocity	Maximum flow velocity at design flow should not exceed 1.5 ft/sec. based on a Mannings n = 0.05.
7.	Flow Depth	Maximum depth of flow at design flow should not exceed 2.0 ft. based on a Mannings n = 0.05.
8.	Vegetation	Provide irrigated perennial turf grass to yield full, dense cover. (See Appendix F for suitable grasses).
9.	Drainage and Flood Control	Provide sufficient flow depth for flood event flows to avoid flooding of critical areas or structures.

Design Example

A completed design form follows as a design example. Blank design forms are provided in Appendix G.



TRAPEZOIDAL GRASS -LINED CHANNEL – PLAN

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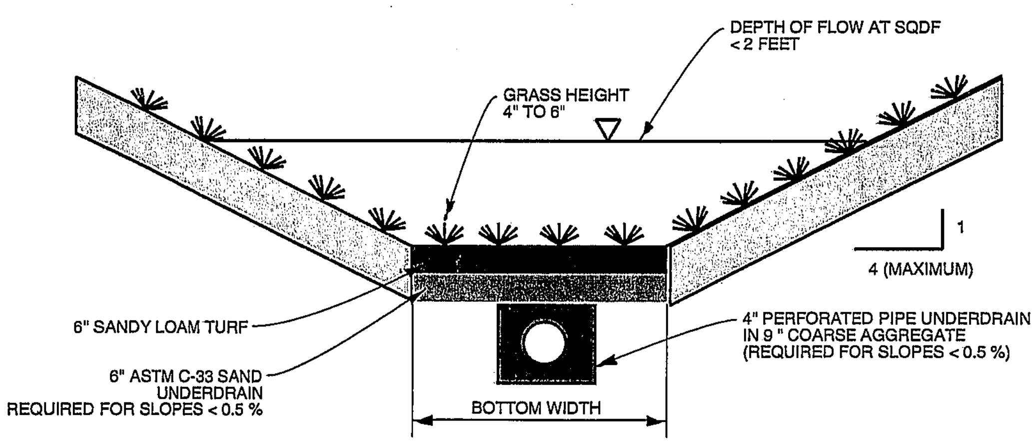
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT, 11/99



TRAPEZOIDAL GRASS-LINED CHANNEL – SECTION

NOT TO SCALE

Figure 3-3 GRASS-LINED CHANNEL

Design Procedure Form for G-5.2: Grass-lined Channel

Designer:____________________

Company:____________________

Date:____________________

Project:____________________

Location:____________________

1. Design Flow	$Q_{P,\,SQDF}$ = 10.0 cfs
2. Channel Geometry	
A. Channel Bottom Width (b)	b = 20.0 ft.
B. Side slope (Z)	Z = 4:1
3. Depth of flow at SQDF (d) (2 ft max, Manning n= 0.05)	d = 1.4 ft.
4. Design Slope	
A. s = 2 percent maximum	s = 0.32 %
B. No. of grade controls required	______ (number)
6. Vegetation (describe)	Tall Fescue
7. Outflow Collection (Check type used or describe "Other")	X Grated Inlet ____ Infiltration Trench ____ Other ________

Notes ____________________

Calculating Effective Imperviousness

The effective imperviousness of a site may be reduced if flow from impervious areas are routed over general site design controls G-5.1: Turf Buffers and/or G-5.2: Grass-lined Channels that are designed in conformance to the criteria presented in this fact sheet.

Calculation Procedure

The allowable reduction in impervious percentage is determined with the use of Figure 3-4 as described in the following steps:

1. Estimate the total imperviousness (impervious percentage) of the site by the determining the weighted average of individual areas of like imperviousness. Table 3-3 may be used as guide for estimating imperviousness of typical site elements.

Table 3-3. Recommended Percent Imperviousness for Typical Site Elements

Site Element	Percent Imperviousness
Asphalt/concrete pavement	100
Gravel pavement	40
Roofs	90
Porous pavement	35[1]
Lawn/turf	0
Open space	0

1. Variable with product type, assumes porous subsoil and use of underdrains

Table 3-4 may be used as an aid in calculating total imperviousness.

Table 3-4. Calculation Sheet for Determination of Total Imperviousness

Site Element	Unit Area (ft^2)	Percent Imperviousness	Weighting Factor[2]	Weighted % Imperviousness[3,4]
Asphalt/concrete pavement		100		
Gravel pavement		40		
Roofs		90		
Porous pavement		35[5]		
Lawn/turf		0		
Open space		0		
Total Contributing Area[1]		–	–	

1. Total contributing area = sum of unit areas
2. Weighting factor = unit area / total contributing area
3. Weighted imperviousness = weighting factor x percent imperviousness
4. Total imperviousness = sum of weighted imperviousness
5. Variable with product type, assumes porous subsoil and use of underdrains

2. Enter Figure 3-4 along the horizontal axis with the value of total imperviousness calculated in Step 1. Move vertically up Figure 3-4 until the appropriate curve (G-5.1 or G-5.2 employed individually or G-5.1 and G-5.2 employed together) is intercepted. Move horizontally across Figure 3-4 until the vertical axis is intercepted. Read the Effective Imperviousness value along the vertical axis.

   Note that if G-5.1 and/or G-5.2 are implemented on only a portion of the site, the site may be divided and effective imperviousness determined for the portion of the site for which site design controls have been implemented. The resulting effective imperviousness may be combined with total imperviousness of the remainder of the site to determine a weighted average total imperviousness for the entire site.

Calculation Example

The calculation procedure described above is illustrated by the following example.

Design Conditions:

1. All flow from impervious areas is routed over a Turf Buffer (G-5.1).
2. The site consists of the site elements and associated units areas shown in Table 3-5.

Table 3-5. Example Calculation Sheet for Determination of Total Imperviousness

Site Element	Unit Area (ft^2)	Percent Imperviousness	Weighting Factor[4]	Weighted % Imperviousness [5,6]
Asphalt/concrete pavement	10,000	100	0.20	20
Gravel pavement	0	40		
Roofs	10,000	90	0.20	18
Porous pavement	0	35		
Lawn	20,000	0	0.40	0
Open space	10,000	0	0.20	0
Total Contributing Area[3]	50,000	–	–	38

Calculations:

3. Total contributing area = sum of unit areas
4. Weighting factors = unit area/total contributing area
5. Weighted imperviousness = Weighting factor x percent imperviousness
6. Total imperviousness = sum of weighted imperviousness
7. Effective imperviousness = 32 percent (from Figure 3-4)

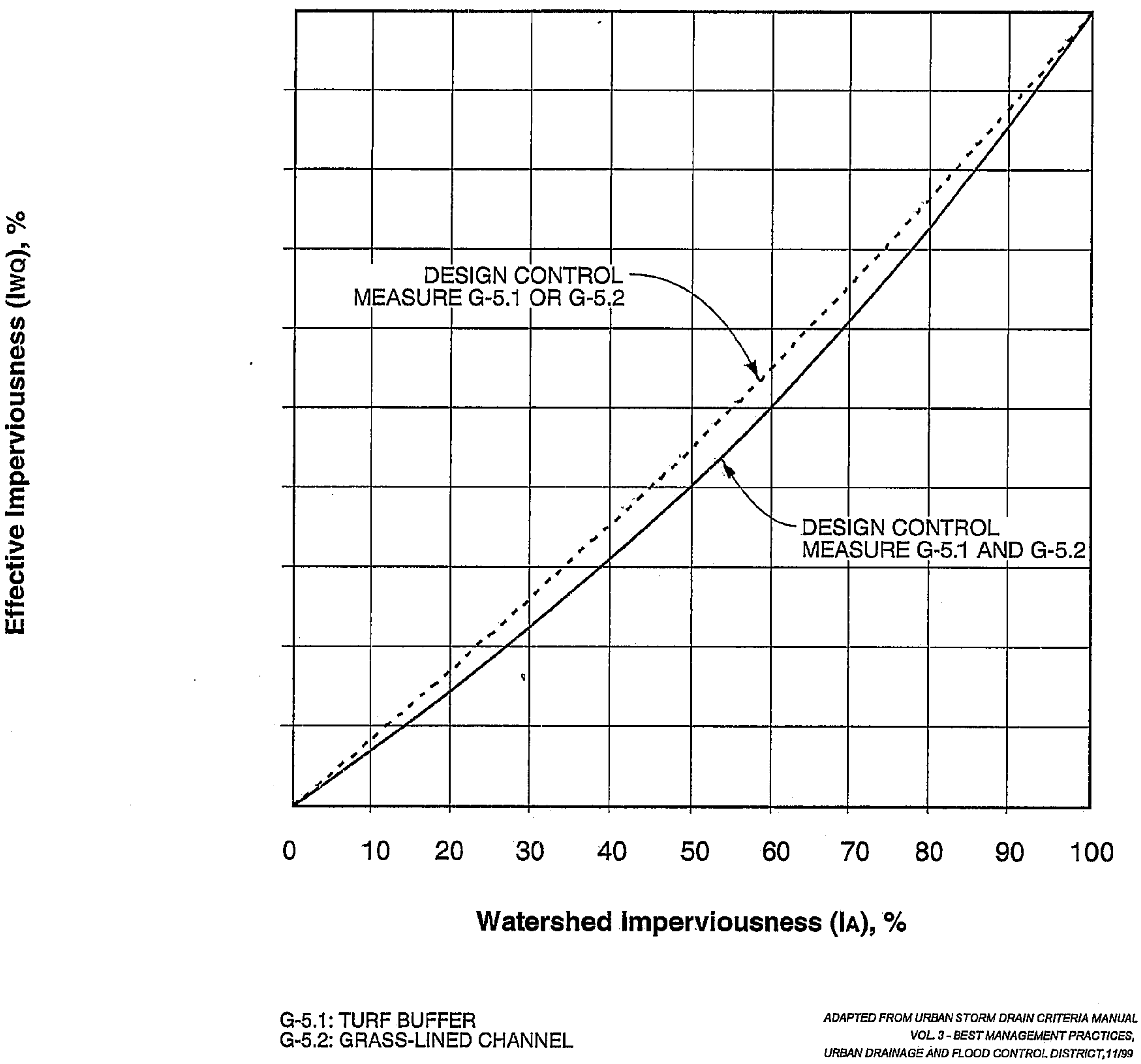


Figure 3-4. DETERMINATION OF EFFECTIVE IMPERVIOUSNESS

SECTION 4

SITE-SPECIFIC SOURCE CONTROL MEASURES

Introduction

Source control measures are low-technology practices designed to prevent pollutants from contacting stormwater runoff or to prevent discharge of contaminated runoff to the storm drainage system. This section addresses site-specific, structural type source control measures consisting of specific design features or elements. Non-structural type source control measures; such as good housekeeping and employee training are not included in this manual. The California Industrial Best Management Practice Manual may be consulted for this type of practice (SWQTF, 1993). The governing stormwater agency may require additional source control measures not included in this manual for specific pollutants, activities or land uses.

This section describes control measures for specific types of sites or activities that have been identified as potential significant sources of pollutants in stormwater. Each of the measures specified in this section should be implemented in conjunction with appropriate nonstructural source control measures to optimize pollution prevention.

The measures addressed in this section apply to both stormwater and non-stormwater discharges. Non-stormwater discharges are the discharge of any substance, such as cooling water, process wastewater, etc., to the storm drainage system or water body that is not composed entirely of stormwater. Stormwater that is mixed or commingled with other non-stormwater flows is considered non-stormwater. Discharges of stormwater and non-stormwater to the storm drainage system or a water body may be subject to local, state, or federal permitting prior to any discharge commencing. The appropriate agency should be contacted prior to any discharge. Discuss the matter with the stormwater staff if you are uncertain as to which agency should be contacted.

Some of the measures presented in this section require connection to the sanitary sewer system. Connection and discharge to the sanitary sewer system without prior approval or obtaining the required permits is prohibited. Contact the stormwater staff of the governing agency to obtain information regarding obtaining sanitary sewer permits from the various agencies within Ventura County. Discharges of certain types of flows to the sanitary sewer system may be cost prohibitive. The designer is urged to contact the appropriate agency prior to completing site and equipment design of the facility.

Description

Site-specific source control measures and associated design features specified for various sites and activities are summarized in Table 4-1. Fact sheets are presented in this section for each source control measure. These sheets include design criteria established by the Permittees to ensure effective implementation of the required source control measures:

Table 4-1. Summary of Site-specific Source Control Design Features

Site-specific Source Control Measure [(a)]	Design Feature or Element						
	Signs, placards, stencils	Surfacing (compatible, impervious)	Covers, screens	Grading/berming tp prevent runon	Grading/berming to provide secondary containment	Sanitary sewer connection	Emergency Storm Drain Seal
Storm Drain Message and Signage (S-1)	X						
Outdoor Material Storage Area Design (S-2)		X	X	X	X		X
Outdoor Trash Storage and Waste Handling Area Design (S-3)		X	X	X		X	
Outdoor Loading/Unloading Dock Area Design (S-4)		X	X	X	X		
Outdoor Repair/Maintenance Bay Design (S-5)		X	X	X	X		X
Outdoor Vehicle/Equipment/ Accessory Washing Area Design (S-6)		X	X	X	X	X	X
Fueling Area Design (S-7)		X	X	X	X		X
Parking Lot Design [(b)]							

(a) Refer to Fact Sheets in Section 4 for detailed information and design criteria
(b) SQUIMP requirements for proper design of parking lots are covered by requirements for General Site Design Control Measures (see Section 3) and Treatment Control Measures (see Section 5).

Storm Drain Message and Signage

Purpose

Waste materials dumped into storm drain inlets can have severe impacts on receiving and ground waters. Posting notices regarding discharge prohibitions at storm drain inlets can prevent waste dumping. This fact sheet contains details on the installation of storm drain messages at storm drain inlets located in new or redeveloped commercial, industrial, and residential sites.

Design Criteria

Storm drain messages have become a popular method of alerting the public about the effects of and the prohibitions against waste disposal into the storm drain system. The signs are typically stenciled or affixed near the storm drain inlet. The message simply informs the public that dumping of wastes into storm drain inlets is prohibited and/or the drain discharges to a receiving water.

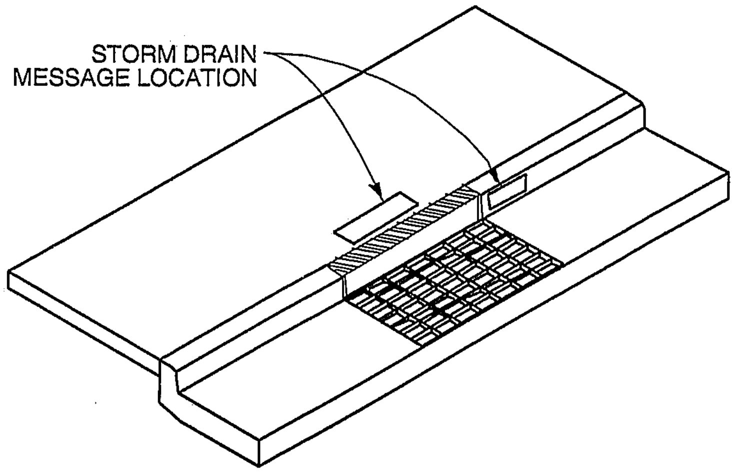
Storm drain message markers or placards are required at all storm drain inlets within the boundary of the development project. The marker should be placed in clear sight facing toward anyone approaching the inlet from either side (see Figure 4-1). All storm drain inlet locations must be identified on the development site map.

Some local agencies within the County have approved storm drain message placards for use. Consult local agency stormwater staff to determine specific requirements for placard types and methods of application.

Signs with language and/or graphical icons, which prohibit illegal dumping, shall be posted at designated public access points along channels and streams within a project area. Consult local agency stormwater staff to determine specific signage requirements.

Maintenance Requirements

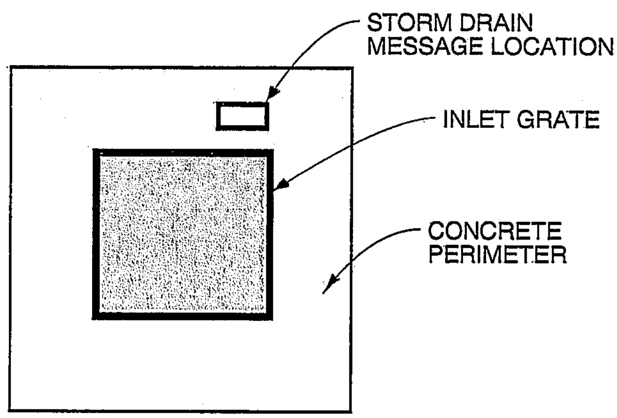
Legibility of markers and signs shall be maintained. If required by the agency with jurisdiction over the project, the owner/operator or homeowner's association shall enter into a maintenance agreement with the agency or record a deed restriction upon the property title to maintain the legibility of placards and signs.



CURB TYPE INLET

NOTES:

1. STORM DRAIN MESSAGE SHALL BE APPLIED IN SUCH A WAY AS TO PROVIDE A CLEAR, LEGIBLE IMAGE.
2. STORM DRAIN MESSAGE SHALL BE PERMANENTLY APPLIED DURING THE CONSTRUCTION OF THE CURB AND GUTTER USING A METHOD APPROVED BY THE LOCAL AGENCY.



AREA TYPE INLET

FIGURE 4-1. STORM DRAIN MESSAGE LOCATION

A017442

Outdoor Material Storage Area Design

Purpose

Materials that are stored outdoors could become sources of pollutants in stormwater runoff if not handled or stored properly. Materials could be in the form of raw products, by-products, finished products, and waste products. The type of pollutants associated with the materials will vary depending on the type of commercial or industrial activity.

Some materials are more of a concern than others. Toxic and hazardous materials must be prevented from coming in contact with stormwater. Non-toxic or non-hazardous materials do not have to be prevented from stormwater contact. However, these materials may have toxic effects on receiving waters if allowed to be discharged with stormwater in significant quantities. Accumulated material on an impervious surface could result in significant debris and sediment being discharged with stormwater runoff causing a significant impact on the rivers or streams that receive the runoff.

Materials may be stored in a variety of ways, including bulk piles, containers, shelving, stacking, and tanks. Stormwater contamination may be prevented by eliminating the possibility of stormwater contact with the material storage areas either through diversion, cover, or capture of the stormwater. Control measures may also include minimizing the storage area. Control measures are site specific, and must meet local agency requirements.

Design Criteria

Design requirements for material storage areas are governed by Building and Fire Codes, and by current City or County ordinances and zoning requirements. Source controls described in the fact sheet are intended to enhance and be consistent with these code and ordinance requirements. The following design features should be incorporated into the design of material storage area when storing materials outside that will contribute significant pollutants to the storm drain.

Source Control Design Feature	Design Criteria
Surfacing	• Construct the storage area base with a material impervious to leaks and spills.
Covers	• Install a cover that extends beyond the storage area, or use a manufactured storage shed for small containers.
Grading/Containment	• Minimize the storage area. • Slope the storage area towards a dead-end sump to contain spills. • Grade or berm storage areas to prevent run-on from surrounding areas. • Direct runoff from downspouts/roofs away from storage areas.

Accumulated Stormwater and Non-stormwater

Stormwater and non-stormwater will accumulate in containment areas and sumps with impervious surfaces. Contaminated accumulated water must be disposed of in accordance with applicable laws and cannot be discharged directly to the storm drain or sanitary sewer system without the appropriate permit.

Outdoor Trash Storage Area Design

Purpose

Stormwater runoff from areas where trash is stored or disposed of can be polluted. In addition, loose trash and debris can be easily transported by the forces of water or wind into nearby storm drain inlets, channels, and/or creeks. Waste handling operations that may be sources of stormwater pollution include dumpsters, litter control, and waste piles. This fact sheet contains details on the specific measures required to prevent or reduce pollutants in stormwater runoff associated with trash storage and handling.

Design Criteria

Design requirements for waste handling areas are governed by Building and Fire Codes, and by current local agency ordinances and zoning requirements. The design criteria described in the fact sheet are meant to enhance and be consistent with these code and ordinance requirements. Hazardous waste should be handled in accordance with legal requirements established in Title 22, California Code of Regulations.

Wastes from commercial and industrial sites are typically hauled by either public or commercial carriers that may have design or access requirements for waste storage areas. The design criteria listed below are recommendations and are not intended to be in conflict with requirements established by the waste hauler. The waste hauler should be contacted prior to the design of your site trash collection area. Conflicts or issues should be discussed with the local agency.

The following trash storage area design controls were developed to enhance the local agency codes and ordinances and should be implemented depending on the type of waste and the type of containment:

Source Control Design Feature	Design Criteria
Surfacing	• Construct the storage area base with a material impervious to leaks and spills.
Screens/Covers	• Install a a screen or wall around trash storage area to prevent off-site transport of loose trash. • Use lined bins or dumpsters to reduce leaking of liquid wastes. • Use water-proof lids on bins/dumpsters or provide a roof to cover enclosure (local agency discretion) to prevent rainfall from entering containers
Grading/Contouring	• Berm or grade the waste handling area to prevent runon of stormwater. • Do not locate storm drains in immediate vicinity of the trash storage area.
Signs	• Post signs on all dumpsters informing users that hazardous materials are not to be disposed of therein.

Maintenance Requirements

The integrity of structural elements that are subject to damage (e.g. screens, covers and signs) must be maintained by the owner/operator. Maintenance agreements between the local agency and the owner/operator may be required. Some agencies will require maintenance deed restrictions to be recorded of the property title. If required by the local agency, maintenance agreements or deed restrictions must be executed by the owner/operator before improvement plans are approved. Refer to Appendix C and D for a further guidance regarding maintenance plans agreements.

Outdoor Loading/Unloading Dock Area Design

Purpose

Materials spilled, leaked, or lost during loading or unloading may collect on impervious surfaces or in the soil and be carried away by runoff or when the area is cleaned. Also, rainfall may wash pollutants from machinery used to load or unload materials. Depressed loading docks (truck wells) are contained areas that can accumulate stormwater runoff. Discharge of spills or contaminated stormwater to the storm drain system is prohibited. This fact sheet contains details on specific measures recommended to prevent or reduce pollutants in stormwater runoff from outdoor loading or unloading areas.

Design Criteria

Design requirements for outdoor loading/unloading of materials are governed by Building and Fire Codes, and by current local agency ordinances and zoning requirements. Source controls described in the fact sheet are meant to enhance and be consistent with these code and ordinance requirements. Companies may have their own design or access requirements for loading docks. The design criteria listed below are not intended to be in conflict with requirements established by individual companies. Conflicts or issues should be discussed with the local agency.

The following design criteria should be followed when developing construction plans for material loading/unloading areas:

Source Control Design Feature	Design Criteria
Surfacing	• Construct floor surfaces with material that is compatible with materials being handled in the loading/unloading area.
Covers	• Cover loading/unloading areas to a distance of at least 3 feet beyond the loading dock or install a seal or door skirt to be used for all material transfers between the trailer and the building.
Grading/Contouring	• Grade or berm storage areas to prevent run-on from surrounding areas. • Direct runoff from downspouts/roofs away from loading areas.
Emergency Storm Drain Seal	• Do not locate storm drains in the loading dock area. Direct connections to storm drains from depressed loading docks are prohibited. • Provide means, such as isolation valves, drain plugs, or drain covers, to prevent spills or contaminated stormwater from entering the storm drainage system.

Accumulated Stormwater and Non-stormwater

Stormwater and non-stormwater will accumulate in containment areas and sumps with impervious surfaces, such as depressed loading docks. Contaminated accumulated water must be disposed of in accordance with applicable laws and cannot be discharged directly to the storm drain or sanitary sewer system without the appropriate permit.

Outdoor Repair/Maintenance Bay Design

Purpose

Activities that can contaminate stormwater include engine repair, service and parking (leaking engines or parts). Oil and grease, solvents, car battery acid, coolant and gasoline from the repair/maintenance bays can severely impact storm water if allowed to come into contact with storm water runoff. This fact sheet contains details on the specific measures required to prevent or reduce pollutants in stormwater runoff from vehicle and equipment maintenance and repair areas.

Design Criteria

Design requirements for vehicle maintenance and repair areas are governed by Building and Fire Codes, and by current local agency ordinances, and zoning requirements. The design criteria described in the fact sheet are meant to enhance and be consistent with these code requirements.

The following design criteria are required for vehicle and equipment maintenance, and repair. All hazardous and toxic wastes must be prevented from entering the storm drainage system.

Source Control Design Feature	Design Criteria
Surfacing	• Construct the vehicle maintenance/repair floor area with Portland cement concrete.
Covers	• Cover or berm areas where vehicle parts with fluids are stored. • Cover or enclose all vehicle maintenance/repair areas.
Grading/Contouring	• Berm or grade the maintenance/repair area to prevent runon and runoff of stormwater or runoff of spills. • Direct runoff from downspouts/roofs away from maintenance/repair areas. • Grade the maintenance/repair area to drain to a dead-end sump for collection of all wash water, leaks and spills. Direct connection of maintenance/repair area to storm drain system is prohibited. • Do not locate storm drains in the immediate vicinity of the maintenance/repair area.
Emergency Storm Drain Seal	• Provide means, such as isolation valves, drain plugs, or drain covers, to prevent spills or contaminated stormwater from entering the storm drainage system.

Accumulated Stormwater and Non-stormwater

Stormwater and non-stormwater will accumulate in containment areas and sumps with impervious surfaces. Contaminated accumulated water must be disposed of in accordance with applicable laws and cannot be discharged directly to the storm drain or sanitary sewer system without the appropriate permit.

Outdoor Vehicle/Equipment/Accessory Washing Area Design

Purpose

Washing vehicles and equipment in areas where wash water flows onto the ground can pollute storm water. Wash waters can contain high concentrations of oil and grease, solvents, phosphates and high suspended solids loads. Sources of washing contamination include outside vehicle/equipment cleaning or wash water discharge to the ground. This fact sheet contains details on the specific measures required to prevent or reduce pollutants in stormwater runoff from vehicle and equipment washing areas.

Design Criteria

Design requirements for vehicle maintenance and repair areas are governed by Building and Fire Codes, and by current local agency ordinances, and zoning requirements. The design criteria described in the fact sheet are meant to enhance and be consistent with these code requirements.

The following design criteria are required for vehicle and equipment washing areas. All hazardous and toxic wastes must be prevented from entering the storm drain system.

Source Control Design Feature	Design Criteria
Surfacing	• Construct the vehicle/equipment wash area floors with Portland cement concrete.
Covers	• Provide a cover that extends over the entire wash area.
Grading/Contouring	• Berm or grade the maintenance/repair area to prevent runon and runoff of stormwater or runoff of spills. • Grade or berm the wash area to contain the wash water within the covered area and direct the wash water to treatment and recycle or pretreatment and proper connection to the sanitary sewer system. Obtain approval from the governing agency before discharging to the sanitary sewer. • Direct runoff from downspouts/roofs away from wash areas. • Do not locate storm drains in the immediate vicinity of the wash area.
Emergency Storm Drain Seal	• Provide means, such as isolation valves, drain plugs, or drain covers, to prevent spills or contaminated stormwater from entering the storm drainage system.

Accumulated Stormwater and Non-stormwater

Stormwater and non-stormwater will accumulate in containment areas and sumps with impervious surfaces. Contaminated accumulated water must be disposed of in accordance with applicable laws and cannot be discharged directly to the storm drain or sanitary sewer system without the appropriate permit.

Purpose

Spills at vehicle and equipment fueling areas can be a significant source of pollution because fuels contain toxic materials and heavy metals that are not easily removed by storm water treatment devices. When storm water mixes with fuel spilled or leaked onto the ground, it becomes polluted by petroleum based materials that are harmful to humans, fish and wildlife. This could occur at large industrial sites or at small commercial sites such as gas stations and convenience stores. This fact sheet contains details on specific measures required to prevent or reduce pollutants in stormwater runoff from vehicle and equipment fueling areas, including retail gas stations.

Design Criteria

Design requirements for fueling areas are governed by Building and Fire Codes and by current local agency ordinances and zoning requirements. The design requirements described in this fact sheet are meant to enhance and be consistent with these code and ordinance requirements.

Source Control Design Feature	Design Criteria
Surfacing	• Fuel dispensing areas must be paved with Portland cement concrete. The fuel dispensing area is defined as extending 6.5 feet from the corner of each fuel dispenser or the length at which the hose and nozzle assemble may be operated plus 1 foot, whichever is less. The paving around the fuel dispensing area may exceed the minimum dimensions of the "fuel dispensing area" stated above. • Use asphalt sealant to protect asphalt paved areas surrounding the fueling area.
Covers	• The fuel dispensing area must be covered[1], and the cover's minimum dimensions must be equal to or greater than the area within the grade break or the fuel dispensing area, as defined above. The cover must not drain onto the fuel dispensing area.
Grading/Contouring	• The fuel dispensing area shall have a 2% to 4% slope to prevent ponding and must be separated from the rest of the site by a grade break that prevents run-on of stormwater to the extent practicable. • Grade the fueling area to drain toward a dead-end sump. • Direct runoff from downspouts/roofs away from fueling areas. • Do not locate storm drains in the immediate vicinity of the fueling area.

1. If fueling large equipment or vehicles that would prohibit the use of covers or roofs, the fueling island should be designed to sufficiently accommodate the larger vehicles and equipment and to prevent run-on and run-off of stormwater. Grade to direct stormwater to a dead-end sump.

Source Control Design Feature	Design Criteria
Emergency Storm Drain Seal	• Provide means, such as isolation valves, drain plugs, or drain covers, to prevent spills or contaminated stormwater from entering the storm drainage system.

Accumulated Stormwater and Non-stormwater

Stormwater and non-stormwater will accumulate in containment areas and sumps with impervious surfaces. Contaminated accumulated water must be disposed of in accordance with applicable laws and cannot be discharged directly to the storm drain or sanitary sewer system without the appropriate permit.

Proof of Control Measure Maintenance

Purpose

Continued effectiveness of control measures specified in this manual depend on diligent ongoing inspection and maintenance. To ensure that such maintenance is provided, the governing stormwater agency may require both a Maintenance Agreement and a Maintenance Plan from the owner/operator of stormwater control measures.

Maintenance Agreement

On-site treatment control measures are to be maintained by the owner/operator. Maintenance agreements between the governing agency and the owner/operator may be required. A Maintenance Agreement with the governing agency must be executed by the owner/operator before occupancy of the project is approved. A sample Maintenance Agreement form is provided in Appendix C.

Maintenance Plan

A post-construction Maintenance Plan shall be prepared and made available at the governing agency's request. The Maintenance Plan should address items such as:

- Operation plan and schedule, including a site map;
- Maintenance and cleaning activities and schedule;
- Equipment and resource requirements necessary to operate and maintain facility;
- Responsible party for operation and maintenance.

Additional guidelines for Maintenance Plans are provided in Appendix D.

SECTION 5

TREATMENT CONTROL MEASURES

Introduction

Treatment control measures are required to augment source controls to reduce pollution from stormwater discharges to the maximum extent practicable. Treatment control measures are engineered technologies designed to remove pollutants from stormwater runoff. The type of treatment control measure(s) to be implemented at a site depends on a number of factors including: type of pollutants in the stormwater runoff, quantity of stormwater runoff to be treated, project site conditions, receiving water conditions, and state industrial permit requirements, when applicable. Land requirements, and costs to design, construct and maintain treatment control measures vary by treatment control measure.

Unlike flood control measures that are designed to handle peak flows, stormwater treatment control measures are designed to treat the more frequent, lower-flow storm events, or the first flush portions of runoff from larger storm events (typically referred to as the first-flush events). Small, frequent storm events represent most of the total average annual rainfall for the area. It's the flow and volume from such small events, referred to as the Stormwater Quality Design Flow (SQDF) and Stormwater Quality Design Volume (SQDV), that is targeted for treatment. There is marginal water quality benefit gained by sizing treatment facilities to handle flows or volumes greater than the SQDF or SQDV.

The treatment control measures presented in this manual are designed based on flow rates or volume of runoff. Those designed based on flow are to be designed for the SQDF, and those designed based on volume are to be designed for the SQDV. Definitions and calculation procedures to determine SQDF and SQDV are presented in this Section. The treatment control measures specified in this manual are to be sized for the SQDF or SQDV only. Flows in excess of SQDF or SQDV are to be diverted around or through the treatment control measure.

The stormwater treatment control measures specified in this section are the more common non-proprietary measures being implemented nationwide. Studies have shown these measures to be reasonably effective if properly installed and maintained. The relative effectiveness of treatment controls specified in this section for removal of pollutants of concern is shown in Table 5-1. Pollutants of concern listed are those that have been identified as causing or contributing to impairment of beneficial uses of water bodies in California. As discussed in Section 2, the measures presented in this section are preferred and will ensure timely plan check review. Alternative technologies that provide equivalent treatment must be approved by the governing stormwater agency on a case by case basis and may result in additional time for agency review and approval, unless coordinated in advance with the agency staff.

Unless otherwise agreed to by the governing stormwater agency, the landowner, site operator, or homeowner's association is responsible for the operation and maintenance of the treatment control measures. Failure to properly operate and maintain the measures could result in reduced treatment of stormwater runoff, or a concentrated loading of pollutants to the storm drain system. To protect against failure, a Maintenance Plan must be developed and implemented for all treatment control measures. Guidelines for maintenance plans are provided in Appendix D of this Manual. The Plan must be made available at the agency's request. In addition, a maintenance agreement with the governing agency may be required. The example maintenance agreements are included in Appendix C.

In addition to maintenance, the governing agency may require water quality monitoring agreements for any of the treatment control measures recommended in this manual. Monitoring may be conducted by the site operator, the agency, or both. Monitoring may be required for a period of time to help the agency evaluate the effectiveness of treatment control measures in reducing pollutants in stormwater runoff.

Description

This section provides fact sheets for design and implementation of recommended treatment control measures. The fact sheets include siting, design, and maintenance requirements to ensure optimal performance of the measures. This manual also contains calculation fact sheets and worksheets to aid in the design of water quality treatment control measures.

Table 5-1. Effectiveness of Treatment Controls Measures for Removal of Pollutants of Concern

Pollutant of Concern	Stormwater Treatment Control Measures[(a)]										
	Grass Strip Filter (T-1)	Grass Swale Filter (T-2)	Extended Detention Basin (T-3)	Wet Detention Basin (T-4)	Constructed Wetland (T-4)	Detention Basin/Sand Filter (T-6)	Porous Pavement Detention (T-7)	Porous Landscape Detention (T-8)	Infiltration Basin (T-9)	Infiltration Trench (T-10)	Media Filter (T-11)
Sediment	H	M	H	H	H	H	H	H	H	H	H
Nutrients	M	L	M	M	M	M	M	M	M	M	M
Metals	M	M	M	M	M	M	M	M	M	M	M
Trash and Debris	H	H	H	H	R	R	R	R	R	R	R
Oxygen Demand	M	M	M	M	M	M	M	M	M	M	M
Toxic Organics	M	M	M	M	M	M	M	M	M	M	M
Bacteria	M	L	L	H	M	M	M	M	M	M	M

(a) = Refer to Fact Sheets in Section 5 for detailed information and design criteria
H = >75% expected removal efficiency for typical urban stormwater runoff
M = 75% to 25% expected removal efficiency for typical urban stormwater runoff
L = <25% expected removal efficiency for typical urban stormwater runoff
R = Recommended for use only downstream of other treatment controls recommend for removal of trash and debris

Calculation of Stormwater Quality Design Flow and Volume

Introduction

The primary control strategy for all of the treatment control measures specified in this Section is to treat the Stormwater Quality Design Flow (SQDF) or Stormwater Quality Design Volume (SQDV) of the storm water runoff. The following paragraphs present calculation procedures and design criteria necessary to determine the SQDF and SQDV.

The treatment control measure equations specified in this Section are listed in Table 5-2 along with the basis of design, SQDF or SQDV, to be used for the listed control measure.

Table 5-2. Sizing Criteria for Treatment Control Measures

Treatment Control Measure	Design Basis
T-1: Grass Strip Filter	SQDF
T-2: Grass Swale Filter	SQDF
T-3: Dry Detention Basin	SQDV
T-4: Wet Detention Basin	SQDV
T-5: Constructed Wetland	SQDV
T-6: Detention Basin/Sand Filter	SQDV
T-7: Porous Pavement Detention	SQDV
T-8: Porous Landscape Detention	SQDV
T-9: Infiltration Basin	SQDV
T-10: Infiltration Trench	SQDV
T-11: Media Filter	SQDV
T-12: Proprietary Control Measures	SQDV or SQDF

Contributing Impervious Area Determination

The SQDF and SQDV are calculated by determining runoff from the impervious and pervious areas of a site that are connected to the treatment control measure. Impervious areas include sidewalks, roadways, parking areas, staging areas, storage areas, slabs, roofs, and other non-vegetated areas, including compacted soil areas. Off-site areas that could run-on to a site and contribute drainage to the treatment control measure should be included in the impervious area determination. The effective imperviousness of a site can be reduced through implementation of general site design control measures (e.g. G-5.1 and G-5.2) to reduce flow from impervious areas, as described in Section 3. Procedures for calculating effective imperviousness are presented in Section 3, Fact Sheet G-5.

Stormwater Quality Design Flow (SQDF) Calculation

Hydrologic calculations for design of flow-based stormwater treatment control measures in Ventura County shall be in accordance with latest edition of the *Hydrology Manual* produced by Ventura County Public Works Agency, Flood Control Department, together with the procedure set forth herein. The designer is specifically reminded to regard minimum subarea sizes required in the *Hydrology Manual* (p. II-3). Where jurisdictions within Ventura County have approved alternative hydrologic calculation methods, the alternative methods may be utilized if they have been approved by the jurisdiction for use in design of flow-based stormwater quality BMPs. This procedure complies with Regional Board Order No. 00-108, NPDES Permit No. CAS004002, Attachment A – Ventura Countywide Stormwater Quality Urban Impact Mitigation Plan, issued July 27, 2000.

The Stormwater Quality Design Flow (SQDF) is defined to be equal to 10 percent of the peak rate of runoff flow from the 50-year storm as determined using the procedures set forth in the *Hydrology Manual.*

Calculation Procedure

1. The Stormwater Quality Design Flow (SQDF) in Ventura County is defined as $Q_{P,\,SQDF}$.

2. Calculate the peak rate of flow from the 50-year storm ($Q_{P,\,50\,yr.}$) using the procedures set forth in the *Hydrology Manual* or as directed by the local agency Drainage Master Plan.

3. Convert $Q_{P,\,50yr}$ (Step 2) to $Q_{P,\,SQDF}$ (Step 1).

$$Q_{P,\,SQDF} = 0.1 \times Q_{P,\,50yr}$$

Example Stormwater Quality Design Flow Calculation

The steps below illustrate calculation of SQDF:

Step 1: SQDF = $Q_{P,\,SQDF}$

Step 2: Calculate the peak rate of flow from a 50-year storm.

$Q_{p,\,50\,yr.}$ = 10 cfs from the *Hydrology Manual*

Step 3: Convert $Q_{p,50\,yr}$ (Step 2) to $Q_{p,\,SQDF}$ (Step 1)

$$Q_{P,\,SQDF} = 0.1 \times 10 \text{ cfs}$$

$$Q_{P,\,SQDF} = 1.0 \text{ cfs}$$

Stormwater Quality Design Volume (SQDV) Calculation

Hydrologic calculations for design of volume-based stormwater treatment controls in Ventura County shall be in accordance with the procedures set forth herein. This procedure complies with Regional Board Order No. 00-108, NPDES Permit No. CAS004002, Attachment A – Ventura Countywide Stormwater Quality Urban Impact Mitigation Plan, issued July 27, 2000.

The Stormwater Quality Design Volume (SQDV) is defined as the volume necessary to capture and treat 80 percent or more of the average annual runoff volume from the site at the design drawdown period specified in the Fact Sheet for the proposed treatment control measure.

Calculation Procedure

1. Review the area draining to the proposed treatment control measure. Determine the effective imperviousness (I_{WQ}) of the drainage area using the procedure presented in Section 3, Fact Sheet G-5.
2. Figure 5-1 provides a direct reading of Unit Basin Storage Volumes required for 80% annual capture of runoff for values of "I_{WQ}" determined in Step 1. Enter the horizontal axis of Figure 5-1 with the "I_{WQ}" value from Step 1. Move vertically up Figure 5-1 until the appropriate drawdown period line is intercepted. (The design drawdown period specified in the respective Fact Sheet for the proposed treatment control measure.) Move horizontally across Figure 5-1from this point until the vertical axis is intercepted. Read the Unit Basin Storage Volume along the vertical axis.

   Figure 5-1 is based on Precipitation Gage 168, Oxnard Airport. This gage has a data record of approximately 40 years of hourly readings and is maintained by Ventura County Flood Control District. Figure 5-1 is for use only in the permit area specified in Regional Board Order No. 00-108, NPDES Permit No. CAS004002.
3. The SQDV for the proposed treatment control measure is then calculated by multiplying the Unit Basin Storage Volume by the contributing drainage area. Due to the mixed units that result (e.g., acre-inches, acre-feet) it is recommended that the resulting volume be converted to cubic feet for use during design.

Example Stormwater Quality Design Volume Calculation

1. Determine the drainage area contributing to control measure, A_t. Example: 10 acres.
2. Determine the area of impervious surfaces in the drainage area, A_i. Example: 6.4 acres.
3. Calculate the percentage of impervious, $I_A = (A_i/ A_t)*100$

   Example: Percent Imperviousness = $(A_i/ A_t)*100$ = (6.4 acres/10 acres)*100 = 64%
4. Determine Effective Imperviousness using Figure 3-4.

   Example: G-5.1 employed → I_{WQ} = 60%
5. Determine design drawdown period for proposed control measure.

   Example: T-3:Extended Detention Basin → Drawdown period = 40 hours
6. Determine the Unit Basin Storage Volume for 80% Annual Capture, V_u using Figure 5-1.

   Example: for $I_{WQ}/100$ = 0.60 and drawdown = 40 hrs, V_u = 0.64 in.
7. Calculate the volume of the basin, V_b, where $V_b = V_u * A_t$.

   Example: V_b = (0.64 in)(10 ac)(ft/12 in(43,560 ft^2 / ac) = 23,232 ft^3.
8. Solution: Size the proposed control measure for 23,232 ft^3 and 40-hour drawdown.

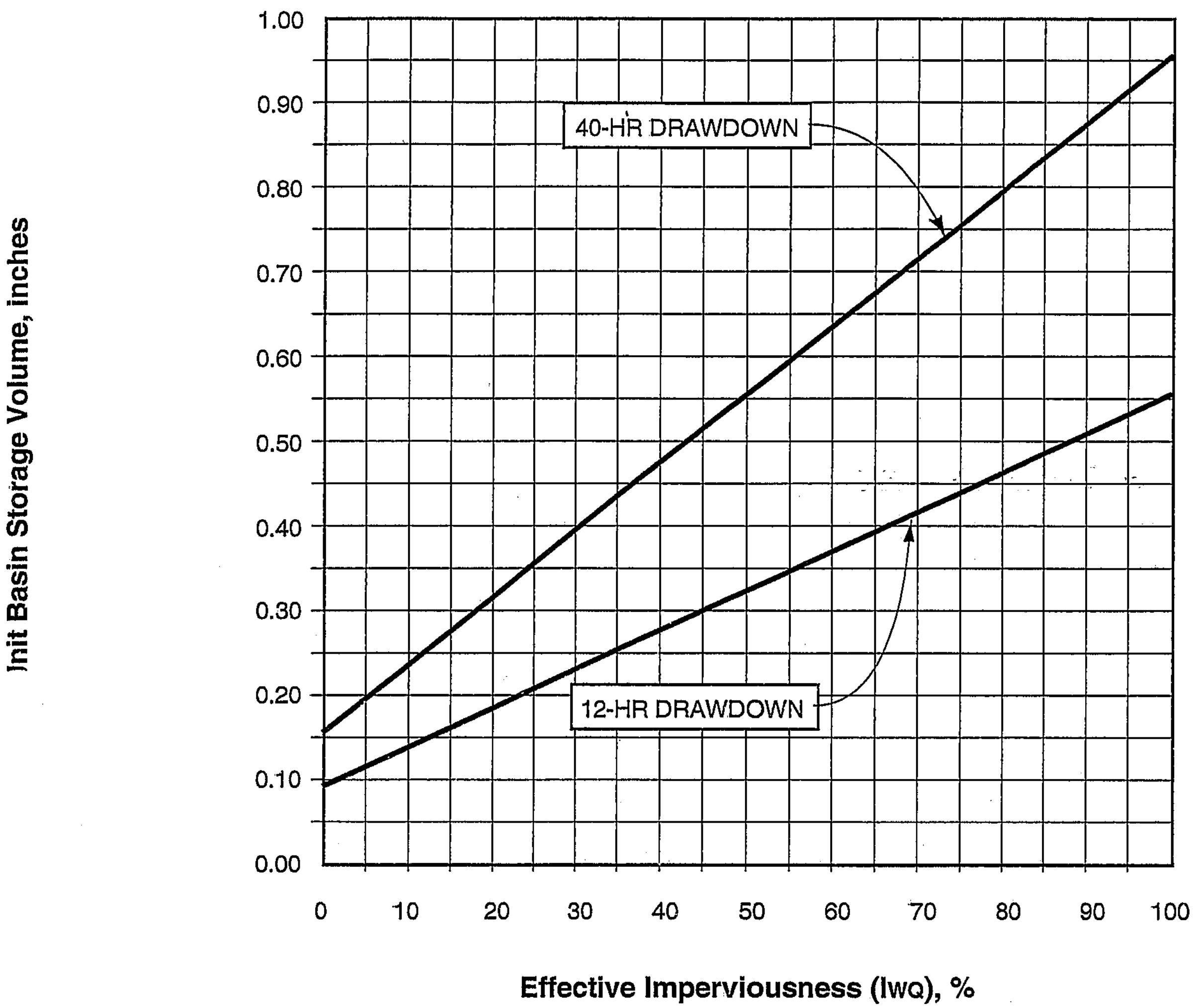


Figure 5-1. Unit Basin Storage Volume vs. Effective Imperviousness

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Description

Grass Strip Filters (GSTF) are uniformly graded and densely vegetated strips of turf grass. Runoff flow to be treated is distributed uniformly across the top width of the strip to achieve sheet flow down the length of the strip. Uniform application to the top of the grass strip may be achieved by routing sheet flow from impervious areas, such as parking lots, directly to the top of the GSTF or by redistributing concentrated flow across the top of the GSTF by means of a level spreader. A GSTF is sized to treat the SQDF from the tributary area. Grass Strip Filters are essentially the same as Grass Buffers described in Fact Sheet G-5.1 in Section 3, with the only differences being design criteria for the linear rate of application along top of the strip and the length of strip in the direction of flow. Applications of GSTFs are illustrated in Figure 5-2.

General Application

Grass Strip Filters are appropriate for use in residential, commercial, industrial and institutional settings and are typically incorporated into the landscape design of the site. They are typically located adjacent to impervious areas to be mitigated. The contributing flow that can be accommodated by the GSTF will be limited according to the design criteria in this fact sheet. Tributary areas are typically less than 5 acres. Several Grass Strip Filters may be used on a single site, each sized according to the tributary area from which it receives flow. To limit the size of units when space is limited, runoff flow from pervious and off-site areas should not be routed over Grass Strip Filters. Irrigation and regular mowing are required to maintain the turf grass cover.

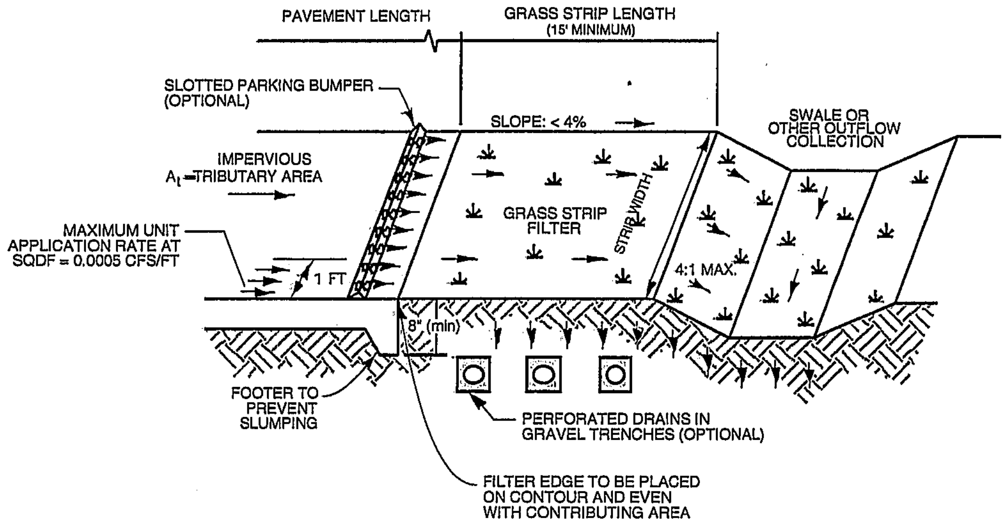
Advantages/Disadvantages

General

Grass Strip Filters are relatively easy to design, install and maintain. Vegetated areas that would normally be included in the site layout, if designed for appropriate flow patterns, may be used as Grass Strip Filters. Landscape architects can easily alter planting schemes to include appropriate turf species to meet design requirements for strips. Finally, maintaining a Grass Strip Filter often requires little more than normal landscape maintenance activities such as irrigation and mowing. Compared with some other means for improving stormwater runoff quality, GSTFs provide a relatively unobtrusive, attractive, long-term and inexpensive stormwater quality management technique. In addition to pollutant removal, GSTFs provide opportunity for infiltration of runoff and reduce peak flows.

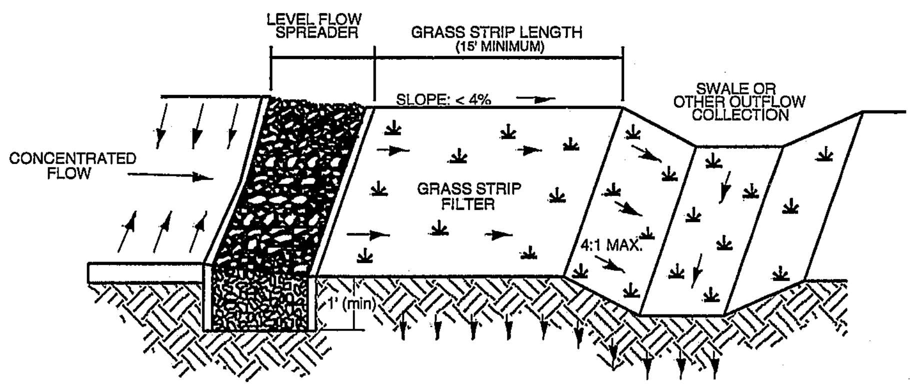
Site Suitability

After final grading the site should have a uniform slope and be capable of maintaining sheet flow conditions. Grass Strip Filters should be located away from or protected from excessive pedestrian or vehicular traffic that can damage the grass cover and affect achievement of sheet flow over the surface.



SHEET FLOW CONTROL

NOT TO SCALE



CONCENTRATED FLOW CONTROL

NOT TO SCALE

Figure 5-2 GRASS STRIP FILTER

ADAPTED FROM URBAN STORM DRAIN CRITERIA MANUAL
VOL. 3 - BEST MANAGEMENT PRACTICES,
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT, 11/99

Pollutant Removal

Relative pollutant removal effectiveness of a GSTF is presented in Table 5-1. Removal effectiveness of GSTF for sediment and particulate forms of metals, nutrients and other pollutants is considered high to moderate. Grass Strip Filters are particularly effective when used as an upstream control measure in combination with grass swale filters, sand filters, and infiltration control measures.

Design Criteria and Procedure

Principal design criteria for GSTFs are listed in Table 5-3.

Table 5-3. Grass Strip Filter Design Criteria

Design Parameter	Unit	Design Criteria
Design Flow (SQDF)	cfs	0.1 x $Q_{P, 50yr}$
Maximum linear unit application rate (q_a)	cfs/ft • width	0.005
Minimum width (normal to flow) (W_{GSTF})	ft	(SQDF) / (q_a)
Minimum length (flow direction) (L_{GSTF})	ft	15
Maximum slope (flow direction)	%	4
Vegetation	–	Turf grass (irrigated) or approved equal
Minimum grass height	inches	2
Maximum grass height	inches	4 (typical) or as required to prevent lodging or shading

Design procedure and application of design criteria are outlined in the following steps:

1. Design Flow — Determine Stormwater Quality Design Flow (SQDF) for impervious area to be mitigated.

   $Q_{P, SQDF} = 0.1 \times Q_{P, 50yr}$ (see Fact Sheet, Section 5)

2. Minimum Width — Calculate minimum width of the Grass Strip Filter (W_{GSTF}) normal to flow direction.

   W_{GSTF} = (SQDF) / (q_a)

   W_{GSTF} = (SQDF) / 0.005 cfs/ft (minimum)

3. Minimum Length — Length of the Grass Strip Filter (L_{GSTF}) in the direction of flow shall not be less than 15 feet.

   L_{GSTF} = 15 feet (minimum)

4. Maximum Slope — Slope of the ground in the direction of flow shall not be greater than 4 percent.

5. Flow Distribution — Incorporate a device at the upstream end of the GSTF to evenly distribute flows along the top width, such as slotted curbing, modular block porous pavement, or other spreader devices. Concentrated flow delivered to the GSTF must distributed evenly by means of a level spreader of similar concept.

6. Vegetation — Provide irrigated perennial turf grass to yield full, dense cover. (See Appendix F for suitable grasses). Note: Some local agencies have restrictions on use of irrigated turf grass; consult with local agency regarding selection of appropriate vegetation. Submit a Landscape Plan for stormwater agency review. Plan shall be prepared by a landscape or other appropriate specialist and shall include a site plan showing location and type of vegetation. Mow grass to maintain height approximately between 2 and 4 inches.

7. Outflow Collection — Provide a means for outflow collection and conveyance (e.g. grass channel/swale, storm sewer, street gutter)

Design Example

A completed design form follows as a design example. Blank design forms are provided in Appendix G.

Design Procedure Form for T-1: Grass Strip Filter (GSTF)

Designer:____

Company:____

Date:____

Project:____

Location:____

1. Design Flow	$Q_{P,\,SQDF}$ = 0.5 cfs
2. Design Width W_{GSTF} = (SQDF) / 0.005 cfs/ft	W_{GSTF} = 100.0 ft.
3. Design Length (15 ft minimum)	L_{GSTF} = 15.0 ft.
4. Design Slope (4 percent maximum)	S_{GSTF} = 3.0 %
5. Flow Distribution (Check type used or describe "Other")	_X_ Slotted curbing ___ Modular Block Porous Pavement ___ Level Spreader ___ Other________
6. Vegetation (describe)	Tall Fescue
7. Outflow Collection (Check type used or describe "Other")	___ Grass Swale _X_ Street Gutter ___ Storm Sewer ___ Underdrain Used ___ Other________

Notes ____

Construction Considerations

Scheduling

Grass Strip Filters should be established and operational by October 1, unless another schedule has been justified in the Landscape Plan and approved by the local agency. To meet the October 1 deadline, the following schedule must be met:

- Seeding should be conducted during the dry season, no later than September 1 to ensure sufficient vegetation by October 1. Irrigation may be required.
- Within 30 days of seeding, or by September 30, whichever is earlier, the site shall be inspected to determine adequacy of vegetation growth, and to determine if erosion or damage has occurred. Areas of damage shall be repaired, seeded, and mulched immediately.
- If vegetation growth is insufficient, or excessive damage or erosion has occurred, the site will be further stabilized with other appropriate erosion control measures such as matting, mulching, etc. If the site can not be adequately stabilized prior to October 1, temporary measures must be installed to divert storm flows around the GSTF until adequate vegetation and stabilization occurs.

During Construction

All construction activity BMPs must remain in place to prevent high sediment loads into the GSTF, if active construction is being conducted upstream of the GSTF. If necessary additional BMPs must be installed.

Post Construction

After all construction activities are complete, necessary temporary BMPs to protect the integrity of the GSTF shall be installed, if necessary, until:

- the drainage area for the GSTF is adequately stabilized,
- vegetation in the GSTF is adequately established, and
- the GSTF maintenance plan is fully implemented.

Maintenance Requirements

To provide optimum treatment, Grass Strip Filters need to be regularly maintained to ensure a dense vegetation growth, and to prevent erosion of the underlying soils.

Maintenance Agreement

Treatment controls are to be maintained by the owner/operator. Maintenance agreement between the owner/operator of the Grass Strip Filters and the local agency may be required. (See Appendix C for example maintenance agreement)

Maintenance Plan

A post-construction Maintenance Plan shall be prepared and made available at the local agency's request. The Maintenance Plan should address at least the following items (see Appendix D for more detailed suggested Maintenance Plan content and format:

- Operation plan and schedule, including site map;
- Maintenance and cleaning activities and schedule;
- Equipment and resource requirements necessary to operate and maintain facility;
- Responsible party for operation and maintenance activities.

Maintenance Activities

At a minimum the following activities must occur to properly maintain a GSTF:

- Mow regularly to maintain vegetation height between 2 and approximately 4 inches, and to promote thick, dense vegetative growth. Clippings are to be removed immediately after mowing.
- Regularly maintain the GSTF to remove all litter, branches, rocks, or other debris. Damaged areas of the filter strip should be repaired immediately by reseeding and applying mulch.
- Remove all accumulated sediment that may obstruct flow through the GSTF. Replace the grass areas damaged in the process.
- Regularly maintain inlet flow spreader.
- Irrigate GSTF during dry season (April through October) when necessary to maintain the vegetation.
- After installing, inspect GSTF after seeding and after major storms. Repair all damage immediately.
- Once the GSTF is established, inspect at least three times per year. Repair all damage immediately.

Grass Swale Filter (GSWF)

Description

Grass Swale Filters (GSWF) are densely vegetated (turf grass) drainageways with gentle sideslopes and gradual slopes in the direction of flow that collect and slowly convey runoff flow to downstream points of discharge. Berms or check dams may be installed perpendicular to flow to provide grade control in steeper slopped areas. Underdrains may be installed at sites with very gradual slopes to avoid standing water. A GSWF is sized to treat the SQDF from the tributary area. Grass Swale Filters are similar to Grass-lined Channels described in Fact Sheet G-5.2 in Section 3, with the only differences being design criteria for hydraulic design parameters (e.g. flow depth, friction factor, and contact time.) Grass Swale Filters require shallower flow depths and longer contact times to provide treatment. Applications of GSWFs are illustrated in Figure 5-3.

General Application

Grass Swale Filters are appropriate for use in residential, commercial, industrial and institutional settings and are typically incorporated into the landscape design of the site. They are often used in conjunction with Turf Buffers or GSTFs to provide effluent collection and conveyance as well as treatment. The contributing flow that can be accommodated by the GSWF will be limited according to the design criteria in this fact sheet. Tributary areas are typically less than 5 acres. Several Grass Swale Filters may be used on a single site, each sized according to the tributary area from which it receives flow. To limit the size of units when space is limited, runoff flow from pervious and off-site areas should not be routed to Grass Swale Filters. Irrigation and regular mowing are required to maintain the turf grass cover.

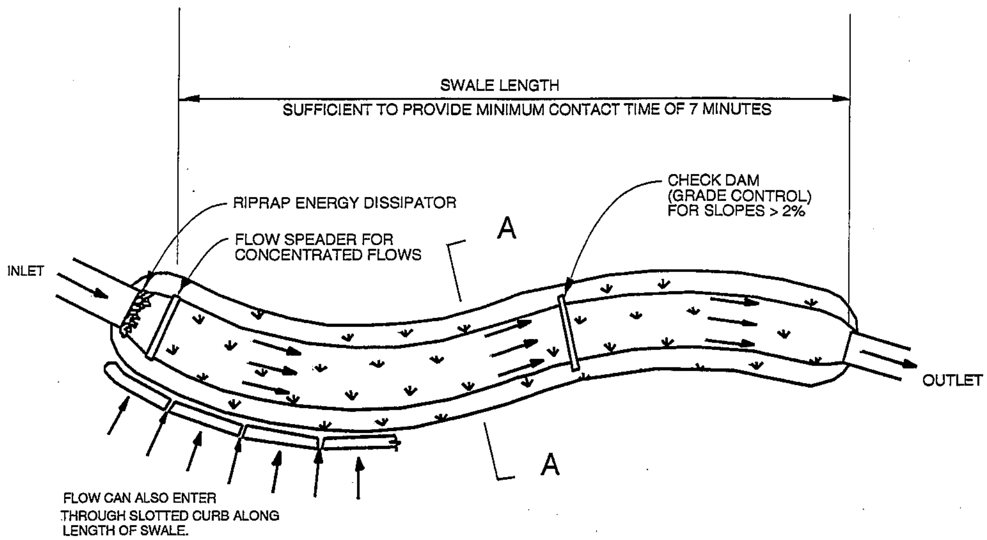
Advantages/Disadvantages

General

Like Grass Strip Filters, Grass Swale Filters are relatively easy to design, install and maintain. Vegetated areas that would normally be included in the site layout, if designed for appropriate flow patterns, may be used as Grass Swale Filters. Landscape architects can easily alter planting schemes to include appropriate turf species to meet design requirements for swales. Finally, maintaining a GSWF often requires little more than normal landscape maintenance activities such as irrigation and mowing. Compared with some other means for improving stormwater runoff quality, grass filters provide a relatively unobtrusive, attractive, long-term and inexpensive stormwater quality management technique. In addition to pollutant removal, GSWFs provide opportunity for infiltration of runoff and reduce peak flows.

Site Suitability

Grass Swale Filters are not practical for sites with slopes greater than about 4 percent. Underdrains are recommended for design slopes less than 0.5 percent when soils types C or D (see Appendix E) are present.



TRAPEZOIDAL GRASS SWALE PLAN

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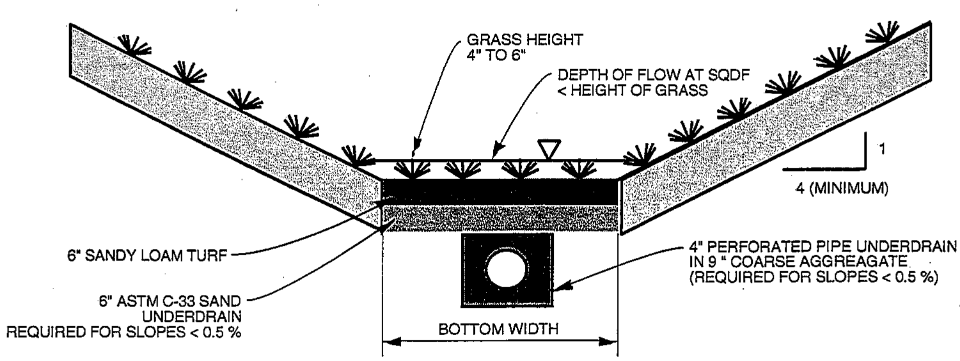

TRAPEZOIDAL GRASS SWALE SECTION

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Figure 5-3 GRASS SWALE FILTER

ADAPTED FROM URBAN STORM DRAIN CRITERIA MANUAL VOL. 3 - BEST MANAGEMENT PRACTICES, URBAN DRAINAGE AND FLOOD CONTROL DISTRICT,11/99

Pollutant Removal

Relative pollutant removal effectiveness of a GSWF is presented in Table 5-1. Removal effectiveness of GSWF for sediment and particulate forms of metals, nutrients and other pollutants is considered moderate to low. Grass Swale Filters are the least effective of the approved treatment control measures. Consequently, they should generally be used in conjunction with one of the other approved treatment control measures.

Design Criteria and Procedure

Principal design criteria for GSWFs are listed in Table 5-4.

Table 5-4. Grass Swale Filter Design Criteria

Design Parameter	Unit	Design Criteria
Design Flow (SQDF)	cfs	0.1 x $Q_{P,\,50yr}$
Swale geometry	–	Trapezoidal or triangular
Maximum channel side slope	H:V	4 :1
Minimum slope in flow direction	%	0.2 (provide underdrains for slopes < 0.5)
Maximum slope in flow direction	%	2.0 (provide grade-control checks for slopes >2.0)
Maximum flow velocity	ft/sec	1.0 (based on Manning n = 0.20)
Maximum depth of flow at SQDF	inches	3 to 5 (1 inch below top of grass)
Minimum contact time	minutes	7 (provide sufficient length to yield min contact time)
Minimum length	ft	sufficient length to provide minimum contact time
Vegetation	–	Turf grass or approved equal
Grass height	Inches	4 to 6 (mow to maintain height)

Design procedure and application of design criteria are outlined in the following steps:

1.	Design Flow	Determine Stormwater Quality Design Flow (SQDF) for impervious area to be mitigated. $Q_{P,\,SQDF} = 0.1 \times Q_{P,\,50yr}$ (see Fact Sheet, Section 5)
2.	Swale Geometry	Use tapezoidal or triangular cross section.
3.	Maximum Side Slope	Side slopes shall not be steeper than 4:1 (5:1 or flatter preferred).
4.	Minimum Slope	Slope of the swale in the direction of flow shall not be less than 0.2 percent. Swales with slopes less than 0.5 percent should be provided with underdrains (see Figure 5-3).
5.	Maximum Slope	Slope of the swale in the direction of flow shall not be greater than 2 percent. Provide grade control checks for slopes greater than 2.0 percent (see Figure 5-3).
6.	Flow Velocity	Maximum flow velocity at design flow should not exceed 1.0 ft/sec. based on a Mannings n = 0.20.
7.	Flow Depth	Maximum depth of flow at design flow should not exceed 3 to 5 inches based on a Mannings n = 0.20
8.	Swale Length	Provide length in the flow direction sufficient to yield a minimum contact time of 7 minutes at SQDF. L = (7 min) x (flow velocity, ft/sec) x 60 sec/min
9.	Vegetation	Provide irrigated perennial turf grass to yield full, dense cover. (See Appendix F for suitable grasses) Note: Some local agencies have restrictions on use of irrigated turf grass; consult with local agency regarding selection of appropriate vegetation. Mow to maintain height of 4 to 6 inches.
10.	Drainage and Flood Control	Provide sufficient flow depth for flood event flows to avoid flooding of critical areas or structures

Design Example

A completed design form follows as a design example. Blank design forms are provided in Appendix G.

Design Procedure Form for T-2: Grass Swale Filter (GSWF)

Designer: ______________________

Company: ______________________

Date: ______________________

Project: ______________________

Location: ______________________

1. Design Flow	$Q_{P, SQDF}$ = 1.0 cfs
2. Swale Geometry a. Swale Bottom Width (b) b. Side slope (Z)	 b = 10.0 ft. Z = 4:1
3. Depth of flow at SQDF (d) (2 ft max, Manning n= 0.20)	d = 4.2 inches
4. Design Slope a. s = 4 percent maximum b. No. of grade controls required	 s = 0.5 % _____ (number)
5. Design flow velocity (Manning n= 0.20)	V = 0.25 ft/sec
6. Design Length L = (7 min) x (flow velocity, ft/sec) x 60	 L = 103 feet
6. Vegetation (describe)	Tall Fescue
7. Outflow Collection (Check type used or describe "Other")	X Grated Inlet ___ Infiltration Trench ___ Underdrain Used ___ Other ______

Notes ______________________

Construction Considerations

Scheduling

Grass Swale Filters should be established and operational by October 1, unless another schedule has been justified in the Landscape Plan and approved by the local agency. To meet the October 1 deadline, the following schedule must be met:

- Seeding should be conducted during the dry season, no later than September 1 to ensure sufficient vegetation by October 1. Irrigation may be required.
- Within 30 days of seeding, or by September 30, whichever is earlier, the site shall be inspected to determine adequacy of vegetation growth, and to determine if erosion or damage has occurred. Areas of damage shall be repaired, seeded, and mulched immediately.
- If vegetation growth is insufficient, or excessive damage or erosion has occurred, the site should be further stabilized with other appropriate erosion control measures such as matting, mulching, etc. If the site can not be adequately stabilized prior to October 1, temporary measures must be installed to divert storm flows around the swale until adequate vegetation and stabilization occurs.

During Construction

All construction activity BMPs must remain in place to prevent high sediment loads into the GSWF, if active construction is being conducted upstream of the GSWF. If necessary additional BMPs must be installed.

Post Construction

After all construction activities are complete, temporary BMPs to protect the integrity of the GSWF shall be installed, if necessary, until:

- the drainage area for the GSWF is adequately stabilized,
- vegetation in the GSWF is adequately established, and
- the GSWF maintenance plan is fully implemented.

Maintenance Requirements

To provide optimum treatment, Grass Swale Filters need to be regularly maintained to ensure a dense vegetation growth, and to prevent erosion of the underlying soils.

Maintenance Agreement

Treatment controls are to be maintained by the owner/operator. Maintenance agreement between the owner/operator of the Grass Swale Filters and the local agency may be required. (See Appendix C for example maintenance agreement.)

Maintenance Plan

A post-construction Maintenance Plan shall be prepared and made available at the local agency's request. The Maintenance Plan should address at least the following items (see Appendix D for more detailed suggested Maintenance Plan content and format:

- Operation plan and schedule, including site map;
- Maintenance and cleaning activities and schedule;
- Equipment and resource requirements necessary to operate and maintain facility;
- Responsible party for operation and maintenance activities.

Maintenance Activities

At a minimum the following activities must occur to properly maintain a GSWF:

- Mow regularly to maintain vegetation height between 4 and approximately 6 inches, and to promote thick, dense vegetative growth. Clippings are to be removed immediately after mowing.
- Regularly maintain the GSWF to remove all litter, branches, rocks, or other debris. Damaged areas of the filter strip should be repaired immediately by reseeding and applying mulch.
- Remove all accumulated sediment that may obstruct flow through the GSWF. Replace the grass areas damaged in the process.
- Regularly maintain inlet flow spreader (if applicable).
- Irrigate GSWF during dry season (April through October) when necessary to maintain the vegetation.
- After installing, inspect GSWF after seeding and after major storms. Repair all damage immediately.
- Once the GSWF is established, inspect at least three times per year. Repair all damage immediately.

Description

Extended detention basins (EDB) are permanent basins formed by excavation and/or construction of embankments to temporarily detain the Stormwater Quality Design Volume (SQDV) of stormwater runoff to allow sedimentation of particulates to occur before the runoff is discharged. Extended detention basins are typically dry between storms, although a shallow pool, 1 to 3 feet deep, can be included in the design for aesthetic purposes and to promote biological uptake and conversion of pollutants. A bottom outlet provides controlled slow release of the detained runoff over a specified time period (40 hours for SQDV). The basic elements of an extended detention basin are shown in Figure 5-4. This configuration is most appropriate for large sites.

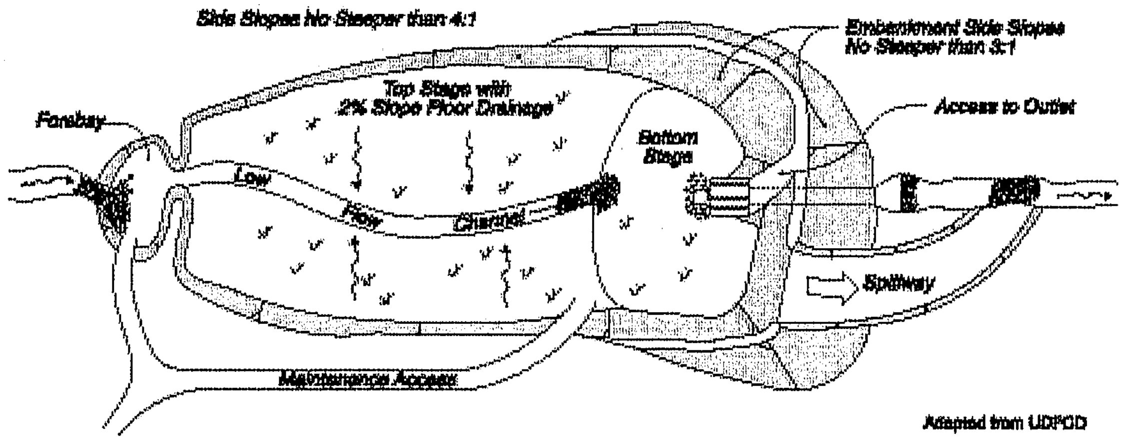
Surface basins are typical, but underground vaults may be appropriate in a small commercial development. Where irrigation water is available, basins should be vegetated to protect the basin slopes and bottom from erosion. To minimize erosion from inlet flow, basins are to be designed with an inlet energy dissipator and an inlet forebay section divided from the main basin by a secondary berm. The bottom of the basin is sloped toward the outlet end at a grade of approximately two percent. A low flow channel is provided to convey incidental flows directly to the outlet end of the basin.

EDBs are sized to detain and release the SQDV. Storm volumes greater than the SQDV are passed through the basin by means of a secondary outlet or spillway. Outlets are designed to include erosion protection.

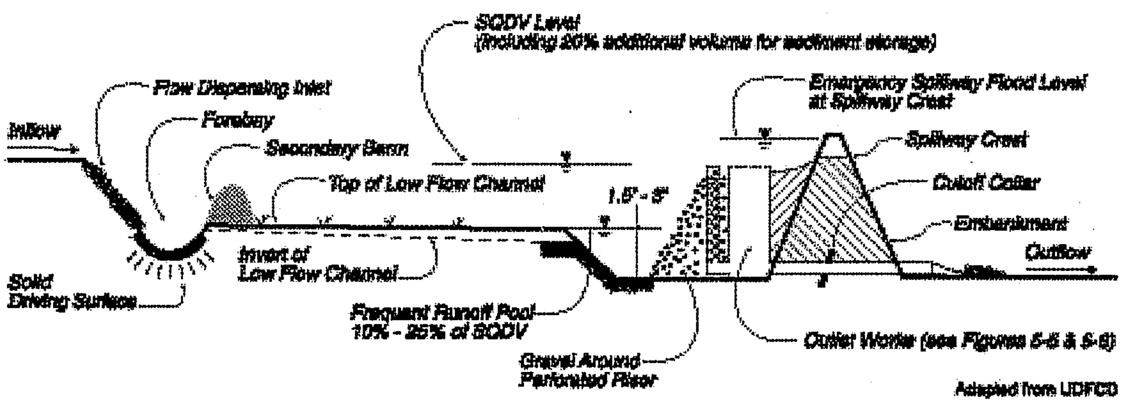
General Application

An EDB serves to reduce peak stormwater runoff rates, as well as provide treatment of stormwater runoff. If the basins are constructed early in the development cycle, they can also serve as sediment traps during construction within the tributary area. However, accumulated sediment must be removed after construction activities are complete and before the basin is placed into final long-term use as an EDB. Basins may be designed as dual-use facilities to provide recreational use during the dry season, and can be designed into flood control basins or sometimes retrofitted into existing flood control basins. EDBs that are intended to serve as a flood control basin, as well as a stormwater treatment control measure, must also be designed in accordance with applicable flood control design standards.

EDBs can serve essentially any size tributary area from an individual commercial development to a large residential or regional area, but are typically used for tributary areas greater than 10 acres. They work well in conjunction with other control measures, such as onsite source controls and downstream infiltration basins.



Plan View



Section View

Figure 5-4. Extended Detention Basin Conceptual Layout

Advantages/Disadvantages

General

EDBs may be designed to provide other benefits such as recreation, wildlife habitat, and open space. Safety issues must be address through proper design.

Site Suitability

Space requirements for EDBs are significant. Land requirements for EDBs typically range from approximately 0.5 to 2.0 percent of the of the tributary development area. Groundwater levels must be considered during site evaluation and design. Vector and vegetation control problems can develop when the seasonal high ground water level is above the basin bottom elevation.

Pollutant Removal

Relative pollutant removal effectiveness of an EDB is presented in Table 5-1. Removal effectiveness of EDBs for sediment and particulate forms of metals, nutrients and other pollutants is considered high to moderate. Removal effectiveness for dissolved pollutants is considered low. EDBs may be used upstream of control measures that are more effective at removing soluble pollutants, such as infiltration basins, filters or wetlands.

Design Criteria and Procedure

Principal design criteria for EDBs are listed in Table 5-5.

Table 5-5. Extended Detention Basin Design Criteria

Design Parameter	Unit	Design Criteria
Drawdown time for SQDV / 50% SQDV	hrs	40 / 12 (minimum)
SQDV	acre-ft	80% annual capture. Use Figure 5-1 @ 40-h drawdown
Basin design volume	acre-ft	1.2 x SQDV (privide 20% sediment storage volume)
Inlet/outlet erosion control	–	Energy dissipator to reduce inlet/outlet velocity
Forebay volume/ drain time	%/min.	5 to 15 % of SQDV / Drain time < 45 minutes
Low-flow channel depth/ flow capacity	in/–	9 / 2 x forebay outlet rate
Bottom slope of upper stage	%	2.0
Length to width ratio (minimum)	–	2:1 (larger preferred)
Upper stage depth/width (minimum)	ft	2.0/30
Bottom stage volume	%	10 to 25 % of SQDV
Bottom stage depth	ft	1.5 to 3 ft deeper than top stage
Freeboard (minimum)	ft	1.0
Embankment side slope (H:V)	–	≥ 4:1 inside/ ≥3:1 outside (without retaining walls)
Maintenance access ramp slope (H:V)	hrs	10:1 or flatter
Maintenance access ramp width	ft	16.0 – approach paved with asphalt concrete

Design procedure and application of design criteria are outlined in the following steps:

a) Basin Storage Volume

Provide a storage volume equal to 120 percent of the SQDV, based on a 40-hr drawdown time, above the lowest outlet (i.e. perforation or orifice) in the basin. The additional 20 percent provides an allowance for sediment accumulation.

a. Determine the percent imperviousness of the tributary area (I_a).

b. Determine effective imperviousness (I_{wq}) by adjusting for site design source controls using Figure 3-4, as appropriate.

c. Determine required unit basin storage volume (V_u) using Figure 5-1 with 40-hr drawdown and I_{wq} value from Step 1.b.

d. Calculate the SQDV in acre-ft as follows:

$$SQDV = (V_u / 12) \times Area$$

where

Area = Watershed area tributary to EDB in acre-ft

e. Calculate Design Volume in acre-ft as follows:

$$\text{Design Volume} = SQDV \times 1.2$$

where

1.2 factor = Multiplier to provide for sediment accumulation

2. Outlet Works

The Outlet Works are to be designed to release the SQDV (i.e. not Design Volume) over a 40-hour period, with no more than 50 percent released in 12 hours. Refer to Figures 5-5 and 5-6 for schematics pertaining to structure geometry; grates, trash racks, and screens; outlet type: orifice plate or perforated riser pipe.

a. For perforated pipe outlets or vertical plates with multiple orifices (see Figure 5-5), use the following equation to determine required area per row of perforations, based on the SQDV(ft^2) and depth of water above the centerline of the bottom perforation D_{BS} (ft).

$$\text{Area/row } (in^2) = SQDV/K_{40}$$

where

$$K_{40} = 0.013D_{BS}^2 + 0.22D_{BS} - 0.10$$

Select appropriate perforation diameter and number of perforations per row (i.e. columns) with the objective of minimizing the number of columns and using a maximum perforation diameter of 2 inches. Rows are spaced at 4 inches on center from the bottom perforation. Thus, there will be 3 rows for each foot of depth plus the top row. The number of rows (nr) may be determined as follows:

$$nr = 1 + (D_{BS} \times 3)$$

Calculate total outlet area by multiplying the area per row by number of rows.

Total orifice area = area/row x nr

b. For single orifice outlet control or single row of orifices at the basin bottom surface elevation (see Figures 5-6), use the following equation based on the SQDV (ft^3) and depth of water above orifice centerline D_{BS} (ft) to determine total orifice area (in^2):

$$\text{Total orifice area} = (\text{SQDV}) \div [(60.19)(D_{BS}^{0.5})(T)]$$

where

T = drawdown period (hrs)= 40 hrs

3. Trash Rack/Gravel Pack

A trash rack or gravel pack around perforated risers shall be provided to protect outlet orifices from clogging. Trash racks are better suited for use with perforated vertical plates for outlet control and allow easier access to outlet orifices for purposes of inspection and cleaning. Trash rack shall be sized to prevent clogging of the primary water quality outlet without restricting with the hydraulic capacity of the outlet control orifices.

4. Basin Shape

Whenever possible, shape the basin with a gradual expansion from the inlet toward the middle and a gradual contraction from middle toward the outlet. The length to width ratio should be a minimum of 2:1. Internal baffling with berms may be necessary to achieve this ratio.

5. Two-Stage Design

A two-stage design with a pool that fills often with frequently occurring runoff minimizes standing water and sediment deposition in the remainder of the basin.

a. Upper Stage: The upper stage should be a minimum of 2 feet deep with the bottom sloped at 2 percent toward the low flow channel. Minimum width of the upper stage should be 30 ft.

b. Bottom Stage: The active storage basin of the bottom stage should be 1.5 to 3 feet deeper than the top stage and store 10 to 25 pecent of the SQDV. A mico-pool below the active storage volume of the bottom stage, if provided, should be one-half the depth of the top stage or 2 feet, which ever is greater.

6. Forebay Design

The forebay provides a location for sedimentation of larger particles that has a solid bottom surface to facilitate mechanical removal of accumulated sediment. The forebay volume should be 5 to 10 percent of the SQDV. A berm should separate the forebay from the upper stage of the basin. The outlet pipe from be 5 to 10 percent of the SQDV. A berm should separate the forebay from the upper stage of the basin. The outlet pipe from the forebay to the lowflow channel should be sized to drain the forebay volume in 45 minutes. The outlet pipe entrance should be offset from the forebay inlet to prevent short circuiting.

7. Low-flow Channel	The low flow channel conveys flow from the forebay to the bottom stage. Erosion protection should be provided where the low-flow channel enters the bottom stage. Lining of the low flow channel with concrete is recommended. The depth of the channel should be at least 9 inches. The flow capacity of the channel should be twice the release capacity of the forebay outlet.
8. Inlet/Outlet Design	Basin inlet and outlet points should be provided with an energy dissipation structure and/or erosion protection.
9. Vegetation	Bottom vegetation provides erosion protection and sediment entrapment. Basin bottoms, berms, and side slopes may be planted with native grasses or with irrigated turf.
10. Embankment	Design embankments to conform to requirements State of California Division of Safety of Dams, if the basin dimensions cause it to fall under that agency's jurisdiction. Interior slopes should be no steeper than 4:1 and exterior slopes no steeper than 3:1. Flatter slopes are preferable.
11. Access	All-weather access to the bottom, forebay, and outlet works shall be provided for maintenance vehicles. Maximum grades of access ramps should be 10 percent and minimum width should be 16 feet. Ramps should be paved with concrete.
12. Bypass	Provide for bypass or overflow of runoff volumes in excess of the SQDV. Spillway and overflow structures should be designed in accordance with applicable standards of the Ventura County Flood Control District.
13. Geotextile Fabric	Non-woven geotextile fabric used in conjunction with gravel packs around perforated risers shall conform the specifications listed in Table 5-6.

Table 5-6. Non-woven Geotextile Fabric Specifications

Property	Test Reference	Minimum Specification
Grab Strength	ASTM D4632	90 lbs
Elongation at peak load	ASTM D4632	50 %
Puncture Strength	ASTM D3787	45 lbs
Permitivity	ASTM D4491	0.7 sec^{-1}
Burst Strength	ASTM D3786	180 psi
Toughness	% Elongation x Grab Strength	5,500 lbs
Ultraviolet Resistance (Percent strength retained at 500 Weatherometer hours)	ASTM D4355	70%

Adapted from SSPWC, 1997.

Design Example

Design forms to document the design procedure are provided in Appendix G. A completed design form follows as a design example.

Design Procedure Form for T-3: Extended Detention Basin

Designer:____________________

Company:____________________

Date:____________________

Project:____________________

Location:____________________

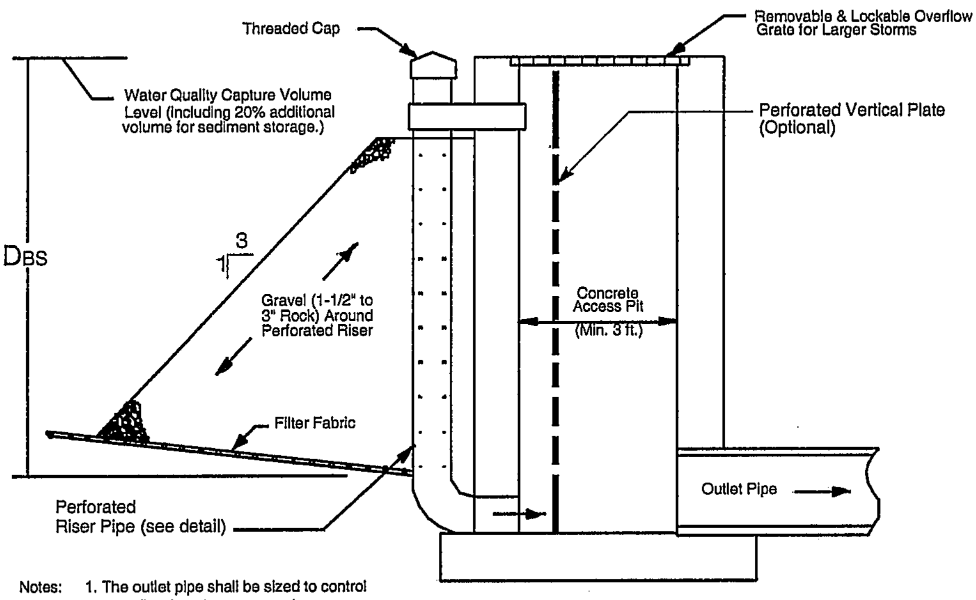
1. Determine Basin Storage Volume			
a. Percent Imperviousness of Tributary Area	I_a =	64	%
b. Effective Imperviousness (Determine using Figure 3-4	I_{wq} =	60	%
c. Required Unit Basin Storage Volume (V_u) Use Figure 5-1 with 40 hr drawdown and I_{wq}	V_u=	0.64	in.
d. Watershed Area Tributary to EDB	Area =	10	acres
e. Calculate SQDV SQDV = (V_u / 12) x Area	SQDV =	0.54	acre-ft
f. Calculate Design Volume Design Volume = SQDV x 1.2	Design Volume =	0.64	acre-ft
2. Outlet Works			
a. Outlet Type (check one)	Single Orifice	X	
	Multi-orifice Plate		
	Perforated Pipe		
	Other		
b. Depth of water above bottom orifice	Depth =	3	feet
c. Single Orifice Outlet			
1) Total Area	A =	5.64	square inches
2) Diameter or W x L	D =	2 x 2.8	inches
d. Multiple Orifice Outlet			
1) Area per row of perforations	A =		
2) Perforation Diameter (2 inches max.)	D =		
3) No. of Perforations (columns) per Row	Perforations =		
4) No. of Rows (4 inch spacing)	Rows =		
5) Total Orifice Area (Area per row) x (Number of Rows)	Area =		

Design Procedure Form for T-3: Extended Detention Basin (Page 2 of 2)

Project: ____________________

3. Trash Rack or Gravel Pack (check one)	Trash Rack X Gravel Pack ____
4. Basin Length-Width Ratio (2:1 minimum)	Ratio = 3:1 L:W
5. Two-Stage Design	
a. Upper Stage	
1) Depth (2 feet minimum)	Depth = 3 feet
2) Width (30 feet minimum)	Width = 40 feet
3) Bottom Slope (2% to low flow channel)	Slope = 2 %
b. Bottom Stage	
1) Depth (1.5 to 3 feet deeper than Upper)	Depth = 5 feet
2) Storage Volume (5-15% of SQDV min.)	Volume = 0.12 acre-ft
6. Forebay Design	
a. Forebay Volume (5-10% of SQDV min.)	Volume = 0.03 acre-ft
b. Outlet pipe drainage time (~45 minutes)	Drainage Time 45 minutes
7. Low Flow Channel	
a. Depth (9 inches min.)	Depth = 2.0 feet
b. Flow Capacity (2 x outlet for Forebay)	Flow Capacity = 60 cfs cfs
8. Vegetation	Native Grasses ____
	Irrigated Turf X
	Other ____
9. Embankment	
a. Interior Slope (4:1 max.)	Interior Slope = 4:1 H/V
b. Exterior Slope (3:1 max.)	Exterior Slope = 3:1 H/V
10. Access	
a. Slope (10% max.)	Slope = 9 %
b. Width (16 feet min.)	Width = 16 feet

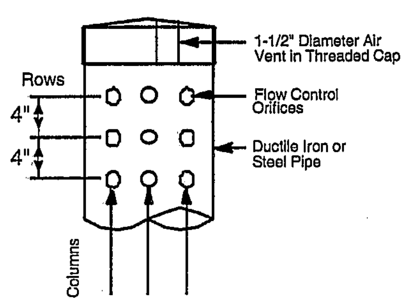
Notes: ____________________



Notes: 1. The outlet pipe shall be sized to control overflow into the concrete riser.
2. Alternate designs include a Hydrobrake outlet (or orifice designs) as long as the hydraulic performance matches this configuration.

OUTLET WORKS
NOT TO SCALE

Notes: 1. Minimum number of holes = 8
2. Minimum hole diameter = 1/4"
3. Maximum hole diameter = 2"



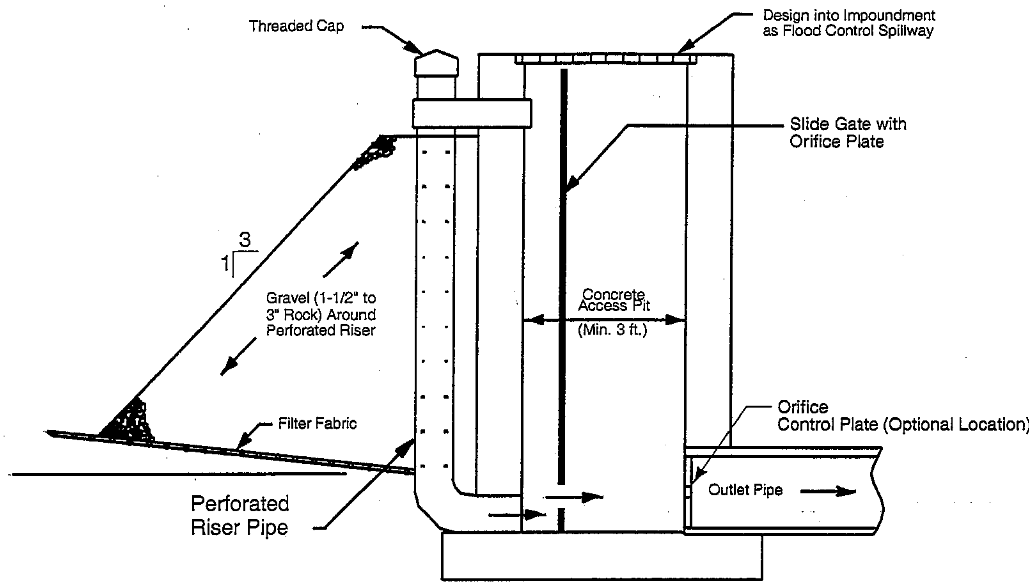
PERFORATED VERTICAL RISER PIPE
NOT TO SCALE

Maximum Number of Perforated Columns				
Riser Diameter (in.)	Hole Diameter, in.			
	1/4"	1/2"	3/4"	1"
4	8	8	--	--
6	12	12	9	--
8	16	16	12	8
10	20	20	14	10
12	24	24	18	12

Hole Diameter, in.	Area of Hole (in.)^2
1/8	0.013
1/4	0.049
3/8	0.110
1/2	0.196
5/8	0.307
3/4	0.442
7/8	0.601
1	0.785

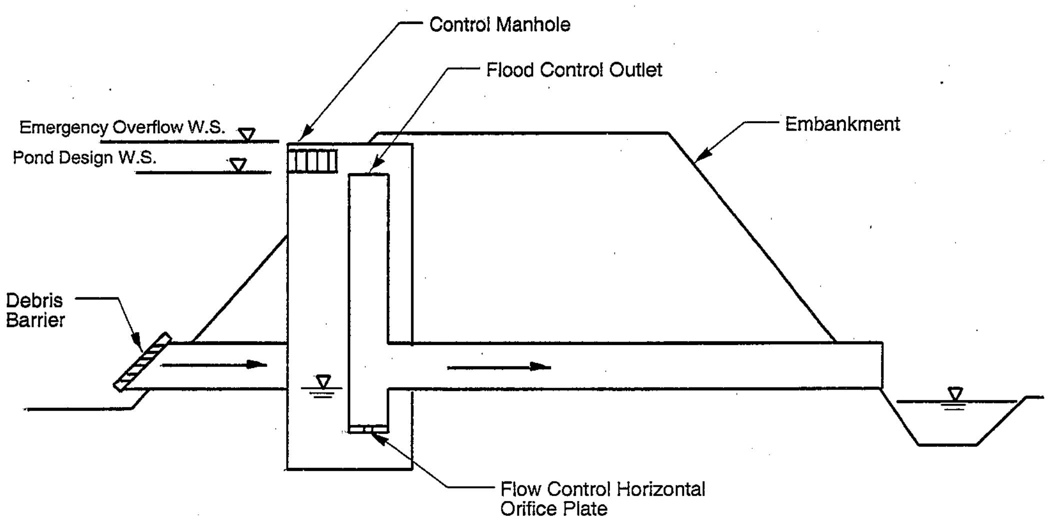
ADAPTED FROM UDFCD, 1999

Figure 5-5 . OUTLET CONFIGURATIONS USING MULTIPLE ORIFICE FLOW CONTROL



PERFORATED RISER PIPE WITH VERTICAL FLOW CONTROL ORIFICE

NOT TO SCALE



CONTROL MANHOLE WITH SUBMERGED HORIZONTAL ORIFICE PLATE

NOT TO SCALE

Figure 5-6. OUTLET CONFIGURATIONS USING SINGLE ORIFICE FLOW CONTROL

Maintenance Requirements

The following maintenance requirements apply to extended detention basins

Maintenance Agreement

On-site treatment control measures are maintained by the owner/operator. Maintenance agreements between the owner/operator and the governing agency may be required. However, if pretreatment is recommended but not included in the design, a maintenance agreement will be required. If required, a maintenance agreement must be executed by the owner/operator before the improvement plans are approved. (See Appendix C for example maintenance agreement.)

Maintenance Plan

A post-construction Maintenance Plan shall be prepared and made available at the governing agency's request. The Maintenance Plan should address at least the following items (see Appendix D for more detailed suggested Maintenance Plan content and format:

- Operation plan and schedule, including a site map
- Maintenance and cleaning activities and schedule
- Equipment and resource requirements necessary to operate and maintain facility
- Responsible party for operation and maintenance

Maintenance Activities

- Inspect basin semiannually, after each significant storm, or more frequently, if needed.. Some important items to check for include: differential settlement, cracking; erosion, leakage, or tree growth on the embankment; the condition of the riprap in the inlet, outlet and pilot channels; sediment accumulation in the basin; and the vigor and density of the grass turf on the basin side slopes and floor. Correct observed problems as necessary.
- Remove litter and debris from banks and basin bottom as required.
- Repair erosion to banks and bottom as required.
- Remove sediment when accumulation reaches 25% of original design depth, or if resuspension is observed. Clean in early spring so vegetation damaged during cleaning has time to re-establish.

a) Inspect outlet for clogging a minimum of twice a year, before and after the rainy season, after large storms, and more frequently if needed. Correct observed problems as necessary.

b) Clean forebay frequently to reduce frequency of main basin cleaning.

a) Control mosquitoes, as necessary.

Wet Detention Basin

Description

Wet detention basins (WDBs) are open earthen basins that feature a permanent pool of water that is displaced by storm water flow, in part or in total, during storm runoff events. Like Extended Detention Basins (see T-3), WDBs are designed to temporarily detain the Stormwater Quality Design Volume (SQDV) of stormwater runoff and to slowly release this volume over a specified period (12 hours). WDBs differ from EDBs in that the influent runoff flow water mixes with and displaces the permanent pool as it enters the basin. The drawdown time for WDBs (12 hours) is shorter than for EDBs (40 hours), because enhanced treatment is provided in the permanent pool. A dry-weather base flow is required to maintain the permanent pool. The basic elements of a WDB are shown in Figure 5-7.

General Application

Wet Detention Basins function similarly to EDBs, serving to reduce peak stormwater runoff rates and providing treatment of runoff primarily through sedimentation. These basins can improve the quality of urban runoff from roads, parking lots, residential neighborhoods, commercial areas, and industrial sites and are generally used as a regional or follow-up treatment because of the base-flow requirements. Because there is a permanent pool present, wet detention basins can also serve as passive recreational areas during the dry season, and can be designed into flood control basins or sometimes retrofitted into existing flood control basins.

Wet detention basins can serve essentially any size tributary area from an individual commercial development to a large residential or regional area, but are typically used for areas greater than 10 acres. These basins work well in conjunction with other BMPs, such as upstream onsite source controls and downstream filter basins or wetland channels.

Advantages/Disadvantages

General

Wet Detention Basins may be designed to provide other benefits such as passive recreation, wildlife habitat, and open space. Safety issues must be addressed through proper design.

Site Suitability

Wet Detention Basin space requirements are significant. Land requirements for WDBs typically range from approximately 0.5 to 2 percent of the tributary development area. These basins are also not suitable for dense urban areas or sites with steep and unstable slopes. Although site suitability concerns are similar to those stated for an EDB, Wet Detention Basins are not suitable for areas with long dry spells and high evaporation rates without perennial groundwater base flow or supplemental water to maintain permanent pool and aquatic vegetation. A complete water budget under the projected watershed conditions should be performed to assure that the base flow will exceed evaporation, evapotranspiration, and seepage losses. This control measure is most appropriate for sites with low-permeability soils (Type C and D).

Vegetation Maintenance

Considerable resources must be committed to properly maintain peripheral aquatic vegetation in WDBs to control mosquito propagation and to maintain effective permanent pool volume.

Pollutant Removal

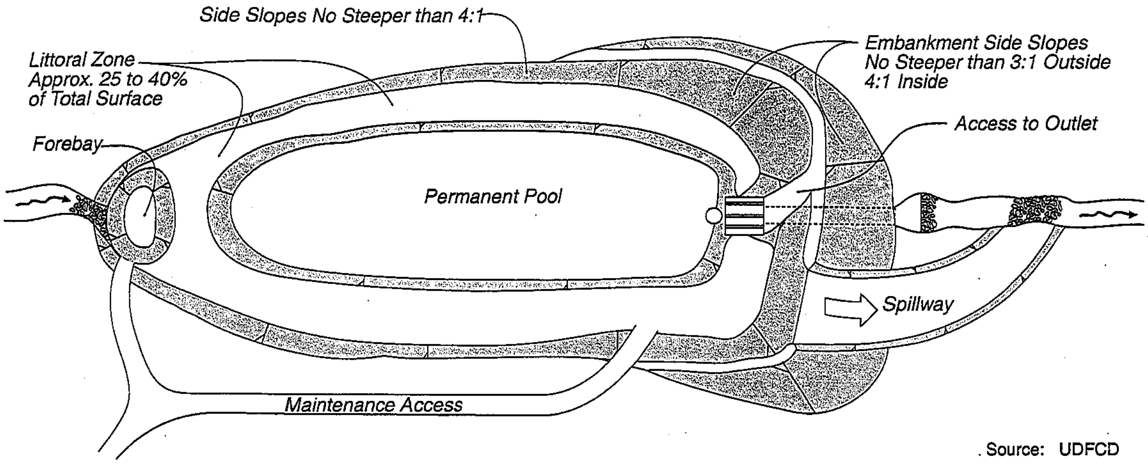
Relative pollutant removal effectiveness of a Wet Detention Basin is presented in Table 5-1. Removal effectiveness of WDBs for sediment and particulate forms of metals, nutrient and other settleable solids is considered high to moderate. WDBs also remove flotables and achieve some degree of dissolved contaminant removal, but effectiveness against dissolved contaminants is low. WDBs may be used upstream of control measures that are more effective at removing soluble pollutants, such as infiltration basins, filters or wetlands.

Design Criteria and Procedure

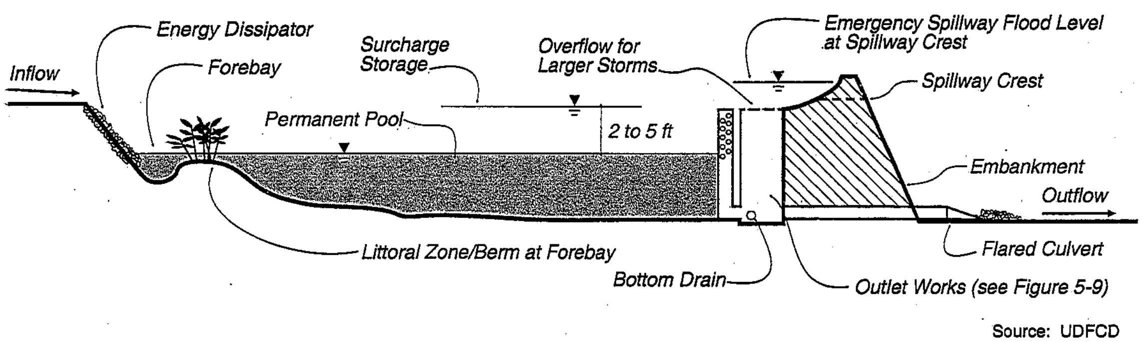
Principal design criteria for WDBs are listed in Table 5-7.

Table 5-7. Wet Detention Basin Design Criteria

Design Parameter	Unit	Design Criteria
Drawdown time for SQDV / 50% SQDV	hrs	12
SQDV	acre-ft	80% annual capture. Use Figure 5-1 @ 12-h drawdown
Inlet/outlet erosion control	–	Energy dissipater to reduce inlet/outlet velocity
Permanent Pool volume	–	1.0 to 1.5 x SQDV
2 Depth Zones Required	–	Littoral Zone (6-12 inches deep, 25-40% of permanent pool surface area) Deeper Zone (4-8 feet average depth of remaining pond area, 12 feet max. depth)
Forebay volume/ drain time	%/min	5 to 10% of SQDV. Drain time < 45 minutes
Length to width ratio (minimum)	–	2:1 (larger preferred)
Minimum bottom width	ft	30
Freeboard (minimum)	ft	1.0
Embankment side slope (H:V)	–	≥ 4:1 inside/ ≥3:1 outside (without retaining walls)
Maintenance access ramp slope (H:V)	hrs	10:1 or flatter
Maintenance access ramp width	ft	16.0 – approach paved with asphalt concrete



Plan View



Section View

Figure 5-7. Conceptual Layout of Wet Detention Basin

Design procedure and application of design criteria for WDBs are outlined in the following steps:

1. Basin Surcharge Volume

Provide a surcharge volume equal to the SQDV, based on a 12-hr drawdown time, above the lowest outlet (i.e. perforation or orifice) in the basin.

a. Determine the percent imperviousness of the tributary area (I_a).

b. Determine effective imperviousness (I_{wq}) by adjusting for site design source controls using Figure 3-4, as appropriate.

c. Determine required unit basin storage volume (V_u) using Figure 5-1 with 12-hr drawdown and I_{wq} value from step 1.b.

d. Calculate the SQDV in acre-ft as follows:

$$SQDV = (V_u / 12) \times Area$$

where Area = Watershed area tributary to WDB (acres)

2. Permanent Pool

The permanent pool provides stormwater quality enhancement between storm runoff events through biochemical processes and continuing sedimentation.

a. Determine the volume of the permanent pool (V_p), which is 1.0 to 1.5 times the SQDV.

b. Depth Zones (see Figure 5-8)

Littoral Zone should be between 6 to 12 inches deep that is between 25 to 40 percent of the permanent pool surface for aquatic plant growth along the perimeter of the pool.

Deeper Zone should be 4 to 8 feet average depth with a maximum depth of 12 feet. This zone should cover the remaining pond area and promote sedimentation and nutrient uptake by phytoplankton.

3. Base Flow

A net influx of water must be available through a perennial base flow and must exceed the losses. The following equation and parameters can be used to estimate the net quantity of base flow available at the time.

$$Q_{net} = Q_{inflow} - Q_{E-P} - Q_{seepage} - Q_{ET}$$

Q_{net} = Net quantity of base flow (acre-ft/year)

Q_{inflow} = Estimated base flow (acre-ft/year). (Estimate by seasonal measurements and/or comparison to similar watersheds.)

Q_{E-P} = Loss due to evaporation minus the precipitation (acre-ft/year)

$Q_{seepage}$ = Loss or gain due to seepage to groundwater (acre-ft/year)

Q_{ET} = Loss due to evapotranspiration (additional loss through plant area above water surface not including the water surface)

4. Outlet Works

The Outlet Works are to be designed to release the SQDV (i.e. not Design Volume) over a 12-hour period. Refer to Figure 5-9 for schematics pertaining to structure geometry; grates, trash racks, and outlet.

a. For perforated pipe outlets or vertical plates with multiple orifices, use the following equation to determine required area per row of perforations, based on the SQDV(acre-ft) and depth of water above the centerline of the bottom perforation D (ft).

$$\text{Area/row (in}^2) = \text{SQDV}/K_{12}$$

where

$$K_{12} = 0.008D^2 + 0.056D - 0.012$$

Select appropriate perforation diameter and number of perforations per row (columns) with the objective of minimizing the number of columns and using a maximum perforation diameter of 2 inches. Rows are spaced at 4 inches on center from the bottom perforation. Thus, there will be 3 rows for each foot of depth plus the top row. The number of rows (nr) may be determined as follows:

$$nr = 1 + (D \times 3)$$

Calculate total outlet area by multiplying the area per row by number of rows.

$$\text{Total orifice area} = \text{area/row} \times nr$$

b. For single orifice outlet control or single row of orifices at the basin bottom surface elevation use the following equation based on the SQDV (ft^3) and depth of water above orifice centerline D (ft) to determine orifice area (in^2):

$$\text{Total orifice area} = (\text{SQDV}) \div [(60.19)(D^{0.5})(T)]$$

where

$$T = \text{drawdown period (hrs)} = 12 \text{ hrs}$$

5. Basin Side Slopes

Side slopes should be stable and sufficiently gentle to limit rill erosion and to facilitate maintenance. Side slopes above the permanent pool should be no steeper than 4:1, preferable 5:1 or flatter. The littoral zone should be very flat (40:1 or flatter) with the depth ranging from 6 inches near the shore and extending to no more than 12 inches at the furthest point from the shore. The side slope below the littoral zone shall be 3:1 or flatter.

6. Forebay Design — The forebay provides a location for sedimentation of larger particles and has a solid bottom surface to facilitate mechanical removal of accumulated sediment. The forebay volume should be 5 to 10 percent of the SQDV. A berm consisting of rock and topsoil mixture should be part of the littoral bench to create the forebay and have a minimum top width of 8 feet and side slopes no steeper than 4:1.

9. Inlet/Outlet Design — Basin inlet and outlet points should provided with an energy dissipation structure and/or erosion protection.

10. Vegetation — Bottom vegetation provides erosion protection and sediment entrapment. Berms, and side slopes may be planted with native grasses or with irrigated turf. The shallow littoral bench should have a 4 to 6 inch thick organic topsoil layer and be vegetated with aquatic species.

11. Embankment — Design embankments to conform to requirements State of California Division of Safety of Dams, if the basin dimensions cause it to fall under that agency's jurisdiction. Interior slopes should be no steeper than 4:1 and exterior slopes no steeper than 3:1. Flatter slopes are preferable.

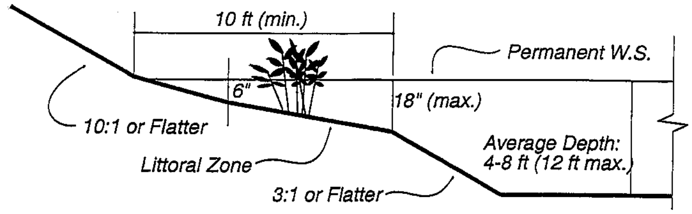
12. Access — All-weather access to the bottom, forebay, and outlet works shall be provided for maintenance vehicles. Maximum grades of access ramps should be 10 percent and minimum width should be 16 feet. Ramps should be paved with concrete.

13. Bypass — Provide for bypass or overflow of runoff volumes in excess of the SQDV. Spillway and overflow structures should be designed in accordance with applicable standards of the City of Woodland Storm Drainage Guidance and Criteria.

14. Underdrains — Provide underdrain trenches near the edge of the pond. The trenches should be no less than 12 inches wide filled with ASTM C-33 sand to within 2 feet of the pond's permanent pool water surface, and with an underdrain pipe connected through a valve to the outlet. These underdrains will permit the drying out of the pond when it has to be "mucked out" to restore volume lost due to sediment deposition.

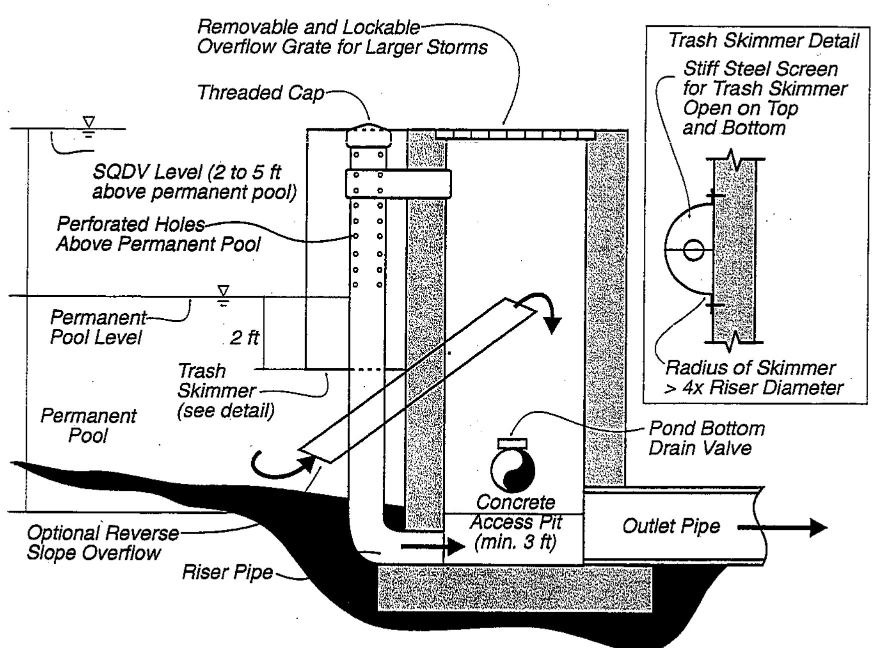
Design Example

Design forms to document the design procedure are provided in Appendix G. A completed design form follows as a design example.



Source: UDFCD

Figure 5-8. Depth Zones for Wet Detention Basin



Notes: 1. Alternate designs are acceptable as long as the hydraulics provides the required emptying times.
2. Use trash skimmer screens of stiff green steel material to protect perforated riser. Must extend from the top of the riser to 2 ft below the permanent pool level.

Source: UDFCD

Figure 5-9. Outlet Works for Wet Detention Basin

Design Procedure Form for T-4: Wet Detention Basin

Designer:____________________

Company:____________________

Date:____________________

Project:____________________

Location:____________________

1. Determine Basin Storage Volume			
a. Percent Imperviousness of Tributary Area	I_a =	64	%
b. Effective Imperviousness (Determine using Figure 3-4	I_{wq} =	60	%
c. Required Unit Basin Storage Volume (V_u) Use Figure 5-1 with 12 hr drawdown and I_{wq}	V_u=	0.28	in.
d. Watershed Area Tributary to EDB	Area =	100.0	acres
Calculate SQDV = (V_u / 12) x Area	SQDV =	2.33	acre-ft
2. Permanent Pool			
a. Volume of Permanent Pool (1.0 to 1.5 times SQDV minimum)	V_p =	2.33	acre-ft
b. Depth			
1) Littoral Zone Depth (6 to 12 inches)	Depth =	1.0	feet
2) Deeper Zone Depth (4 to 8 ft average, 10 ft max)	Average Depth =	6.0	feet
	Max Depth =	9.0	feet
c, Permanent Pool Surface Area			
1) Littoral Zone Area (25%-40% Permanent Pool Surface)	Area =	0.175	acres
	% of total	30.0	%
2) Deeper Zone Area (60%- 40% Permanent Pool Surface)	Area =	0.408	acres
	% of total	70.0	%
3) Total Area	Total area =	0.583	acres
3. Estimated Net Base Flow (must be > 0)			
$Q_{net} = Q_{inflow} - Q_{evap} - Q_{seepage} - Q_{evapotranspiration}$	Q_{inflow} =	2.33	acre-ft
	Q_{evap} =	0.3	acre-ft
	$Q_{seepage}$ =	0.8	acre-ft
	$Q_{evapotranspiration}$	0.8	acre-ft
	Q_{net} =	0.43	acre-ft

Design Procedure Form for T-4: Wet Detention Basin (Page 2 of 3)

Project:____

4. Outlet Works			
a. Outlet Type (check one)	Single Orifice	X (1 row)	
	Multi-orifice Plate		
	Perforated Pipe		
	Other		
b. Depth of water above bottom orifice	Depth =	3.0	feet
c. Single Orifice Outlet			
1) Total Area	A =	81.13	square inches
2) Diameter or L x W	D =	4 @ 5.08	inches
d. Multiple Orifice Outlet			
1) Area per row of perforations	A =		
2) Perforation Diameter (2 inches max.)	D =		
3) No. of Perforations (columns) per Row	Perforations =		
4) No. of Rows (4 inch spacing)	Rows =		
5) Total Orifice Area (Area per row) x (Number of Rows)	Area =		
5. Trash Rack or Gravel Pack Present?	Yes/No	Yes	
6. Basin Shape			
a. Length-Width Ratio	Ratio =	3:1	L/W
7. Forebay Design			
a. Forebay Volume (5-10% of SQDV min.)	Volume =	0.12	acre-ft
b. Outlet pipe drainage time (< 45 minutes)	Drainage Time	45	mins.
8. Embankment Slope			
a. Interior Slope (4:1 max.)	Interior Slope =	4:1	L/W
b, Exterior Slope (3:1 max.)	Exterior Slope =	3:1	L/W

Design Procedure Form for T-4: Wet Detention Basin (Page 3 of 3)

Project:____________________

9. Vegetation (Check type used or describe "Other")	__X__ Native Grasses _____ Irrigated Turf Grass _____ Emergent Aquatic Plants (specify type / density) _____ Other ____________________
10. Underdrains Provided?	Yes /No ___No___

Notes:

Maintenance Requirements

The following maintenance requirements apply to wet detention basins

Maintenance Agreement

On-site treatment control measures are maintained by the owner/operator. Maintenance agreements between the owner/operator and the City may be required. However, if pretreatment is recommended but not included in the design, a maintenance agreement will be required. If required, a maintenance agreement must be executed by the owner/operator before the improvement plans are approved. (See Appendix C for example maintenance agreement.)

Maintenance Plan

A post-construction Maintenance Plan shall be prepared and made available at the City's request. The Maintenance Plan should address at least the following items (see Appendix D for more detailed suggested Maintenance Plan content and format:

- Operation plan and schedule, including a site map
- Maintenance and cleaning activities and schedule
- Equipment and resource requirements necessary to operate and maintain facility
- Responsible party for operation and maintenance

Maintenance Activities

- Inspect basin semiannually, after each significant storm, or more frequently, if needed.. Some important items to check for include: differential settlement, cracking; erosion, leakage, or tree growth on the embankment; the condition of the riprap in the inlet, outlet and pilot channels; sediment accumulation in the basin; and the vigor and density of the grass turf on the basin side slopes and floor. Correct observed problems as necessary.
- Remove litter and debris from banks and basin bottom as required.
- Repair erosion to banks and bottom as required.
- Remove sediment when accumulation reaches 25% of original design depth, or if resuspension is observed. Clean in early spring so vegetation damaged during cleaning has time to re-establish.
- Inspect outlet for clogging a minimum of twice a year, before and after the rainy season, after large storms, and more frequently if needed. Correct observed problems as necessary.
- Clean forebay frequently to reduce frequency of main basin cleaning.
- Control mosquitoes, as necessary. Mosquito control is an important issue for WDBs and may require extensive and frequent control of peripheral vegetation.

Description

A Constructed Wetland Basin (CWBs) is a single-stage treatment system consisting of a forebay and a permanent micropool with aquatic plants. CWBs funtion in a similar manner to Wet Detention Basins (WDBs) in that the influent runoff flow water mixes with and displaces a permanent pool as it enters the basin. The surcharge volume above the permanent pool is slowly released over a specified period (40 hours for SQDV). A base flow is required to maintain the permanent water pool. CDBs differ from WDBs primarily in terms of depth and volume of the permanent pool and the extensive presence of aquatic plants (rushes, willows, cattails, and reeds). Plants provide energy dissipation and enhance pollutant removal by sedimentation and biological uptake. A conceptual layout of a CWB is shown in Figure 5-10.

Constructed Wetlands differ from "natural" wetlands in that they are man-made and are designed to enhance stormwater quality. Sometimes natural wetlands can be incorporated into the constructed wetland system. Such action, however, requires the approval of federal and state regulators. Constructed wetlands are generally not allowed to be used to mitigate the loss of natural wetlands, but are allowed to be disturbed by maintenance activities. Nevertheless, any activity that disturbs a constructed wetland should be first cleared through the U.S. Army Corps of Engineers to ensure some form of an individual, general, or nationwide 404 permit coverage.

General Application

Constructed wetlands are ideal for large, regional tributary areas where space is available to provide shallow water conditions. Land uses for which this BMP is appropriate include large residential developments, and commercial, institutional and industrial areas where incorporation of a green space and a wetland into the landscape is desirable and feasible. CWBs can be used effectively in combination with upstream treatment controls sucha s Grass Strip Filters and Grass Swale Filters. A base flow of water is required to maintain aquatic conditions.

Advantages/Disadvantages

General

CWBs offer an attractive, effective means for improving stormwater quality. As part of a landscape design, a constructed wetland can offer the beauty of water and vegetation in a predominantly dry area, if base flow is available or provisions are made to maintain the permanent pool. CWBs offer the potential for wildlife habitat and passive recreation. For example, a constructed wetland can be used in a park-like area where people can picnic, stroll or bird watch.

The primary drawback to wetlands is the need for a continuous base flow to maintain aquatic plants. In addition, salts and scum can accumulate and, unless properly designed and managed, can be flushed out during larger storms.

Site Suitability

Adequate space of around 1 to 2 percent of the tributary watershed is usually required. Constructed wetlands, however, require more land space than WDBs for similar drainage areas because part of the constructed wetland must be shallower than a wet detention basin. A perennial base flow is needed to sustain a wetland, and should be determined using a complete water budget analysis.

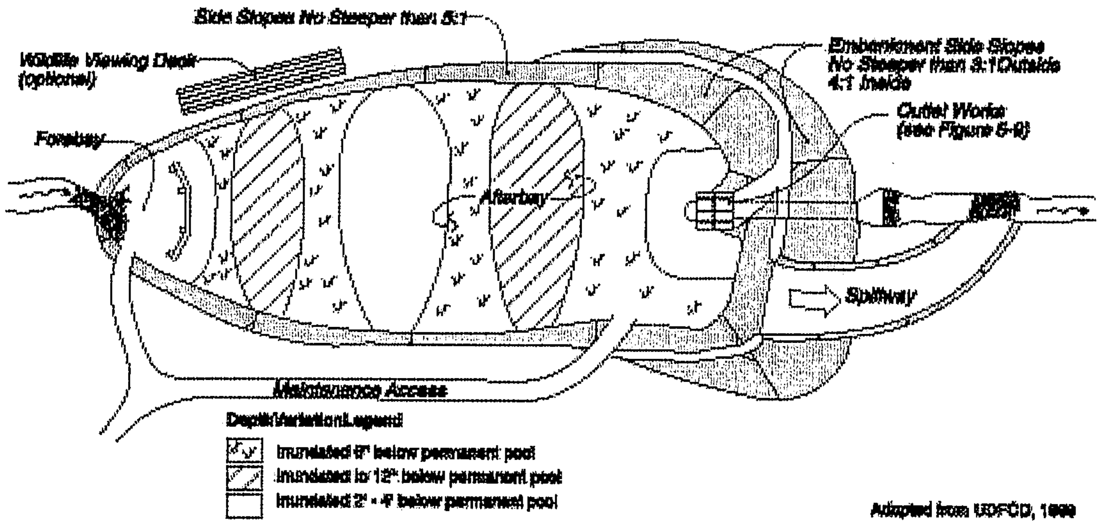
This control measure is most appropriate for sites with low-permeability soils (Type C and D) that will support aquatic plant growth. Infiltration through a wetland bottom cannot be relied upon because the bottom is either covered by soils of low permeability or because the groundwater is higher than the wetland's bottom. Wetland bottom channels also require a near-zero longitudinal slope; drop structures are used to create and maintain a flat grade.

Vegetation Maintenance

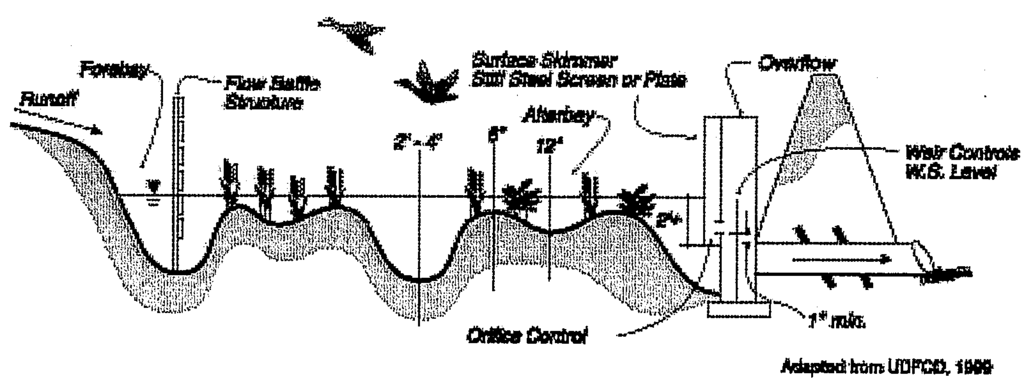
Considerable resources must be committed to provide nutrient removal and to maintain desirable mix and density of vegetation. Regular harvesting and removal of aquatic plants is required if the removal of nutrients is assured. Sediment removal is also necessary to maintain the proper distribution of growth zones and of water movement within the wetland. Water and plant management to avoid mosquito propagation is also essential.

Pollutant Removal

Wetlands remove a variety of constituents but their effectiveness varies significantly. Relative pollutant removal effectiveness of a CWB is presented in Table 5-1. With periodic sediment removal and plant harvesting, expected removal efficiencies for sediments, organic matter, and metals can be moderate to high; for phosphorus and nitrogen, low to moderate. Pollutants are removed primarily through sedimentation and entrapment, with some of the removal occurring through biological uptake by vegetation and microorganisms. Without a continuous dry-weather base flow, salts and algae can concentrate in the water column and can be released into the receiving water in higher levels at the beginning of a storm event as they are displaced. Harvesting aquatic plants and periodic removal of sediment also removes nutrients and pollutants associated with the sediment.



Plan View



Section View

Figure 5-10 . Conceptual Layout of Constructed Wetland Basin

Design Criteria and Procedure

Principal design criteria for CWBs are listed in Table 5-8.

Table 5-8. Constructed Wetland Basin Design Criteria

Design Parameter	Unit	Design Criteria
Drawdown time for SQDV / 50% SQDV	hrs	40 / 12 (minimum)
SQDV	acre-ft	80% annual capture. Use Figure 5-1 @ 40-h drawdown
Permanent pool volume (minimum)	%	75% of SQDV
Inlet/outlet erosion control	–	Energy dissipater to reduce inlet/outlet velocity
Permanent Pool Area / Depth		
Forebay, free water surface, and outlet areas	% / ft	30% to 50% of the permanent pool surface area / 2 to 4ft
Wetland zones with emergent vegetation	% / ft	50% to 70% of the permanent pool surface area / 0.5 to 1.0 ft (30% to 50 % should be 0.5 ft deep)
Forebay volume	%	5 to 10 % of SQDV
Surcharge depth above permanent pool	ft	2.0 ft maximum
Length to width ratio (minimum)	–	2:1 (larger preferred)
Freeboard (minimum)	ft	1.0
Wetland (Littoral) zone bottom slope	%	10.0 maximum
Embankment side slope	(H:V)	≥ 4:1 inside/ ≥3:1 outside (without retaining walls)
Maintenance access ramp slope (H:V)	hrs	10:1 or flatter
Maintenance access ramp width	ft	16.0 – approach paved with asphalt concrete

Design procedure and application of design criteria are outlined in the following steps:

1. Basin Storage Volume — Provide a storage volume equal to 100 percent of the SQDV, based on a 40-hr drawdown time, above the lowest outlet (i.e. perforation or orifice) in the basin.

   a. Determine the percent imperviousness of the tributary area (I_a).

   b. Determine effective imperviousness (I_{wq}) by adjusting for site design source controls using Figure 3-4, as appropriate.

   c. Determine required unit basin storage volume (V_u) using Figure 5-1 with 40-hr drawdown and I_{wq} value from step 1.b.

   d. Calculate the SQDV in acre-ft as follows:

   SQDV = (V_u /12) x Area

   where Area = Watershed area tributary to CWB

2. Basin Depth/Volume

The volume of the permanent wetland pool shall be not less than 75% of the SQDV. Distribution of wetland area is needed for a diverse ecology. Distribute component areas as follows:

Components	Percent of Permanent Pool Surface Area	Water Design Depth
Forebay, outlet and free water surface areas	30-50%	2 to 4 feet
Wetland zones with emergent vegetation	50-70%	6 to 12 inches (1/3 to 1/2 of this area should be 6 inches deep with bottom slope ≤ 10%)

3. Depth of Surcharge

The surcharge depth of the SQDV above the permanent pool's water surface should not exceed 2.0 feet.

4. Outlet Works

Provide outlet works that limit the SQDV depth to 2 feet or less. The Outlet Works are to be designed to release the SQDV over at least a 40 hour period. A single orifice outlet control is depicted in Figure 5-10.

For single orifice outlet control or single row of orifices at the basin bottom surface elevation (see Figures 5-6), use the following equation based on the SQDV (ft^3) and depth of water above orifice centerline D (ft) to determine orifice area (in^2):

$$\text{Total orifice area} = (SQDV) \div [(60.19)(D^{0.5})(T)]$$

where

$$T = \text{drawdown period (hrs)} = 40 \text{ hrs}$$

For perforated pipe outlets or vertical plates with multiple orifices (see Figure 5-5), use the following equation to determine required area per row of perforations, based on the SQDV(ft^2) and depth of water above the centerline of the bottom perforation D (ft).

$$\text{Area/row } (in^2) = SQDV/K_{40}$$

where

$$K_{40} = 0.13D^2 + 0.22D - 0.10$$

Select appropriate perforation diameter and number of perforations per row (columns) with the objective of minimizing the number of columns and using a maximum perforation diameter of 2 inches. Rows are spaced at 4 inches on center from the bottom perforation.

Thus, there will be 3 rows for each foot of depth plus the top row. The number of rows (nr) may be determined as follows:

$$nr = 1 + (D_{BS}/3)$$

Calculate total outlet area by multiplying the area per row by number of rows.

$$\text{Total orifice area} = \text{area/row} \times nr$$

5. Basin Use

Determine if flood storage or other uses will be provided for above the wetland surcharge storage or in an upstream facility. Design for combined uses when they are provided for.

6. Basin Shape

Whenever possible, shape the basin with a gradual expansion from the inlet and a gradual contraction toward the outlet. The length to width ratio should be between 2:1 to 4:1 with a 3:1 recommended. Internal baffling with berms or modification of inlet and outlet points may be necessary to achieve this ratio.

7. Basin Side Slopes

Side slopes should be stable and sufficiently gentle to limit rill erosion and to facilitate maintenance. Internal side slopes should be no steeper than 4:1, external side slopes should be less than 3:1.

8. Base Flow

A net influx of water must be available through a perennial base flow and must exceed the losses. The following equation and parameters can be used to estimate the net quantity of base flow available at the time.

$$Q_{net} = Q_{inflow} - Q_{E\text{-}P} - Q_{seepage} - Q_{ET}$$

Q_{net} = Net quantity of base flow (acre-ft/year)

Q_{inflow} = Estimated base flow (acre-ft/year). (Estimate by seasonal measurements and/or comparison to similar watersheds.)

$Q_{E\text{-}P}$ = Loss due to evaporation minus the precipitation (acre-ft/year)

$Q_{seepage}$ = Loss or gain due to seepage to groundwater (acre-ft/year)

Q_{ET} = Loss due to evapotranspiration (additional loss through plant area above water surface not including the water surface)

9. Inlet/Outlet Design

Basin inlet and outlet points should provided with an energy dissipation structure and/or erosion protection. Outlets should be placed in an offbay that is at least 3 feet deep. The outlet should be protected from clogging by a skimmer shield that starts at the bottom of the permanent pool and extends above the maximum SQDV depth. Also, provide for a trash rack.

11. Forebay/Afterbay

The forebay provides a location for sedimentation of larger particles that has a solid bottom surface to facilitate mechanical removal of accumulated sediment. The after bay is optional. The forebay volume should be 5% to 10 % of the SQDV. Depth should be 2.0 to 4.0 ft.

12. Vegetation	Selected wetland plants and grasses should be planted in the wetland bottom. The shallow littoral bench should have a 4 to 6 inch layer of organic topsoil. Berms and side-sloping areas should be planted with native or irrigated turf grasses. The selection of plant species for a constructed wetland shall take into consideration the water fluctuation likely to occur in the wetland. Permanent pool water level should controlled as necessary to establish wetland plants and raised to final operating level after plants are established.
12. Access	All-weather access to the forebay, and outlet works shall be provided for maintenance vehicles. Maximum grades of access ramps should be 10 percent and minimum width should be 16 feet. Ramps should be paved with concrete.
13. Bypass	Provide for bypass or overflow of runoff volumes in excess of the SQDV. Spillway and overflow structures should be designed in accordance with applicable standards of the Ventura County Flood Control District.

Design Example

Design forms to document the design procedure are provided in Appendix G. A completed design form follows as a design example.

Design Procedure Form for T-5: Constructed Wetlands Basin

Designer:________________________

Company:________________________

Date:________________________

Project:________________________

Location:________________________

1. Determine Basin Storage Volume			
a. Percent Imperviousness of Tributary Area	I_a =	50	%
b. Effective Imperviousness (Determine using Figure 3-4	I_{wq} =	50	%
c. Required Unit Basin Storage Volume (V_u) Use Figure 5-1 with 40 hr drawdown and I_{wq}	V_u=	0.56	in.
d. Watershed Area Tributary to EDB	Area =	50	acres
e. Calculate SQDV SQDV = (V_u / 12) x Area	SQDV =	2.33	acre-ft
2. Wetland Pond Volume, Depth, and Water Surface Area		**Minimums**	
a. Calculated Requirements, Minimum Permanent Pool: $Vol_{pool} \geq 0.75$ x SQDV	Vol_{pool} >	1.75	acre-ft
	Water Area>	0.70	acres, estimated
		Actual Design	
	Vol_{pool} =	1.80	acre-ft, actual
	Water Area =	1.20	acres, actual
b. Forebay Depth Range = 2.0' – 4.0'	Depth =	3.0	ft
Volume Range = 5%to 10 % of SQDV	Volume =	0.09	acre-ft,% = 5.0
c. Outlet Pool Depth Range = 2.0' – 4.0'	Depth =	3.0	ft
Volume Range = 6%to 10% of SQDV	Volume =	0.18	acre-ft,% = 10.0

Continued on next page

Design Procedure Form for T-5: Constructed Wetlands Basin (Page 2 of 3)

Project:____

3. Wetland Pond Volume, Depth, and Water Surface Area (Continued)	
d. Free Water Surface Areas (Area = 30-50% combined) (Depth Range = 2.0′ – 4.0′)	Depth = 2.0 ft Area = 0.60 acres, % = 50 Volume = 1.20 acre-ft
e. Wetland Zones with Emergent Vegetation (Depth Range = 6″ – 12″) (Area = 50-70%)	Depth = 1.0 ft Area = 0.60 acres, % = 50 Volume = 0.60 acre-ft
4. Estimated Net Base Flow (must be > 0) $Q_{net} = Q_{inflow} - Q_{evap} - Q_{seepage} - Q_{evapotranspiration}$	Q_{inflow} = 362.0 acre-ft Q_{evap} = 1.40 acre-ft $Q_{seepage}$ = 2.80 acre-ft $Q_{evapotranspiration}$ 1.50 acre-ft Q_{net} = 356.30 acre-ft
5. Outlet Works	
a. Outlet Type (check one)	Single Orifice X Multi-orifice Plate ____ Perforated Pipe ____ Other ____
b. Depth of water above bottom orifice	Depth = 3.0 feet
c. Single Orifice Outlet	
1) Total Area	A = 24.34 square inches
2) Diameter (or L x W)	D = 3 x 8.11 inches
d. Multiple Orifice Outlet	
1) Area per row of perforations	A = ____
2) Perforation Diameter (2 inches max.)	D = ____
3) No. of Perforations (columns) per Row	Perforations = ____
4) No. of Rows (4 inch spacing)	Rows = ____
5) Total Orifice Area (Area per row) x (Number of Rows)	Area = ____

Design Procedure Form for T-5: Constructed Wetlands Basin (Page 3 of 3)

Project: ______________________________

6. Trash Rack or Gravel Pack Present?	Yes/No ___Yes___
7. Basin Shape a. Length-Width Ratio	Ratio = ___3:1___ L:W
8. Embankment Side Slope a. Interior Side Slope (4:1 max.) b, Exterior Side Slope (3:1 max.)	 Int. Side Slope = ___4:1___ L:W Ext. Side Slope = ___3:1___ L:W
9. Vegetation (Check type used or describe "Other")	_X_ Native Grasses ___ Irrigated Turf Grass _X_ Emergent Aquatic Plants (specify type / density)* ___ Other ______ *Describe Species Density and Mix: See attached specification

Notes:

A017505

Maintenance Requirements

The following maintenance requirements apply to Constructed Wetland Basins

Maintenance Agreement

On-site treatment control measures are maintained by the owner/operator. Maintenance agreements between the owner/operator and the governing agency may be required. However, if pretreatment is recommended but not included in the design, a maintenance agreement will be required. If required, a maintenance agreement must be executed by the owner/operator before the improvement plans are approved.

Maintenance Plan

A post-construction Maintenance Plan shall be prepared and made available at the governing agency's request. The Maintenance Plan should address items such as:

- Operation plan and schedule, including a site map
- Maintenance and cleaning activities and schedule
- Equipment and resource requirements necessary to operate and maintain facility
- Responsible party for operation and maintenance

See Appendix D for additional Maintenance Plan requirements and suggested template.

Maintenance Activities

- Inspect constructed wetlands a minimum of twice a year, before and after the rainy season, after large storm events, or more frequently if needed. Some important items to check for include: differential settlement, cracking; erosion, leakage, or tree growth on the embankment; the condition of the riprap in the inlet, outlet and pilot channels; sediment accumulation in the basin; and the vigor and density of the vegetation on the basin side slopes and floor. Correct observed problems as necessary.
- Remove litter and debris from banks and basin bottom as required.
- Repair erosion to banks and bottom as required.
- Clean forebay every two years at a minimum, to avoid accumulation in main wetland area. Environmental regulations and permits may be involved with the removal of wetland deposits. When the main wetland area needs to be cleaned, it is suggested that the main area be cleaned one half at a time with at least one growing season in between cleanings. This will help to preserve the vegetation and enable the wetland to recover more quickly from the cleaning.
- Inspect outlet for clogging a minimum of twice a year, before and after the rainy season, after large storms, and more frequently if needed. Correct observed problems as necessary.
- Control mosquitoes, as necessary. The forebay (deep water only) can be stocked with Gambusia fish (mosquito fish), if approved by the Department of Fish and Game and other appropriate agencies.

Detention Basin/Sand Filter

Description

A detention basin/sand filter (DBSF) consists of a runoff storage zone underlain by a sand bed filter with an underdrain system constructed in an earthen basin. The basin is divided into a forebay settling basin to remove large sediment followed by sand filter basin. During storm events, runoff accumulates in the surcharge zone and gradually infiltrates into the underlying sand bed, filling the void spaces of the sand. The underdrain gradually dewaters the sand bed and discharges the runoff to downstream conveyance. Schematic plan and section views of a typical DBSF are shown in Figure 5-11.

General Application

A DBSF is generally suited to offline, onsite configurations where there is no base flow and the sediment load is relatively low. Drainage areas of up to 100 acres are appropriate for DBSFs.

Advantages/Disadvantages

General

Primary advantages of DBSFs include effective water quality enhancement through settling and filtering.

The primary disadvantage is the potential for clogging of the filter media. For this reason, systems should not be put into operation while construction activities are taking place in the tributary catchment. Maintenance requirements to maintain permeability of the filter media can be high if sediment loads are excessive.

Site Suitability

Because an underdrain system is incorporated into this control measure, DBSFs are suited to most soil types; presence of sandy soils is not a requirement. DBSFs are best suited to flat or gently sloping terrain , because of the need to construct zero-slope filter beds.

Pollutant Removal

Relative pollutant removal effectiveness of a DBSF is presented in Table 5-1. Removal effectiveness of DBSFs for sediment and particulate forms of metals, nutrients and other pollutants is considered high to moderate. Removal effectiveness for dissolved pollutants is considered low.

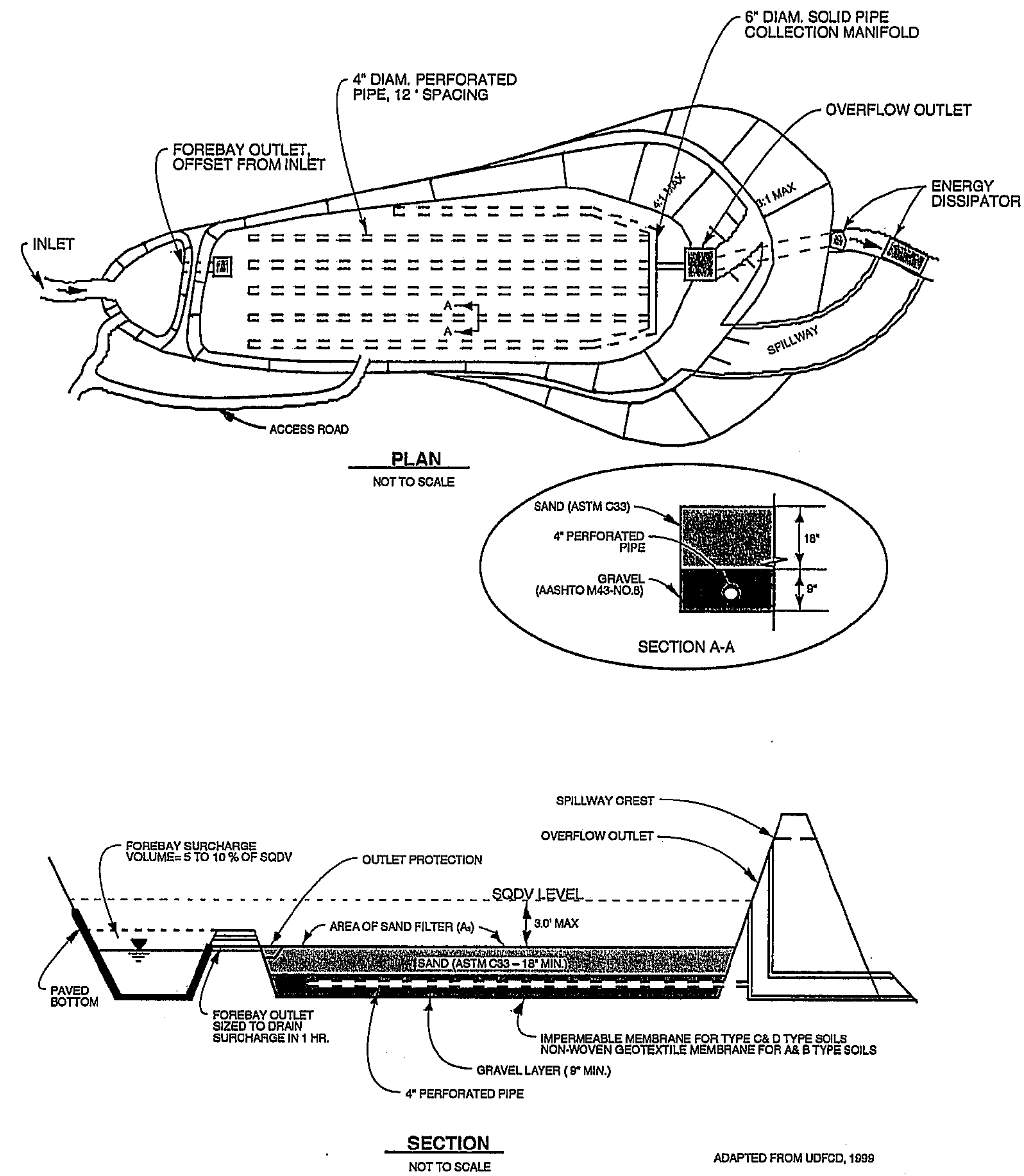


FIGURE 5-11. DETENTION BASIN/SAND FILTER

Design Criteria and Procedure

Principal design criteria for DBSFs are listed in Table 5-9.

Table 5-9. Detention Basin /Sand Filter Design Criteria

Design Parameter	Unit	Design Criteria
Drawdown time for SQDV / 50% SQDV	hrs	40 / 12 (minimum)
SQDV	acre-ft	80% annual capture. Use Figure 5-1 @ 40-h drawdown
Forebay surcharge volume	%	5 to 10% of SQDV
Max depth at SQDV	ft	3 feet
Inlet/outlet erosion control	–	Energy dissipater to reduce inlet/outlet velocity
Length to width ratio (minimum)	–	2:1 (larger preferred)
Freeboard (minimum)	ft	1.0
Filter bed media	--	Sand: 18 inches, Gravel: 9 inches.
Embankment side slope (H:V)	–	≥ 4:1 inside/ ≥3:1 outside (without retaining walls)
Maintenance access ramp slope (H:V)	hrs	10:1 or flatter
Maintenance access ramp width	ft	16.0 – approach paved with asphalt concrete

Design procedure and application of design criteria are outlined in the following steps:

1. Basin Storage Volume

Provide a storage volume equal to 100 percent of the SQDV, based on a 40-hr drawdown time, above the san bed of the basin.

a. Determine the percent imperviousness of the tributary area (I_a).

b. Determine effective imperviousness (I_{wq}) by adjusting for site design source controls using Figure 3-4, as appropriate.

c. Determine required unit basin storage volume (V_u) using Figure 5-1 with 40-hr drawdown and I_{wq} value from step 1.b.

d. Calculate the SQDV in acre-ft as follows:

$$SQDV = (V_u /12) \times Area$$

where

Area = Watershed area tributary to DBSF

2. Basin Depth — Maximum design volume depth should be 3 feet.

3. Filter Surface Area — Calculate the minimum sand filter area (A_s at the basin's bottom with the following equation:

$$A_s = \text{Design Volume} / (3 \times 43{,}560 \text{ ft}^2)$$

4. Filter Bed — An 18-inch layer of sand (ASTM C 33) over a 9-inch gravel layer (ASSHTO M43-No. 8) shall line the entire DBSF for purposes of filtering and draining the SQDV.

   If expansive soils are a concern or if the tributary catchment has chemical or petroleum products handled or stored, install an impermeable membrane below the gravel layer.

5. Outlet Works — A grated outlet structure with overflow should be provided to convey flows in excess of the SQDV out of the basin.

Design Example

Design forms to document the design procedure are provided in Appendix G. A completed design form follows as a design example.

Design Procedure Form for T-6: Detention Basin / Sand Filter

Designer:__________

Company:__________

Date:__________

Project:__________

Location:__________

1. Determine Basin Storage Volume			
a. Percent Imperviousness of Tributary Area	I_a =	64	%
b. Effective Imperviousness (Determine using Figure 3-4	I_{wq} =	60	%
c. Required Unit Basin Storage Volume (V_u) Use Figure 5-1 with 40 hr drawdown and I_{wq}	V_u=	0.64	in.
d. Watershed Area Tributary to DBSF	Area =	10.0	acres
e. Calculate SQDV SQDV = (V_u / 12) x Area	SQDV =	0.54	acre-ft
2. Filter Surface Area (A_s)			
a. A_s (min) = (SQDV / 3) x 43,560 ft^2)	A_s (min) =	7,840.80	ft^3
b. Design A_s	A_s =	7,850.0	ft^2
3. Design basin depth, based on design filter area			
D = Design Volume/ Design A_s	D =	3.0	ft
4. Filter Bed			
a) ASTM C33 Sand Layer (18 in. minimum)		18	inches
b) ASSHTO M43-No.8 Gravel Layer (9 in. min.)		9	inches

Notes:

Maintenance Requirements

The following maintenance requirements apply to Detention Basin/Sand Filters.

Maintenance Agreement

On-site treatment control measures are maintained by the owner/operator. Maintenance agreements between the owner/operator and the governing agency may be required. However, if pretreatment is recommended but not included in the design, a maintenance agreement will be required. If required, a maintenance agreement must be executed by the owner/operator before the improvement plans are approved. See Appendix C for example maintenance and access agreement.

Maintenance Plan

A post-construction Maintenance Plan shall be prepared and made available at the governing agency's request. The Maintenance Plan should address items such as:

- Operation plan and schedule, including a site map
- Maintenance and cleaning activities and schedule
- Equipment and resource requirements necessary to operate and maintain facility
- Responsible party for operation and maintenance

See Appendix D for additional Maintenance Plan requirements and suggested template.

Maintenance Activities

- Inspect basin a minimum of twice a year, before and after the rainy season, after large storm events, or more frequently if needed. Some important items to check for include: differential settlement, cracking; erosion, leakage, or tree growth on the embankment; the condition of the riprap in the inlet, outlet and pilot channels; sediment accumulation in the basin; and the vigor and density of the vegetation on the basin side slopes and floor. Correct observed problems as necessary.
- Remove litter and debris from banks and basin bottom as required.
- Repair erosion to banks and bottom as required.
- Check infiltration rate of sand bed twice annually, once after significant rainfall.
- Scarify top 3 to 5 inches of filters surface by raking once annually or as required to restore infiltration rate of the filter.
- Clean forebay every two years at a minimum, to avoid accumulation in main basin.
- Inspect outlet for clogging a minimum of twice a year, before and after the rainy season, after large storms, and more frequently if needed. Correct observed problems as necessary.

Porous Pavement Detention Basin

Description

A Porous Pavement Detention Basin (PPD) consists of an installation of Modular Block Porous (MBP) pavement that is flat (i.e., $S_o = 0.00\%$ in all directions) and is provided with a 2-inch deep surcharge zone to temporarily store the WQCV draining from an adjacent area. Runoff will infiltrate the porous pavement and sublayers of sand a gravel and will slowly exit through an underdrain.

Modular Block Porous Pavement consists of open void concrete block units laid on a two-layer sand and gravel subgrade. The surface pavement voids are filled with sand. A typical cross section of a PPD system is shown in Figure 5-12. An alternate approach is to use stabilized-grass porous pavement, consisting of grass turf reinforced with plastic rings and filter fabric underlain by gravel.

General Application

A PPD may be used in low vehicle-movement zones such as residential driveways and is often used as a parking pad surface. Although PPDs are typically used as parking pads in a parking lot, there are other potential applications such as:

- Low vehicle movement airport zones such as parking aprons and maintenance roads
- Crossover/emergency stopping/parking lanes on divided highways.
- Residential street parking lanes
- Residential driveways
- Maintenance roads and trails
- Emergency vehicle and fire access lanes in apartment/multi-family/complex situations

Vehicle movement lanes that lead up to the porous pavement parking pads should be solid asphalt or concrete pavement. Grass can be used in the block voids; however it may require irrigation and lawn care.

Advantages/Disadvantages

General

In addition to relatively high pollutant removal effectiveness, PPD can reduce flooding potential by infiltrating or slowing down runoff. Modular Block patterns, colors and materials can serve functional and aesthetic purposes. An additional advantage is to provide a means to provide storm water capture for sites that have little available open area for detention.

The primary disadvantage for use of PPD is cost. Also, uneven driving surfaces and potential traps for the high heels of women's shoes may be a problem. The cost of restorative maintenance can be somewhat high when the system seals with sediment and no longer functions properly as a permeable pavement.

Site Suitability

PPDs may be installed without free draining subsoils when provided with underdrains. An underdrain ensures the drainage of the gravel subgrade whenever the subsoils are not free draining. In cases when the subsoils are not free draining, an impermeable liner should be provided to drain the water in the gravel pack and to mitigate concerns about expansive soils.

The PPD should also be located far enough from foundations in expansive soils so as to limit damage to potential structures. In addition, when a commercial or an industrial site may be handling chemicals and petroleum products that may spill to the ground, an impermeable liner with an underdrain is required to prevent groundwater and soil contamination.

Pollutant Removal

Removal rates for both suspended sediment and associated constituents are projected to be high to moderate. Runoff through the sand and gravel of the modular block voids and entrapment in the gravel media are the primary removal mechanisms of pollutants. Removal rates for dissolved constituents are expected to be low to moderate. Relative pollutant removal effectiveness of a DBSF is presented in Table 5-1.

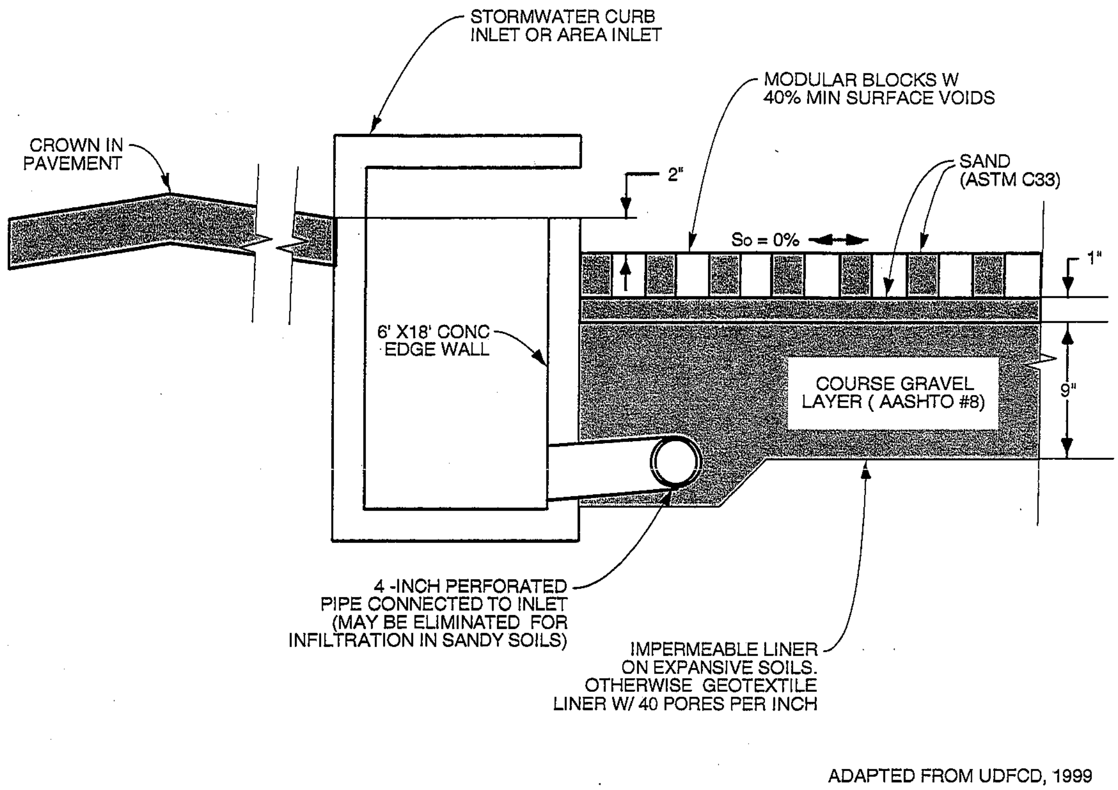


Figure 5-12. Porous Pavement Detention

Design Criteria and Procedure

Principal design criteria for PPDs are listed in Table 5-10.

Table 5-10. Porous Pavement Detetnion Design Criteria

Design Parameter	Unit	Design Criteria
Drawdown time for SQDV	hrs	12 (minimum)
SQDV	acre-ft	80% annual capture. Use Figure 5-1 @ 12-h drawdown
Modular Porous Block Type	%	40% surface area open
Porous Pavement Infill	--	ASTM C-33 Sand or equivalent
Base courses	--	1-inch sand (ASTM C-33) over 9-inch gravel
Perimeter Wall Width	in	6

Design procedure and application of design criteria are outlined in the following steps:

1. Basin Storage Volume Provide a storage volume equal to 100 percent of the QDV, based on a 12-hr drawdown time.

   a. Determine the percent imperviousness of the tributary area (I_a).

   b. Determine effective imperviousness (I_{wq}) by adjusting for site design source controls using Figure 3-4, as appropriate.

   c. Determine required unit basin storage volume (V_u) using Figure 5-1 with 12-hr drawdown and I_{wq} value from step 1.b.

   d. Calculate the SQDV in acre-ft as follows:

   $$SQDV = (V_u / 12) \times Area$$

   where Area = Watershed area tributary to PPD

2. Basin Surface Area Calculate minimum required surface area based on surcharge depth of 2 inches as follows:

   $$\text{Surface Area} = SQDV\ (ft^3) / 0.17\ (ft)$$

3. Select Block Type Select appropriate modular blocks that have no less than 40 percent of the surface area open. The manufacturer's installation requirements shall be followed with the exception that porous pavement infill material requirements and base course dimension are adhered to.

4. Porous Pavement Infill The MBP openings should be filled with ASTM C-33graded sand (fine concrete aggregate, not sandy loam turf).

5. Base Courses — Provide 1-inch sand over 9-inch gravel base courses as shown in Figure 5-12.

6. Perimeter Wall — Provide a concrete perimeter wall to confine the edges of the PPD area. The wall should be minimum 6-inch wide and at least 6 inches deeper than all the porous media and modular block depth combined.

7. Subbase — If expansive soils or rock are a concern or the tributary catchment has chemical or petroleum products handled or stored, install an impermeable membrane below the base course. Otherwise install a non-woven geotextile membrane to encourage filtration.

8. Overflow — Provide an overflow, possibly with an inlet to a storm sewer, set at 2 inches above the level of the porous pavement surface. Make sure the 2-inch ponding depth is contained and does not flow out of the area at ends or sides.

Design Example

Design forms to document the design procedure are provided in Appendix G. A completed design form follows as a design example.

Design Procedure Form for T-7: Porous Pavement Detention

Designer:____________________

Company:____________________

Date:____________________

Project:____________________

Location:____________________

1. Determine Basin Storage Volume			
a. Percent Imperviousness of Tributary Area	I_a =	100	%
b. Effective Imperviousness (Determine using Figure 3-4	I_{wq} =	100	%
c. Required Unit Basin Storage Volume (V_u) Use Figure 5-1 with 12 hr drawdown and I_{wq}	V_u=	0.65	in.
d. Watershed Area Tributary to DBSF	Area =	0.1	acres
e. Calculate SQDV SQDV = (V_u / 12) x Area	SQDV =	0.0054	acre-ft
1. Basin Surface Area			
a. Design Volume (SQDV)	SQDV =	236	ft^3
b. A_s = Design Volume / (0.17 ft) (based on surcharge depth of 2 inches)	A_s	1,388	ft^2
2. Block Type	Block name:	Uni-Green	
	Manufacturer:	Pavestone	
a. Minimum open area = 40%	Open Area =	40	%
b. Minimum thickness = 4 inches	Thickness	4.0	inches
3. Base Course (Check)			
a. ASTM C33 Sand Layer (1 inch)	Sand Layer	X	
b. ASSHTO M43-No.8 Gravel Layer (9 inches)	Gravel Layer	X	

Notes:

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Maintenance Requirements

The following maintenance requirements apply to Porous Pavement Detention.

Maintenance Agreement

On-site treatment control measures are maintained by the owner/operator. Maintenance agreements between the owner/operator and the governing agency may be required. However, if pretreatment is recommended but not included in the design, a maintenance agreement will be required. If required, a maintenance agreement must be executed by the owner/operator before the improvement plans are approved. See Appendix C for example maintenance and access agreement.

Maintenance Plan

A post-construction Maintenance Plan shall be prepared and made available at the governing agency's request. The Maintenance Plan should address items such as:

- Operation plan and schedule, including a site map
- Maintenance and cleaning activities and schedule
- Equipment and resource requirements necessary to operate and maintain facility
- Responsible party for operation and maintenance

See Appendix D for additional Maintenance Plan requirements and suggested template.

Maintenance Activities

- Inspect PPD a minimum of twice a year during storm events to determine if runoff is infiltrating properly.
- If infiltration is significantly reduced, remove surface sand by vacuuming. Dispose and replace sand with fresh ASTM C-33 sand.
- Remove litter and debris from PPD area as required.

Porous Landscape Detention Basin

Description

A Porous Landscape Detention (PLD) basin functions similarly to Porous Pavement Detention (PPD) except vegetation is used instead of porous blocks. A PLD consists of a low-lying vegetated area underlain by a sand bed with an underdrain pipe. A shallow surcharge zone is provided above the PLD for temporary storage of the SQDV. During runoff events, runoff accumulates in the vegetated zone and gradually infiltrates into the underlying sand bed, filling the void spaces of the sand. The underdrain gradually dewaters the sand bed and discharges the runoff to downstream conveyance. Like the PPD, a PLD allows detention of the SQDV to be provided on sites with limited open area available for stormwater detention. A typical cross section of a PLD is shown in Figure 5-13.

General Application

A PLD can be located in just about any of the open areas of a site. It is ideally suited for small installations such as:

- Parking lot islands
- Street medians
- Roadside swale features
- Site entrance or buffer features

A PLD can be implemented on a larger scale, serving as an infiltration basin/sand filter for an entire site, if desired, provided the stormwater quality capture volume and average depth requirements are met.

Advantages/Disadvantages

General

PLDs provide storm water capture on a site while reducing the impact on developable land. Aside from the relatively high degree of pollutant removal provided, PLDs can reduce flooding potential by infiltrating or slowing down runoff. A PLD provides a natural moisture source for vegetation, enabling "green areas" to exist with reduced irrigation.

The primary disadvantage of a PLD is the potential for clogging if sediment loading is excessive. The cost of restorative maintenance can be high when the system seals with sediment and no longer functions as a storm water basin. A PLD should be placed away from building foundations or other areas where expansive soils are present, although underdrain and impermeable liner can ameliorate some of these concerns.

Site Suitability

If an underdrain system is incorporated into the design, PLDs are suited for almost any site regardless of soil type. An underdrain ensures the drainage of the subgrade whenever the subsoils are not free draining. If sandy soils (type A or B) are present, the facility can be installed without an underdrain. However, sandy subsoils are not a requirement. In cases when the subsoils are not free draining, an impermeable liner should be provided to drain the water in the subgrade and to mitigate concerns about expansive soils. This BMP has a relatively flat surface area and may be more difficult to incorporate it into steeply sloping terrain.

The PLD should be located far enough from foundations in expansive soils so as to limit damage to potential structures. In addition, when a commercial or an industrial site may be handling chemicals and petroleum products that may spill to the ground, an impermeable liner with an underdrain is required to prevent groundwater and soil contamination.

Pollutant Removal

The degree of pollutant removal by a PLD should be significant and should equal or exceed the removal effectiveness provided by sand filters. In addition to removal by settling, PLDs provides filtering, adsorption, and biological uptake of constituents in stormwater. Relative pollutant removal effectiveness is indicated in Table 5-1.

Design Criteria and Procedure

Principal design criteria for SFBs are listed in Table 5-11.

Table 5-11. Extended Detention Basin Design Criteria

Design Parameter	Unit	Design Criteria
Drawdown time for SQDV	hrs	12 hrs
SQDV	acre-ft	80% annual capture. Use Figure 5-1 @ 12-h drawdown
Average surcharge depth	in	6-12
Sand-peat layer	in	18" (minimum)– 75% ASTM C-3 Sand + 25% peat
Gravel layer	in	9" – ASSHTO #8 Coarse Aggregate
Vegetative (sandy loam turf) layer	in	6"

When implementing multiple small PLDs on a site, it is increasingly important to accurately account for each upstream drainage area tributary to each PLD site to make sure that each facility is properly sized, and that all portions of the development site are directed to a PLD.

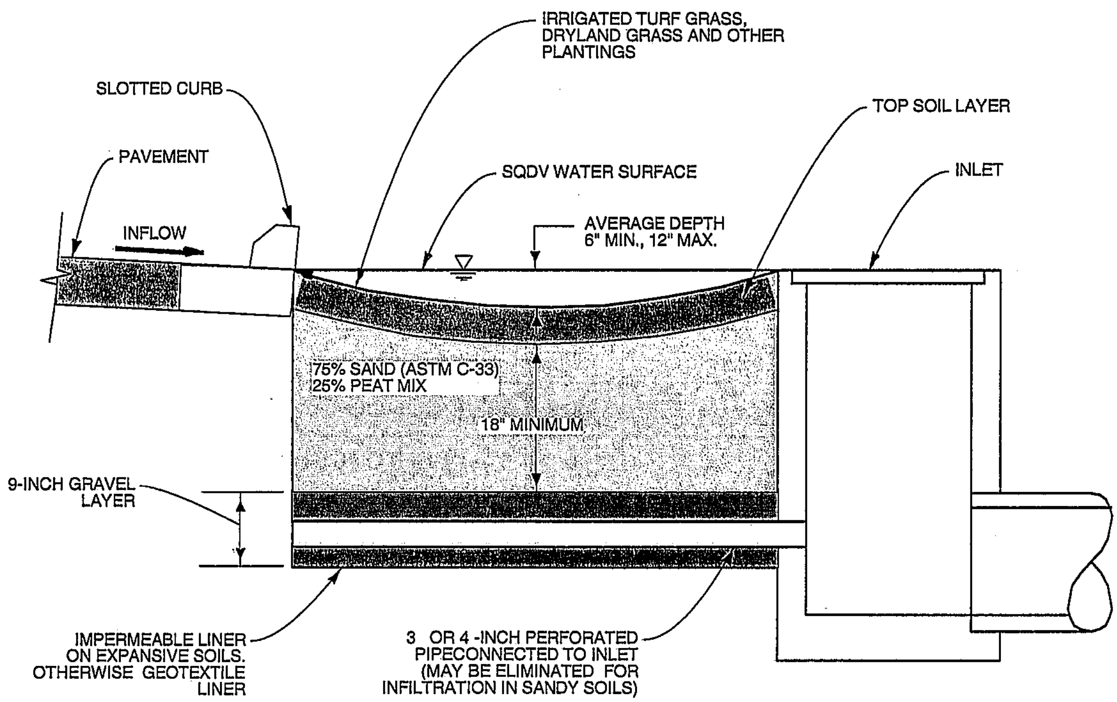

Figure 5-13. POROUS LANDSCAPE DETENTION

Design procedure and application of design criteria are outlined in the following steps:

1. Basin Storage Volume — Provide a storage volume equal to 100 percent of the SQDV, based on a 12-hr drawdown time.

   a. Determine the percent imperviousness of the tributary area (I_a).

   b. Determine effective imperviousness (I_{wq}) by adjusting for site design source controls using Figure 3-4, as appropriate.

   c. Determine required unit basin storage volume (V_u) using Figure 5-1 with 12-hr drawdown and I_{wq} value from step 1.b.

   d. Calculate the SQDV in acre-ft as follows:

   $$SQDV = (V_u /12) \times Area$$

   where

   Area = Watershed area tributary to PLD

2. Basin Surface Area — Calculate minimum required surface area as follows:

   Surface Area = SQDV / average surcharge depth

3. Base Courses — Provide 18-inch sand + peat layer over 9-inch gravel layer as shown in Figure 5-13. Thoroughly mix 75% sand (ASTM C-33) with 25% peat for filtration and adsorption of contaminants.

4. Subbase — If expansive soils or rock are a concern or the tributary catchment has chemical or petroleum products handled or stored, install an impermeable membrane below the base course. Otherwise install a non-woven geotextile membrane to encourage filtration.

5. Surcharge Depth — Maintain the average SQDV depth between 6 and 12 inches. Average depth is defined as water volume divided by the water surface area.

6. Vegetative Layer — Provide a sandy loam turf layer above the sand-peat mix layer. This layer shall be no less than 6 inches thick, but a thicker layer is recommended to promote healthier vegetation.

7. Overflow — Provide an overflow, possibly with an inlet to a storm sewer, set above the SQDV surcharge water level

Design Example

Design forms to document the design procedure are provided in Appendix G. A completed design form follows as a design example.

Design Procedure Form for T-8: Porous Landscape Detention Basin

Designer:____________________

Company:____________________

Date:____________________

Project:____________________

Location:____________________

1. Determine Basin Storage Volume			
a. Percent Imperviousness of Tributary Area	I_a =	100	%
b. Effective Imperviousness (Determine using Figure 3-4	I_{wq} =	100	%
c. Required Unit Basin Storage Volume (V_u) Use Figure 5-1 with 12 hr drawdown and I_{wq}	V_u=	0.65	in.
d. Watershed Area Tributary to DBSF	Area =	0.25	acres
e. Calculate SQDV SQDV = (V_u / 12) x Area	SQDV =	0.0135	acre-ft
2. Basin Surface Area			
a. Design Volume (SQDV)	SQDV =	590	ft^3
b. Average Depth	Average Depth =	1.0	ft
c. A_s = Design Volume / Average Depth	A_s =	590	ft^2
3. Base Course Layers (check)	Sandy Loam Turf	X	in. (6″ min)
	Sand/peat mix	X	in. (18″ min)
	Gravel	X	in. (9″ min)
4. Subsurface Drainage (check)	X	Infiltration to subgrade with permeable geotextile membrane	
	_____	Underdrain with impermeable membrane	
	_____	Underdrain with permeable goetextile membrane	

Notes:

____

____

____

Maintenance Requirements

The following maintenance requirements apply to Porous Landscape Detention.

Maintenance Agreement

On-site treatment control measures are maintained by the owner/operator. Maintenance agreements between the owner/operator and the governing agency may be required. However, if pretreatment is recommended but not included in the design, a maintenance agreement will be required. If required, a maintenance agreement must be executed by the owner/operator before the improvement plans are approved. See Appendix C for example maintenance and access agreement.

Maintenance Plan

A post-construction Maintenance Plan shall be prepared and made available at the governing agency's request. The Maintenance Plan should address items such as:

- Operation plan and schedule, including a site map
- Maintenance and cleaning activities and schedule
- Equipment and resource requirements necessary to operate and maintain facility
- Responsible party for operation and maintenance

See Appendix D for additional Maintenance Plan requirements and suggested template.

Maintenance Activities

- Mow grass and remove weeds to limit unwanted vegetation as required. Maintain irrigated turf grass height at 2 to 4 inches and non-irrigated native grasses at 4 to 6 inches.
- Remove litter and debris from PPD area as required.
- Inspect PLD a minimum of twice a year during storm events to determine if runoff is infiltrating properly.
- If infiltration is significantly reduced, remove and replace sandy loam turf and landscaping layer. May be required every 5 to 10 years or more frequently depending on sediment loads to the PLD.

Description

An Infiltration Basin (INB) consists of an earthen basin constructed in naturally pervious soils (Type A or B soils) with a flat bottom and provided with inlet structure to dissipate energy of incoming flow and an emergency spillway to control excess flows. An optional relief underdrain may be provided to drain the basin if standing water conditions occur. A forebay settling basin as described for EDBs should be provided if high sediment loads are anticipated. An INB functions by retaining the SQDV in the basin and allowing the retained runoff to percolate into the underlying native soils over a specified period of time (40 hours). The bottoms of basins are typically vegetated with dry-land grasses or irrigated turf grass. . A typical layout of an INB system is shown in Figure 5-14.

General Application

Infiltration basins can serve drainage areas up to 50 acres. Infiltration basins can be sized to pass storm volumes greater than the storm quality capture volume (SQDV). However, treatment efficiencies are reduced and the threat of system failure increases as the volume of runoff directed to the infiltration basin increases above the SQDV. It is recommended that the basin be sized to treat the storm quality capture volume only and divert all other flows around the treatment control measure.

Advantages/Disadvantages

General

In addition to removing pollutants effectively, infiltration basins also control runoff volume, which may serve to reduce downstream bank erosion in watercourses. INBs, are empty when not in use and can be dual-purpose facilities. A grass-covered area in a park, for example, could function as an infiltration basin during the wet season, and as a park during the dry season .

The primary disadvantage of an infiltration basin is the potential for clogging if excessive sediment is allowed to flow into the facility. Basins cannot be put into operation until the upstream tributary area is stabilized. The cost of restorative maintenance can be high if soil infiltration rates are significantly reduced due sediment deposition.

Also, there is a risk of groundwater contamination in very coarse soils since coarse soils do not effectively remove dissolved pollutants. This may require groundwater monitoring

Site Suitability

An infiltration basin requires significant space and is suitable for large drainage areas (10 to 50 acres. INBs infiltration basins cannot be placed on fill or unstable sites. Also, INBs should not be placed in high-risk areas such as service/gas stations, truck stops, and heavy industrial sites due to the groundwater contamination risk.

Before exploring the use of infiltration BMPs, preliminary soil investigations, including a percolation test, shall be performed to assess whether the soils on site have an extended infiltration rate of at least 0.5 inches per hour. Separate on-site infiltration systems from the groundwater table (or bedrock) by a minimum of 10 feet vertically to provide sufficient infiltration volume within the soil. Tributary area should have a low potential for erosion. Other suitability considerations include the soil makeup (Appendix E), site topography, and the location of other facilities. Prior to the use of infiltration basins consultation with local agencies is recommended to identify the location of unconfined groundwater basins and vulnerable unconfined aquifers to determine the appropriateness of this BMP. In an area identified as an unconfined groundwater basin or a vulnerable unconfined aquifer the application of infiltration BMPs should be limited to those that provide pre-treatment to ensure groundwater is protected for pollutants of concern.

The site must further provide a relatively flat area in which to construct the facility. Infiltration facilities shall be sited at least 50 feet away from slopes steeper than 15 percent. Adequate spacing (100 feet or more) shall be provided between infiltration facilities and non-potable wells, tanks, drain fields and springs. For separation between infiltration BMPs and potable water supply wells, follow Department of Health Services requirements in the Guidelines for Location of Water Wells. INBs shall also be sited at least 20 feet down slope or 100 feet up slope from building foundations. A geotechnical expert shall be consulted when necessary to verify appropriate placement on site.

An important consideration for all infiltration facility configurations is that, during construction, great care must be taken not to reduce the infiltration capacity of the soil in the facility through compaction or by using the infiltration area as a sediment trap. Infiltration facilities shall be constructed late in the site development after soils (that might erode and clog the units) have been stabilized, or shall be protected until the site is stabilized.

Pollutant Removal

The amount of pollutant removed by INBs should be significant and should equal or exceed the removal rates provided by sand filters. In addition to settling, infiltration basins provide filtering, adsorption, and biological uptake of constituents in stormwater. Relative pollutant removal effectiveness is indicated in Table 5-1.

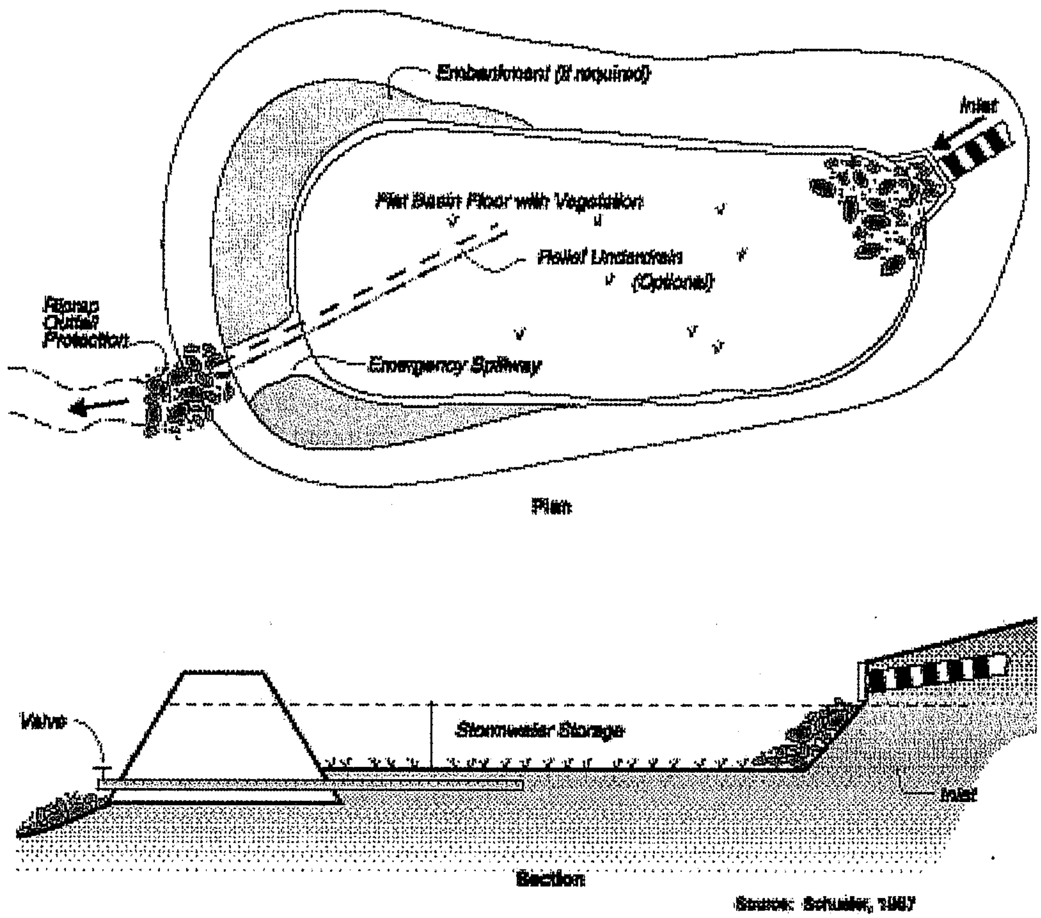

Figure 5-14. INFILTRATION BASIN

Design Criteria and Procedure

Principal design criteria for INBs are listed in Table 5-12.

Table 5-12. Infiltration Basin Design Criteria

Design Parameter	Unit	Design Criteria
Drawdown time for SQDV	hrs	40
SQDV	acre-ft	80% annual capture. Use Figure 5-1 @ 40-h drawdown
Bottom Basin Elevation	ft	5 feet above seasonally high groundwater table minimum.
Freeboard (minimum)	ft	1.0
Setbacks	ft ft.	100 feet from wells, tanks, fields, springs 20 feet down slope or 100 feet up slope from foundations
Inlet/outlet erosion control	–	Energy dissipater to reduce inlet/outlet velocity
Embankment side slope (H:V)	–	≥ 4:1 inside/ ≥3:1 outside (without retaining walls)
Maintenance access ramp slope (H:V)	hrs	10:1 or flatter
Maintenance access ramp width	ft	16.0 – approach paved with asphalt concrete
Vegetation	–	Side slopes and bottom (may require irrigation during summer)

Design procedure and application of design criteria are outlined in the following steps:

1. Basin Storage Volume — Provide a storage volume equal to 100 percent of the SQDV, based on a 40-hr drawdown time.

   a. Determine the percent imperviousness of the tributary area (I_a).

   b. Determine effective imperviousness (I_{wq}) by adjusting for site design source controls using Figure 3-4, as appropriate.

   c. Determine required unit basin storage volume (V_u) using Figure 5-1 with 40-hr drawdown and I_{wq} value from step 1.b.

   d. Calculate the SQDV in acre-ft as follows:

   $$SQDV = (V_u /12) \times Area$$

   where

   Area = Watershed area tributary to INB

2. Basin Surface Area — Calculate the minimum surface area of the infiltration system:

$$A_m = V/D_m$$

A017529

where:

A_m = minimum area required (ft^2)

V = volume of the infiltration basin (ft^3)

D_m = maximum allowable depth (ft)

where:

$D_m = tI/12s$

and: I = site infiltration rate in (in/hr)

s = safety factor

t = minimum drawdown time = 40 hours

In the formula for maximum allowable depth, the safety factor accounts for the possibility of inaccuracy in the infiltration rate measurement. The less certain the infiltration rate the higher the safety factor shall be. Minimum safety factors shall be as follows:

- Without site-specific borings and percolation tests, use s=10
- With borings (but no percolation test), use s=6
- With percolation test (but no borings), use s=5
- With borings and percolation test, use s=3

3. Inline/Offline — Basins may be on-line or off-line with flood control facilities. For on-line basins, the water quality outlet may be superimposed on the flood control outlet or may be constructed as a separate outlet.

4. Vegetation — Bottom vegetation provides erosion protection and sediment entrapment. Basin bottoms, berms, and side slopes may be planted with native grasses or with irrigated turf.

5. Embankments — Design embankments to conform to requirements State of California Division of Safety of Dams, if the basin dimensions cause it to fall under that agency's jurisdiction. Interior slopes should be no steeper than 4:1 and exterior slopes no steeper than 3:1. Flatter slopes are preferable.

6. Access — All-weather access to the bottom, forebay, and outlet works shall be provided for maintenance vehicles. Maximum grades of access ramps should be 10 percent and minimum width should be 16 feet. Ramps should be paved with concrete. Provide security fencing, except when used as a recreation area.

7. Bypass — Provide for bypass or overflow of runoff volumes in excess of the SQDV. Spillway and overflow structures should be designed in accordance with applicable standards of the Ventura County Flood Control District.

Design Example

Design forms to document the design procedure are provided in Appendix G. A completed design form follows as a design example.

Design Procedure Form for T-9: Infiltration Basin

Designer:____________________

Company:____________________

Date:____________________

Project:____________________

Location:____________________

1. Determine Basin Storage Volume			
a. Percent Imperviousness of Tributary Area	I_a =	100	%
b. Effective Imperviousness (Determine using Figure 3-4	I_{wq} =	100	%
c. Required Unit Basin Storage Volume (V_u) Use Figure 5-1 with 40 hr drawdown and I_{wq}	V_u=	0.95	in.
d. Watershed Area Tributary to DBSF	Area =	0.2	acres
e. Calculate SQDV SQDV = (V_u / 12) x Area	SQDV =	0.0158	acre-ft
2. Maximum Allowable Depth (D_m = tI/12s)			
a. Site infiltration rate (I)	I =	2.0	in/hr
b. minimum drawdown time (t = 40 hours)	t =	40	hrs
c. safety factor (s)	s =	3	
d. D_m = tI/12s	D_m =	2.22	ft.
3. Basin Surface Area A_m = SQDV / D_m	A_m =	310	ft^2
4. Vegetation (Check type used or describe "Other")	_X_ Native Grasses ____ Irrigated Turf Grass ____ Other		

Notes:

____

____

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Maintenance Requirements

The following maintenance requirements apply to Infiltration Basins.

Maintenance Agreement

On-site treatment control measures are maintained by the owner/operator. Maintenance agreements between the owner/operator and the governing agency may be required. However, if pretreatment is recommended but not included in the design, a maintenance agreement will be required. If required, a maintenance agreement must be executed by the owner/operator before the improvement plans are approved. See Appendix C for example maintenance and access agreement.

Maintenance Plan

A post-construction Maintenance Plan shall be prepared and made available at the governing agency's request. The Maintenance Plan should address items such as:

- Operation plan and schedule, including a site map
- Maintenance and cleaning activities and schedule
- Equipment and resource requirements necessary to operate and maintain facility
- Responsible party for operation and maintenance

See Appendix D for additional Maintenance Plan requirements and suggested template.

Maintenance Activities

- Inspect a minimum of twice a year, before and after the rainy season, after large storms, or more frequently if needed.
- Clean when loss of infiltrative capacity is observed. If drawdown time is observed to have increased significantly over the design drawdown time, removal of sediment may be necessary. This is an expensive maintenance activity and the need for it can be minimized through prevention of upstream erosion.
- Mow, as appropriate for vegetative cover species.
- Monitor health of vegetation and replace as necessary.
- Control mosquitoes as necessary.
- Remove litter and debris from INB area as required.

Infiltration Trench

Description

An Infiltration Trench (INT) consists of subsurface gravel and sand bed constructed in naturally pervious soils (Type A or B soils) where runoff is stored until it infiltrates into the soil profile. Upstream control measures such as Turf Buffers (see G-5.1), Grass-lined Channels(see G-5.2), Grass Strip Filters (see T-1, or Grass Swales Filters (see T-2), are typically combined with INTs to provide sediment removal upstream of the INT. The trench is designed to retain and infiltrate the SQDV over a specified period of time (40 hours). A screened overflow pipe or outlet should be provided to convey runoff in excess of the SQDV to downstream drainage. An observation well constructed of perforated PVC pipe should be provided to allow the depth of water in the trench to be monitored. Typical elements of an INT system are shown in Figure 5-15. Infiltration vaults and leach fields are variations of the infiltration trench concept in which runoff is distributed to upper zone of the subsurface gravel bed by means of perforated pipes. Illustrations of infiltration vaults and leach fields are shown in Figure 5-16 and 5-17, respectively.

General Application

Infiltration trenches are typically used to serve areas less than 10 acres and are usually combined with upstream treatment control measures to reduce sediment load to the INT. For example, INTs are commonly used in combination with Turf Buffers to treat runoff from parking lots or other paved areas as illustrated in Figure 5-15. Infiltration trenches are easily incorporated into the landscape features of development sites.

Advantages/Disadvantages

General

In addition to removing pollutants effectively, infiltration trenches, like infiltration basins, also control runoff volume, which may serve to reduce downstream bank erosion in watercourses.

The primary disadvantage of an infiltration trench, as for any infiltration device, is the potential for clogging if excessive sediment is allowed to flow into the facility. The cost of restorative maintenance can be high if soil infiltration rates are significantly reduced due sediment deposition.

Also, there is a risk of groundwater contamination in very coarse soils since coarse soils do not effectively remove dissolved pollutants. This may require groundwater monitoring. INTs cannot be put into operation until the upstream tributary area is stabilized.

Site Suitability

INBs cannot be placed on fill or unstable sites. Also, INBs should not be placed in high-risk areas such as service/gas stations, truck stops, and heavy industrial sites due to the groundwater contamination risk.

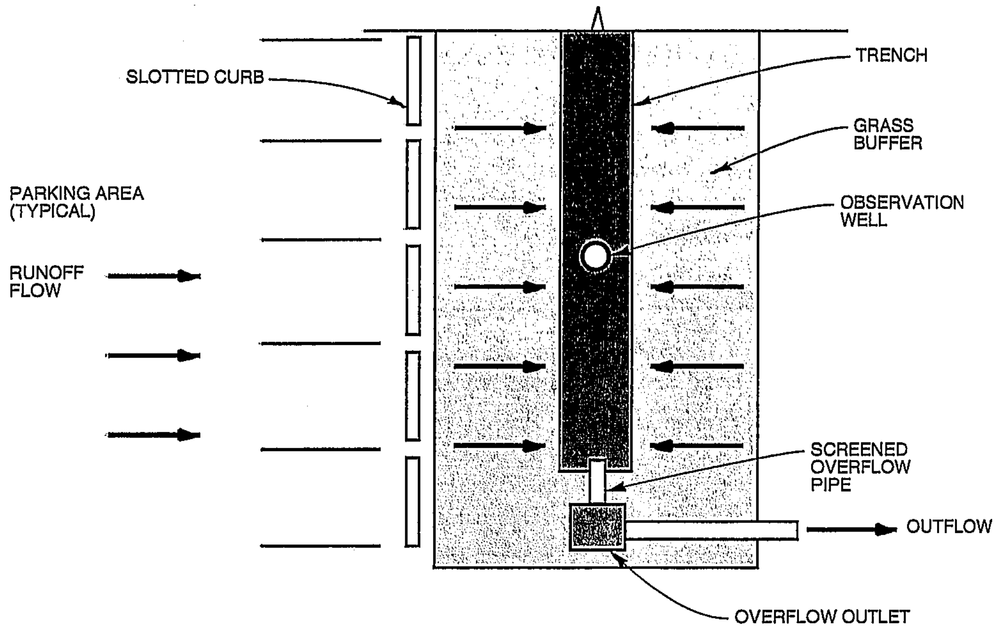
Before exploring the use of infiltration treatment control measures preliminary soil investigations, including a percolation test, shall be performed to assess whether the soils on site have an extended infiltration rate of at least 0.5 inches per hour. Separate on-site infiltration systems from the groundwater table (or bedrock) by a minimum of 5 feet vertically to provide sufficient infiltration volume within the soil. Tributary area should have a low potential for erosion. Other suitability considerations include the soil makeup (Appendix E), site topography, and the location of other facilities.

Infiltration facilities shall be sited at least 50 feet away from slopes steeper than 15 percent. Adequate spacing (100 feet or more) shall be provided between infiltration facilities and non-potable wells, tanks, drain fields and springs. For separation between infiltration BMPs and potable water supply wells, follow Department of Health Services requirements in the Guidelines for Location of Water Wells. INTs shall also be sited at least 20 feet down slope or 100 feet up slope from building foundations. A geotechnical expert shall be consulted when necessary to verify appropriate placement on site.

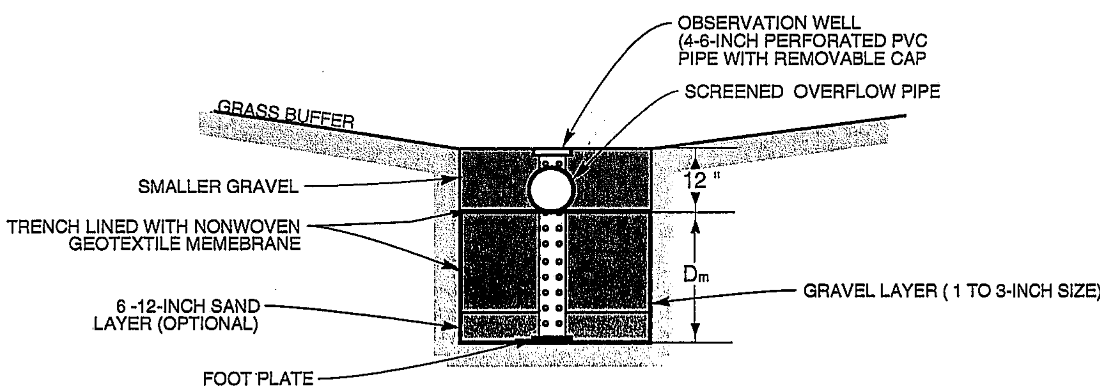
An important consideration for all infiltration facility configurations is that, during construction, great care must be taken not to reduce the infiltration capacity of the soil in the facility through compaction or by using the infiltration area as a sediment trap. Infiltration facilities shall be constructed late in the site development after soils (that might erode and clog the units) have been stabilized, or shall be protected until the site is stabilized.

Pollutant Removal

The amount of pollutant removed by INTs should be significant and should equal or exceed the removal rates provided by sand filters. In addition to settling, infiltration basins provide filtering, adsorption, and biological uptake of constituents in stormwater. Relative pollutant removal effectiveness is indicated in Table 5-1.



PLAN VIEW



SECTION VIEW

Figure 5-15. IINFILTRATION TRENCH

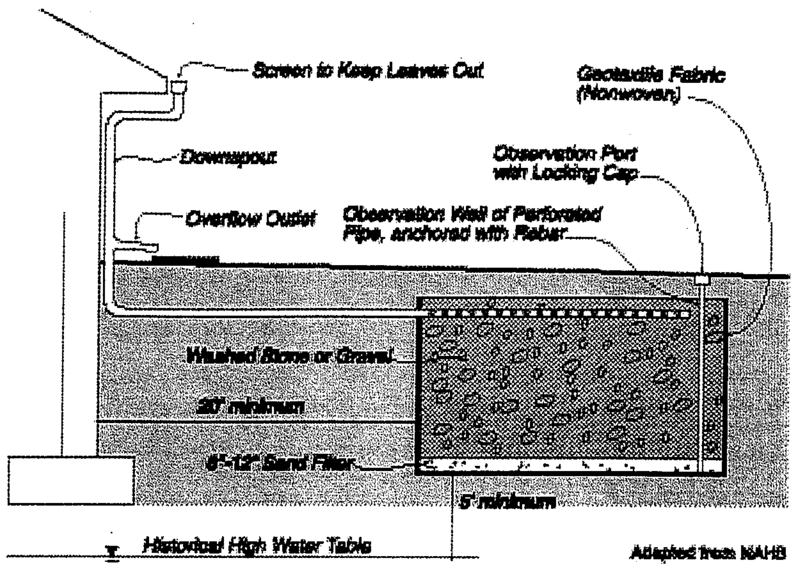


FIGURE 5-16. INFILTRATION VAULT

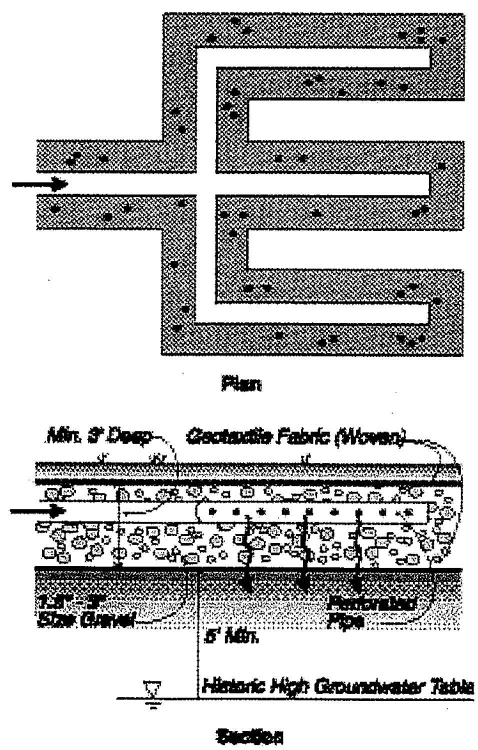


FIGURE 5--17. LEACH FIELD

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Design Criteria and Procedure

Principal design criteria for INTs are listed in Table 5-13. These criteria also apply to vaults and leach fields .

Table 5-13. Infiltration Trench Design Criteria

Design Parameter	Unit	Design Criteria
Drawdown time for SQDV	hrs	40
SQDV	acre-ft	80% annual capture. Use Figure 5-1 @ 40-h drawdown
Trench bottom elevation	ft	5 feet above seasonally high groundwater table minimum.
Trench surcharge depth (D_m)	ft	$D_m = \leq 8.0$ ft
Gravel bed material	ft	Clean, washed aggregate 1 to 3 inches in diameter
Trench lining material	–	Geotextile fabric (see Table 5-7)
Setbacks	ft ft.	100 feet from wells, tanks, fields, springs 20 feet down slope or 100 feet up slope from foundations Do not locate under tree drip-lines

Design procedure and application of design criteria are outlined in the following steps:

1. Trench Storage Volume — Provide a storage volume equal to 100 percent of the SQDV, based on a 40-hr drawdown time.

   a. Determine the percent imperviousness of the tributary area (I_a).

   b. Determine effective imperviousness (I_{wq}) by adjusting for site design source controls using Figure 3-4, as appropriate.

   c. Determine required unit basin storage volume (V_u) using Figure 5-1 with 40-hr drawdown and I_{wq} value from step 1.b.

   d. Calculate the SQDV in acre-ft as follows:

   $$SQDV = (V_u/12) \times Area$$

   where

   Area = Watershed area tributary to INB

2. Trench Water Depth — Calculate the maximum allowable depth of water surcharge in the trench. Maximum depth should not exceed 8 feet.:

   $$D_m = tI/12s$$

   where I = site infiltration rate in (in/hr)

   s = safety factor

   t = minimum drawdown time = 40 hours

In the formula for maximum allowable depth, the safety factor accounts for the possibility of inaccuracy in the infiltration rate measurement. The less certain the infiltration rate the higher the safety factor shall be. Minimum safety factors shall be as follows:

- Without site-specific borings and percolation tests, use s=10
- With borings (but no percolation test), use s=6
- With percolation test (but no borings), use s=5
- With borings and percolation test, use s=3

3. Trench Surface Area

Calculate the minimum surface area of the trench bottom:

$$A_m = V/D_m$$

where:

$A_m =$	minimum area required (ft^2)
$V =$	SQDV (ft^3)
$D_m =$	maximum allowable depth (ft)

4. Observation Well

Provide a vertical section of perforated PVC pipe, 4 to 6 inches in diameter, installed flush with top of trench on a foot plate and with a locking, removable cap.

5. Bypass

Provide for bypass or overflow of runoff volumes in excess of the SQDV by means of a screened overflow pipe connected to downstream storm drainage or grated overflow outlet.

Design Example

Design forms to document the design procedure are provided in Appendix G. A completed design form follows as a design example.

Design Procedure Form for T-10: Infiltration Trench

Designer:____________________

Company:____________________

Date:____________________

Project:____________________

Location:____________________

1. Determine Basin Storage Volume			
a. Percent Imperviousness of Tributary Area	I_a =	70	%
b. Effective Imperviousness (Determine using Figure 3-4	I_{wq} =	66	%
c. Required Unit Basin Storage Volume (V_u) Use Figure 5-1 with 40 hr drawdown and I_{wq}	V_u=	0.68	in.
d. Watershed Area Tributary to DBSF	Area =	0.5	acres
e. Calculate SQDV SQDV = (V_u / 12) x Area	SQDV =	0.028	acre-ft
2. Maximum Allowable Depth (D_m=tI/12s)			
a. Site infiltration rate (I)	I =	3.0	in/hr
b. minimum drawdown time (t = 40 hours)	t =	40	hrs
c. safety factor (s)	s =	3	
d. D_m=tI/12s	D_m =	3.33	ft.
3. Trench Bottom Surface Area			
A_s = SQDV / D_m	A_s =	366	ft^2

Notes:

Maintenance Requirements

The following maintenance requirements apply to Infiltration Trenches.

Maintenance Agreement

On-site treatment control measures are maintained by the owner/operator. Maintenance agreements between the owner/operator and the governing agency may be required. However, if pretreatment is recommended but not included in the design, a maintenance agreement will be required. If required, a maintenance agreement must be executed by the owner/operator before the improvement plans are approved. See Appendix C for example maintenance and access agreement.

Maintenance Plan

A post-construction Maintenance Plan shall be prepared and made available at the governing agency's request. The Maintenance Plan should address items such as:

- Operation plan and schedule, including a site map
- Maintenance and cleaning activities and schedule
- Equipment and resource requirements necessary to operate and maintain facility
- Responsible party for operation and maintenance

See Appendix D for additional Maintenance Plan requirements and suggested template.

Maintenance Activities

- Inspect a minimum of twice a year, before and after the rainy season, after large storms, or more frequently if needed.
- Clean when loss of infiltrative capacity is observed. If drawdown time is observed to have increased significantly over the design drawdown time, removal of sediment may be necessary. This is an expensive maintenance activity and the need for it can be minimized through prevention of upstream erosion.
- Mow, as appropriate for vegetative cover species.
- Monitor health of vegetation and replace as necessary.
- Control mosquitoes as necessary.
- Remove litter and debris from INT area as required.

Description

A media filter (MF) is a two-stage constructed treatment system, including a pretreatment settling basin and a filter bed containing sand or other filter media. Media filters are typically concrete vault structures with a solid wall or baffle wall separating the sediment chamber from the filter bed. The filter bed is supported by a gravel base course and is underdrained with perforated pipe.

This section provides design information for three types of media filters that are named after the area of the country where they were developed:

- T11.1: Austin Sand Filter System – large units, above or below surface, used in large drainage areas (up to 50 acres).
- T-11.2: DC Underground Sand Filter – underground line system used for small drainage areas (up to 1.5 acres); receives concentrated flows.
- T-11.3: Delaware (Linear) Sand Filter - situated along perimeter of small drainage area (up to 5 acres); receives sheet or concentration flows; can be used in areas of high ground water.

Due to size constraints, media filters are designed to only treat the SQDV. Diversion structures are used to route storm volumes in excess of the SQDV around the filter (see Appendix B).

General Application

Media Filters are generally suited to offline, onsite configurations where there is no base flow and the sediment load is relatively low. Media Filters remove particulate and floatable materials and are appropriate for drainage areas of up to 100 acres. Media filters are well suited to Southern California because they do not require vegetation and require less space than other treatment control measures with similar removal efficiencies when a partial treatment sedimentation basin is used. The effectiveness of the MF was proven in the City of Austin, where they are widely used today.

Selection of a unit configuration for a MF depends on the size of the drainage area and the facility location. Land uses for which MF are appropriate include residential, commercial, institutional, and industrial, except for extractive, chemical/petroleum, food and printing. A MF is not appropriate for agricultural sites or other areas with expanses of erosive soil upstream of the unit.

For large watersheds, i.e., 50 to 100 acres, an Austin sand filter is recommended. For small catchments requiring underground facilities, a DC sand filter is recommended. Delaware sand filters are especially suitable for paved sites and industrial sites because they can be situated to accept sheet flow from adjacent pavement.

To operate effectively, the filter media must be protected against clogging caused by excessive sediment or highly turbid waters. Placing a settling basin upstream of the filter provides this protection. For this reason, filters should not be put into operation while construction activities are taking place in the tributary catchment.

Advantages/Disadvantages

General

Primary advantages of MFs include effective water quality enhancement through settling and filtering. They also require less space than other treatment practices and can be located underground. Media Filters may be used when there is a lack of water for irrigation or base flow and it is infeasible to use a wet detention basin, wetlands or biofilter, which could be advantageous for Southern California.

The primary disadvantage of MFs is the potential for clogging. Although settling basins or other control measures effective for sediment removal, such as Grass Strip Filters or Grass Swale Filters, placed upstream of the filter will reduce this potential. Other disadvantages include significant head loss that may limit use on flat sites.

Site Suitability

Media Filter systems are designed to function by gravity. For systems located at sites without sufficient vertical relief to operate the filter by gravity, the design must be augmented to include a clear well and pumps to lift the stormwater from the settling basin to the filter. Note, costs for maintenance increase significantly when pumping is employed.

Because an underdrain system is incorporated into its design, MFs are suited for most soil conditions ; presence of sandy soils is not a requirement. This BMP has a relatively flat surface area, so it may be more challenging to incorporate it into the steeply sloping terrain. MFs should not be located close to construction sites or close to building foundations or areas where expansive soils are a concern.

Pollutant Removal

Media Filters effectively remove sediment and pollutants associated with sediment. Relative pollutant removal effectiveness of MFs is presented in Table 5-1.

Design Criteria and Procedure

T-11.1: Austin Sand Filter

There are two possible filter configurations used by Austin that may be considered.

- Full Sedimentation

  In this configuration, sedimentation occurs in a settling basin designed to hold the entire SQDV and release it to the filter over an extended draw-down time (40 hours). (See Figure 5-18 for typical configuration).

- Partial Sedimentation

  In this configuration, the settling basin holds a minimum of 20% of the water quality volume and does not incorporate an extended draw-down period. This removes the heavier sediment and large trash only and requires more intensive maintenance than the full sedimentation system. A larger filter surface area will be required to compensate for the more rapid clogging of the filter.

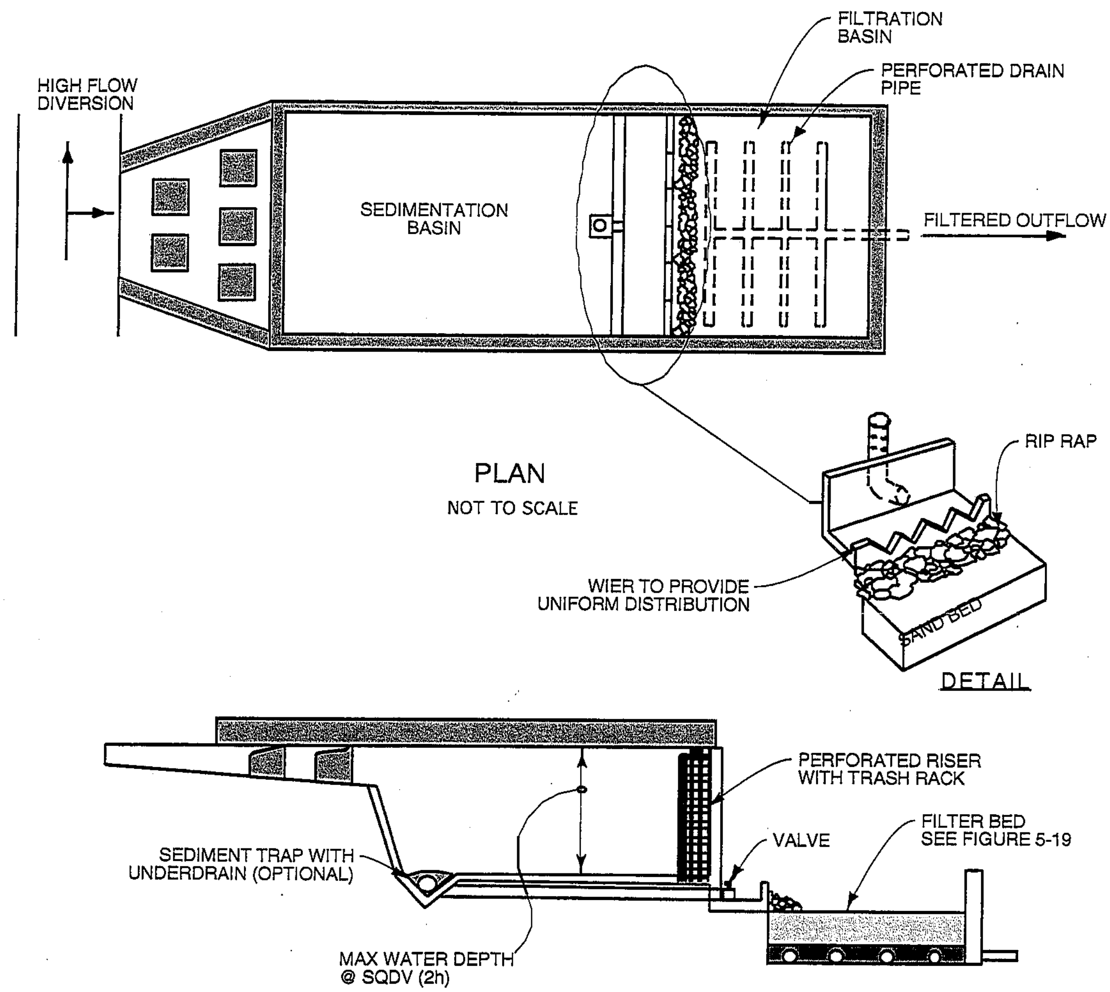
Design criteria for partial sedimentation are not included in this manual due to the increased maintenance required for this type of control measure. This configuration will only be considered when it is adequately shown that space limitations will not allow full sedimentation, and other control measures recommended in this manual are not viable alternatives.

Settling Basin Design

Settling basin design criteria for Austin Sand Filters are summarized in Table 5-14.

Table 5-14. Austin Sand Filter Sedimentation Basin Design Criteria

Design Parameter	Unit	Design Criteria
Maximum drainage area	acres	100
Minimum basin depth	ft	3.0
Minimum surface area (A_s)	ft^2	SQDV ÷ 10 ft
Length to width ratio, L:W	–	2:1 or greater
Minimum draw-down time	hrs	40
Freeboard	ft	1.0 ft above maximum water surface elevation
Minimum basin volume	ft^3	SQDV + freeboard volume
Maximum inlet velocity	fps	3.0
Minimum particle sized removed	micron	20 (specific gravity = 2.65)



Source: Austin, Texas

NOTE: SEDIMENTATION POND MAY BE USED IN LIEU OF CONCRETE BASIN. FILTRATION BASIN MAY BE BUILT DIRECTLY INTO GROUND OVER AN IMPERVIOUS GEOMEMBRANE IF SOIL CONDITIONS ALLOW.

ELEVATION
NOT TO SCALE

FIGURE 5-18. AUSTIN SAND FILTER

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Design procedure and application of design criteria for Austin Filter Sedimentation Basin are outlined in the following steps:

1.Basin Storage Volume	Provide a storage volume equal to 100 percent of the SQDV, based on a 40-hr drawdown time, above the lowest outlet (i.e. perforation or orifice) in the basin. a. Determine the percent imperviousness of the tributary area (I_a). b. Determine effective imperviousness (I_{wq}) by adjusting for site design source controls using Figure 3-4, as appropriate. c. Determine required unit basin storage volume (V_u) using Figure 5-1 with 40-hr drawdown and I_{wq} value from step 1.b. d. Calculate the SQDV in acre-ft as follows: SQDV = (V_u /12) x Area where Area = Watershed area tributary to Media Filter
2. Inlet/Outlet Design	Basin inlet and outlet points should provided with an energy dissipation structure and/or erosion protection. Energy dissipation devices may be necessary in order to reduce inlet velocities that exceed three (3) feet per second.
3. Basin Shape	Whenever possible, shape the basin with a gradual expansion from the inlet and a gradual contraction toward the outlet. The sedimentation basin design should maximize the distance from where the heavier sediment is deposited near the inlet to where the outlet structure is located. This will improve basin performance and reduce maintenance requirements. Short circuiting (i.e., flow reaching the outlet structure before it passes through the sedimentation basin volume) flow should be avoided. Dead storage areas (areas within the basin which are by-passed by the flow regime and are, therefore, ineffective in the settling process) should be minimized. The length to width ratio should be a minimum of 2:1. Internal baffling with berms may be necessary to achieve this ratio and could be used to mitigate short-circuiting and/or dead storage problems.
4. Trash Rack/Gravel Pack	A trash rack or gravel pack around perforated risers shall be provided to protect outlet orifices from clogging. Trash racks are better suited to use of perforated vertical plates for outlet control and allow easier access to outlet orifices for purposes of inspection and cleaning. Trash rack shall be sized to prevent clogging of the primary water quality outlet without restricting with the hydraulic capacity of the outlet controls orifices.

5. Sediment Trap (optional)

A sediment trap is a storage area that captures sediment and removes it from the basin flow regime. In so doing the sediment trap inhibits resuspension of solids during subsequent runoff events, improving long-term removal efficiency. The trap also maintains adequate volume to hold the water quality volume that would otherwise be partially lost due to sediment storage. Sediment traps may reduce maintenance requirements by reducing the frequency of sediment removal. It is recommended that the sediment trap volume be equal to 10 percent of the sedimentation basin volume. All water collected in the sediment trap shall drain out within 40 hours. The invert of the drain pipe should be above the surface of the sand bed filtration basin. The minimum grading of the piping to the filtration basin should be 1/4 inch per foot (two percent slope). Access for cleaning the sediment trap drain system is necessary.

6. Settling Basin Liner

If an impermeable liner is required to protect ground water quality it shall meet the specifications for clay liner given in Table 5-20. The clay liner should have a minimum thickness of 12 inches. If an impermeable liner is not required then a geotextile fabric liner shall be installed that meets the specifications listed in Table 5-17 unless the basin has been excavated to bedrock. If a geotextile liner is used it should have a minimum thickness of 30 mils and be ultraviolet resistant.

Filter Basin Design

Filter basin design criteria for Austin Sand Filters are summarized in Table 5-15.

Table 5-15. Austin Sand Filter.Basin Design Criteria

Design Parameter	Unit	Design Criteria
Minimum gravel depth over sand filter	inches	2.0
Minimum water depth over filter, h	ft	3.0
Minimum sand depth, d_f	inches	18.0
Minimum filtration rate of filter, k	ft/d	3.5
Slope of sand filter surface	%	0
Minimum gravel cover over underdrain	inches	.2
Sand size, diameter	inches	0.02 – 0.04
Under drain gravel size, diameter	inches	0.5 – 2.0
Minimum inside diameter underdrain	inches	6.0
Underdrain pipe type	–	PVC schedule 40 (or thicker)
Minimum slope of underdrain	%	1.0
Minimum underdrain peroration, diameter	inches	0.375
Minimum perorations per row	–	6
Minimum space between perforation rows	inches	6
Maximum drawdown time, t_f	hr	40.0
Minimum gravel bed depth, d_g	inches	16

Design procedure and application of design criteria for Austin Filter Sedimentation Basin are outlined in the following steps:

1. Maximum Water Depth . Determine maximum allowable depth of water (2h) in the sedimentation basin considering elevation differences between inlet and outlet invert elevations of sedimentation basin and filter surface elevation. (This height will establish weir height or elevation of inlet invert for bypass pipes and orifices.)

2. Filter Surface Area Surface area is the primary design parameter, and is a function of sand permeability, bed depth, hydraulic head and sediment loading. The required filter surface area (A_f) can be calculated using the following equation and design criteria provided in Table 5-16

$$A_{fm} = \frac{(SQDV)\, d_f}{k (h + d_f) t_f}$$

Where: WQV = SQDV, cf

A_{fm} = filter surface area, ft^2

d_f = sand bed depth, ft

k = coefficient of permeability for sand filter (ft./hr.)

h = one-half of maximum allowable water depth (2h) over filter, ft.

t_f =t ime required for runoff volume to pass through filter, hrs.

2. Filter Basin Volume

The storage capacity of the filtration basin, above the surface of the filter media, should be greater than or equal to 20 percent of the SQDV. This capacity is necessary in order to account for backwater effects resulting from partially clogged filter media.

3. Inlet Structure

The inlet structure should spread the flow uniformly across the surface of the filter media. Flow spreaders, weirs or multiple orifice openings are recommended.

4. Filter Bed

The sand bed may be a choice of one of the two configurations given below. Note: Sand bed depths are final, consolidated depths. Consolidated effects must be taken into account.

1) Sand Bed with Gravel Layer (Figure 5-19A)

The sand layer is a minimum depth of 18 inches consisting of 0.02-0.04 inch diameter sand. Under the sand is a layer of 0.5 to 2.0-inch diameter gravel which provides a minimum of two inches of cover over the top of the underdrain lateral pipes. No gravel is required under the lateral pipes. A layer of geotextile fabric meeting the specifications in Table 5-16 must separate the sand and gravel and must be used to be wrap around the lateral pipes.

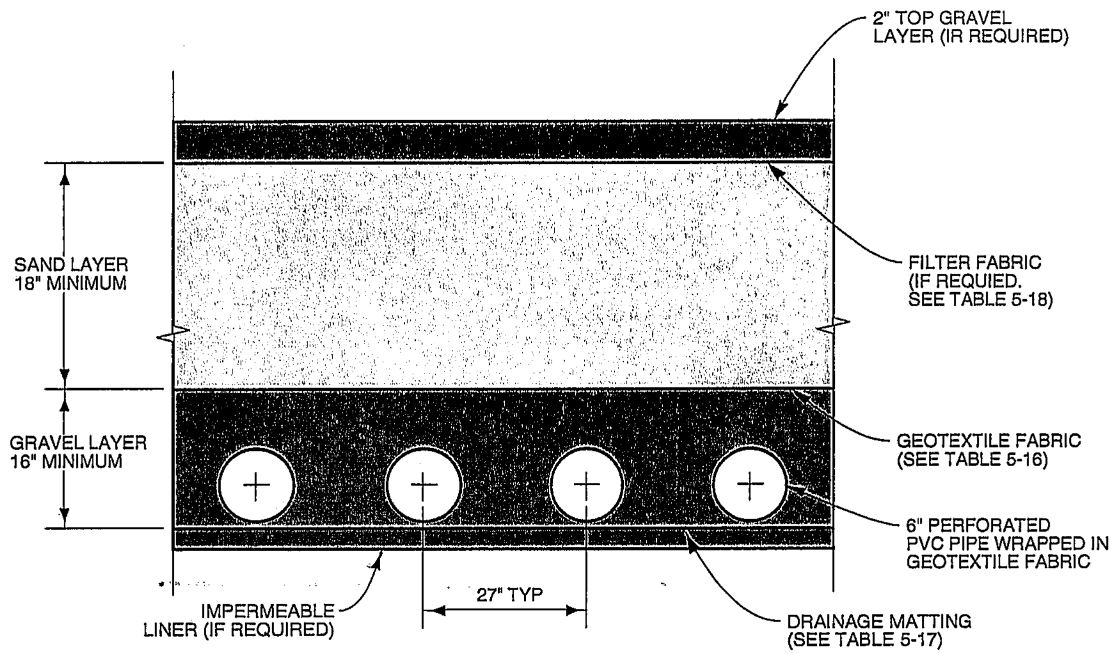
Drainage matting meeting the specifications in table 5-17 should be placed under the laterals to provide for adequate vertical and horizontal hydraulic conductivity to the laterals.

In areas with high sediment load (total suspended solids concentration ≥200 mg/L), the two-inch layer of stone on top of the sand filter should be underlain with Enkadrain 9120 filter fabric or equivalent meeting the specifications in Table 5-18.

2) Sand Bed - Trench Design (Figure 5-19B)

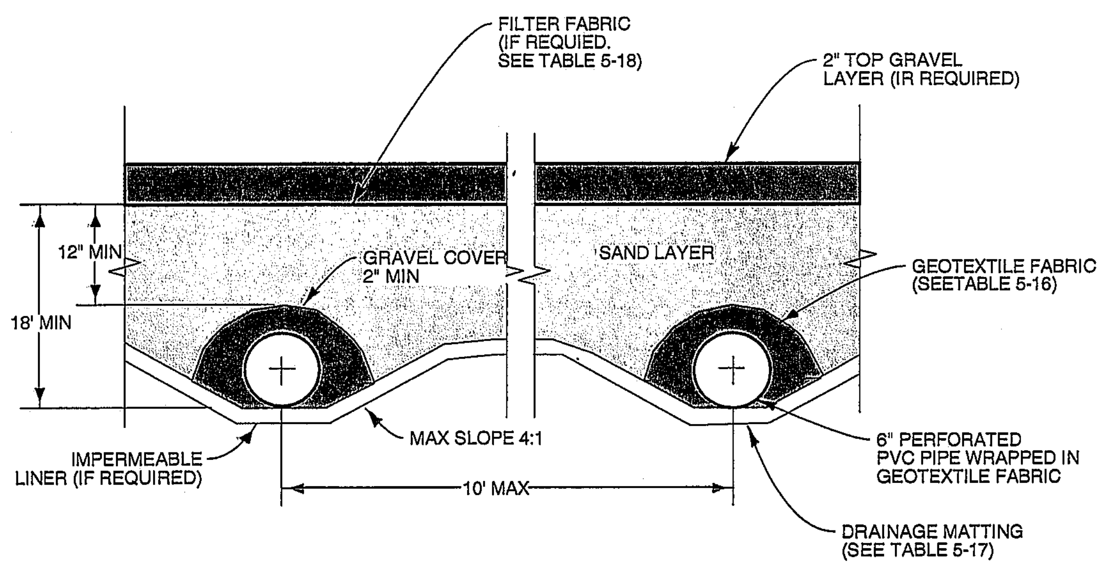
The top layer shall be 12-18 inches of 0.02-0.04 inch diameter sand. Laterals shall be placed in trenches with a covering of 0.5 to 2.0-inch gravel and geotextile fabric (see Table 5-16). The laterals shall be underlain by a layer of drainage matting (see Table 5-17).

In areas with high sediment load (total suspended solids concentration ≥200 mg/L), the two-inch layer of stone on top of the sand filter should be underlain with Enkadrain 9120 filter fabric or equivalent meeting the specifications in Table 5-18.



NOT TO SCALE

FIGURE 5-19A. FILTER BED WITH GRAVEL UNDERDRAIN



NOT TO SCALE

FIGURE 5-19B. FILTER BED WITH TRENCH UNDERDRAIN

Table 5-16. Geotextile Fabric Specifications

Property	Test Method	Unit	Specification
Material			Nonwoven geotextile fabric
Unit Weight		Oz./Sq.yd.	8 (min.)
Filtration Weight		In/Sec	0.08 (min.)
Puncture Strength	ASTM D-751 (Modified)	Lb.	125 (min.)
Mullen Burst Strength	ASTM D-751	PSI	400 (min.)
Tensile Strength	ASTM-D-1682	Lb.	300 (min.)
Equiv. Opening Size	US Standard Sieve	No.	80 (min.)

Table 5-17. Drainage Matting Specifications

Property	Test Method	Unit	Specification
Material			Nonwoven geotextile fabric
Unit Weight		Oz/Sq.yd.	20
Flow Rate (fabric)		GPM/ft.	180 (min.)
Permeability	ASTM D-2434	Cm/Sec.	12.4 x 10^{-2}
Grab strength (fabric)	ASTM D-1682	Lb.	Dry Lg. 90 Dry Wd:70 Wet Lg.95 Wet Wd: 70
Puncture strength (fabric)	COE CW-02215	Lb.	42 (min.)
Mullen burst strength	ASTM D-1117	Psi	140 (min.)
Equiv. opening size	US Standard Sieve	No.	100 (70-120)
Flow rate (drainage core)	Drexel Univ. Test Method	GPM/ft. width	14

Source: City of Austin

Table 5-18. Filter Fabric Specifications

Property	Test Method	Unit	Specification
Material			Non-woven geotextile fabric
Unit Weight		Oz./Sq.yd.	4.3 (min.)
Flow rate		gpm/ft^2	120 (min.)
Puncture Strength	ASTM D-751 (Modified)	Lb.	60 (min.)
Thickness		in.	0.8 (min.)

5. Underdrain Piping

The underdrain piping consists of the main collector pipe(s) and perforated lateral branch pipes. The piping should be reinforced to withstand the weight of the overburden. Internal diameters of lateral branch pipes should be six (6) inches or greater and perforations should be 3/8 inch. Each row of perforations should contain at least six (6) holes and the maximum spacing between rows of perforations should not exceed six (6) inches. All piping is to be schedule 40 polyvinyl chloride or greater strength. The minimum grade of piping shall be 1/8 inch per foot (one (1) percent slope)(slopes down to .5% are acceptable with prior approval). Access for cleaning all underdrain piping is needed.

Note: No draw-down time is to be associated with sand filtration basins, only with sedimentation basins. Thus, it is not necessary to have a specifically designed orifice for the filtration outlet structure.

6. Filter Basin Liner

If an impermeable liner is required to protect ground water quality it shall meet the specifications for clay liner given in Table 5-19. The clay liner should have a minimum thickness of 12 inches. If an impermeable liner is not required then a geotextile fabric liner shall be installed that meets the specifications listed in Table 5-16 unless the basin has been excavated to bedrock. If a geotextile liner is used it should have a minimum thickness of 30 mils and be ultraviolet resistant.

Table 5-19. Clay Liner Specifications

Property	Test Method	Unit	Specification
Permeability	ASTM D-2434	cm./sec.	$1x10^{-6}$
Plasticity Index of Clay	ASTM D-423 & D-424	%	Not less than 15
Liquid Limit of Clay	ASTM D-2216	%	Not less than 30
Clay Particles Passing	ASTM D-422	%	Not less than 30
Clay Compaction	ASTM D-2216	%	95% of Standard Proctor Density

Source: City of Austin

Design Example

Design forms to document the design procedure are provided in Appendix G. A completed design form follows as a design example.

Design Procedure Form for T-11.1: Austin Sand Filter

Designer:________________________________

Company:________________________________

Date:________________________________

Project:________________________________

Location:________________________________

1. Determine Basin Storage Volume			
a. Percent Imperviousness of Tributary Area	I_a =	68	%
b. Effective Imperviousness (Determine using Figure 3-4	I_{wq} =	60	%
c. Required Unit Basin Storage Volume (V_u) Use Figure 5-1 with 40 hr drawdown and I_{wq}	V_u=	0.64	in.
d. Watershed Area Tributary to DBSF	Area =	2.31	acres
e. Calculate SQDV SQDV = (V_u / 12) x Area	SQDV =	0.123	acre-ft
2. Maximum Water Depth			
a. Storm drainage system invert elevation at proposed connection to storm drain	Inlet Elevation	90	ft
b. Minimum control measure outlet invert elevation of sand filter at minimum grade:	Outlet Elevation	90.75 @ 1%	ft
c, Estimate filter depth or use minimum depth of filter media and determine the difference in elevation between inverts of filter inlet and outlet:	Filter Depth	97.5	ft
d. Site plan surface elevation at control measure location	Surface Elvation	103.0	ft
e. Determine inlet invert elevation into sedimentation basin	Inlet Elevation (Sed. Basin)	100.0	ft
f. Determine maximum allowable depth of water (2h) in the sedimentation basin considering elevation differences between inlet and outlet invert elevations of sedimentation basin and filterand surface elevation. (This height will establish weir height or elevation of inlet invert for bypass pipes and orifices.)	Maximum Allowable Depth	3.0	ft

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Design Procedure Form for T-11.1: Austin Sand Filter (Page 2 of 2)

Project:____

3. Filter Surface Area			
a. Sand Bed Depth	d_f =	1.5	ft
b. Coefficient of permeability for sand filter	k =	0.1458	ft. / hr.
c. One half of maximum allowable depth over filter. (h)	h =	1.5	ft
d. Time required for runoff to pass through filter.	t_f =	40	hrs.
e. Filter Surface Area (minimum) $A_{fm} = \frac{(SQDV)\,d_f}{k\,(h + d_f)\,t_f}$	A_{fm} =	459	ft^2
4. Filter Basin Volume			
Filter Basin Volume = 0.2 x SQDV	FBV =	1,072	ft^3

Notes:

T-11.2: DC Filter

The District of Columbia (D.C.) Environmental Regulation Administration developed an underground stormwater sand filter (referred to as the D.C. Sand Filter) contained in a structural shell with three chambers (see Figure 5-20). The shell may consist of precast or cast-in-place concrete.

The plunge pool in the first chamber and the throat of the second chamber, which are hydraulically connected by an underwater rectangular opening, absorbs energy and provides pretreatment, trapping grit and floating organic material such as oil, grease, and tree leaves. The second chamber contains a typical sand filter with a subsurface drainage system consisting of perforated PVC pipe in a stone bed. The third chamber, or clearwell, collects the flow from the underdrain pipes, and overflow pipes when installed, and directs the waters to the storm drainage system. A hooded large storm bypass pipe directly connecting the first chamber with the clearwell is illustrated in Figure 5-21. When storm flows are diverted upstream of the sediment chamber, an in-system overflow or bypass is neither necessary nor desired.

A major advantage of the D.C. sand filter is that it does not take up any space on the surface. It can be placed under on-site roadways (e.g., not public rights of way), parking lots, or sidewalks, and under planting spaces adjacent to buildings. The system works best for watersheds of approximately one acre of impervious surface. For larger watersheds, two or more DC sand filters will be required.

The load-carrying capacity of the filter structure must be considered when it is located under parking lots, driveways, roadways, and certain sidewalks (such as those adjacent to State highways). Traffic intensity may also be a factor. The structure must be designed by a licensed structural engineer. The effects of buoyancy must be considered in the design of an underground vault in areas with high ground water.

For cost, reliability, and maintenance considerations, it is preferable that the filter work by gravity flow. This requires sufficient vertical clearance between the invert of the prospective inflow storm piping and the invert of the storm drain which will receive the outflow.

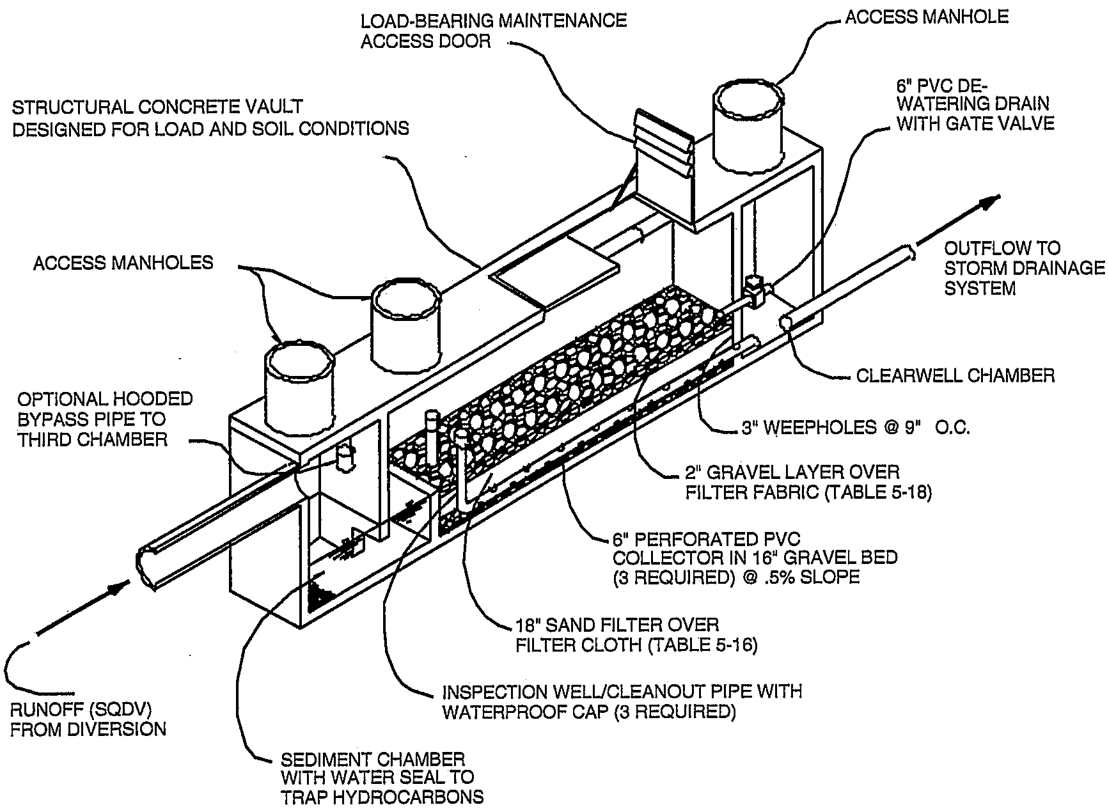
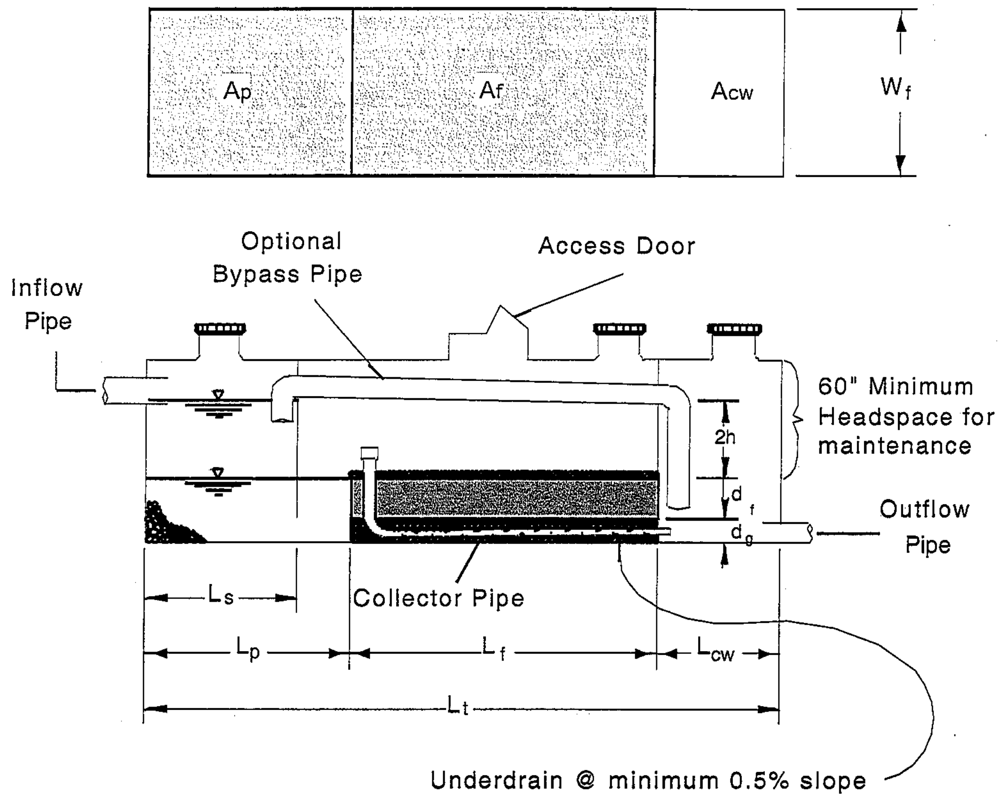


FIGURE 5-20. DC SAND FILTER



Where:
A_p = Area of sediment chamber
A_f = Area of sand filter
A_{cw} = Area of clearwell
W_f = Width of filter
L_s = Minimum length of sediment chamber
L_p = Final length of permanent pool
L_f = Filter length
L_{cw} = Length of clearwell
L_t = Total length, sum of $L_p + L_f + L_{cw}$
2h = Maximum achievable ponding depth over filter
d_f = sand bed depth
d_g = gravel depth

Figure 5-21. DIMENSIONAL RELATIONSHIPS FOR DC SAND FILTER

Design Criteria

Principal design criteria for DC Sand Filters are summarized in Table 5-20.

Table 5-20. DC Sand Filter Design Criteria

Design Parameter	Unit	Criteria Value
Maximum drainage area	acres	1.5
Maximum draw down time in filter, t_f	hrs	40
Minimum gravel depth over filter media	in.	2.0
Minimum sand filter depth, d_f	in.	18
Minimum gravel depth below filter, d_g	in.	16
Minimum cover of gravel over underdrain pipe	in.	2
Filter coefficient, k	ft/day	2
Minimum volume of SQDV to be contained in sediment chamber	%	20
Minimum slope of underdrain	%	1
Maximum diameter of upper level gravel cover	in.	1
Minimum length of clearwell, L_{cw}	ft.	3.0
Filter sand sizing	—	ASTM C 33 concrete sand
Minimum size diameter gravel in underdrain	in.	0.5 to 2
Minimum size underdrain pipe	—	6" Sch 40 reinforced PVC pipe
Minimum size diameter perforation in drainage pipe	in.	3/8
Minimum number of perforation holes per underdrain pipe	—	6
Maximum spacing between perforation holes	in.	6
Maximum spacing of underdrain pipes	in.	27 (center to center)

Design Procedure

Design procedure and application of design criteria for DC Sand Filter are outlined in the following steps (see Figure 5-21 for dimensional relationships):

1. Maximum Water Depth — Determine maximum allowable depth of water (2h) in the filter basin considering elevation differences between inlet and outlet invert elevations. (This height will establish weir height or elevation of inlet invert for bypass pipes and orifices).

2. Sand Filter Area — Determine the minimum area of the DC Filter using the Austin Filter Formula for partial sedimentation treatment.

$$A_{fm} = \frac{(SQDV)(d_f)}{k(h + d_f)(t_f)}$$

where:

A_{fm} = filter surface area, ft^2

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d_f = sand bed depth, ft

k = filter coefficient @ 0.0833 ft./hr.

h = one-half of maximum allowable water depth (2h), ft.

t_f = 40 h draw-down time

3. Filter Width / Length

Considering site constraints, select a Filter Width (W_f). Then compute the Filter Length (L_f) using the minimum area required (A_{fm}).

$L_f = A_{fm}/W_f$

Round the length and determine adjusted area, Af.

$A_f = W_f \times L_f$

(After Note: From this point, formulas assume rectangular cross section of filter shell.)

4. Storage Volume
   a. above filter (V_{tf}) — $V_{tf} = A_f \times 2h$
   b. in filter voids (Vv) — $V_v = A_f \times (d_f + d_g) \times (0.4)$ {assume 40% voids}

5. Flow Through Filter During Filling (V_Q)

$V_Q = k \times A_f \times (d_f + d_g) \times t_f / d_f$

Use: $k = 2$ ft/day = 0.0833 ft/hr.

$t_f = 1$ hr. to fill voids

6. Net Volume to be Stored in Sediment Chamber Awaiting Filtration (Vst)

V_{st} =SQDV - $V_{tf} - V_v$ - V_Q

7. Minimum Length of Permanent Pool (L_{pm})

$L_{pm} = V_{st} /(2h)(W_f)$ {See Figure 5-21 for dimensional relationships}

8. Minimum Length of Sediment Chamber (L_s)
   a. If $V_{st} > (0.2SQDV)$ — use: $L_s = V_{st} /(2h)(W_f)$
   b. If $V_{st} < (0.2SQDV)$ — use: $L_s = 0.2SQDV /(2h)(W_f)$

Note: It may be economical to adjust final dimensions to correspond with standard precast structures or to round off to simplify measurements during construction.

9. Final Length of Permanent Pool (L_p)
   a. If L_{pm}, < $(L_s + 2)$ — use: $L_p = L_{pm}$
   b. If L_{pm}, > $(L_s + 2)$ — use: $L_p = (L_s + 2)$

10. Length of Clearwell (L_{cw})	Set the length of the clearwell (L_{cw}) for adequate maintenance and/or access for monitoring flow rate and chemical composition of effluent (minimum 3 ft.).
11. Filter Bed	
a. Top Gravel Layer	The washed gravel layer at the top of the filter should be two inches thick composed of stone 0.5 inch to 2.0 inch diameter in size. In areas with high sediment load (TSS concentration >200 mg/L), the two-inch layer of stone on top of the sand filter should be underlain with filter fabric meeting the specifications in Table 5-19.
b. Sand Layer	The sand layer should be a minimum depth of 18 inches consisting of ASTM C33 concrete sand. A layer of geotextile fabric meeting the specifications in Table 5-16 must separate the sand and gravel layer below.
c. Gravel Layer	The gravel layer surrounding the collector pipes should be at least 16 inches thick and be composed of 0.5 to 2-inch diameter stone and provide at least two inches of cover over the tops of the drainage pipes.
12. Underdrain Piping	The underdrain piping consists of the main collector pipe(s) and perforated lateral branch pipes. The piping should be reinforced to withstand the weight of the overburden. Internal diameters of lateral branch pipes should be six (6) inches or greater and perforations should be 3/8 inch. Each row of perforations should contain at least six (6) holes and the maximum spacing between rows of perforations should not exceed six (6) inches. All piping is to be schedule 40 polyvinyl chloride or greater strength. The minimum grade of piping shall be 1/8 inch per foot (one (1) percent slope)(Note: slopes down to 0.5% are acceptable with prior approval). Access for cleaning all underdrain piping is needed.
13. Weep Holes	In addition to the underdrain pipes, weepholes should be installed between the filter chamber and the clearwell to provide relief in case of pipe clogging. The weepholes should be three (3) inches in diameter. Minimum spacing should be nine (9) inches center to center. The openings on the filter side of the dividing wall should be covered to the width of the trench with 12 inch high plastic hardware cloth of 1/4 inch mesh or galvanized steel wire, minimum wire diameter 0.03-inch, number 4 mesh hardware cloth anchored firmly to the dividing wall structure and folded a minimum of six (6) inches back under the bottom stone.
14. Dewatering Drain	A six (6) inch diameter DIP or PVC dewatering drain with a gate valve is to be installed at the top of the stone/sand filter bed through the partition separating the filtration chamber from the clearwell chamber.

15. Bypass Pipe — Where a bypass pipe is needed, it shall be DIP or PVC with supports every 18 inches minimum.

Design Example

Design forms to document the design procedure are provided in Appendix G. A completed design form follows as a design example.

Design Procedure Form for T-11.2:: DC Sand Filter

Designer:____________________

Company:____________________

Date:____________________

Project:____________________

Location:____________________

1. Determine Basin Storage Volume			
a. Percent Imperviousness of Tributary Area	I_a =	68	%
b. Effective Imperviousness (Determine using Figure 3-4	I_{wq} =	60	%
c. Required Unit Basin Storage Volume (V_u) Use Figure 5-1 with 40 hr drawdown and I_{wq}	V_u=	0.64	in.
d. Watershed Area Tributary to DBSF	Area =	1.0	acres
e. Calculate SQDV SQDV = (V_u / 12) x Area	SQDV =	0.053	acre-ft
1. Minimum Filter Area $A_{fm} = \frac{(SQDV)(d_f)}{k\,t\,(h+d_f)}$			
a. SQDV	SQDV =	2,323	ft³
b. Sand bed depth (d_f)	d_f =	1.5	ft
c. Filter Coefficient (k)	k =	0.0833	ft. / hr.
d. Draw-down time (t_f= 40 hour)	t =	40	hr
e. one half maximum allowable water depth over filter (h)	h =	1.67	ft
f. Minimum filter area	A_{fm} =	482	ft²
2. Select Filter Width, Compute Filter Length			
a. Select a Filter Width (W_f)	W_f =	12.0	ft.
b. Compute filter length $L_f = A_{fm}/W_f$	L_f =	40.1	ft.
c. Determine adjusted filter area (Round L_f to closest whole number) A_f = W_f x L_f	A_f =	480	ft²
(From this point, formula assume rectangular cross section of filter shell.)			

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Design Procedure Form for T-11.2: DC Filter (Page 2 of 2)

Project:________________

3. Compute the Storage Volume of Top of the Filter (V_{tf}) $V_{tf} = A_f \times 2h$	$V_{tf} =$ 1,603 ft^3
4. Compute the Storage in the Filter Voids (Vv) (Assume 40% voids in the filter media) $V_v = A_f \times (d_f + d_g) \times 0.40$	$V_v =$ 544 ft^3
5. Flow Through Filter During Filling (V_Q) (Assume 1-hour to fill) $V_Q = k \times A_f \times (d_f + d_g) \times t_f / d_f$ Use: k = 2 ft/day = 0.0833 ft/hr. t_f = 1 hr. to fill voids	$V_Q =$ 75.5 ft^3
6. Compute Net Volume to be Stored in Permanent Pool Awaiting Filtration (Vst) $V_{st} = SQDV - V_{tf} - V_v - V_Q$	$V_{st} =$ 100.5 ft^3
7. Compute Minimum Length of Permanent Pool (Lpm) $L_{pm} = V_{st} / (2h)(W_f)$	$L_{pm} =$ 2.5 ft
8. Compute Minimum Length of Sediment Chamber (L_s) (to contain 20% of SQDV) If $V_{st} < (0.2SQDV)$, use: $L_s = 0.2SQDV / (2h)(W_f)$ If $V_{st} > (0.2SQDV)$, use: $L_s = V_{st} / (2h)(W_f)$	$L_s =$ 11.6 ft
9. Set Final Length of Permanent Pool (Lp) If $L_{pm} \geq (L_s + 2\text{ ft})$, use: $L_p = L_m$ If $L_{pm} < (L_s + 2\text{ ft})$, use: $L_p = (L_s + 2\text{ ft})$	$L_p =$ 13.6 ft
10. Set Final Length of Clear Well (Lcw) L_{cw} = 3 ft minimum	$L_{cw} =$ 4.0 ft

Notes:

T-11.3: Delaware (Linear) Sand Filter

A schematic drawing of the modified Delaware Sand Filter (DSF) is shown in Figure 5-22. The system consists of two parallel concrete trenches divided by a close-spaced wall. The first trench serves as the sedimentation chamber. When accepting sheet flow, it is fitted with a grated cover. Concentrated stormwater may also be conveyed to the chamber in enclosed storm drain pipes. The second chamber, which contains the sand filter, is always fitted with a solid cover.

Storm flows enter the sedimentation chamber through the grates, causing the sedimentation pool to rise and overflow into the filter chamber through the weir notches at the top of the dividing wall. This provides assurance that the water to be treated arrives at the filter as sheet flow. This is essential to prevent scouring of the sand. The permanent pool in the sedimentation chamber is dead storage, which inhibits resuspension of particles that were deposited in earlier storms and prevents the heavier sediments from being washed into the filter chamber. Floatable materials and hydrocarbon films, however, may reach the filter media through the surface outflow.

The second trench contains the top 2 inches stone filter layer, the middle 18 inches of sand, and the bottom 16 inch stone layer. Six inch diameter PVC underdrains are provided in this stone layer to carry the filtered water to the clearwell and ultimately to the storm drain. For smaller units, less than 20 feet in length, a gravel underdrain bed with the weep holes may be used in place of PVC pipe.

For systems where storm flows in excess of the SQDV are not diverted upstream of the filter, an overflow weir into the clearwell from the sedimentation chamber will convey the runoff greater than the SQDV directly to the storm sewer. The overflow weir shall be sized to pass volume of water that exceeds the SQDV. Where retention of hydrocarbons is a concern, the weir should be fitted with a metal hood or commercial catch basin trap.

To ensure the filter can be drained if plugged, a 6-inch dewatering drain with gate valve is included in the design of the filter.

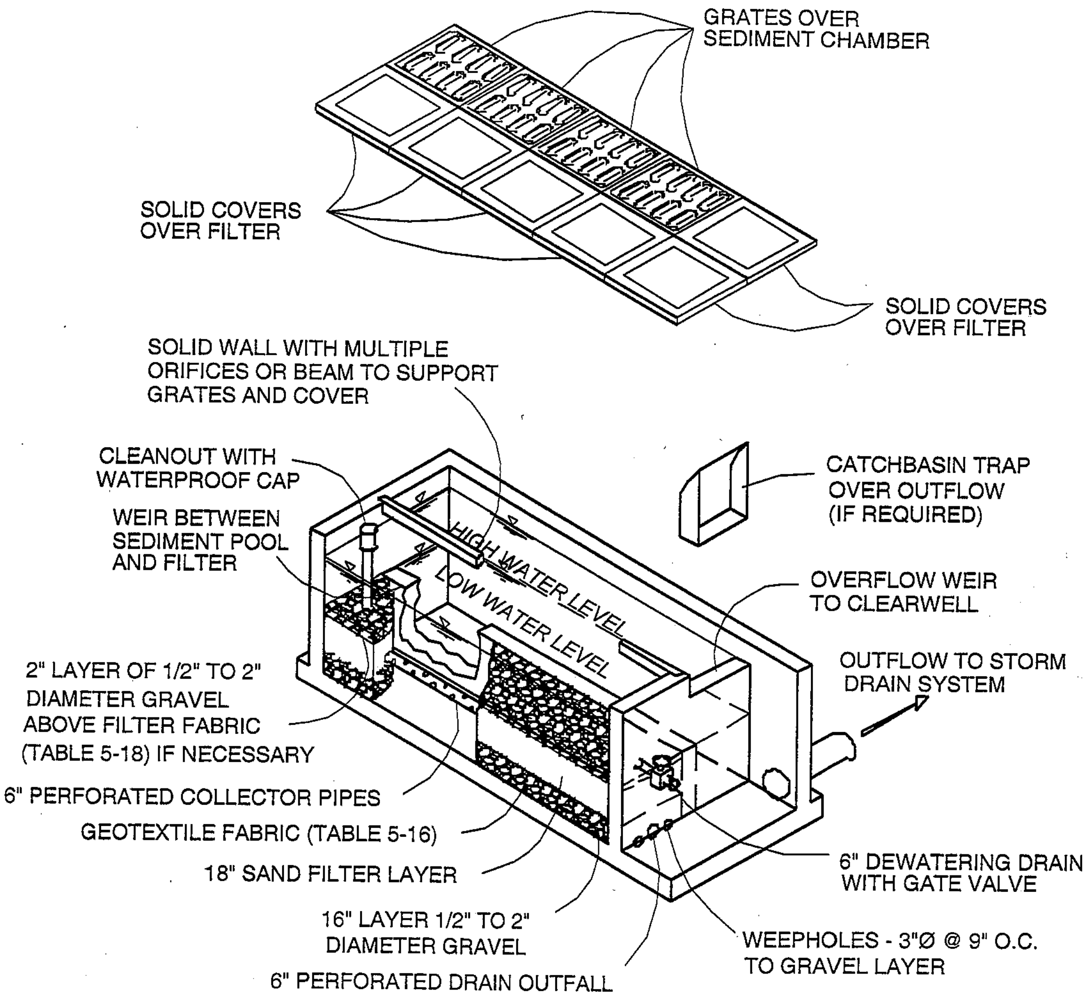


FIGURE 5-22. DELAWARE SAND FILTER

Design Criteria

Principal design criteria for the Delaware Sand Filter are summarized in Table 5-21

Table 5-21. Delaware Sand Filter Design Criteria

Design Parameter	Unit	Criteria
Maximum drainage area	acres	5
SQDV	acre-ft	80% annual capture. Use Figure 5-1 @ 40-h drawdown
Weir height between sedimentation chamber and sand filter	in.	Set weir height 2" above sand filter bed
Minimum draw down time, t_f	hrs	40
Minimum gravel depth over sand	in.	2
Minimum sand depth, d_f	in.	18
Minimum gravel underdrain depth, d_g	in.	16
Filter coefficient, k	ft/day	2
Top layer and underdrain gravel size	in.	0.5 to 2-inch diameter stone
Sand size	—	ASTM C33 concrete sand
Slope of top layer	%	0 (horizontal)
Minimum slope of underdrain or bottom of filter	%	0.5%
Minimum size underdrain	—	6" PVC schedule 40
Minimum size diameter perforation	in.	3/8
Minimum number of holes per row	—	6
Minimum spacing between rows	in.	6
Minimum weephole diameter	in.	3
Minimum spacing between weepholes	in.	9 (center to center)
Sedimentation chamber and sand filter width	in.	18 to 30

Design Procedure

Design procedure and application of design criteria for Delaware Sand Filter are outlined in the following steps:

1. Maximum Water Depth — Based on site constraints determine the maximum ponding depth over filter (2h). If an overflow device is built into the DSF shell, size the overflow weir in procedures in Appendix B.

2. Sand Filter / Sediment Chamber Surface Area — The DSF shell must have the capacity to accept and store the SQDV. The dimensions are sized to provide a filter area which processes the SQDV in the desired time frame (40 hrs.). The areas of the sedimentation chamber and filter bed are typically set equal. The required areas are calculated as follows depending on the maximum depth of water above the

	filter bed:
a. If $2h < 2.67$ ft	Use: $A_{sm} = A_{fm} = SQDV/(4.1h + 0.9)$
b. If $2h > 2.67$ ft	Use: $A_{sm} = A_{fm} = \frac{(SQDV)(d_f)}{(k)(h + d_f)(t_f)}$

Where:

$SQDV$ = Stomwater Quality Design Volume, ft^3

A_{fm} = filter surface area, ft^2

A_{sm} = sediment chamber area, ft^2

d_f = sand bed depth, ft

k = filter coefficient @ 0.0833 ft./hr.

h = one-half of max allowable water depth (2h), ft.

t_f = 40 h draw-down time

3. Select sediment chamber and filter width ($W_s = W_f$) — Site considerations usually dictate the final dimensions of the facility. Sediment chambers and filter chambers are normally 18-30 inches wide. Use of standard grates requires a width of 26 inches.

4. Sediment Chamber/ Filter Length — $L_s = L_f = A_{fm} / W_f$

   Round length upward as appropriate. Compute adjusted Area

   $A_s = A_f = W_f \times L_f$

5. Storage Volume in filter voids (Vv) — $V_v = A_f \times (d_f + d_g) \times (0.4)$ {assume 40% voids}

6. Flow Through Filter During Filling (V_Q) — $V_Q = k \times A_f \times (d_f + d_g) \times t_f / d_f$

   Use: $k = 2$ ft/day $= 0.0833$ ft/hr.

   $t_f = 1$ hr. to fill voids

7. Net Volume Required to be Stored in Chambers Awaiting Filtration (V_{st}) — $V_{st} = SQDV - V_v - V_Q$

8. Available Storage in Chambers (V_{sf}) — $V_{sf} = 2h(A_f + A_s)$

   If $V_{sf} \geq V_{st}$, proceed with design

   If $V_{sf} < V_{st}$, adjust width and/or length and repeat steps 3 –8.

9. Filter Bed

   a. Top Gravel Layer — The washed gravel layer at the top of the filter should be two

	inches thick composed of stone 0.5 to 2.0 inches in diameter.
	In areas with high sediment load (TSS concentration >200 mg/L), the two-inch layer of stone on top of the sand filter should be underlain with filter fabric meeting the specifications in Table 5-18.
b. Sand Layer	The sand layer should be a minimum depth of 18 inches consisting of ASTM C33 concrete sand. A layer of geotextile fabric meeting the specifications in Table 5-16 must separate the sand and gravel layer below.
c. Gravel Layer	The gravel layer surrounding the collector pipes should be at least 16 inches thick and be composed of 0.5 to 2-inch diameter stone and provide at least two inches of cover over the tops of the drainage pipes.
10. Underdrain Piping	The underdrain piping should follow the same criteria and design as the Austin Sand Filter.
	Shallow rectangular drain tiles may be fabricated from such materials as fiberglass structural channels, saving several inches of filter depth. Drain tiles should be in two-foot lengths and spaced to provide gaps 1/8-inch less than the smallest gravel sizes on all four sides. Sections of tile may be cast in the dividing wall between the filter and the clearwell to provide shallow outflow orifices.
11. Weep Holes	Weephole configuration should follow the same criteria as the DC Sand Filter.
12. Grates and Covers	Grates and cast steel covers are designed to take the same wheel loads as the adjacent pavement. Where possible, use standard grates to reduce costs. Grates and covers should be supported by a galvanized steel perimeter frame
13. Hoods / Traps	In applications where trapping of hydrocarbons and other floating pollutants is required, large-storm overflow weirs should be equipped with a 10-gauge aluminum hood or commercially available catch basin trap. The hood or trap should extend a minimum of one foot into the permanent pool.
14. Dewatering Drain	A six inch diameter dewatering drain with gate valve is to be installed at the top of the stone/sand filter bed through the partition separating the filter chamber from the clearwell chamber.

Design Example

Design forms to document the design procedure are provided in Appendix G. A completed design form follows as a design example.

Design Procedure Form for T-11.3: Delaware Sand Filter

Designer: ______________________________

Company: ______________________________

Date: ______________________________

Project: ______________________________

Location: ______________________________

1. Minimum Surface Areas of the Chambers

   If 2h < 2.67 feet (2'-8")

   $A_{sm} = A_{fm} =$ SQDV / (4.1h + 0.9)

   If 2h > 2.67 feet (2'-8")

   $$A_{sm} = A_{fm} = \frac{(SQDV)(d_f)}{kt(h+d_f)}$$

a. SQDV	SQDV =	1300	ft^3
b. Sand bed depth (d_f)	d_f =	1.5	ft
c. Filter Coefficient (k)	k =	0.0833	ft. / hr.
d. Draw-down time (t_r)	t =	40	hr
e. One half maximum allowable water depth over filter (h)	h =	1.67	ft
f. A_{sm} (Sediment Chamber Area) and A_{fm} (Filter Surface Area)	A_{sm} and A_{fm} =	185	ft^2

2. Sediment Chamber and Filter Width / Length

a. Select width ($W_s = W_f$ = 18 to 30 inches)	$W_s = W_f$ =	2.167	ft.
b. Filter length ($L_s = L_f = A_{fm} / W_f$)	$L_s = L_f$ =	85.2	ft.
c. Adjusted length (rounded)	$L_s = L_f$ =	86.0	ft.
d. Adjusted area ($A_s = A_f = W_f \times L_f$)	$A_s = A_f$ =	186.4	ft^2

3. System Storage Volume

a. Storage in filter voids ($V_v = A_f \times (d_f + d_f) \times 0.4$)	V_v =	211.2	ft.
b. Flow through filter ($V_Q = k\, A_f (d_f + h)$ 1hr/ d_f)	V_Q =	32.8	ft.
c. Required net storage ($V_{st} = SQDV - V_v - V_Q$)	V_{st} =	1,056	ft.
d. Available storage ($V_{sf} = 2h(A_f + A_s)$)	V_{sf} =	1,245	ft^2

If $V_{sf} \geq V_{st}$, sizing is complete

If $V_{sf} < V_{st}$, repeat steps 2 and 3

Construction Considerations

- Erosion and sediment control measures must be configured to prevent any inflow of stormwater into the sand filter during its construction.
- The sand filter must be adequately protected once constructed and not be placed in service until all soil surfaces in the drainage watershed have been stabilized with vegetated cover. Should construction runoff enter the filter system prior to site revegetation, all contaminated materials must be removed and replaced with new clean materials.
- The top of the sand filter must be completely level. No grade is allowed.
- The inverts of the notches, multiple orifices, or weirs dividing the sedimentation chamber from the filter chamber must also be completely level. Otherwise, water will not arrive at the filter as sheet flow and only the downgradient end of the filter will function.
- Inflow grates or slotted curbs may conform to the grade of the completed pavement as long as the filters, notches, multiple orifices, and weirs connecting the sedimentation and filter chambers are completely level.
- If precast concrete lids are used, lifting rings or threaded sockets must be provided to allow easy removal with lifting equipment. Lifting equipment must be readily available to the facility operators.
- Where under-drains are used, the minimum slope of the pipe shall be 0.5%. Where only gravel filtered water conveyance is provided, the filter floor must be sloped towards the weepholes at a minimum slope of 0.5%.

Maintenance Requirements

Maintenance Agreement

On-site treatment control measures are to be maintained by the owner/operator. Maintenance agreements between the City and the owner/operator may be required. A Maintenance Agreement with the City must be executed by the owner/operator before the improvement plans are approved.

Maintenance Plan

A post-construction Maintenance Plan shall be prepared and made available at the City's request. The Maintenance Plan should address items such as:

- Operation plan and schedule, including a site map;
- Maintenance and cleaning activities and schedule;
- Equipment and resource requirements necessary to operate and maintain facility;
- Responsible party for operation and maintenance.

Additional guidelines for Maintenance Plans are provided in Appendix D.

Maintenance Activities

- During the first year of operation, the cover grates or precast lids on the chambers must be removed quarterly and an inspection made to assure that the system is functioning. Once the system is functioning properly, this inspection may be made on a semiannual basis.

- When the filter takes 36 hours or more to drain or when deposition of sediments in the filtration chamber indicate that the filter media is clogging and not performing properly, sediments and sand must be removed. The coloration of the sand will provide a good indication of what depth of removal is required. Clean sand must then be placed in the filter to restore the design depth. Where a layer of geotextile fabric and gravel overlay the filter, the fabric and gravel shall be rolled up and removed and a similar layer of clean fabric and gravel installed. Any discolored sand shall also be removed and replaced.
- Grass must be prevented from washing into the filter.
- Disposal of petroleum hydrocarbon contaminated sand, gravel or filter cloth must be done in accordance with all applicable laws.
- Trash collected on the grates protecting the inlets should be removed no less frequently than weekly to assure preserving the inflow capacity of the control measures.
- Monitoring manholes, flumes, and other facilities should be kept clean and ready for use.

Monitoring Agreement

The owner/operator may be required to enter into a monitoring agreement with the City to establish pollutant removal efficiencies of the sand filter.

Sand filters may be required to be designed to accommodate the installation, operation and maintenance of automatic sampling equipment to measure the input and output flow rates and the chemical composition of the inflow and outflow.

At a minimum, the sand filter system will be equipped with monitoring manholes in the inflow and outflow pipes. The City and its consultants will conduct the monitoring program unless otherwise agreed to by the agency. The type and length of monitoring program will be determined on a case-by-case basis.

Alternative and Proprietary Control Measures

This manual provides guidance for the selection and design of some of the more common on-site stormwater treatment control measures for new development. The standard treatment control measures (T-1 through T-11) included in this section are non-proprietary designs that have been reviewed and evaluated by the Permittees and determined to be generally acceptable. Because the performance of these measures has already been demonstrated and reviewed by the Permittees, the plan check review and approval process will be routine for development projects that have selected one of the control measures from this guidance manual.

The Permittees recognize, however, that these pre-accepted treatment control measures may not be appropriate for all projects due to physical site constraints. Thus, the Permittees will consider the use of alternative or proprietary control measures under the follow conditions:

1. If design guidelines for standard treatment control measures cannot be met due to physical site constraints, Permittees retain the discretion of using a lesser performance or design standard prior to accepting proprietary devices. For example: a grass swale filter with 1.5 feet/sec velocity would be considered preferable to installation of a proprietary fabric filter.
2. Alternative or proprietary treatment control devices will only be considered for approval after standard treatment control measures in the guidance manual have been rejected.
3. If, for a specific development, the average cost of installation and operation of standard treatment controls is substantially greater than the average costs for similar installations, alternative or proprietary treatment technologies may be considered for approval.
4. Alternative or proprietary treatment technologies may be approved for redevelopment projects where existing site constraints preclude installation of standard treatment controls.

Alternative control measures may include landscape-type features or proprietary devices. Site designers should contact the local agency stormwater staff early on in the planning process in order to adequately demonstrate that the level and reliability of treatment provided by an alternative control measure is equivalent to that of the pre-accepted designs. Each Permittee shall review the design and construction method of the proposed technology to determine if the device is suitable for the specific land use and pollutant to be removed.

In general, any alternative measure must be designed to treat the stormwater quality design volume, SQDV or the water quality flow, SQDF. Procedures to calculate the SQDV and SQDF are provided in the Calculation Fact Sheets. Site runoff in excess of the SQDV and SQDF may be diverted around or through the treatment device. In addition, the project applicant must demonstrate that the pollutant removal of the proposed alternative control measure will be comparable to the pre-accepted control measures. Performance data and sound engineering principles must be provided to demonstrate effective reliable treatment. Any proposed alternative must include all maintenance, operation, and construction requirements.

There are numerous manufactured proprietary devices available on the market. When proprietary control measures have been determined by the Permittees to be pre-accepted, an Appendix may be added to this guidance manual and updated periodically to provide a list and description of acceptable proprietary devices.

The Permittees encourages the development of innovative stormwater control measures and may consider a limited number of promising alternative control measures, including proprietary devices, on a 'pilot basis'. In order for a pilot project to be considered for proprietary devices, the manufacturer and/or property owner must commit to participate and fund a monitoring program to verify the device's performance. Site designers should anticipate additional review time and contact the local agency stormwater staff early in the process to request consideration of pilot installation projects.

100,000 Square Foot Commercial Development : Any commercial development that creates at least 100,000 square feet of impermeable area, including parking areas.

Automotive Repair Shop: A facility that is categorized in any one of the following Standard Industrial Classification (SIC) codes: 5013, 5014, 5541, 7532-7534, or 7536-7539.

Backfill: Earth or engineered material used to refill a trench or an excavation.

Berm: An earthen mound used to direct the flow of runoff around or through a structure.

Best Management Practice (BMP): Any program, technology, process, siting criteria, operational methods or measures, or engineered systems, which when implemented prevent, control, remove, or reduce pollution.

Best Management Practices (BMPs): Includes schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the United States. BMPs also include treatment requirements, operating procedures, and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

Buffer Strip or Zone: Strip of erosion-resistant vegetation over which stormwater runoff is directed.

Catch Basin: Box-like underground concrete structure with openings in curbs and gutters designed to collect runoff from streets and pavements.

Clean Water Act (CWA): (33 U.S.C. 1251 et seq.) requirement of the National Pollutant Discharge Elimination System (NPDES) program are defined under Sections 307, 402, 318 and 405 of the CWA.

Commercial Development: Any development on private land that is not heavy industrial or residential. The category includes, but is not limited to: hospitals, laboratories and other medical facilities, educational institutions, recreational facilities, plant nurseries, multi-apartment buildings, car wash facilities, mini-malls and other business complexes, shopping malls, hotels, office buildings, public warehouses and other light industrial complexes.

Conduit: Any channel or pipe for directing the flow of water.

Construction General Permit: A NPDES permit issued by the State Water Resources Control Board (SWRCB) for the discharge of stormwater associated with construction activity from soil disturbance of five (5) acres or more.

Conveyance System: Any channel or pipe for collecting and directing the Stormwater.

Culvert: A covered channel or a large diameter pipe that crosses under a road, sidewalk, etc.

Dead-end Sump: A below surface collection chamber for small drainage areas that is not connected to the public storm drainage system. Accumulated water in the chamber must be pumped and disposed in accordance with all applicable laws.

Designated Public Access Points: Any pedestrian, bicycle, equestrian, or vehicular point of access to jurisdictional channels in the area of Ventura County subject to permit requirements.

Detention: The temporary storage of stormwater runoff to allow treatment by sedimentation and metered discharge of runoff at reduced peak flow rates.

Directly Adjacent: Situated within 200 feet of the contiguous zone required for the continued maintenance, function, and structural stability of the environmentally sensitive area.

Directly Connected Impervious Area (DCIA): The area covered by a building, impermeable pavement, and/ or other impervious surfaces, which drains directly into the storm drain without first flowing across permeable land area (e.g. turf buffers).

Directly Discharging: Outflow from a drainage conveyance system that is composed entirely or predominantly of flows from the subject, property, development, subdivision, or industrial facility, and not commingled with the flows from adjacent lands.

Discharge: A release or flow of Stormwater or other substance from a conveyance system or storage container.

Environmentally Sensitive Area (ESA): An area "in which plant or animal life or their habitats are either rare or especially valuable because of their special nature or role in an ecosystem and which would be easily disturbed or degraded by human activities and developments" (California Public Resources Code § 30107.5). Areas subject to stormwater mitigation requirements are: 303d listed water bodies in all reaches that are unimproved and soft-bottomed and all California Coastal Commission's *Environmentally Sensitive Habitat Areas* as delineated on maps in Local Coastal Plans. The California Department of Fish and Game's (CDFG) *Significant Natural Areas* map will be considered for inclusion as the department field verifies the designated locations.

Erosion: The wearing away of land surface by wind or water. Erosion occurs naturally from weather or runoff but can be intensified by land-clearing practices relating to farming, residential or industrial development, road building, or timber cutting.

Excavation: The process of removing earth, stone, or other materials, usually by digging.

Facility: Is a collection of industrial process discharging stormwater associated with industrial activity within the property boundary or operational unit.

Filter Fabric: Geotextile of relatively small mesh or pore size that is used to: (a) allow water to pass through while keeping sediment out (permeable); or (b) prevent both runoff and sediment from passing through (impermeable).

Grading: The cutting and/or filling of the land surface to a desired shape or elevation.

Hazardous Substance: (1) Any material that poses a threat to human health and/or the environment. Typical hazardous substances are toxic, corrosive, ignitable, explosive, or chemically reactive; (2) Any substance named by EPA to be reported if a designated quantity of the substance is spilled in the waters of the United States or if otherwise emitted into the environment.

Hazardous Waste: By-products of society that can pose a substantial or potential hazard to human health or the environment when improperly managed. Possesses at least one of four characteristics (flammable, corrosivity, reactivity, or toxicity), or appears on special EPA lists.

Hillside: Property located in an area with known erosive soil conditions, where the development contemplates grading on any natural slope that is 25 percent or greater.

Illegal Discharges: Any discharge to a municipal separate storm sewer that is not composed entirely of stormwater except discharges authorized by an NPDES permit (other than the NPDES permit for discharges from the municipal separate storm sewer) and discharges resulting from fire fighting activities.

Industrial General Permit: A NPDES permit issued by the State Water Resources Control Board for the discharge of Stormwater associated with industrial activity.

Infiltration: The downward entry of water into the surface of the soil.

Inlet: An entrance into a ditch, storm sewer, or other waterway.

Material Storage Areas: On site locations where raw materials, products, final products, by-products, or waste materials are stored.

New Development: Land disturbing activities; structural development, including construction or installation of a building or structure, creation of impervious surfaces; and land subdivision.

Non-Stormwater Discharge: Any discharge to municipal separate storm drain that is not composed entirely of stormwater. Discharges containing process wastewater, non-contact cooling water, or sanitary wastewater are non-stormwater discharges.

Non-Structural Source Control Measure: Low technology, low cost activities, procedures or management practices designed to prevent pollutants associated with site functions and activities from being discharged with Stormwater runoff. Examples include good housekeeping practices, employee training, standard operating practices, inventory control measures, etc.

Notice of Intent (NOI): A formal notice to State Water Resources Control Board submitted by the owner/developer that a construction project is about to begin. The NOI provides information on the owner, location, type of project, and certifies that the permittee will comply with the conditions of the construction general permit.

NPDES Permit: An authorization, license, or equivalent control document issued by EPA or an approved State agency to implement the requirements of the NPDES program.

Outfall: The point where stormwater discharges from a pipe, channel, ditch, or other conveyance to a waterway.

Parking Lot: Land area or facility for the temporary parking or storage of motor vehicles used personally, for business or for commerce with an impervious surface area of 5,000 square feet or more, or with 25 or more parking spaces.

Permeability: A property of soil that enables water or air to move through it. Usually expressed in inches/hour or inches/day.

Pollutant: A substance introduced into the environment that adversely affects the usefulness of a resource.

Precipitation: Any form of rain or snow.

Pretreatment: Treatment of wastewater before it is discharged to a wastewater collection system.

Process Wastewater: Wastewater that has been used in one or more industrial processes.

Receiving Stream: (for purposes of this Manual only) any natural or man-made surface water body that receives and conveys stormwater runoff.

Redevelopment: Development that includes, but is not limited to the following: the expansion of a building footprint or addition or replacement of a structure; structural development including an increase in gross floor area and/or exterior construction or remodeling; replacement of impervious surface that is not part of a routine maintenance activity; land disturbing activities related with structural or impervious surfaces. Redevelopment that results in the creation or addition of 5,000 square feet or more of impervious surfaces is subject to the requirements for stormwater mitigation. If the creation or addition of impervious surfaces is fifty percent or more of the existing impervious surface area, then stormwater runoff from the entire area (existing and changes) must be considered for purposes of stormwater mitigation. If the creation or changed area is less than fifty percent of the existing impervious area, then Stormwater runoff from only the changed area needs mitigation.

Restaurant: A stand-alone facility that sells prepared foods and drinks for consumption, including stationary lunch counters and refreshment stands selling prepared foods and drinks for immediate consumption (SIC code 5812).

Retail Gasoline Outlet: Any facility engaged in selling gasoline and lubricating oils.

Retention: The storage of stormwater to prevent it from leaving the development site; may be temporary or permanent.

Runoff: Water originating from rainfall and other precipitations (e.g., sprinkler irrigation) that is found in drainage facilities, rivers, streams, springs, seeps, ponds, lakes, wetlands, and shallow groundwater.

Runon: Stormwater surface flow or other surface flow which enters property other than that where it originated.

Secondary Containment: Structures, usually dikes or berms, surrounding tanks or other storage containers and designed to catch spilled material from the storage containers.

Sedimentation: The process of depositing soil particles, clays, sands, or other sediments that were picked up by runoff.

Sediments: Soil, sand, and minerals washed from land into water usually after rain, that accumulate in reservoirs, rivers, and harbors, destroying aquatic animal habitat and clouding the water so that adequate sunlight might not reach aquatic plants.

Source Control BMP or Measure: Any schedules of activities, structural devices, prohibitions of practices, maintenance procedures, managerial practices or operational practices that aim to prevent Stormwater pollution by reducing the potential for contamination at the source of pollution.

Source Control BMPs: Operational practices or design features that prevent pollution by reducing potential pollutants at the source.

Spill Guard: A device used to prevent spills of liquid materials from storage containers.

Spill Prevention Control and Countermeasures Plan (SPCC): Plan consisting of structures, such as curbing, and action plans to prevent and respond to spills of hazardous substances as defined in the Clean Water Act.

Storm Drains: Above and below ground structures for transporting stormwater to streams or outfalls for flood control purposes.

Storm Drain System: Network of above and below-ground structures for transporting stormwater to streams or outfalls.

Storm Event: A rainfall event that produces more than 0.1 inch of precipitation and is separated from the previous storm event by at least 72 hours of dry weather.

Stormwater Discharge Associated with Industrial Activity: Discharge from any conveyance which is used for collecting and conveying stormwater which is related to manufacturing processing or raw materials storage areas at an industrial plant [see 40 CFR 122.26(b)(14)].

Stormwater: Stormwater runoff, snow-melt runoff, surface runoff, and drainage, excluding infiltration and irrigation tailwater.

Structural BMP or Control Measure: Any structural facility designed and constructed to mitigate the adverse impacts of stormwater and urban runoff pollution (e.g. canopy, structural enclosure). The category may include both Treatment Control BMPs and Source Control BMPs.

Treatment Control BMP or Measure: Any engineered system designed to remove pollutants by simple gravity settling of particulate pollutants, filtration, biological uptake, media adsorption or any other physical, biological, or chemical process.

Treatment: The application of engineered systems that use physical, chemical, or biological processes to remove pollutants. Such processes include, but are not limited to, filtration, gravity settling, media adsorption, biodegradation, biological uptake, chemical oxidation and UV radiation.

Standard Calculations for Diversion Structure Design

Introduction

Storm water runoff in excess of the water quality flow or volume is to be diverted around or through the treatment control measure. The following paragraphs provide equations and design criteria necessary to design diversion structures to divert runoff in excess of the SQDV or SDQF around or through the treatment control measures.

Diversion Structure Design

Capture or isolation of the SQDV is typically achieved by employing one of the following techniques:

- Divert the SQDV into the treatment control measure from the on-site storm drain system using weirs or orifices at or upstream of the point of entrance to the treatment control measure.
- Bypassing flows in excess of the SQDV within the treatment control measure using weirs and pipes for channel or pipe storm drain systems or routing excessive flows through a vegetated swale.

By employing diversion techniques, the water quality flow or volume is treated and discharged to the storm drain system and runoff that exceeds the water quality flow or volume is diverted or bypassed, untreated, directly to the downstream storm drain system.

Equations and criteria to design a diversion structure are provided below. Alternative designs may be considered subject to approval.

All diversion structures are designed using the on-site storm design event. The drainage design storm is established by the governing agency and is not the same as the stormwater quality design flow or volume. The drainage design storm is used to design the conveyance system, i.e. pipes, swales, etc. of the site without regard for treatment. The design engineer must ensure sufficient head room in the on-site system above the diversion to accommodate overflows.

Diverting Flows at the Inlet or Upstream of the Treatment Control Device

Diverting flow at the inlet to the treatment control is the more common approach to divert excess runoff. Figure B-1 illustrates the more commonly used diversion structures. The height of the weir to divert the flow is determined a follows:

<u>Treatment Control Measures Designed Based on the SQDV</u>

1. Determine the SQDV (see Section 5)
2. Utilizing design techniques provided in the treatment control measure fact sheets, determine the maximum height of the water level in the treatment control measure when

the entire SQDV is being held,

3. Set the height of the diversion weir to the maximum height of the water level.
4. Determine weir dimensions needed to divert peak flows of the drainage design storm using the following equation for a rectangular sharp-crested weir

$$Q_d = CLh^{1.5} \qquad \textit{eqn B-1}$$

Where: Q_d = Peak flow rate for drainage design storm, cfs

L = Effective length of weir, ft

C = Weir discharge coefficient

h = Depth of the flow above the crest of the weir, ft

The discharge coefficient "C" accounts for many factors, such as velocity of approach, in the weir equation. The height of the weir (H) and the height of the flow over the weir (h) are two characteristics of the sharp-crested weir that affect the value of C. Table B-1 can be used to approximate C for rectangular sharp-crested weirs without end contractions.

5. Provide sufficient head room in the treatment control to accommodate depth of flow over the weir.

Table B-1. Weir Discharge Coefficient (C) for Rectangular Sharp-crested Weirs Without End Contractions[1]

H/h	Head (h) over weir, ft						
	0.2	0.4	0.6	0.8	1.0	2.0	5.0
0.5	4.18	4.13	4.12	4.11	4.11	4.10	4.10
1.0	3.75	3.71	3.69	3.68	3.68	3.67	3.67
2.0	3.53	3.49	3.48	3.47	3.46	3.46	3.45
10.0	3.36	3.32	3.30	3.30	3.29	3.29	3.28
∞	3.32	3.28	3.26	3.26	3.25	3.25	3.24

1. From Lindsay and Franzini , (1979)

Treatment Control Measures Designed Based on the SQDF

1. Establish the size of the on-site drainage system (pipe diameter or dimensions) based on the drainage design storm
2. Determine the SQDF (see Section 5)
3. Determine the depth of flow in the on-site drainage system when carrying the SQDF using Manning's equation (eqn B-2)

$$SQDF = \frac{1.49}{n} A R^{\frac{2}{3}} S^{\frac{1}{2}} \qquad \textit{eqn B-2}$$

Where: SQDF = Water Quality Flow, cfs

n = Manning's roughness coefficient

A = Cross sectional area of drainage pipe or channel, ft^2

R = Hydraulic radius, ft

S = Slope of pipe or channel, ft/ft

4. Using nomographs or computer programs, determine the depth of flow at SQDF. Set the weir height at this depth.

5. Using Equation B-1, establish weir dimensions. Provide sufficient head room in treatment control to accommodate flows over the weir.

Bypassing Excess Flows within the Treatment Control Measure

For certain site conditions, bypassing runoff in excess of the SQDV must be achieved in the treatment control measure. When this occurs, the control measure must be designed to ensure the bypass system can be accommodated in the unit, i.e. sufficient depth, width and length to accommodate pipes, length of weirs, etc. The following discusses design considerations for the different treatment control measures.

Bypassing Flows through Infiltration and Sedimentation/Filtration Treatment Control Measures

Weirs, orifices or pipes in treatment control measures are used to bypass runoff in excessive of the SQDV and SQDF. Design of these measures is similar to the approach described above under diverting flows at the inlet to the treatment control measure. Bypass for filtration devices occurs in the sedimentation chamber.

Weirs

Weirs are commonly used to bypass excess storm events. Determining the height of the weir is based on the maximum water elevation in a treatment control device when holding the entire SQDV. To design the weir, use the procedures established under Diversion Structures for Treatment Control Measures Designed Using the SQDV.

Orifices

Orifices can be considered in place of weirs or pipes. To avoid drawing floatables into the bypass, a hooded orifice (see Figure B-2) should be designed using the equation B-3:

$$Q_d = CA(2gh)^{0.5} \qquad \textit{eqn B-3}$$

Where: Q_d = Peak flow rate for drainage design storm, cfs

C = Orifice discharge coefficient, (use 0.6)

A = Area of orifice, ft^2

h = Depth of the water above midpoint of orifice, ft

g = 32.2 ft/sec^2

Hoods should extend into one-third of the permanent pool depth or one-foot whichever is greater. Commercial catch basin traps can be used in lieu of a hood.

Determining the elevation of the orifice is based on determining the maximum water elevation in a treatment control device when holding the entire SQDV. Use the procedures established under Diversion Structures for Treatment Control Measures Designed Using the SQDV to establish the elevation of the mid-point of the orifice opening.

The size of the orifice is determined by using Equation B-3 for the orifice to bypass the peak flow of the on-site storm.

Ensure sufficient head room in the treatment unit to accommodate flows through orifice.

Pipes

Pipes can also be employed to bypass excess runoff. Determining the invert elevation of the bypass inlet is based on determining the maximum water elevation in a treatment control device when holding the entire SQDV. To do this, use the procedures established under Diversion Structures for Treatment Control Measures Designed Using the SQDV to design a diversion weir.

For filtration control measures, a hooded inlet using a 90° elbow should be considered at the inlet to the bypass pipe to prevent drawing floatables into the bypass (see Figure B-2). Hoods should extend into one-third of the permanent pool depth or one-foot whichever is greater. Commercial catch basin traps can be used in lieu of a hood.

For infiltration control measures (see Figure B-3) bypass pipes are perforated and wrapped with filter fabric to avoid drawing sediment and small particles into the bypass pipe. Hoods are not necessary for these overflow pipes.

Bypass pipes are sized using the Manning's equation (Equation B-4) and sized to pass the peak flow of the drainage design storm, and assume the bypass pipes are flowing full. With this assumption, the Manning's equation, Equation 4-4, reduces to:

$$D = \left(\frac{2.159 Q_d n}{s^{\frac{1}{2}}} \right)^{\frac{3}{8}} \qquad \textit{eqn B-4}$$

Where: D = Diameter of pipe, ft

Q_d = Peak flow rate for drainage design storm, cfs

n = Manning's coefficient for pipe material

s = Slope of pipe, ft/ft (0.5% minimum required)

Provide sufficient head room in the treatment control to accommodate flows.

Routing Excess Runoff Through a Grass Swale Filter

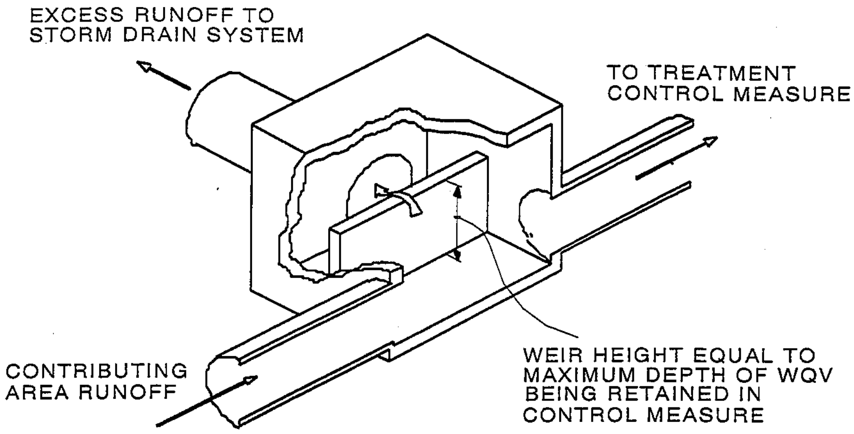
The depth of flow in a grass swale filter at SQDF is determined using a roughness coefficient of 0.2. If additional flows beyond the SQDF are to be directed to the grass swale filter, the roughness coefficient for these flows will be lower (approximately 0.03), because the flows exceeding the SQDF do not flow through the grass and are only influenced by surface friction/roughness. Swales with distinctly different roughness coefficients can be designed using an equivalent roughness coefficient that is determined based on the roughness associated with the wetted perimeters (P). For most on-site grass swale filter designs, there will be two different "n" values. An equivalent "n_e" value can be determined using equation B-5:

$$n_e^{\frac{3}{2}} = \frac{P_1 n_1^{\frac{3}{2}} + P_2 n_2^{\frac{3}{2}}}{P} \qquad \textit{eqn B-5}$$

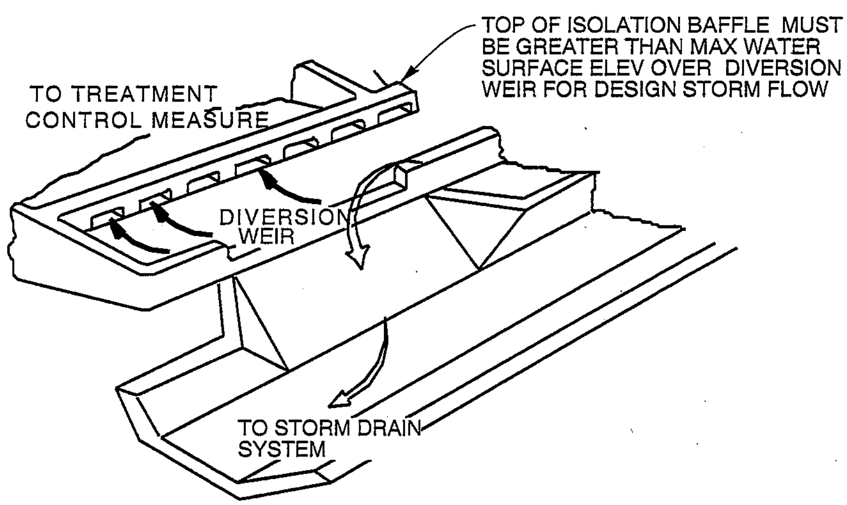
An iterative approach is used to develop an equivalent "n_e", that can be calculated with most computer hydraulic program applications:

1. Estimate an equivalent roughness coefficient (estimated "n_e"),
2. Using the estimated roughness coefficient, determine the depth of flow using trial and error solution of Equation B-2 substituting the peak flow of the drainage design storm for the SQDF,
3. Using the calculated depth determine the wetted perimeter for the drainage system,
4. Using the wetted perimeter associated with each "n" for the drainage system, and using Equation B-5, calculate the equivalent roughness coefficient (calculated "n_e"), and compare to the estimated "n_e",
5. The process continues until the calculated "n_e" equals the estimated "n_e". This value is the equivalent roughness coefficient and used to design the grass swale filter according to recommendations provided in Fact Sheet T-2.

Note - This approach results in conservative n values. High flows in the swale may cause some vegetation to bend resulting in a lower n_1 and lower equivalent "n_e".



PIPE INTERCEPTOR ISOLATION/DIVERSION STRUCTURE



SURFACE CHANNEL DIVERSION STRUCTURE

FIGURE B-1. COMMON DIVERSION STRUCTURES AT INLETS

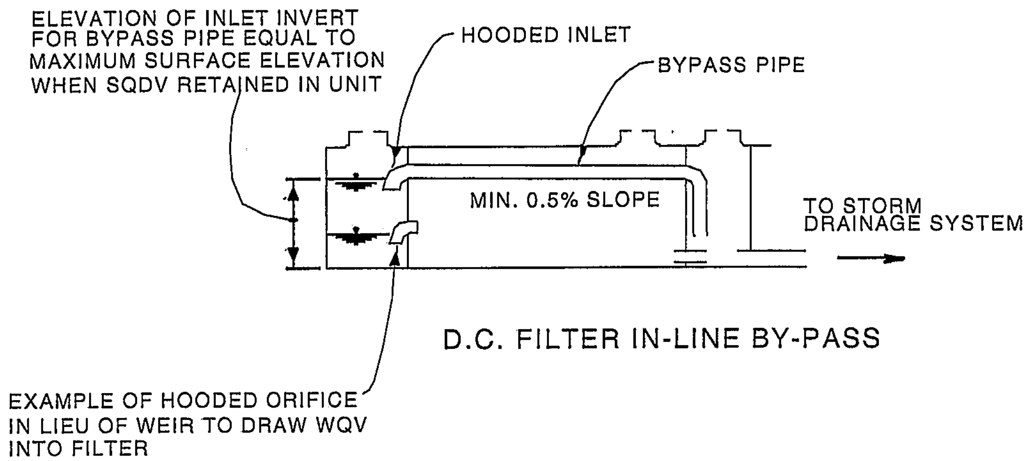


FIGURE B-2. ILLUSTRATION OF PIPE BYPASS IN A FILTRATION DEVICE

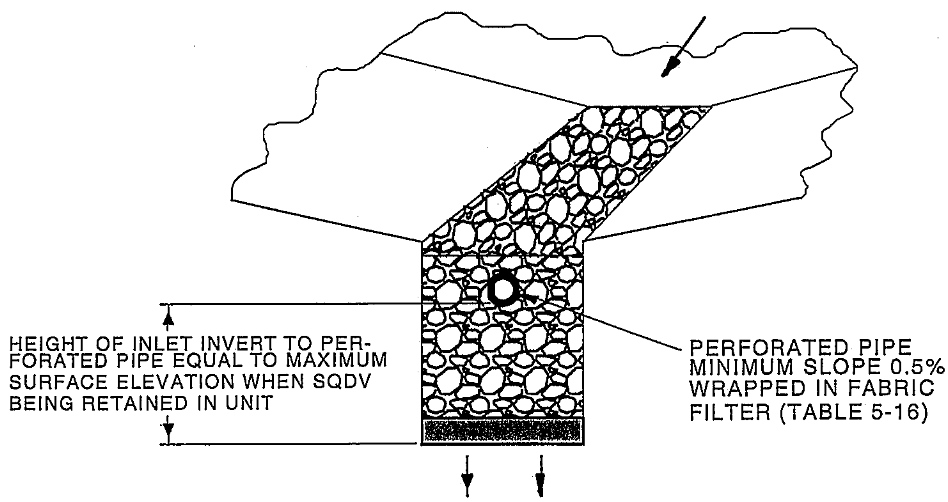


FIGURE B-3. ILLUSTRATION OF PIPE BYPASS IN INFILTRATION TRENCH

Stormwater Treatment Device Access and Maintenance Agreement

(Long Form)

Recorded at the request of:
City of ____________________

____

After recording, return to:
City of ____________
City Clerk
____
____

Stormwater Treatment Device
Access and Maintenance
Agreement

OWNER: ____

PROPERTY ADDRESS:____

APN:____

THIS AGREEMENT is made and entered into in____________________, California, this___day of______________, by and between____, hereinafter referred to as "Owner" and the CITY OF___________________, a municipal corporation, located in the County of Ventura, State of California hereinafter referred to as "CITY";

WHEREAS, the Owner owns real property ("Property") in the City of _________, County of Ventura, State of California, more specifically described in Exhibit "A" and depicted in Exhibit "B", each of which exhibits is attached hereto and incorporated herein by this reference;

WHEREAS, at the time of initial approval of development project known as___________ ____within the Property described herein, the City required the project to employ on-site control measures to minimize pollutants in urban runoff;

A017587

WHEREAS, the Owner has chosen to install a ________________________________ ____, hereinafter referred to as "Device", as the on-site control measure to minimize pollutants in urban runoff;

WHEREAS, said Device has been installed in accordance with plans and specifications accepted by the City;

WHEREAS, said Device, with installation on private property and draining only private property, is a private facility with all maintenance or replacement, therefore, the sole responsibility of the Owner in accordance with the terms of this Agreement;

WHEREAS, the Owner is aware that periodic and continuous maintenance, including, but not necessarily limited to, filter material replacement and sediment removal, is required to assure peak performance of Device and that, furthermore, such maintenance activity will require compliance with all Local, State, or Federal laws and regulations, including those pertaining to confined space and waste disposal methods, in effect at the time such maintenance occurs;

NOW THEREFORE, it is mutually stipulated and agreed as follows:

1. Owner hereby provides the City of City's designee complete access, of any duration, to the Device and its immediate vicinity at any time, upon reasonable notice, or in the event of emergency, as determined by City's Director of Public Works no advance notice, for the purpose of inspection, sampling, testing of the Device, and in case of emergency, to undertake all necessary repairs or other preventative measures at owner's expense as provided in paragraph 3 below. City shall make every effort at all times to minimize or avoid interference with Owner's use of the Property.

2. Owner shall use its best efforts diligently to maintain the Device in a manner assuring peak performance at all times. All reasonable precautions shall be exercised by Owner and Owner's representative or contractor in the removal and extraction of material(s) from the Device and the ultimate disposal of the material(s) in a manner consistent with all relevant laws and regulations in effect at the time. As may be requested from time to time by the City, the Owner shall provide the City with documentation identifying the material(s) removed, the quantity, and disposal destination.

3. In the event Owner, or its successors or assigns, fails to accomplish the necessary maintenance contemplated by this Agreement, within five (5) days of being given written notice by the City, the City is hereby authorized to cause any maintenance necessary to be done and charge the entire cost and expense to the Owner or Owner's successors or assigns, including administrative costs, attorneys fees and interest thereon at the maximum rate authorized by the Civil Code from the date of the notice of expense until paid in full.

4. The City may require the owner to post security in form and for a time period satisfactory to the city of guarantee the performance of the obligations state herein. Should the Owner fail to perform the obligations under the Agreement, the City may, in the case of a cash bond, act for the Owner using the proceeds from it, or in the case of a surety bond, require the sureties

to perform the obligations of the Agreement. As an additional remedy, the Director may withdraw any previous stormwater related approval with respect to the property on which a Device has been installed until such time as Owner repays to City it's reasonable costs incurred in accordance with paragraph 3 above.

5. This agreement shall be recorded in the Office of the Recorder of Ventura County, California, at the expense of the Owner and shall constitute notice to all successors and assigns of the title to said Property of the obligation herein set forth, and also a lien in such amount as will fully reimburse the City, including interest as herein above set forth, subject to foreclosure in event of default in payment.

6. In event of legal action occasioned by any default or action of the Owner, or its successors or assigns, then the Owner and its successors or assigns agree(s) to pay all costs incurred by the City in enforcing the terms of this Agreement, including reasonable attorney's fees and costs, and that the same shall become a part of the lien against said Property.

7. It is the intent of the parties hereto that burdens and benefits herein undertaken shall constitute covenants that run with said Property and constitute a lien there against.

8. The obligations herein undertaken shall be binding upon the heirs, successors, executors, administrators and assigns of the parties hereto. The term "Owner" shall include not only the present Owner, but also its heirs, successors, executors, administrators, and assigns. Owner shall notify any successor to title of all or part of the Property about the existence of this Agreement. Owner shall provide such notice prior to such successor obtaining an interest in all or part of the Property. Owner shall provide a copy of such notice to the City at the same time such notice is provided to the successor.

9. Time is of the essence in the performance of this Agreement.

10. Any notice to a party required or called for in this Agreement shall be served in person, or by deposit in the U.S. Mail, first class postage prepaid, to the address set forth below. Notice(s) shall be deemed effective upon receipt, or seventy-two (72) hours after deposit in the U.S. Mail, whichever is earlier. A party may change a notice address only by providing written notice thereof to the other party.

IF TO CITY:

____

____

____

____

IF TO OWNER:

____

____

____

____

IN WITNESS THEREOF, the parties hereto have affixed their signatures as of the date first written above.

APPROVED AS TO FORM:

____
City Attorney

OWNER:

____
Name:__________________________
Title:___________________________

CITY OF_______________________:

____
Name:__________________________
Title:___________________________

OWNER:

____
Name:__________________________
Title:___________________________

ATTEST:

____
City Clerk Date

NOTARIES ON FOLLOWING PAGE

EXHIBIT A

(Legal Description)

EXHIBIT B
(Map/llustration)

(Short Form)

Recorded at the request of and mail to :

____

____

____

Covenant and Agreement Regarding Stormwater Treatment Device Maintenance

The undersigned hereby certify that we are the owners of hereinafter legally described real property located in the City of ______________________, County of Ventura, State of Calfornia.

Legal Description: ____

____

as recorded in Book ________________________, Page _______, Records of Ventura County,

which property is located and known as **(Address):** ________________________________

____.

And in consideration of the City of _________________ allowing ________________________

____

on said property, we do hereby covenant and agree to and with said City to maintain according to the Maintenance Plan (Attachment 1), all structural stormwater treatment devices including the following:

____

____.

This Covenant and Agreement shall run all of the above described land and shall be binding upon ourselves, and future owners, encumbrancers, their successors, heirs, or assignees and shall continue in effect until released by the authority of the City upon submittal of request, applicable fees, and evidence that this Covenant and Agreement is no longer required by law.

NOTARIES ON FOLLOWING PAGE

Maintenance Plan Guidance

This form identifies the basic information that shall be included in a maintenance plan. Refer to Fact Sheets for individual control measures regarding device-specific maintenance requirements.

A. Site Map:

1. Provide a site map showing boundaries of the site, acreage and drainage patterns/contour lines. Show each discharge location from the site and any drainage flowing onto the site. Distinguish between soft and hard surfaces on the map.
2. Identify locations of existing and proposed storm drain facilities, private sanitary sewer systems and grade-breaks for purposes of pollution prevention.
3. With legend, show locations of expected sources of pollution generation (outdoor work and storage areas, heavy traffic areas, delivery areas, trash enclosures, fueling areas, industrial clarifiers, wash-racks, etc). Identify any areas having contaminated soil or where toxins are stored or have been stored/disposed of in the past.
4. With legend, indicate types and locations of stormwater control measures which will be built to permanently control stormwater pollution. Distinguish between pollution prevention, treatment, sewer diversion, and containment devices.

B Baseline Descriptions:

1. List the property owners and persons responsible for operation and maintenance of the stormwater control measures on site. Include phone numbers and addresses.
2. Identify the intended method of providing financing for operation, inspection, routine maintenance and upkeep of stormwater control measures.
3. List all permanent stormwater control measures. Provide a brief description of stormwater control measures selected and if appropriate, facts sheets or additional information.
4. As appropriate for each stormwater control measure provide:
   a. A written description and check list of all maintenance and waste disposal activities that will be performed. Distinguish between the maintenance appropriate for a 2-year establishment period and expected long-term maintenance. For example, maintenance requirements for vegetation in a constructed wetland may be more intensive during the first few years until the vegetation is established. The post-establishment maintenance plan shall address maintenance needs (e.g., pruning, irrigation, weeding) for a larger, more stable system. Include maintenance performance procedures for facility components that require relatively unique maintenance knowledge, such as specific plant removal / replacement, landscape features, or constructed wetland maintenance. These procedures shall provide enough detail for a person unfamiliar with maintenance to perform the activity, or identify the specific skills or knowledge necessary to perform and document the maintenance.

b. A description of site inspection procedures and documentation system, including record-keeping and retention requirements.

c. An inspection and maintenance schedule, preferably in the form of a table or matrix, for each activity for all facility components. The schedule shall demonstrate how it will satisfy the specified level of performance, and how the maintenance / inspection activities relate to storm events and seasonal issues.

d. Identification of the equipment and materials required to perform the maintenance.

5. As appropriate, list all housekeeping procedures for prohibiting illicit discharges or potential illicit discharges to the storm drain. Identify housekeeping BMPs that reduce maintenance of treatment control measures. These procedures are listed based on facility operations and can be found in the Ventura County Industrial/Commercial Clean Business Program document.

C. Spill Plan:

1. Provide emergency notification procedures (phone and agency/persons to contact)
2. As appropriate for site, provide emergency containment and cleaning procedures.
3. Note downstream receiving water bodies or wetlands which may be affected by spills or chronic untreated discharges.
4. As appropriate, create an emergency sampling procedure for spills. (Emergency sampling can protect the property owner from erroneous liability for down-stream receiving area clean-ups).

D. Facility Changes:

1. Operational or facility changes which significantly affect the character or quantity of pollutants discharging into the stormwater control measures will require modifications to the Maintenance Plan and/or additional stormwater control measures.

E. Training:

1. Identify appropriate persons to be trained and assure proper training.
2. Training to include:
   a. Good housekeeping procedures defined in the plan.
   b. Proper maintenance of all pollution mitigation devices.
   c. Identification and cleanup procedures for spills and overflows.
   d. Large-scale spill or hazardous material response.
   e. Safety concerns when maintaining devices and cleaning spills.

F. Basic Inspection and Maintenance Activities:

1. Create and maintain on site, a log for inspector names, dates and stormwater control measure devices to be inspected and maintained. Provide a checklist for each inspection and maintenance category.

2. Once annually, perform testing of any mechanical or electrical devices prior to wet weather.
3. Report any significant changes in stormwater control measures to the site management. As appropriate, assure mechanical devices are working properly and/or landscaped BMP plantings are irrigated and nurtured to promote thick growth.
4. Note any significant maintenance requirements due to spills or unexpected discharges.
5. As appropriate, perform maintenance and replacement as scheduled and as needed in a timely manner to assure stormwater control measures are performing as designed and approved.
6. Assure *unauthorized* low-flow discharges from the property do not by-pass stormwater control measures.
7. Perform an annual assessment of each pollution generation operation and it's associated stormwater control measures to determine if any part of the pollution reduction train can be improved.

G. Revisions of Pollution Mitigation Measures:

1. If future correction or modification of pass stormwater control measures or procedures is required, the owner shall obtain approval from the governing stormwater agency prior to commencing any work. Corrective measures or modifications shall not cause discharges to by-pass or otherwise impede existing stormwater control measures.

H. Monitoring & Reporting Program

1. The governing stormwater agency may require a Monitoring & Reporting Program to assure the stormwater control measures approved for the site are performing according to design.
2. If required by local agency, the Maintenance Plan shall include performance testing and reporting protocols.

Hydrologic Soil Groups

This appendix includes information on the Hydrologic Soil Groups in Ventura County to use in designing various stormwater control measures:

Relevance of Hydrologic Soil Groups Information

The hydrologic soil groups of a development area are pertinent to design of controls that involve infiltration and for identifying sites appropriate for detention basins. The predominant soil group will control the effectiveness of infiltration facilities or the suitability of an area for impounding water. Hydrologic soil group information should be used for preliminary siting studies only. Actual design should be based on in-situ soil investigations and testing by a qualified engineer or geologist.

Table C-1
Typical Infiltration Rates

Soil Type (Hydrologic Soil Group)	*Soil Type VCFCD*	*Infiltration Rate (in/hr)*
A	6,7	1.00 -8.3
B	4,5	0.5 -1.00
C	2,3	0.17-0.27
D	1	0.02-0.10

Infiltration rates shown represent the range covered by multiple sources, e.g. ASCE, BASMAA, etc.

Hydrologic Soil Groups

The hydrologic soil groups are classified by the USDA Natural Resources Conservation Service (NRCS), formerly the Soil Conservation Service. There are four hydrologic soil groups: A, B, C and D. Soils may be classified by two groups. Soil groups A and B have the highest infiltration rates, unless the soils under consideration have been compacted during construction. Soil groups A and B are typically the best candidate soils for construction of infiltration facilities. Sites with soil groups C and D are usually more appropriate for detention basins.

Soils in group A have a low runoff potential and high infiltration rate, as the soils typically are sands and gravel. Soil group B includes soils with moderate infiltration rates when completely wetted. Group B soils are sandy loam soils with moderately fine to moderately coarse textures. Soils in group C have slow infiltration rates when thoroughly wetted and these soils typically are silty-loam soils with an impeding layer or soils with moderately fine to fine texture. Group D soils have a high runoff potential and very slow infiltration rate when thoroughly wetted. Group D soils include clay soils with high swelling potential, soils in a permanent high water table and shallow soils over nearly impervious material.

The hydrologic soil information presented here should be used as a general overview. For more specific information, consult the *Ventura County Soil Survey* (USDA, NRCS) or contact the Ventura County Resource Conservation District at (805) 386-4685.

Plants Suitable for Vegetative Control Measures

Vegetation serves primarily to maintain soil porosity and prevent erosion. The effectiveness and aesthetic appeal of control measures are enhanced by selection of appropriate vegetative cover. Turf grass is preferred, and some other ground covers also may be appropriate. Some local agencies have restrictions on use of irrigated turf grass; consult with local agency regarding selection of appropriate vegetation.

An important maintenance consideration in the selection of appropriate vegetation is whether irrigation is planned for the site.

Table F-1 provides a sample list of appropriate vegetative covers. Figure F-1is a map showing approximate zones of suitability for the listed species. These zones represent areas of climatological suitability according to the *Sunset Western Garden Book* and are referenced for each species in Table F-1. Additional suggested vegetative species are listed in Table F-2. The map and tables are intended as guides in selecting vegetative covers. For specific species suitability and care information, refer to the sources listed for these tables. Contact the Natural Resources Conservation Service or the Ventura County Resource Conservation District for additional information.

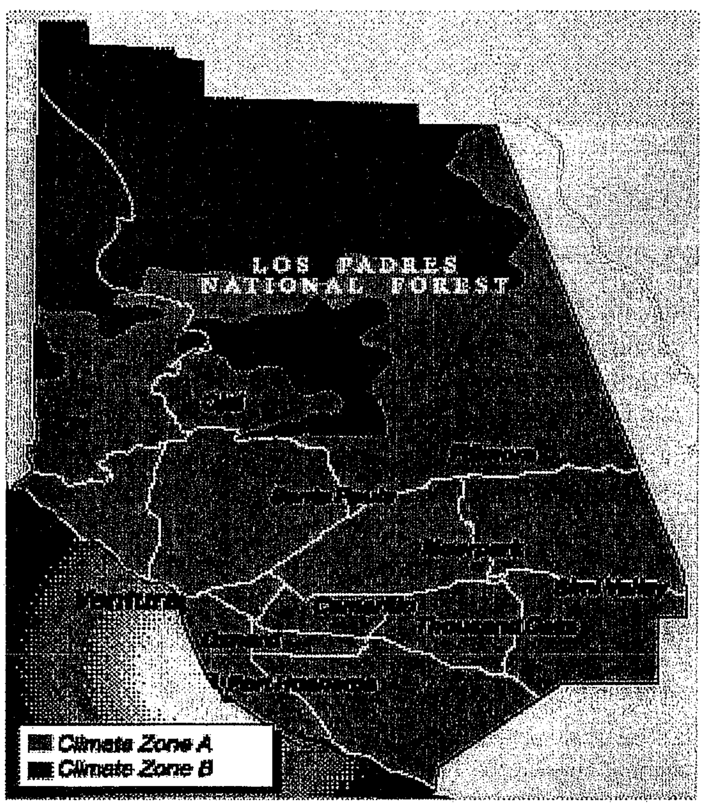


Figure F-1. Vegetation Suitability Zones

Table F-1. Sample List of Appropriate Vegetative Covers

Plant Name Common (Latin)	Appropriate Species	Map Zones*	Maintenance and Usage Notes**
Bermuda Grass (Cynodon)	Santa Ana hybrid	A	Moderate maintenance. Dormant (brown) in winter. Heat tolerant. Erosion control, swales.
Fescue (Festuca)	Red fescue (F. rubra)	A, B	Low to moderate maintenance. Tolerates some shade and poor soil. Lawns, swales, erosion control.
	"Kentucky 31" Tall Fescue (F. elatior)	A, B	Low maintenance. Tolerate shade and compacted soils. Rapid germination. Lawns, swales, erosion control. Useful as overseed for Bermuda grass during dormant (winter) season.
Ryegrass (Lolium)	Perennial (L. perenne)	A, B	Moderate maintenance. Heat intolerant. Fast sprouting. Useful as overseed for Bermuda grass during dormant (winter) season. Swales.
	Annual (L. multiflorum)	A, B	Annual (may live several seasons in mild climate). Moderate maintenance. Heat intolerant. Fast growing. Useful as overseed for winter-dormant species. Swales.

*See Figure F-1
**Generally, these species will require supplemental irrigation.
Sources: ASCE, MWCG, Sunset

Table F-2. Additional Suggested Vegetative Covers

Plant Name Common (Latin)	Appropriate Species	Usage Notes
Orchard grass (Dactylis)	"Akaroa" or "Berber" (D. glomerata)	Irrigated and Non-irrigated Sites
Wheatgrass (Agropyron)	"Luna" or "Topar" pubescent (A. intermedium trichophorum)	Irrigated and Non-irrigated Sites
Zorro Fescue (Vulpia)	(V. myuros)	Irrigated and Non-irrigated Sites
Creeping wild Rye (Leymus)	(L. triticoides)	Nonirrigated Sites
Brome (Bromus)	Blando (B. mollis)	Nonirrigated Sites
	California or "Cucamonga" (B. carinatus)	Nonirrigated Sites

Source: NRCS-FOTG

Appendix G

Design Forms

Design Procedure Form for G-5.1: Turf Buffer

Designer:____

Company:____

Date:____

Project:____

Location:____

1. Design Flow	$Q_{P, SQDF}$ = ____________ cfs
2. Design Width W_{TB} = (SQDF) / 0.05 cfs/ft	W_{TB} = ____________ ft.
3. Design Length (8 ft minimum)	L_{TB} = ____________ ft.
4. Design Slope (4 percent maximum)	L_{TB} = ____________ %
5. Flow Distribution (Check type used or describe "Other")	____ Slotted curbing ____ Modular Block Porous Pavement ____ Level Spreader ____ Other ____________
6. Vegetation (describe)	____
7. Outflow Collection (Check type used or describe "Other")	____ Grass-lined Channel / Swale ____ Street Gutter ____ Storm Drain ____ Underdrain Used ____ Other ____________

Notes ____

Design Procedure Form for G-5.2: Grass–lined Channel

Designer:____________________

Company:____________________

Date:____________________

Project:____________________

Location:____________________

1. Design Flow	$Q_{P, SQDF}$ = ________ cfs
2. Channel Geometry A. Channel Bottom Width (b) B. Side slope (Z)	 b = ________ ft. Z = ________
3. Depth of flow at SQDF (d) (2 ft max, Manning n= 0.05)	d = ________ ft.
4. Design Slope A. s = 2 percent maximum B. No. of grade controls required	 s = ________ % ________ (number)
6. Vegetation (describe)	________ ________
7. Outflow Collection (Check type used or describe "Other")	____ Grated Inlet ____ Infiltration Trench ____ Other ________ ________

Notes ____________________

Design Procedure Form for T-1: Grass Strip Filter (GSTF)

Designer: ______________________________

Company: ______________________________

Date: ______________________________

Project: ______________________________

Location: ______________________________

1. Design Flow	$Q_{P, SQDF}$ = ____________ cfs
2. Design Width W_{GSTF} = (SQDF) / 0.005 cfs/ft	W_{GSTF} = ____________ ft.
3. Design Length (15 ft minimum)	L_{GSTF} = ____________ ft.
4. Design Slope (4 percent maximum)	S_{GSTF} = ____________ %
5. Flow Distribution (Check type used or describe "Other")	____ Slotted curbing ____ Modular Block Porous Pavement ____ Level Spreader ____ Other ____________________ ______________________________
6. Vegetation (describe)	____ ______________________________
7. Outflow Collection (Check type used or describe "Other")	____ Grass Channel / Swale ____ Street Gutter ____ Storm Drain ____ Underdrain Used ____ Other ____________________ ______________________________

Notes ______________________________

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Design Procedure Form for T-2: Grass Swale Filter (GSWF)

Designer:____________________

Company:____________________

Date:____________________

Project:____________________

Location:____________________

1. Design Flow	$Q_{P,\ SQDF}$ = __________ cfs
2. Swale Geometry a. Swale Bottom Width (b) b. Side slope (Z)	 b = __________ ft. Z = __________
3. Depth of flow at SQDF (d) (2 ft max, Manning n= 0.20)	d = __________ inches
4. Design Slope a. s = 2 percent maximum b. No. of grade controls required	 s = __________ % __________ (number)
5. Design flow velocity (Manning n= 0.20)	V = __________ft/sec
6. Design Length L = (7 min) x (flow velocity, ft/sec) x 60	 L = __________feet
6. Vegetation (describe)	_____ ____________________
7. Outflow Collection (Check type used or describe "Other")	_____ Grated Inlet _____ Infiltration Trench _____ Underdrain Used _____ Other ____________________ ____________________

Notes ____

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Design Procedure Form for T-3: Extended Detention Basin

Designer:____________________

Company:____________________

Date:____________________

Project:____________________

Location:____________________

1. Determine Basin Storage Volume			
a. Percent Imperviousness of Tributary Area	I_a =	________	%
b. Effective Imperviousness (Determine using Figure 3-4	I_{wq} =	________	%
c. Required Unit Basin Storage Volume (V_u) Use Figure 5-1 with 40 hr drawdown and I_{wq}	V_u=	________	acre-ft
d. Watershed Area Tributary to EDB	Area =	________	acres
e. Calculate SQDV SQDV = (V_u / 12) x Area	SQDV =	________	acre-ft
f. Calculate Design Volume Design Volume = SQDV x 1.2	Design Volume =	________	acre-ft
2. Outlet Works			
a. Outlet Type (check one)	Single Orifice	________	
	Multi-orifice Plate	________	
	Perforated Pipe	________	
	Other	________	
b. Depth of water above bottom orifice	Depth =	________	feet
c. Single Orifice Outlet			
1) Total Area	A =	________	square inches
2) Diameter or W x L	D =	________	inches
d. Multiple Orifice Outlet			
1) Area per row of perforations	A =	________	square inches
2) Perforation Diameter (2 inches max.)	D =	________	
3) No. of Perforations (columns) per Row	Perforations =	________	
4) No. of Rows (4 inch spacing)	Rows =	________	
5) Total Orifice Area (Area per row) x (Number of Rows)	Area =	________	square inches

Design Procedure Form for T-3: Extended Detention Basin (Page 2 of 2)

Project:____

3. Trash Rack or Gravel Pack (check one)	Trash Rack____ Gravel Pack____		
4. Basin Length-Width Ratio (2:1 minimum)	Ratio =	____________	L:W
5. Two-Stage Design			
a. Upper Stage			
1) Depth (2 feet minimum)	Depth =	________	Feet
2) Width (30 feet minimum)	Width =	________	Feet
3) Bottom Slope (2% to low flow channel)	Slope =	________	%
b. Bottom Stage			
1) Depth (1.5 to 3 feet deeper than Upper)	Depth =	________	Feet
2) Storage Volume (5-15% of SQDV min.)	Volume =	________	Acre-ft
6. Forebay Design			
a. Forebay Volume (5-10% of SQDV min.)	Volume =	_________	Acre-ft
b. Outlet pipe drainage time (~45 minutes)	Drainage Time	_________	Minutes
7. Low Flow Channel			
a. Depth (9 inches min.)	Depth =	__________	Feet
b. Flow Capacity (2 x outlet for Forebay)	Flow Capacity =	__________	GPM/CFM
8. Vegetation	Native Grasses	_________	
	Irrigated Turf	_________	
	Other	________________	
9. Embankment			
a. Interior Slope (4:1 max.)	Interior Slope =	_________	H/V
b. Exterior Slope (3:1 max.)	Exterior Slope =	_________	H/V
10. Access			
a. Slope (10% max.)	Slope =	___________	%
b. Width (16 feet min.)	Width =	___________	Feet

Notes

Design Procedure Form for T-4: Wet Detention Basin

Designer:________________________________

Company:________________________________

Date:________________________________

Project:________________________________

Location:________________________________

1. Determine Basin Storage Volume	
a. Percent Imperviousness of Tributary Area	I_a = ________ %
b. Effective Imperviousness (Determine using Figure 3-4	I_{wq} = ________ %
c. Required Unit Basin Storage Volume (V_u) Use Figure 5-1 with 40 hr drawdown and I_{wq}	V_u= ________ acre-ft
d. Watershed Area Tributary to EDB	Area = ________ acres
Calculate SQDV = (V_u / 12) x Area	SQDV = ________ acre-ft
2. Permanent Pool	
a. Volume of Permanent Pool (0.75 times SQDV)	V_p = ________ Acre-ft
b. Littoral Zone Depth (6 to 12 inches)	Depth = ________ Inches/feet
c, Littoral Zone Area (25%-45% Permanent Pool Surface)	Area = ________ acres
	% of Total Area = ________ %
d. Deeper Zone Depth (4 to 8 feet average, 12 feet maximum)	Depth = ________ feet
3. Estimated Net Base Flow (must be > 0)	
$Q_{net} = Q_{inflow} - Q_{evap} - Q_{seepage} - Q_{evapotranspiration}$	Q_{inflow} = ________ Acre-ft
	Q_{evap} = ________ Acre-ft
	$Q_{seepage}$ = ________ Acre-ft
	$Q_{evapotranspiration}$ ________ Acre-ft
	Q_{net} = ________ Acre-ft

Notes:

____

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Design Procedure Form for T-4: Wet Detention Basin (Page 2 of 3)

Project:____

4. Outlet Works			
a. Outlet Type (check one)	Single Orifice	________	
	Multi-orifice Plate	________	
	Perforated Pipe	________	
	Other	________	
b. Depth of water above bottom orifice	Depth =	________	feet
c. Single Orifice Outlet			
1) Diameter	D =	________	feet
2) Area	A =	________	square feet
d. Multiple Orifice Outlet			
1) Area per row of perforations	A =	________	square feet
2) Perforation Diameter (2 inches max.)	D =	________	inches
3) No. of Perforations (columns) per Row	Perforations =	________	
4) No. of Rows (4 inch spacing)	Rows =	________	
5) Total Orifice Area (Area per row) x (Number of Rows)	Area =	________	square feet
5. Trash Rack or Gravel Pack Present?	Yes/No	________	
6. Basin Shape			
a. Length-Width Ratio	Ratio =	________	L:W
7. Forebay Design			
a. Forebay Volume (5-10% of SQDV min.)	Volume =	________	Acre-ft
b. Outlet pipe drainage time (< 45 minutes)	Drainage Time	________	Mins.
8. Embankment Slope			
a. Interior Slope (4:1 max.)	Interior Slope =	________	L/W
b, Exterior Slope (3:1 max.)	Exterior Slope =	________	L/W

Design Procedure Form for T-4: Wet Detention Basin (Page 3 of 3)

Project:____

9. Vegetation (Check type used or describe "Other")	_____ Native Grasses _____ Irrigated Turf Grass _____ Emergent Aquatic Plants (specify type / density) _____ Other ________________________ ________________________________
10. Underdrains Provided?	Yes /No ________

Notes:

____

A017509

Design Procedure Form for T-5: Constructed Wetlands Basin

Designer:____________________

Company:____________________

Date:____________________

Project:____________________

Location:____________________

1. Determine Basin Storage Volume			
a. Percent Imperviousness of Tributary Area	I_a =	________	%
b. Effective Imperviousness (Determine using Figure 3-4	I_{wq} =	________	%
c. Required Unit Basin Storage Volume (V_u) Use Figure 5-1 with 40 hr drawdown and I_{wq}	V_u=	________	in.
d. Watershed Area Tributary to EDB	Area =	________	acres
e. Calculate SQDV SQDV = (V_u / 12) x Area	SQDV =	________	acre-ft
2. Wetland Pond Volume, Depth, and Water Surface Area		<u>**Minimums**</u>	
a. Calculated Requirements, Minimum Permanent Pool: $Vol_{pool} \geq 0.75$ x SQDV	Vol_{pool} >	________	acre-ft
	Water Area>	________	acres, estimated
		<u>**Actual Design**</u>	
	Vol_{pool} =	________	acre-ft, actual
	Water Area =	________	acres, actual
b. Forebay Depth Range = 2.0' – 4.0'	Depth =	________	ft
Volume Range = 5%to 10 % of SQDV	Volume =	________	acre-ft,% =____
c. Outlet Pool Depth Range = 2.0' – 4.0'	Depth =	________	ft
Volume Range = 6%to 10% of SQDV	Volume =	________	acre-ft,% =____

Continued on next page

Design Procedure Form for T-5: Constructed Wetlands Basin (Page 2 of 3)

Project:________________________________

2. Wetland Pond Volume, Depth, and Water Surface Area (Continued)	
d. Free Water Surface Areas (Area = 30-50% combined) (Depth Range = 2.0' – 4.0')	Depth = ________ ft Area = ________ acres, % = ____ Volume = ________ acre-ft
e. Wetland Zones with Emergent Vegetation (Depth Range = 6" – 12") (Area = 50-70%)	Depth = ________ ft Area = ________ acres, % = ____ Volume = ________ acre-ft
3. Estimated Net Base Flow (must be > 0) $Q_{net} = Q_{inflow} - Q_{evap} - Q_{seepage} - Q_{evapotranspiration}$	Q_{inflow} = ________ acre-ft Q_{evap} = ________ acre-ft $Q_{seepage}$ = ________ acre-ft $Q_{evapotranspiration}$ ________ acre-ft Q_{net} = ________ acre-ft
4. Outlet Works a. Outlet Type (check one)	Single Orifice ________ Multi-orifice Plate ________ Perforated Pipe ________ Other ________
b. Depth of water above bottom orifice	Depth = ________ feet
c. Single Orifice Outlet	
1) Diameter	D = ________ feet
2) Area	A = ________ square feet
d. Multiple Orifice Outlet	
1) Area per row of perforations	A = ________ square inches
2) Perforation Diameter (2 inches max.)	D = ________
3) No. of Perforations (columns) per Row	Perforations = ________
4) No. of Rows (4 inch spacing)	Rows = ________
5) Total Orifice Area (Area per row) x (Number of Rows)	Area = ________ square inches

Design Procedure Form for T-5: Constructed Wetlands Basin (Page 3 of 3)

Project: ____________________

5. Trash Rack or Gravel Pack Present?	Yes/No ________
6. Basin Shape a. Length-Width Ratio	Ratio = ________ L:W
8. Embankment Slope a. Interior Slope (4:1 max.) b, Exterior Slope (3:1 max.)	Interior Slope = ________ L:W Exterior Slope = ________ L:W
9. Vegetation (Check type used or describe "Other")	____ Native Grasses ____ Irrigated Turf Grass ____ Emergent Aquatic Plants (specify type / density)* ____ Other ________ *Describe Species Density and Mix: ________

Notes:

Design Procedure Form for T-6: Detention Basin / Sand Filter

Designer:____________________

Company:____________________

Date:____________________

Project:____________________

Location:____________________

1. Determine Basin Storage Volume			
a. Percent Imperviousness of Tributary Area	$I_a =$	______	%
b. Effective Imperviousness (Determine using Figure 3-4	$I_{wq} =$	______	%
c. Required Unit Basin Storage Volume (V_u) Use Figure 5-1 with 40 hr drawdown and I_{wq}	V_u=	______	acre-ft
d. Watershed Area Tributary to DBSF	Area =	______	acres
e. Calculate SQDV SQDV = (V_u / 12) x Area	SQDV =	______	acre-ft
2. Filter Surface Area (A_s)			
a. A_s (min) = Design Volume / (3 x 43,560 ft^2)	A_s (min) =	______	ft^2
b. Design A_s	A_s =	______	ft^2
3. Design basin depth, based on design filter area			
D = Design Volume/ Design A_s	D =	______	ft
4. Filter Bed			
a) ASTM C33 Sand Layer (18 in. minimum)		______	inches
b) ASSHTO M43-No.8 Gravel Layer (9 in. min.)		______	inches

Notes:

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Design Procedure Form for T-7: Porous Pavement Detention

Designer:______________________________

Company:______________________________

Date:______________________________

Project:______________________________

Location:______________________________

1. Determine Basin Storage Volume			
a. Percent Imperviousness of Tributary Area	I_a =	________	%
b. Effective Imperviousness (Determine using Figure 3-4	I_{wq} =	________	%
c. Required Unit Basin Storage Volume (V_u) Use Figure 5-1 with 12 hr drawdown and I_{wq}	V_u=	________	acre-ft
d. Watershed Area Tributary to DBSF	Area =	________	acres
e. Calculate SQDV SQDV = (V_u / 12) x Area	SQDV =	________	acre-ft
1. Basin Surface Area			
a. Design Volume (SQDV)	SQDV =	________	ft^3
b. A_s = Design Volume / (0.17 ft) (based on surcharge depth of 2 inches)	A_s =	________	ft^2
2. Block Type	Block name:	________	
	Manufacturer:	________	
a. Minimum open area = 40%	Open Area =	________	%
b. Minimum thickness = 4 inches	Thickness	________	inches
3. Base Course (Check)			
a. ASTM C33 Sand Layer (1 inch)	Sand Layer	________	
b. ASSHTO M43-No.8 Gravel Layer (9 inches)	Gravel Layer	________	

Notes:

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Design Procedure Form for T-8: Porous Landscape Detention Basin

Designer:____________________

Company:____________________

Date:____________________

Project:____________________

Location:____________________

1. Determine Basin Storage Volume			
a. Percent Imperviousness of Tributary Area	I_a =	______	%
b. Effective Imperviousness (Determine using Figure 3-4	I_{wq} =	______	%
c. Required Unit Basin Storage Volume (V_u) Use Figure 5-1 with 12 hr drawdown and I_{wq}	V_u=	______	acre-ft
d. Watershed Area Tributary to DBSF	Area =	______	acres
e. Calculate SQDV SQDV = (V_u / 12) x Area	SQDV =	______	acre-ft
2. Basin Surface Area			
a. Design Volume (SQDV)	SQDV =	______	ft^3
b. Average Depth	Average Depth =	______	ft
c. A_s = Design Volume / Average Depth	A_s =	______	ft^2
3. Base Course Layers (check)	Sandy Loam Turf	______	in. (6" min)
	Sand/peat mix	______	in. (18" min)
	Gravel	______	in. (9" min)
4. Subsurface Drainage (check)	______	Infiltration to subgrade with permeable geotextile membrane	
	______	Underdrain with impermeable membrane	
	______	Underdrain with permeable goetextile membrane	

Notes:

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Design Procedure Form for T-9: Infiltration Basin

Designer: ______________________

Company: ______________________

Date: ______________________

Project: ______________________

Location: ______________________

1. Determine Basin Storage Volume	
a. Percent Imperviousness of Tributary Area	I_a = ________ %
b. Effective Imperviousness (Determine using Figure 3-4	I_{wq} = ________ %
c. Required Unit Basin Storage Volume (V_u) Use Figure 5-1 with 40 hr drawdown and I_{wq}	V_u= ________ acre-ft
d. Watershed Area Tributary to DBSF	Area = ________ acres
e. Calculate SQDV SQDV = (V_u / 12) x Area	SQDV = ________ acre-ft
2. Maximum Allowable Depth (D_m = tI/12s)	
a. Site infiltration rate (I)	I = ________ in/hr
b. minimum drawdown time (t = 40 hours)	t = ________ hrs
c. safety factor (s)	s = ________
d. D_m = tI/12s	D_m = ________ ft.
3. Basin Surface Area A_m = SQDV / D_m	A_m = ________ ft^2
4. Vegetation (Check type used or describe "Other")	____ Native Grasses ____ Irrigated Turf Grass ____ Other

Notes:

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Design Procedure Form for T-10: Infiltration Trench

Designer:____

Company:____

Date:____

Project:____

Location:____

1. Determine Basin Storage Volume			
a. Percent Imperviousness of Tributary Area	I_a =	________	%
b. Effective Imperviousness (Determine using Figure 3-4	I_{wq} =	________	%
c. Required Unit Basin Storage Volume (V_u) Use Figure 5-1 with 40 hr drawdown and I_{wq}	V_u=	________	acre-ft
d. Watershed Area Tributary to DBSF	Area =	________	acres
e. Calculate SQDV SQDV = (V_u / 12) x Area	SQDV =	________	acre-ft
2. Trench Water Depth			
a. Soil iniltration rate	I =	________	In/hr
b. Safety factor (S)	s =	________	ft
c. Drawdown time (t = 40 hours)	t =	________	hrs
d. Max water depth (≤ 8 ft) D_m = (I x t) /12s	D_m =	________	ft.
3. Trench Bottom Surface Area A_s = SQDV / D_m	A_s =	________	ft^2

Notes:

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Design Procedure Form for T-11.1: Austin Sand Filter

Designer:____________________

Company:____________________

Date:____________________

Project:____________________

Location:____________________

1. Determine Basin Storage Volume			
a. Percent Imperviousness of Tributary Area	I_a =	________	%
b. Effective Imperviousness (Determine using Figure 3-4	I_{wq} =	________	%
c. Required Unit Basin Storage Volume (V_u) Use Figure 5-1 with 40 hr drawdown and I_{wq}	V_u=	________	in.
d. Watershed Area Tributary to DBSF	Area =	________	acres
e. Calculate SQDV SQDV = (V_u / 12) x Area	SQDV =	________	acre-ft
2. Maximum Water Depth			
a. Storm drainage system invert elevation at proposed connection to storm drain	Inlet Elevation	________	ft
b. Minimum control measure outlet invert elevation of sand filter at minimum grade:	Outlet Elevation	________	ft
c, Estimate filter depth or use minimum depth of filter media and determine the difference in elevation between inverts of filter inlet and outlet:	Filter Depth	________	ft
d. Site plan surface elevation at control measure location	Surface Elvation	________	ft
e. Determine inlet invert elevation into sedimentation basin	Inlet Elevation (Sed. Basin)	________	ft
f. Determine maximum allowable depth of water (2h) in the sedimentation basin considering elevation differences between inlet and outlet invert elevations of sedimentation basin and filterand surface elevation. (This height will establish weir height or elevation of inlet invert for bypass pipes and orifices.)	Maximum Allowable Depth	________	ft

Design Procedure Form for T-11.1: Austin Sand Filter (Page 2 of 2)

Project:______________________________

3. Filter Surface Area			
a. Sand Bed Depth	d_f =	______	ft
b. Coefficient of permeability for sand filter	k =	______	ft. / hr.
c. One half of maximum allowable depth over filter. (h)	h =	______	ft
d. Time required for runoff to pass through filter.	t_f =	______	hrs.
e. Filter Surface Area (minimum) $A_{fm} = \frac{(SQDV)(d_f)}{k(h+d_f)t_f}$	A_{fm} =	______	ft^2
4. Filter Basin Volume Filter Basin Volume = 0.2 x SQDV	FBV =	______	ft^3

Notes:

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Design Procedure Form for T-11.2:: DC Sand Filter

Designer:____

Company:____

Date:____

Project:____

Location:____

1. Determine Basin Storage Volume			
a. Percent Imperviousness of Tributary Area	I_a =	________	%
b. Effective Imperviousness (Determine using Figure 3-4	I_{wq} =	________	%
c. Required Unit Basin Storage Volume (V_u) Use Figure 5-1 with 40 hr drawdown and I_{wq}	V_u=	________	in.
d. Watershed Area Tributary to DBSF	Area =	________	acres
e. Calculate SQDV SQDV = (V_u / 12) x Area	SQDV =	________	acre-ft
2. Minimum Filter Area $A_{fm} = \frac{(SQDV)(d_f)}{k(h+d_f)t_f}$			
a. SQDV	SQDV =	________	ft^3
b. Sand bed depth (d_f)	d_f =	________	ft
c. Filter Coefficient (k)	k =	________	ft. / hr.
d. Draw-down time (t_f= 40 hour)	t =	________	hr
e. one half maximum allowable water depth over filter (h)	h =	________	ft
f. Minimum filter area	A_{fm} =	________	ft^2
3. Select Filter Width, Compute Filter Length			
a. Select a Filter Width (W_f)	W_f =	________	ft.
b. Compute filter length $L_f = A_{fm}/W_f$	L_f =	________	ft.
c. Determine adjusted filter area (Round L_f to closest whole number) $A_f = W_f \times L_f$	A_f =	________	ft^2
(From this point, formula assume rectangular cross section of filter shell.)			

Design Procedure Form for T-11.2: DC Filter (Page 2 of 2)

Project:____________________

4. Compute the Storage Volume of Top of the Filter (V_{tf}) $V_{tf} = A_f \times 2h$	V_{tf} = __________ ft^3
5. Compute the Storage in the Filter Voids (Vv) (Assume 40% voids in the filter media) $V_v = A_f \times (d_f + d_g) \times 0.40$	V_v = __________ ft^3
6. Flow Through Filter During Filling (V_Q) (Assume 1-hour to fill) $V_Q = k \times A_f \times (d_f + d_g) \times t_f / d_f$ Use: k = 2 ft/day = 0.0833 ft/hr. t_f = 1 hr. to fill voids	V_Q = __________ ft^3
7. Compute Net Volume to be Stored in Permanent Pool Awaiting Filtration (Vst) $V_{st} = SQDV - V_{tf} - V_v - V_Q$	V_{st} = __________ ft^3
8. Compute Minimum Length of Permanent Pool (Lpm) $L_{pm} = V_{st} / (2h)(W_f)$	L_{pm} = __________ ft
9. Compute Minimum Length of Sediment Chamber (L_s) (to contain 20% of SQDV) If $V_{st} < (0.2SQDV)$, use: $L_s = 0.2SQDV / (2h)(W_f)$ If $V_{st} > (0.2SQDV)$, use: $L_s = V_{st} / (2h)(W_f)$	L_s = __________ ft
10. Set Final Length of Permanent Pool (Lp) If $L_{pm} \geq (L_s + 2\text{ ft})$, use: $L_p = L_m$ If $L_{pm} < (L_s + 2\text{ ft})$, use: $L_p = (L_s + 2\text{ ft})$	L_p = __________ ft
11. Set Final Length of Clear Well (Lcw) L_{cw} = 3 ft minimum	L_{cw} = __________ ft

Notes:

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Design Procedure Form for T-11.3: Delaware Sand Filter

Designer:______________________________

Company:______________________________

Date:______________________________

Project:______________________________

Location:______________________________

1. Minimum Surface Areas of the Chambers	
If 2h < 2.67 feet (2'-8")	
$A_{sm} = A_{fm} = SQDV / (4.1h + 0.9)$	
If 2h > 2.67 feet (2'-8")	
$A_{sm} = A_{fm} = \frac{SQDV(d_f)}{k(h + d_f)t_f}$	
a. SQDV	SQDV = ______ ft^3
b. Sand bed depth (d_f)	d_f = ______ ft
c. Filter Coefficient (k)	k = ______ ft. / hr.
d. Draw-down time (t_f)	t = ______ hr
e. One half maximum allowable water depth over filter (h)	h = ______ ft
f. A_{sm} (Sediment Chamber Area) and A_{fm} (Filter Surface Area)	A_{sm} and A_{fm} = ______ ft^2
2. Sediment Chamber and Filter Width / Length	
a. Select width ($W_s = W_f$ = 18 to 30 inches)	$W_s = W_f$ = ______ ft.
b. Filter length ($L_s = L_f = A_{fm} / W_f$)	$L_s = L_f$ = ______ ft.
c. Adjusted length (rounded)	$L_s = L_f$ = ______ ft.
d. Adjusted area ($A_s = A_f = W_f \times L_f$)	$A_s = A_f$ = ______ ft^2
3. System Storage Volume	
a. Storage in filter voids ($V_v = A_f \times (d_f + d_f) \times 0.4$)	V_v = ______ ft.
b. Flow through filter ($V_Q = k\, A_f (d_f + h)$ 1hr/ d_f)	V_Q = ______ ft.
c. Required net storage ($V_{st} = SQDV - V_v - V_Q$)	V_{st} = ______ ft.
d. Available storage ($V_{sf} = 2h(A_f + A_s)$)	V_{sf} = ______ ft^2
If $V_{sf} \geq V_{st}$, sizing is complete	
If $V_{sf} < V_{st}$, repeat steps 2 and 3	

A017522

VENTURA COUNTYWIDE STORMWATER QUALITY URBAN IMPACT MITIGATION PLAN

FOR THE VENTURA COUNTY FLOOD CONTROL DISTRICT, THE COUNTY OF VENTURA, AND THE CITIES OF VENTURA COUNTY

VENTURA COUNTYWIDE URBAN RUNOFF AND STORM WATER NPDES PERMIT

STORM WATER QUALITY URBAN IMPACT MITIGATION PLAN

BACKGROUND

The Ventura Countywide Stormwater Quality Management Program (Ventura Program) was established pursuant to Section 402(p) of the Federal Clean Water Act, which requires that all point source discharges of pollutants into waters of the United States, including discharges from municipal storm drain systems, be regulated by a National Pollutant Discharge Elimination System (NPDES) permit. On August 22, 1994 the California Regional Water Quality Control Board, Los Angeles Region (Regional Board), issued NPDES permit CAS063339 (Permit) to the Ventura County Flood Control District (VCFCD), the County of Ventura, and the cities of Camarillo, Fillmore, Moorpark, Ojai, Oxnard, Port Hueneme, San Buenaventura, Santa Paula, Simi Valley, and Thousand Oaks for discharges from municipal storm drain systems in Ventura County. On February 11, 1999 these twelve agencies, the Co-permittees, submitted a Stormwater Quality Management Plan (1999 Plan) in accordance with Title 23, California Code of Regulation and as required by Permit. The 1999 Plan served as application for reissuance of waste discharge requirements and presented activities designed to advance the municipal storm water program that the Co-permittees implemented during the first five-year permit term. The 1999 Plan included a program for development planning. The Regional Board accepted the 1999 Plan, however, delayed reissuance of the Permit. On March 8, 2000, the Regional Board approved a final Standard Urban Storm Water Mitigation Plan (SUSMP) for Los Angles County and the Cities in Los Angeles County. Subsequently, at the request of the Regional Board, the Co-permittees prepared the Ventura Countywide Stormwater Quality Urban Impact Mitigation Plan (SQUIMP) to be consistent with SUSMP requirements and will be modifying the 1999 Plan to include the modified requirements.

The requirement to implement a program for development planning is based on, federal and state statutes including: Section 402 (p) of the Clean Water Act, Section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990 ("CZARA"), and the California Water Code. The Clean Water Act amendments of 1987 established a framework for regulating storm water discharges from municipal, industrial, and construction activities under the NPDES program. The primary objectives of the municipal storm water program requirements are to:

1. Effectively prohibit non-storm water discharges, and

2. Reduce the discharge of pollutants from storm water conveyance systems to the Maximum Extent Practicable (MEP statutory standard).

The SQUIMP was developed as part of the municipal storm water program to address storm water pollution from new development and redevelopment by the private sector. This SQUIMP contains a list of the minimum required Best Management Practices (BMPs) that shall be used for a designated project. Additional BMPs may be required by ordinance or code adopted by the Co-permittees and applied generally or on a case by case basis. The Co-permittees are required to implement the requirements set herein in their own jurisdictions. Developers shall incorporate appropriate SQUIMP requirements into the project plans for the projects covered by the SQUIMP requirements. Each Co-permittee will approve the project plan as part of the development plan approval process.

All projects that fall into one of eight categories are identified in the Ventura Countywide Municipal Permit as requiring SQUIMPs. These categories are:

- Single-Family Hillside Residences
- 100,000 Square Foot Commercial Developments
- Automotive Repair Shops
- Retail Gasoline Outlets
- Restaurants
- Home Subdivisions with 10 or more housing units
- Location within or directly adjacent to or discharging directly to an environmentally sensitive area
- Parking lots with 5,000 square feet or more impervious parking or access surfaces or with 25 or more parking spaces and potentially exposed to storm water runoff

The SQUIMP requirements shall take effect not later than January 27, 2001 for projects identified herein that have not received development/planning permit approval or been deemed complete for processing prior to July 27, 2000..

DEFINITIONS

"100,000 Square Foot Commercial Development" means any commercial development that creates at least 100,000 square feet of impermeable area, including parking areas.

"Automotive Repair Shop" means a facility that is categorized in any one of the following Standard Industrial Classification (SIC) codes: 5013, 5014, 5541, 7532-7534, or 7536-7539.

"Best Management Practice (BMP)" means any program, technology, process, siting criteria, operational methods or measures, or engineered systems, which when implemented prevent, control, remove, or reduce pollution.

"Commercial Development" means any development on private land that is not heavy industrial or residential. The category includes, but is not limited to: hospitals, laboratories and other medical facilities, educational institutions, recreational facilities, plant nurseries, multi-apartment buildings, car wash facilities, mini-malls and other business complexes, shopping malls, hotels, office buildings, public warehouses and other light industrial complexes.

"Designated Public Access Points" means any pedestrian, bicycle, equestrian, or vehicular point of access to jurisdictional channels in the area of Ventura County subject to permit requirements.

"Directly Adjacent" means situated within 200 feet of the contiguous zone required for the continued maintenance, function, and structural stability of the environmentally sensitive area.

"Directly Connected Impervious Area (DCIA)" means the area covered by a building, impermeable pavement, and/ or other impervious surfaces, which drains directly into the storm drain without first flowing across permeable land area (e.g. lawns).

."Directly Discharging" means outflow from a drainage conveyance system that is composed entirely or predominantly of flows from the subject, property, development, subdivision, or industrial facility, and not commingled with the flows from adjacent lands.

"Environmentally Sensitive Area" means an area "in which plant or animal life or their habitats are either rare or especially valuable because of their special nature or role in an ecosystem and which would be easily disturbed or degraded by human activities and developments" (California Public Resources Code § 30107.5)

Areas subject to storm water mitigation requirements are: areas designated as an Area of Special Biological Significance (ASBS) by the State Water Resources Control Board, an area designated as a significant natural resource by the California Resources Agency, or an area identified by the Discharger as environmentally sensitive for water quality purposes, based on the Regional Board Basin Plan and Clean Water Act Section 303(d) Impaired Water-bodies List for the County of Ventura.

"Hillside" means property located in an area with known erosive soil conditions, where the development contemplates grading on any natural slope that is twenty-five percent or greater.

"Infiltration" means the downward entry of water into the surface of the soil.

"New Development" means land disturbing activities; structural development, including construction or installation of a building or structure, creation of impervious surfaces; and land subdivision.

"Parking Lot" means land area or facility for the temporary parking or storage of motor vehicles used personally, for business or for commerce with an impervious surface area of 5,000 square feet or more, or with 25 or more parking spaces.

"Redevelopment" means, but is not limited to, the expansion of a building footprint or addition or replacement of a structure; structural development including an increase in gross floor area and/or exterior construction or remodeling; replacement of impervious surface that is not part of a routine maintenance activity; land disturbing activities related with structural or impervious surfaces. Redevelopment that results in the creation or addition of 5,000 square feet or more of impervious surfaces is subject to the requirements for storm water mitigation. If the creation or addition of impervious surfaces is fifty percent or more of the existing impervious surface area, then storm water runoff from the entire area (existing and additions) must be considered for purposes of storm water mitigation. If the creation or additions is less than fifty percent of the existing impervious area, then storm water runoff from only the addition area needs mitigation.

"Restaurant" means a stand-alone facility that sells prepared foods and drinks for consumption, including stationary lunch counters and refreshment stands selling prepared foods and drinks for immediate consumption. (SIC code 5812).

"Retail Gasoline Outlet" means any facility engaged in selling gasoline and lubricating oils.

"Source Control BMP" means any schedules of activities, structural devices, prohibitions of practices, maintenance procedures, managerial practices or operational practices that aim to prevent storm water pollution by reducing the potential for contamination at the source of pollution.

"Storm Event" means a rainfall event that produces more than 0.1 inch of precipitation and that, which is separated from the previous storm event by at least 72 hours of dry weather.

"Structural BMP" means any structural facility designed and constructed to mitigate the adverse impacts of storm water and urban runoff pollution (e.g. canopy, structural enclosure). The category may include both Treatment Control BMPs and Source Control BMPs.

"Treatment" means the application of engineered systems that use physical, chemical, or biological processes to remove pollutants. Such processes include, but are not limited to, filtration, gravity settling, media adsorption, biodegradation, biological uptake, chemical oxidation and UV radiation.

"Treatment Control BMP" means any engineered system designed to remove pollutants by simple gravity settling of particulate pollutants, filtration, biological uptake, media adsorption or any other physical, biological, or chemical process.

CONFLICTS WITH LOCAL PRACTICES

Where provisions of the SQUIMP requirements conflict with established local codes, (e.g., specific language of signage used on storm drain stenciling), the Co-permittees may continue the local practice and modify the SQUIMP to be consistent with the code, except that to the extent that the standards in the SQUIMP are more stringent than those under local codes, such more stringent standards shall apply.

SQUIMP PROVISIONS APPLICABLE TO ALL CATEGORIES

REQUIREMENTS

1. PEAK STORM WATER RUNOFF DISCHARGE RATES

The Discharger shall control the post-development peak storm water runoff discharge rates to maintain or reduce pre-development downstream erosion, and to protect stream habitat.

2. CONSERVE NATURAL AREAS

If applicable, the following items are required and shall be implemented in the site layout during the subdivision design and approval process, consistent with applicable General Plan and Local Area Plan policies:

- Concentrate or cluster Development on portions of a site while leaving the remaining land in a natural undisturbed condition.
- Limit clearing and grading of native vegetation at a site to the minimum amount needed to build lots, allow access, and provide fire protection.
- Maximize trees and other vegetation at each site by planting additional vegetation, clustering tree areas, and promoting the use of native and/or drought tolerant plants.
- Promote natural vegetation by using parking lot islands and other landscaped areas.
- Preserve riparian areas and wetlands.

3. MINIMIZE STORM WATER POLLUTANTS OF CONCERN

Storm water runoff from a site has the potential to contribute oil and grease, suspended solids, metals, gasoline, pesticides, and pathogens to the storm water conveyance system. The development shall be designed so as to minimize, to the maximum extent practicable, the introduction of pollutants of concern that may result in significant impacts, generated from site runoff of directly connected impervious areas (DCIA), to the storm water conveyance system. Pollutants of concern consist of any pollutants that exhibit one or more of the following characteristics: current loadings or historic deposits of the pollutant are impacting the beneficial uses of a receiving water, elevated levels of the pollutant are found in sediments of a receiving water and/or have the potential to bioaccumulate in organisms therein, or the detectable inputs of the pollutant are at concentrations or loads considered potentially toxic to humans and/or flora and fauna. The storm water pollutants of concern currently identified by the Program are total and fecal coliform, mercury, PAHs, DDT and byproducts, diazinon, sediment/TSS, chlorpyrifos, copper, lead, thallium, bis(2-ethylhexyl)phthalate, and phosphorous. The program may amend the list of pollutants of concern as additional information becomes available.

In meeting this specific requirement, "minimization of the pollutants of concern" will require the incorporation of a BMP or combination of BMPs best suited to maximize the reduction of pollutant loadings in that runoff to the Maximum Extent Practicable. Those BMPs best suited for that purpose are those listed in the ***Ventura Countywide Stormwater Quality Management Program's Land Development Guidelines***; ***California Storm Water Best Management Practices Handbooks***; ***Caltrans Storm Water Quality Handbook: Planning and Design Staff Guide***; ***Start at the Source (1999) by Bay Area Stormwater Management Agencies Association***, ***Manual for Storm Water Management in Washington State***; ***The Maryland Storm Water Design Manual***; ***Florida Development Manual: A Guide to Sound Land and Water Management***; Denver ***Urban Storm Drainage Criteria Manual, Volume 3 – Best Management Practices*** and ***Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters***, USEPA Report No. EPA-840-B-92-002, as "likely to have significant impact" beneficial to water quality for targeted pollutants that are of concern at the site in question. However, it is possible that a combination of BMPs not so designated may, in a particular circumstance, be better suited to maximize the reduction of the pollutants.

Examples of BMPs that can be used for minimizing the introduction of pollutants of concern generated from site runoff are identified in Table 2. All BMPs for development planning recommended in one of the above references may be used, subject to the criteria set in this SQUIMP.

4. PROTECT SLOPES AND CHANNELS

Project plans shall include BMPs consistent with local codes and ordinances and the SQUIMP to decrease the potential of slopes and/or channels from eroding and impacting storm water runoff:

- Convey runoff safely from the tops of slopes and stabilize disturbed slopes
- Utilize natural drainage systems to the Maximum Extent Practicable
- Control or reduce or eliminate flow to natural drainage systems to the Maximum Extent Practicable
- Stabilize permanent channel crossings
- Vegetate slopes with first consideration given to native or drought tolerant species
- Install energy dissipaters, such as riprap, at the outlets of new storm drains, culverts, conduits, or channels that enter unlined channels in accordance with applicable specificationsto minimize erosion, with the approval of all agencies

with jurisdiction, e.g., the U.S. Army Corps of Engineers and the California Department of Fish and Game

5. PROVIDE STORM DRAIN SYSTEM STENCILING AND SIGNAGE

Storm drain stencils are highly visible source controls that are typically placed directly adjacent to storm drain inlets. The stencil contains a brief statement that prohibits the dumping of improper materials into the storm water conveyance system. Graphical icons, either illustrating anti-dumping symbols or images of receiving water fauna, are effective supplements to the anti-dumping message.

- All storm drain inlets and catch basins within the project area shall be stenciled with prohibitive language (such as: "DON'T DUMP! DRAINS TO OCEAN") and/or graphical icons to discourage illegal dumping.
- Signs and prohibitive language and/or graphical icons, which prohibit illegal dumping, shall be posted at designated public access points along channels and creeks within the project area.
- Legibility of stencils and signs shall be maintained.

6. PROPERLY DESIGN OUTDOOR MATERIAL STORAGE AREAS

Outdoor material storage areas refer to storage areas or storage facilities solely for the storage of materials. Improper storage of materials outdoors may provide an opportunity for toxic compounds, oil and grease, heavy metals, nutrients, suspended solids, and other pollutants to enter the storm water conveyance system. Where proposed project plans include outdoor areas for permanent storage of materials that may contribute pollutants to the storm water conveyance system, the following Structural or Treatment BMPs are required:

- Materials with the potential to contaminate storm water shall be: (1) placed in an enclosure such as, but not limited to, a cabinet, shed, or similar structure that prevents contact with runoff or spillage to the storm water conveyance system; or (2) protected by secondary containment structures such as berms, dikes, or curbs.
- The storage area shall be paved and sufficiently impervious to contain leaks and spills.

- The storage area shall have a roof or awning to minimize collection of storm water within the secondary containment area.

7. PROPERLY DESIGN TRASH STORAGE AREAS

A trash storage area refers to an area where a trash receptacle or receptacles are located for use as a repository for solid wastes. Loose trash and debris can be easily transported by the forces of water or wind into nearby storm drain inlets, channels, and/or creeks. All trash container areas shall meet the following Structural or Treatment Control BMP requirements (individual single family residences are exempt from these requirements):

- Trash container areas shall have drainage from adjoining roofs and pavement diverted around the area(s).
- Trash container areas shall be screened or walled to prevent off-site transport of trash.

8. PROVIDE PROOF OF ONGOING BMP MAINTENANCE

Improper maintenance is one of the most common reasons why water quality controls will not function as designed or systems to fail entirely. It is important to consider who will be responsible for maintenance of a permanent BMP and what equipment is required to perform the maintenance properly. As part of project review, if a project applicant has included or is required to include, Structural or Treatment Control BMPs in project plans, the Co-permittee shall require that the applicant provide verification of maintenance provisions through such means as may be appropriate, including, but not limited to legal agreements, covenants, CEQA mitigation requirements and/or Conditional Use Permits.

For all properties, the verification will include the developer's signed statement, as part of the project application, accepting responsibility for all structural and treatment control BMP maintenance until the time the property is transferred and, where applicable, a signed agreement from the public or private entity assuming responsibility for Structural or Treatment Control BMP maintenance. The transfer of property to a private or public owner shall have conditions requiring the recipient to assume responsibility for maintenance of any Structural or Treatment Control BMP included in the sales or lease agreement for that property. The condition of transfer shall include a provision that the property owners conduct maintenance inspection of all Structural or Treatment Control BMPs at least once a year and retain proof of inspection. For residential properties where the Structural or Treatment Control BMPs are located within a common area which will be maintained by a homeowner's association, language regarding the responsibility for maintenance shall be included in the projects conditions, covenants and restrictions (CC&Rs). Printed educational materials will be required to accompany the first deed transfer to highlight the existence of the requirement and to provide information on what storm water management facilities are present, signs that maintenance is needed, how the necessary maintenance can be performed, and assistance that the Co-permittee can provide. The transfer of this information shall also be required with any subsequent sale of the property.

If Structural or Treatment Control BMPs are located within a public area proposed for transfer, they will be the responsibility of the developer until they are accepted for transfer by the appropriate public agency. Structural or Treatment Control BMPs proposed for transfer shall meet design standards adopted by the public entity for the BMP installed and should be approved by the appropriate public agency prior to installation.

9. DESIGN STANDARDS FOR STRUCTURAL OR TREATMENT CONTROL BMPs

Structural or Treatment Control BMPs selected for use at any project covered by this SQUIMP shall meet the design standards of this Section unless specifically exempted.

Volume-based and flow-based design standards may be used separately or in combination to equivalent treatment of storm water discharges. Volume-based criteria should be used in the sizing of detention/retention or infiltration structures; flow-based criteria should be used on swales, catch basin devices, or wetlands. Other, BMP-specific criteria may be applicable. Project applicants should refer to the ***Ventura Countywide Storm Water Quality Management Program Land Development Guidelines*** for further information.

Volume-based Post-construction Structural or Treatment Control BMPs shall be designed to mitigate (infiltrate or treat) storm water runoff from either:

1. the volume of annual runoff based on unit basin storage water quality volume, to achieve 80 percent or more volume treatment by the method recommended in ***California Stormwater Best Management Practices Handbook – Industrial/ Commercial,*** (1993), the ***Ventura Countywide Stormwater Quality Management Program Land Development Guidelines***, or
2. the 85th percentile 24-hour runoff event determined as the maximized capture storm water volume for the area, from the formula recommended in ***Urban Runoff Quality Management, WEF Manual of Practice No. 23/ ASCE Manual of Practice No. 87, (1998)***, or
3. the volume of runoff produced from a 0.75 inch storm event, prior to its discharge to a storm water conveyance system, or
4. the volume of runoff produced from a historical-record based reference 24-hour rainfall criterion for "treatment" that achieves approximately the same reduction in pollutant loads achieved by the 85th percentile 24-hour runoff event,

OR

Flow Based Post-Construction Structural or Treatment Control BMPs shall be sized to handle the flow generated from either:

1. 10% of the 50-year design flow rate, or
2. a flow that will result in treatment of the same portion of runoff as treated using volumetric standards above, or
3. a rain event equal to at least 0.2 inches per hour intensity, or

4. a rain event equal to at least two times the 85th percentile hourly rainfall intensity for Ventura County

Limited Exclusion

Where the land area for development or redevelopment is less than 5,000 square feet, restaurants are excluded from the numerical Structural or Treatment Control BMP design standard requirement only.

10. PROVISIONS APPLICABLE TO INDIVIDUAL PRIORITY PROJECT CATEGORIES

REQUIREMENTS

A. 100,000 SQUARE FOOT COMMERCIAL DEVELOPMENTS

1. PROPERLY DESIGN LOADING/UNLOADING DOCK AREAS

Loading/unloading dock areas have the potential for material spills to be quickly transported to the storm water conveyance system. To minimize this potential, the following design criteria are required:

- Cover loading dock areas or design drainage to minimize run-on and runoff of storm water.
- Direct connections to storm drains from depressed loading docks (truck wells) are prohibited.

2. PROPERLY DESIGN REPAIR/MAINTENANCE BAYS

Oil and grease, solvents, car battery acid, coolant and gasoline from the repair/maintenance bays can negatively impact storm water if allowed to come into contact with storm water runoff. Therefore, design plans for repair bays shall include the following:

- Repair/maintenance bays shall be indoors or designed in such a way that does not allow storm water run-on or contact with storm water runoff.
- Design a repair/maintenance bay drainage system to capture all washwater, leaks and spills. Connect drains to a sump for collection and disposal. Direct connection of the repair/maintenance bays to the storm drain system is prohibited. If required by local jurisdiction, obtain an Industrial Waste Discharge Permit.

3. PROPERLY DESIGN VEHICLE/EQUIPMENT WASH AREAS

The activity of vehicle/equipment washing/steam cleaning has the potential to contribute metals, oil and grease, solvents, phosphates, and suspended solids to the storm water conveyance system. Include, in the project plans, an area for washing/steam cleaning of vehicles and equipment. The area in the site design shall be:

- Self-contained and/or covered, equipped with a clarifier, or other pretreatment facility, and properly connected to a sanitary sewer.

B. RESTAURANTS

1. PROPERLY DESIGN EQUIPMENT/ACCESSORY WASH AREAS

The activity of outdoor equipment/accessory washing/steam cleaning has the potential to contribute metals, oil and grease, solvents, phosphates, and suspended solids to the storm water conveyance system. Include in the project plans an area for the washing/steam cleaning of equipment and accessories. This area shall be:

- Self-contained, connected to a grease interceptor, and properly connected to a sanitary sewer.
- If the wash area is to be located outdoors, it shall be covered, paved, have secondary containment, be connected to a grease interceptor and be connected to the sanitary sewer.

C. RETAIL GASOLINE OUTLETS

1. PROPERLY DESIGN FUELING AREA

Fueling areas have the potential to contribute oil and grease, solvents, car battery acid, coolant and gasoline to the storm water conveyance system. The project plans shall include the following BMPs:

- The fuel dispensing area shall be covered with an overhanging roof structure or canopy. The canopy's minimum dimensions shall be equal to or greater than the area within the grade break. The canopy shall not drain onto the fuel dispensing area, and the canopy downspouts shall be routed to prevent drainage across the fueling area.
- The fuel dispensing area shall be paved with Portland cement concrete (or equivalent smooth impervious surface), and the use of asphalt concrete shall be prohibited.

- The fuel dispensing area shall have a 2% to 4% slope to prevent ponding, and shall be separated from the rest of the site by a grade break that prevents run-on of storm water to the extent practicable.
- At a minimum, the concrete fuel dispensing area shall extend 6.5 feet (2.0 meters) from the corner of each fuel dispenser, or the length at which the hose and nozzle assembly may be operated plus 1 foot (0.3 meter), whichever is less.

D. AUTOMOTIVE REPAIR SHOPS

1. PROPERLY DESIGN FUELING AREA

Fueling areas have the potential to contribute oil and grease, solvents, car battery acid, coolant and gasoline to the storm water conveyance system. Therefore, design plans, which include fueling areas, shall contain the following:

- The fuel dispensing area shall be covered with an overhanging roof structure or canopy. The cover's minimum dimensions shall be equal to or greater than the area within the grade break. The cover shall not drain onto the fuel dispensing area and the downspouts shall be routed to prevent drainage across the fueling area.
- The fuel dispensing areas shall be paved with Portland cement concrete (or equivalent smooth impervious surface), and the use of asphalt concrete shall be prohibited.
- The fuel dispensing area shall have a 2% to 4% slope to prevent ponding, and shall be separated from the rest of the site by a grade break that prevents run-on of storm water.
- At a minimum, the concrete fuel dispensing area shall extend 6.5 feet (2.0 meters) from the corner of each fuel dispenser, or the length at which the hose and nozzle assembly may be operated plus 1 foot (0.3 meter), whichever is less.

2. PROPERLY DESIGN REPAIR/MAINTENANCE BAYS

Oil and grease, solvents, car battery acid, coolant and gasoline from the repair/maintenance bays can negatively impact storm water if allowed to come into contact with storm water runoff. Therefore, design plans for repair bays shall include the following:

- Repair/maintenance bays shall be indoors or designed in such a way that does not allow storm water run-on or contact with storm water runoff.

- Design a repair/maintenance bay drainage system to capture all wash-water, leaks and spills. Connect drains to a sump for collection and disposal. Direct connection of the repair/maintenance bays to the storm drain system is prohibited. If required by local jurisdiction, an Industrial Waste Discharge Permit should be obtained.

3. PROPERLY DESIGN VEHICLE/EQUIPMENT WASH AREAS

The activity of vehicle/equipment washing/steam cleaning has the potential to contribute metals, oil and grease, solvents, phosphates, and suspended solids to the storm water conveyance system. Include, in the project plans, an area for washing/steam cleaning of vehicles and equipment. This area shall be:

- Self-contained and/or covered, equipped with a clarifier, or other pretreatment facility, and properly connected to a sanitary sewer or to a permitted disposal facility.

4. PROPERLY DESIGN LOADING/UNLOADING DOCK AREAS

Loading/unloading dock areas have the potential for material spills to be quickly transported to the storm water conveyance system. To minimize this potential, the following design criteria are required:

- Cover loading dock areas or design drainage to minimize run-on and runoff of storm water

- Direct connections to storm drains from depressed loading docks (truck wells) are prohibited

E. PARKING LOTS

1. PROPERLY DESIGN PARKING AREA

Parking lots contain pollutants such as heavy metals, oil and grease, and polycyclic aromatic hydrocarbons that are deposited on parking lot surfaces by motor vehicles. These pollutants are directly transported to surface waters. To minimize the offsite transport of pollutants, the following design criteria are required:

- Reduce impervious land coverage of parking areas
- Infiltrate runoff before it reaches the storm drain system
- Treat runoff before it reaches the storm drain system

2. PROPERLY DESIGN TO LIMIT OIL CONTAMINATION AND PERFORM MAINTENANCE

Parking lots may accumulate oil, grease, and water insoluble hydrocarbons from vehicle drippings and engine system leaks.

- Treat to remove oil and petroleum hydrocarbons at parking lots that are heavily used (e.g. fast food outlets, lots with 25 or more parking spaces, sports event parking lots, shopping malls, grocery stores, discount warehouse stores)
- Ensure adequate operation and maintenance of treatment systems, particularly sludge and oil removal, and system fouling/plugging prevention control

11. WAIVER

A Co-permittee may, through adoption of an ordinance or code incorporating the treatment requirements of the SQUIMP, provide for a waiver from the requirement if impracticability for a specific property can be established. A waiver for impracticability shall be granted only when all other Structural or Treatment Control BMPs have been considered and rejected as infeasible. Recognized situations of impracticability include, (i) extreme limitations of space for treatment on a redevelopment project, (ii) unfavorable or unstable soil conditions at a site to attempt infiltration, and (iii) risk of ground water contamination because a known unconfined aquifer lies beneath the land surface or an existing or potential underground source of drinking water is less than 10 feet from the soil surface. Any other justificationfor impracticability shall be separately petitioned by the Co-permittee and submitted to the Regional Board for consideration. The Regional Board may consider approval of the waiver justification or may delegate the authority to approve a class of waiver justifications to the Regional Board Executive Officer. The supplementary waiver justification becomes recognized and effective only after approval by the Regional Board or the Regional Board Executive Officer. A waiver granted by a Co-permittee to any development or redevelopment project may be revoked by the Regional Board Executive Officer for cause and with proper notice upon petition.

If a waiver is granted for impracticability, the Co-permittee shall require the project proponent to transfer the savings in cost, as determined by the Co-permittee, to a storm water mitigation fund operated by a public agency or a non-profit entity to be used to promote regional or alternative solutions for storm water pollution in the watershed.

12. LIMITATION ON USE OF INFILTRATION BMPs

Three factors significantly influence the potential for storm water to contaminate ground water. They are (i) pollutant mobility, (ii) pollutant abundance in storm water, (iii) and soluble fraction of pollutant. The risk of contamination of groundwater may be reduced by pretreatment of storm water. A discussion of limitations and guidance for infiltration practices is contained in, ***Potential Groundwater Contamination from Intentional and Non-Intentional Storm water Infiltration, Report No. EPA/600/R-94/051, USEPA (1994).***

The distance of the groundwater table from the infiltration BMP may also be a factor determining the risk of contamination. A historic high water table distance separation of ten feet depth in California presumptively poses negligible risk for storm water not associated with industrial activity or high vehicular traffic except in cases where groundwater basins are unconfined. Unconfined groundwater basins and vulnerable unconfined aquifers are areas that have been identified by the County of Ventura Public Works Agency, Water Resources Division and the Regional Board as areas where the application of infiltration BMPs should be limited to those that provide pre-treatment to ensure groundwater is protected from pollutants of concern.

Infiltration BMPs are not recommended for areas of industrial activity or areas subject to high vehicular traffic (25,000 or greater average daily traffic (ADT) on main roadway or 15,000 or more ADT on any intersecting roadway) unless appropriate pretreatment is provided to ensure groundwater is protected and the infiltration BMP is not rendered ineffective by overload.

13. ALTERNATIVE CERTIFICATION FOR STORM WATER TREATMENT MITIGATION

In lieu of conducting detailed BMP review to verify Structural or Treatment Control BMPs adequacy, a Co-permittee may elect to accept a signed certification from a Civil Engineer or a Licensed Architect registered in the State of California, that the plan meets the criteria established herein. The Co-permittee is encouraged to verify that certifying person(s) have been trained on BMP design for water quality, not more than two years prior to the signature date. Training conducted by an organization with storm water BMP design expertise (e.g., a University,American Society of Civil Engineers,American Society of Landscape Architects, American Public Works Association, or the California Water Environment Association) may be considered qualifying.

14. RESOURCES AND REFERENCE

TABLE 1

SUGGESTED RESOURCES	HOW TO GET A COPY

Ventura Countywide Stormwater Quality Management Program Land Development Guidelines Presents guidance for designing storm water BMPs	Ventura County Flood Control District 800 South Victoria Avenue Ventura, CA 93009 805-650-4064
Start at the Source (1999) by Bay Area Stormwater Management Agencies Association Detailed discussion of permeable pavements and alternative driveway designs presented.	Bay Area Stormwater Management Agencies Association 2101 Webster Street Suite 500 Oakland, CA 510-286-1255
Design of Stormwater Filtering Systems (1996) by Richard A. Claytor and Thomas R. Schuler Presents detailed engineering guidance on ten different storm water-filtering systems.	Center for Watershed Protection 8391 Main Street Ellicott City, MD 21043 410-461-8323
Better Site Design: A Handbook for Changing Development Rules in Your Community (1998) Presents guidance for different model development alternatives.	Center for Watershed Protection 8391 Main Street Ellicott City, MD 21043 410-461-8323
Design Manual for Use of Bioretention in Stormwater Management (1993) Presents guidance for designing bioretention facilities.	Prince George's County Watershed Protection Branch 9400 Peppercorn Place, Suite 600 Landover, MD 20785
Operation, Maintenance and Management of Stormwater Management (1997) Provides a thorough look at storm water practices including, planning and design considerations, programmatic and regulatory aspects, maintenance considerations, and costs.	Watershed Management Institute, Inc. 410 White Oak Drive Crawfordville, FL 32327 850-926-5310
California Storm Water Best Management Practices Handbooks (1993) for Construction Activity, Municipal, and Industrial/Commercial Presents a description of a large variety of Structural BMPs, Treatment Control, BMPs and Source Control BMPs	Los Angeles County Department of Public Works Cashiers Office 900 S. Fremont Avenue Alhambra, CA 91803 626-458-6959

Second Nature: Adapting LA's Landscape for Sustainable Living (1999) by Tree People Detailed discussion of BMP designs presented to conserve water, improve water quality, and achieve flood protection.	Tree People 12601 Mullholland Drive Beverly Hills, CA 90210 818-753-4600
Florida Development Manual: A Guide to Sound Land and Water Management (1988) Presents detailed guidance for designing BMPs	Florida Department of the Environment 2600 Blairstone Road, Mail Station 3570 Tallahassee, FL 32399 850-921-9472
Stormwater Management in Washington State (2000) Vols. 1-5 Presents detailed guidance on BMP design for new development and construction.	Department of Printing State of Washington Department of Ecology P.O. Box 798 Olympia, WA 98507-0798 360-407-7529
Maryland Stormwater Design Manual (2000) Presents guidance for designing storm water BMPs	Maryland Department of the Environment 2500 Broening Highway Baltimore, MD 21224 410-631-3000
Texas Nonpoint Source Book – Online Module (1998)www.txnpsbook.org Presents BMP design and guidance information on-line	Texas Statewide Storm Water Quality Task Force North Central Texas Council of Governments 616 Six Flags Drive Arlington, TX 76005 817-695-9150
Urban Storm Drainage, Criteria Manual – Volume 3, Best Management Practices (1999) Presents guidance for designing BMPs	Urban Drainage and Flood Control District 2480 West 26th Avenue, Suite 156-B Denver, CO 80211 303-455-6277
National Storm water Best Management Practices (BMP) Database, Version 1.0 Provides data on performance and evaluation of storm water BMPs	American Society of Civil Engineers 1801 Alexander Bell Drive Reston, VA 20191 703-296-6000
Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters (1993) Report No. EPA–840-B-92-002. Provides an overview of, planning and design considerations, programmatic and regulatory aspects, maintenance considerations, and costs.	National Technical Information Service U.S. Department of Commerce Springfield, VA 22161 800-553-6847
Caltrans Storm Water Quality Handbook: Planning and Design Staff Guide (Best Management Practices Handbooks (1998) Presents guidance for design of storm water BMPs	California Department of Transportation P.O. Box 942874 Sacramento, CA 94274-0001 916-653-2975

TABLE 2

EXAMPLE BEST MANAGEMENT PRACTICES (BMPs)

The following are examples of BMPs that can be used for minimizing the introduction of pollutants of concern that may result in significant impacts, generated from site runoff to the storm water conveyance system. (See Table 1: Suggested Resources for additional sources of information):

- Provide reduced width sidewalks and incorporate landscaped buffer areas between sidewalks and streets. However, sidewalk widths shall still comply with regulations for the Americans with Disabilities Act and other life safety requirements.
- Design residential streets for the minimum required pavement widths needed to comply with all zoning and applicable ordinances to support travel lanes; on-street parking; emergency, maintenance, and service vehicle access; sidewalks; and vegetated open channels.
- Comply with all zoning and applicable ordinances to minimize the number of residential street cul-de-sacs and incorporate landscaped areas to reduce their impervious cover. The radius of cul-de-sacs should be the minimum required to accommodate emergency and maintenance vehicles. Alternative turnarounds should be considered.
- Use permeable materials for private sidewalks, driveways, parking lots, or interior roadway surfaces (examples: hybrid lots, parking groves, permeable overflow parking, etc.).
- Use open space development that incorporates smaller lot sizes.
- Reduce building density.
- Comply with all zoning and applicable ordinances to reduce overall lot imperviousness by promoting alternative driveway surfaces and shared driveways that connect two or more homes together.
- Comply with all zoning and applicable ordinances to reduce the overall imperviousness associatedwith parking lots by providing compact car spaces, minimizing stall dimensions, incorporating efficient parking lanes, and using pervious materials in spillover parking areas.
- Direct rooftop runoff to pervious areas such as yards, open channels, or vegetated areas, and avoid routing rooftop runoff to the roadway or the storm water conveyance system.
- Biofilters including vegetated swales and strips
- Extended/dry detention basins
- Infiltration basin
- Infiltration trenches or vaults
- Wet detention basins/wet ponds
- Constructed wetlands

TABLE 2 (Continued)

- Media filtration
- Bioretention facility
- Foundation planting
- Normal flow storage/separation systems
- Clarifiers
- Filtration systems
- Primary waste water treatment systems
- Cistern

Appendix I
Environmentally Sensitive Areas

All projects located in or directly adjacent to or directly discharging to an Environmentally Sensitive Area (ESA) are subject to stormwater mitigation requirements, where the development will:

- Discharge stormwater and urban runoff that is likely to impact a sensitive biological species or habitat; and
- Create 2,500 square feet or more of impervious surface area.

Re-development of single family homes are exempt.

ESAs will include 303d listed water bodies in all reaches that are unimproved and soft-bottomed and all California Coastal Commission's *Environmentally Sensitive Habitat Areas* as delineated on maps in Local Coastal Plans. The California Department of Fish and Game's (CDFG) *Significant Natural Areas* map will be considered for inclusion as the department field verifies the designated locations (CDFG has requested that these areas not be included until they are field verified).

This appendix will be updated in the future to include a map(s) showing the location of any newly identified ESAs within Ventura County.

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URBANIZATION AND CHANNEL STABILITY ASSESSMENT IN THE ARROYO SIMI WATERSHED OF VENTURA COUNTY, CA

FINAL REPORT

by

AQUA TERRA Consultants
Mountain View, California 94043

ATC Project No. 20301-01
Contract NO. AE 03-G13, PW 03-112

Prepared for

Ventura County Watershed Protection Division
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March 25, 2004

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ABSTRACT

Ventura County Watershed Protection District (VCWPD) has developed a Stormwater Quality Urban Impact Mitigation Plan (SQUIMP) at the request of the Los Angeles Regional Water Quality Control Board (LARWQCB). The SQUIMP addresses storm water pollution from new development and redevelopment in the private sector. One listed requirement of the SQUIMP (as defined in NPDES Permit No CAS004002) is that "The discharger shall control the post-development peak storm water runoff discharge rates to maintain or reduce pre-development downstream erosion, and to protect stream habitat."

To respond to this requirement, VCWPD developed, in conjunction with the LARWQCB, the Urban Stream Erosion Prevention Model (USEP) work plan to address the issues of urbanization impacts on stream erosion and habitat alteration. Chapter 3 of the USEP work plan describes the initial pilot effort to develop a hydrologic model of the upper Calleguas Creek watershed using the U. S. EPA HSPF (Hydrologic Simulation Program - FORTRAN) model. This study extends the initial model setup to include the specific habitat sites monitored in USEP, and evaluates the hydrologic information available from the model for stream erosion assessment and urbanization impacts.

In this study, the literature was reviewed to develop a methodology and procedures to assess channel erodibility and stability relationships utilizing channel characteristics and information available from the hydrologic watershed model of the Arroyo Simi watershed in the Upper Calleguas Creek watershed. Model simulations were performed for a range of alternative scenarios, and the model information was analyzed to assess impacts on the hydrology of the watershed, including the flow duration and flood frequency characteristics, and to determine how often (i.e., percent of time) channel scour/erosion conditions occur at the USEP study sites. Calculated shear stress timeseries values were analyzed to determine how often the values exceed critical values for channel scour, thereby establishing the potential for channel scour and unstable conditions. Model runs were performed for a 31-year period of historic record, a Baseline Condition was established based on the calibrated time period, and alternative scenarios were simulated for a Natural or pre-development condition, three Urbanization projections, and a Detention Basin condition. Recommendations are included to refine and improve the study results and pursue efforts needed to establish a development design standard that can protect downstream channel stability and habitat.

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For AQUA TERRA, Mr. Anthony Donigian was the Project Manager, responsible for the overall conduct of the study, including the literature review, methodology development and report preparation. Mr. Jason Love was the Project Engineer responsible for performing model scenario setup and simulation, analysis of model results, and assistance in report preparation. Mr. Tom Jobes and Ms. Vitina Mandella assisted in data analysis, soil sample and cross section evaluations, and model setup.

SECTION 1.0
Introduction

Ventura County Watershed Protection District (VCWPD) has developed a Stormwater Quality Urban Impact Mitigation Plan (SQUIMP) at the request of the Los Angeles Regional Water Quality Control Board (LARWQCB). The SQUIMP addresses storm water pollution from new development and redevelopment in the private sector. One listed requirement of the SQUIMP (as defined in NPDES Permit No CAS004002) is that "The discharger shall control the post-development peak storm water runoff discharge rates to maintain or reduce pre-development downstream erosion, and to protect stream habitat."

To respond to this requirement, VCWPD developed, in conjunction with the LARWQCB, the Urbanization Stream Erosion Prevention Model (USEP) work plan to address the issues of urbanization impacts on stream erosion and habitat alteration. Chapter 3 of the USEP work plan describes the initial pilot effort to develop a hydrologic model of the upper Calleguas Creek watershed using the U. S. EPA HSPF (Hydrologic Simulation Program - FORTRAN) model (Bicknell et al., 1997, 2001). This study extends the initial model setup to include the specific habitat sites monitored in USEP, and evaluates the hydrologic information available from the model for stream erosion assessment and urbanization impacts.

HSPF is a comprehensive watershed model of hydrology and water quality, that includes modeling of both land surface and subsurface hydrologic and water quality processes, linked and closely integrated with corresponding stream and reservoir processes. It is the ***premier*** model currently available for comprehensive watershed assessments. HSPF has enjoyed widespread usage and acceptance, since its initial release in 1980, as demonstrated through hundreds of applications across the U.S. and abroad. HSPF is jointly supported and maintained by **both** the U.S. EPA and the USGS, a rare occurrence where two federal agencies agree on support of a single modeling system. In addition, HSPF is the primary watershed model included in the EPA BASINS modeling system and it has recently been incorporated into the U.S. Army Corps of Engineers Watershed Modeling System (WMS). This widespread usage and support has helped to ensure the continuing availability and maintenance of the code for two decades, in spite of varying federal priorities and budget restrictions. HSPF is currently being used for watershed studies in Minnesota, Washington State, Oregon, Australia, Kentucky, South Carolina, Nevada, and Florida.

Phase I of the pilot study consisted of a preliminary model setup and calibration/validation of HSPF to the Arroyo Simi watershed in the upper Calleguas Creek watershed (shown below in Figure 1.1). In the Phase II effort, this model was refined and extended to include the USEP study sites, and to improve its use as a tool for flood assessment, channel stability and degradation, flood mitigation, and overall watershed management issues (AQUA TERRA Consultants, 2003). Companion task orders were also issued concurrently to evaluate the use of HSPF as a flood design tool, compared to current VCWPD procedures, and for this effort, to analyze issues of urbanization impacts on stream erosion and habitat alteration as part of the County=s USEP (Urbanization and Stream Erosion Prevention) model work plan (VCWPD, 2001).

Figure 1.1 Location of the Arroyo Simi Watershed

1.1 Background and Objectives

In its effort to control peak stormwater discharge rates, VCWPD has proposed the following design criteria (Ventura Countywide Stormwater Quality Management Program, 2002):

a) 2-year post development discharge rates shall not exceed the predeveloped discharge rates for the 2-year frequency storm event.
b) Peak flows shall be determined using the procedures set forth in the latest edition of the Hydrology Manual and Direct Runoff curves produced by VCWPD.

These criteria apply to SQUIMP category projects, excluding single family hillside residences, that directly discharge to unlined receiving streams. To further assess and evaluate the 2-year event criterion, VCWPD sponsored this effort to use the Arroyo Simi model to investigate changes in the stream erosive conditions as affected by projected land use changes and detention alternatives. The objective is to evaluate whether the 2-year event criterion is protective of stream habitat and channel stability, under both current conditions and projected increases in urbanization and detention basin alternatives.

Using the final Arroyo Simi Model, the following subtasks were performed to address stream sediment erosive conditions, and urbanization impacts and mitigation alternatives. The objective was to specifically address the requirements of the NPDES permit language, requiring control of "peak storm water runoff discharge rates to maintain or reduce pre-development downstream erosion, and to protect stream habitat". The procedures will be demonstrated within the Arroyo Simi watershed to address general requirements that may be applicable throughout the County.

1. **Review available sediment literature and studies on Calleguas Creek:** In this task, the sediment studies noted in the USEP will be reviewed, along with other literature, to assess the available sediment information on Calleguas Creek and to develop channel erodibility and stability relationships utilizing channel characteristics and information available from the hydrologic model (e.g. flow rate, velocity, calculated shear stress). The intent is to analyze the model information to determine how often (i.e., percent of time) channel scour/erosion conditions occur. For example, the calculated shear stress timeseries values can be analyzed to determine how often the values exceed critical values for channel scour, thereby establish the potential for channel scour conditions.

2. **Refine model segmentation for both channel sites and land areas:** Since the USEP includes sites outside of the original model setup, the model domain was extended to include the Oak Canyon USEP sites and the mainstem site downstream of Madera. In addition, the spatial scale of the channel reaches at each of the USEP sites was refined for better definition of both land and stream segments, and representation of detention/debris basins.

3. **Define baseline and alternative scenarios:** In order to use the model to assess alternative watershed conditions and urbanization impacts, alternative scenarios were defined and the model parameterized to represent those conditions. Current or baseline conditions, natural (pre-development) conditions, future growth conditions (e.g. 2020), and detention alternatives were identified in conjunction with VCWPD staff.

4. **Perform scenario simulations and analyze results:** All currrent/baseline and scenario results were analyzed in a similar fashion, so that the differences could be evaluated for identifying urbanization impacts. The methodology developed in Task 1 was used to assess how often (i.e. what percent of time) scour/deposition conditions occur under each scenario, with the differences from natural conditions representing the urbanization impacts, and the differences for detention scenarios representing mitigation impacts.

Duration (cumulative frequency) curves were used to analyze model results for flow rate and shear stress; shear stress values were compared to 'critical shear values' for scour and channel stability (developed from Task 1 and channel characteristics) to assess the frequency, duration, and 'percent of time' for scour and unstable conditions. Also, flood statistics (e.g. 2-year, 5-year, 10-year peak flows) were generated for each scenario using accepted standard statistical procedures for flood analysis, to assess scenario impacts on flood events along with changes in the time duration of erosive conditions.

1.2 Conclusions and Recommendations

All modeling studies and procedures need a healthy dose of reality, and for the current study this 'reality' is derived from the VCWPD and USEP field data and observations. Although the modeling results and channel stability methodology appear to indicate significant time when unstable conditions occur in the Arroyo Simi watershed, the following seem to indicate the opposite:

a. The USEP data and observations collected over a 2-year period show very little change in channel cross sections at the six study sites, indicating relatively stable channels. Visual inspection of the plotted cross sections showed very little change for most all sites over the entire study period. Elevations of individual points along a cross section would change from survey to survey, but usually less than 0.5 to 1.0 feet.

b. The only major scour event observed occurred at the Madera site between surveys in October 2001 and January 2002, when local scour in a 20-foot cross section of the stream, with an overall width of about 140 feet, dropped bed elevations about seven feet. This appears to have resulted from a few small to moderate storm events (less than 1 inch rainfall) in the interim winter storm period. However, by the time of a November 2002 survey, the bed elevation was essentially restored to its October 2001 level, due primarily to a single large event with more than 3 inches of rainfall on November 7-9, 2002. This behavior is generally indicative of the dynamic equilibrium behavior of stream channels, with alternating scour and deposition events, without major cross-sectional changes, and demonstrates relatively stable channel conditions. The only qualifying caveat is that the surveys were done during a relatively dry period and for only 2 years, but significant storm events were observed.

c. Booth and Jackson (1999) indicate that a level of 10% EIA appears to be a threshold for channel stability based on studies of numerous watersheds in the Northwest. As noted earlier, the Baseline period EIA for the Arroyo Simi watershed is about 6.7%, and even under the 50% Urbanization scenario it is less than 8%. Although this is not definitive proof, it is an indication that somewhat stable channels may be likely.

Since the flow simulations produced by the Arroyo Simi model are reasonable and consistent with the available data, the primary cause for over-stating the occurrence of unstable conditions is the calculation of extremely low values for the critical bed shear stress. These values are a direct function of the bed material particle sizes and the hydraulic radius of the channel reach. Since cross-section data at the USEP sites provided a sound basis for the hydraulic radius calculations in HSPF, and the values appeared to be reasonable, the bed material data needs to be further investigated and analyzed.

Based on the above discussion and the model results presented in this report, the following conclusions and recommendations are provided.

1.2.1 Conclusions

a. The Arroyo Simi Watershed model is shown to be a useful tool to evaluate alternative development conditions and mitigation scenarios for the Arroyo Simi watershed and other similar watersheds in the region.

b. The methodology developed to assess the frequency of channel scour and stability conditions addresses identified needs in the literature to assess these conditions over a range of flow values and storm events.

c. The methodology as applied to the Arroyo Simi USEP sites appears to over-state the occurrence of unstable conditions, primarily due to limitations in the available data on bed material particle size fractions controlling values of critical shear stress (See recommendations below).

d. Model simulations of Natural, pre-development conditions provide a reasonable projection of flow and shear stress behavior for comparison to current or Baseline conditions on the watershed. This is demonstrated at the Madera site where the stream changes from an ephemeral one under natural conditions, to a continuous one under Baseline conditions.

e. The study results also show significant differences between the Natural and Base conditions, especially for the 2-year and 5-year peaks at Royal and Madera. For the 2-year event the peaks are higher by factors of 8 to 10 for the Base condition, and the 5-year events are higher by about a factor of 2. This clearly reflects the impacts of current urbanization levels included in the Baseline scenario. If a 2-year storm is proposed as a 'development standard' it will likely need to be compared to a 'current' condition, since requiring future development to approach a 'natural' condition may lead to excessive storage requirements.

f. The Urbanization scenarios showed small but consistent impacts reflecting the relatively small increase in overall urban area and %EIA values for our scenarios. The changes in the flow duration curves demonstrate that all high flows are increased, a common effect of urbanization, but low to moderate flows are also increased due to the urban irrigation that accompanies development in semi-arid regions.

g. The impacts of urbanization and detention are shown more clearly on the changes in the 2-year, 5-year, and 10-year peak flows for the various scenarios. There is a small, but consistent increase in peak flow rates from the Baseline to each Urbanization scenario, and then a significant reduction for the Detention scenario. So, although the flow duration curves showed very small changes, the storm peak changes are more consistent with the expected impacts due to development and detention.

1.2.2 Recommendations

a. The Arroyo Simi watershed model calibration and validation should be finalized (see recommendations in Study Report (AQUA TERRA Consultants, 2003)), and the results presented herein re-assessed before major decisions are made based on the modeling analyses developed in this study. We do not foresee any major changes to the conclusions but this should be confirmed.

b. To provide an improved representation of urbanization scenarios, the % EIA values used in the Arroyo Simi model should be confirmed and/or further evaluated with aerial photos, small site surveys, or pilot studies. The current values appear reasonable based on the model calibration results, but the critical importance of accurate EIA values, for both current and future projections would help to improve confidence in the model results and the ability to represent future conditions.

c. To provide a more accurate basis for calculating the critical bed shear values, the available bed material particle size data and Wolman pebble count information should be further analyzed, and possibly additional samples taken. The USEP bed sampling procedures did not cover an extensive area at each site, and the Wolman count procedures focus on coarse sand, gravel, and cobble sizes, so some combination of the two may be needed to develop an appropriate reference particle diameter for calculating the critical bed shear stress (tau) for stability assessment. Model results should then be re-analyzed with the resulting range of critical shear values to better assess channel stability conditions. This would not require additional model runs, just analyses of existing shear stress timeseries from the current runs.

d. Additional Urbanization and Detention scenarios should be evaluated to provide more spatially refined urbanization patterns and alternative detention basin designs and locations. Also, changes in land use distribution among urban land uses, e.g. increases in medium and high density residential compared to low density, should be considered for future scenarios. The current Baseline and Urbanization scenarios assume the same distribution of urban land categories.

e. Detailed analysis of the proposed 2-year event as a 'Development Standard' was not possible in this study due to the limited bed sediment data, and its associated effect on over estimating unstable conditions (as noted above), and the relatively small impacts of the urbanization scenarios. However, a 'Standards' development would be a logical and necessary next step following further investigation of the recommendations noted above. Analyses of the historic 2-year peaks and associated storm volumes, from the 31-year simulations, are recommended to determine appropriate design volumes for such a design event. Once reasonable critical shear stress values are determined, the impacts of mitigation (e.g. detention storage) with such a design event can be determined on channel stability conditions using the current model.

f. A Development Standard based on the Arroyo Simi watershed will likely be applicable to other areas in adjacent regions. However, this should be evaluated and confirmed in conjunction with the ongoing Calleguas Watershed effort, the Southern California Coastal Water Research Project (SCCWRP) to investigate the connection between urbanization and stream erosion, and other regional studies, to arrive at a generally accepted standard appropriate for the Southern California region and other semi-arid climates.

g. Recent wildfires damaged significant areas of the Arroyo Simi, Calleguas, and other watersheds in Southern California in late 2003. The modeling procedures and techniques, used for comparing and evaluating alternative watershed conditions, as demonstrated in this study, would also be appropriate for assessing potential impacts of fire-damaged areas on hydrology, soil erosion, and channel stability.

1.3 Report Format

Section 2 describes the results of our literature review along with the developed study methodology, and an overview of the Arroyo Simi watershed model calibrated in the previous study. Section 3 discusses our analysis of the USEP bed and channel cross section data, parameterization of shear stress and stability thresholds, and the Baseline simulations for comparison with the scenario runs. The model scenarios are described, and results presented and discussed in Section 4, while Section 5 presents our conclusions and recommendations.

SECTION 2.0
METHODOLOGY AND APPROACH

As part of the methodology and approach development effort, the literature on urbanization impacts was reviewed and evaluated. This provided the foundation and rationale for use of the Arroyo Simi model, along with the USEP site data, to develop procedures for assessing erosive conditions at the USEP sites, evaluating impacts of mitigation alternatives, and developing potential design criteria for channel protection and stability. This section discusses results of the literature review and the overall methodology and approach selected to address the objectives of this study.

2.1 Literature Review

There exists extensive literature on the impacts of urbanization on hydrology, channel stability, and stream habitat, mostly for specific sites in various regions of the country. Unfortunately the literature for arid regions is much more limited, and procedures for channel stability and stream habitat are in their infancy. Consequently, a focus of this effort was to identify research with specific objectives appropriate for arid regions and channel geomorphology.

Fortunately a recent extensive literature review was performed for hydromodification assessment for the Santa Clara Valley in Northern California (GeoSyntec, 2003), with climatic conditions similar to Ventura County. Hydromodifcation is defined by GeoSyntec as "the change in runoff characteristics from a change in land use conditions", with the primary change of concern being urbanization. Their summary of the effects of urbanization on hydrology lists the following:

- Development has a varying degree of influence on stream flow changes, depending on the natural watershed and development conditions. Urbanization changes watershed storage and pathways of runoff, reducing lag times.
- The relative proportion of subsurface to surface flow shifts to primarily surface runoff and the natural storage of the watershed is reduced.
- Increases peak flows by factors of 2 to 60, especially in the more frequent events.
- Increases runoff volume by factors of 2 to 40.
- The long-term duration of flows increase, especially for the smaller frequent storms.
- Increases duration of smaller flow events by factors of 30 to 100.
- Sediment transporting flows increase by factors of 5 to 10 for the studies reviewed. This would be dependent on stream type and the size of bed material.
- Reduced base flow can cause a reduction in riparian vegetation. Loss of riparian vegetation can be a destabilizing factor of channel stability.
- The frequency of occurrence of runoff events increases, especially for the smaller frequent storms.
- Seasonal flow volume shifts. Dry season baseflows can decrease where the loss of infiltration is significant. Reduced baseflows may cause a reduction in riparian vegetation.
- Summertime baseflows can increase in areas where urban dry season flow is significant compared to normal dry season flows.
- Alter wetland and riparian hydro-periods.

Thus, in summary, urbanization, as reflected in an increase in impervious area, results in increased peak flows and storm volumes, especially for the smaller more frequent storm events. These events are likely to demonstrate increased duration of flows, including flows that perform sediment transport and channel forming processes. The net change is a major impact on channel and bank scour, erosion, and stability.

Citing research by Doyle et al. (2000), Bledsoe (2001), and Bledsoe and Watson (2001), GeoSyntec also listed the following urbanization parameters that appear to have more impact on channel stability than others they considered:

- Increased drainage density and connectedness from rain gutters, curbs and gutters, sewers, channels, etc.
- Increased imperviousness areas and connectivity of impervious surfaces.
- Location of development relative to stream channels, existence of buffer strips.
- Natural watershed soil characteristics (high infiltration areas versus low infiltration areas) and the extent these areas were developed.
- Decreased interception and evapotranspiration by removal of riparian vegetation.

These parameters primarily influence the flow regime of the watershed, including the frequency and duration of channel flows, as impacted by the urbanization changes. In fact, a common theme throughout the research literature is the need to consider both the frequency and duration of flow rates and velocities, along with the resulting shear stress imposed on the channel bed and banks, in order to assess the occurrence of erosive conditions and channel forming events.

Bledsoe and Watson (2001) and Bledsoe (2002) note that mitigation of urbanization impacts will often require consideration of the complete flow regime, including flow duration and frequency, as opposed to a single design storm event; they contend that this is needed for a realistic assessment of the cumulative impacts of urbanization. Since flow duration and frequency data is generally available only at gaged sites, continuous hydrologic modeling has been used to develop the needed information at ungaged sites where channel degradation and stability are major concerns. GeoSyntec (2003) also noted that in the literature they reviewed "Most all the research on the effects of urbanization and development of the tools ... used some form of continuous hydrologic modeling".

Booth and Jackson (1997) and Cappuccitti and Page (2000) have demonstrated the use of hydrologic modeling to address channel stability considerations and design standards in the Pacific Northwest and in the State of Maryland, respectively. Both of these studies used continuous hydrologic simulations produced by the U.S. EPA HSPF model. Booth and Jackson (1997) used results from HSPF simulations to evaluate a combined *flow peak and duration standard* to assess development impacts in King County, WA and the mitigation potential of detention basins.

For the Maryland State Department of the Environment (MDE), Cappuccitti and Page (2000) calibrated HSPF to the Benson Creek Watershed, used a 'design storm' to size detention basin alternatives, and then used the model to simulate the detention basin performance for historic, recorded storm events. They analyzed channel stability conditions using a 'critical shear stress ratio', using model results to calculate actual bed shear stress and then dividing by the critical shear stress estimated from bed particle data. The channel was considered unstable at ratios greater than 2.5, stable at ratios less than 1.2, and transitional for intermediate values, based on work by Prestegaard et al. (2000) for Maryland streams, and by Johnson et al. (1999).

Strecker (2001) recommended the use of continuous modeling to assess the true effectiveness of Low-Impact Development (LID) techniques, after discussing the inadequacy of traditional event-based flood design techniques (e.g. rational formula, curve number, time of concentration) for accurate evaluations. Bledsoe (2002) calculated the frequency and duration of critical shear stress exceedance, i.e. that level of shear stress needed for bed particle entrainment, ***during a single storm event***, and used that metric to assess alternative development and detention conditions. He further recommended that future research should investigate the use of his approach with the more robust procedures of continuous simulation across stream types and management practices.

Much of the available literature on urbanization impacts is derived from studies in mostly humid regions of the country, dominated by the Pacific Northwest, the Mid-Atlantic regions, and the Mid-West. Booth and Jackson (1997) state outright that their study sites do not include, and are unrepresentative of arid and semi-arid watersheds. Bledsoe (2002) investigates small urban watershed in Colorado, but limits his analyses to a single event. Caraco (2000), on the other hand, has explored and summarized some of the characteristics of stormwater strategies for arid and semi-arid watersheds. For definition purposes, arid regions are defined as those with less than 15 inches of annual rainfall, while semi-arid regions get 15 to 35 inches, with a distinct dry season where evaporation greatly exceeds rainfall. Clearly, the Calleguas Creek Watershed qualifies as a semi-arid watershed. Caraco summarizes the key considerations for these watersheds, located primarily in the western U.S., as follows:

- Aquatic resources and management objectives are fundamentally different
- Rainfall depths are much lower
- Evaporation rates are much higher
- Pollutant concentrations in stormwater are much greater
- Vegetative cover is sparse
- Sediment movement is great
- Dry weather flow is rare, unless return flows are present

Although many of these observations are self-evident, the implications are significant. The prevalence of ephemeral streams for arid/semi-arid watersheds requires that stream protection needs be re-interpreted, and not adapted from humid regions. Also, design storm frequencies, such as the 2-year event peaks need to be re-evaluated under these conditions, as opposed to accepted because they have been established in other regions. Although the conventional impacts of urbanization in a humid region includes increases in peak flows, and reduction in baseflows, in arid/semi-arid watersheds dry weather flows often will increase due to extensive urban landscape watering and/or point source discharges. The effects of urban landscape watering were evident in the modeling of the Arroyo Simi in the Upper Calleguas Creek Watershed (AQUA TERRA Consultants, 2003), and have been documented for neighboring watersheds in Los Angeles (Ackerman et al., 2003). Consequently, for arid/semi-arid watersheds the impacts of urbanization on maintaining, and possibly increasing, baseflows due to supplemental irrigation (and other sources) needs to be addressed so that the frequency and durations of erosive channel flows can be accurately represented.

Clearly continuous hydrologic modeling is recognized as a very useful, if not critical, tool for watershed assessments. When properly calibrated and validated, continuous watershed models can provide a complete 'synthetic' record of flow, at any point of concern in the watershed, for flood peak frequency analyses, storm hydrograph definition, flow duration information, and water balance assessments. When this information is combined with bed shear stress and critical stress calculations, it can provide a framework for channel stability and protection investigations that specifically consider the frequency and duration of erosive events. This is the framework for the Study Methodology described in Section 2.2, below.

2.2 Study Methodology

The methodology developed for this study combines the approach developed by Cappuccitti and Page (2000) for MDE using shear stress ratios, with the work of Bledsoe (2002), and others, on shear stress frequency duration, and extends it with continuous hydrologic modeling to estimate the *'% of time for erosive conditions'* for the stream segment of concern. This metric, *'% of time for erosive conditions'*, can then be calculated under alternative land use conditions and mitigation alternatives to assess the impacts of urbanization, or mitigation required, to maintain channel stability and ensure stream and habitat protection from scour and degradation.

The basic steps in the study methodology are as follows:

1. Using a continuous hydrologic model, calculate the bed shear stress, τ, for daily or hourly timesteps for an extended period, 20 to 30 years.
2. Analyze the extended timeseries to determine the stress-duration curve, analogous to the well known flow-duration curve.
3. Calculate the 'critical shear stress', or τ_c, for bed material entrainment.
4. Divide the curve from Step 2 by τ_c to obtain a shear stress ratio, τ/τ_c, duration curve.
5. Establish the ratio τ/τ_c value that represents the threshold for erosive conditions and channel protection.
6. From the curve in Step 4, calculate the *'% of time for erosive conditions'*. This represents the risk of channel erosion for the stream segment, under the conditions simulated by the hydrologic model.

These steps are then repeated for each alternative scenario – current, natural/historic, future land use conditions, and detention basin or mitigation practices – with the differences, compared to current or baseline conditions, representing the increased or decreased risk of channel erosion for each scenario.

The formulas for calculating bed and critical shear stress are well established, and have been described by Doyle et al. (2000), Johnson et al. (1999), and many others. The **average shear stress** exerted on the wetted perimeter, bed and banks, of a stream cross-section is

$$\tau = \gamma R S \qquad (2.1)$$

where γ is the unit weight of water, R is the hydraulic radius, and S is the energy slope which can be assumed to be the bed slope. **Critical shear stress**, τ_c, which is the shear threshold at which bed material movement is initiated, is given by

$$\tau_c = \theta (\gamma_s - \gamma) D \qquad (2.2)$$

where θ is the dimensionless Shields parameter for entrainment of a sediment particle of size D, and γ_s is the unit weight of sediment. Using Equations 2.1 and 2.2, the **shear stress ratio**, τ_R,
is given as follows:

$$\tau_R = \tau/\tau_c$$

Johnson et al (1999) established a ratio threshold value of 2.5 above which a channel was considered unstable, stable at ratios less than 1.5, and transitional for intermediate values. MDE set a threshold ratio of 1.2 based on work by Prestegaard (2000). Although there is uncertainty about what specific threshold value to use, the shear stress ratio has been used by numerous investigators to assess channel stability conditions.

HSPF uses Equation 2.1 to calculate the boundary shear stress for each simulation time step, often on an hourly basis, during the entire span of the model run. The hydraulic characteristics of a stream reach are represented by a function table (FTABLE) that includes the relationships between stage, storage (volume), surface area, and discharge. For each timestep, the HYDR module of HSPF calculates these variables using a storage-routing procedure for the hydraulic routing function. The hydraulic radius, R in Equation 2.1, is calculated as a function of average water depth (AVDEP) and mean top width (TWID), as follows:

HRAD = (AVDEP*TWID)/(2.*AVDEP + TWID)

Average depth is computed as: AVDEP = VOL/SAREA

The mean top width is found using: TWID = SAREA/LEN

where: LEN = length of the RCHRES, supplied by the user

If the stream reach is a lake, alternative methods are used for the shear calculations (see Users Manual for details).

Thus, the shear stress is calculated in each time step using the calculated value of R and Equation 2.1. From the equations shown above, it is clear that the accuracy of the FTABLE for a specific reach is an important factor in adequately representing the hydraulic radius, as a function of the stage (or depth of flow), and the subsequent shear values.

Figure 2.1 shows schematically how calculated shear stress values vary dynamically during model simulations of a storm event. In the SEDTRN module of HSPF (although not used in this study), critical shear stress parameters (one for scour and one for deposition) are assigned by the model user for each size fraction, and are adjusted so that the model calculates scour during high flow events, deposition and settling during low flow periods, and transport with neither scour nor settling for moderate flow rates. To generate the shear stress duration curves needed for the Study Methodology, the hourly shear values produced by HSPF during the entire model period are analyzed to establish their frequency-duration characteristics.

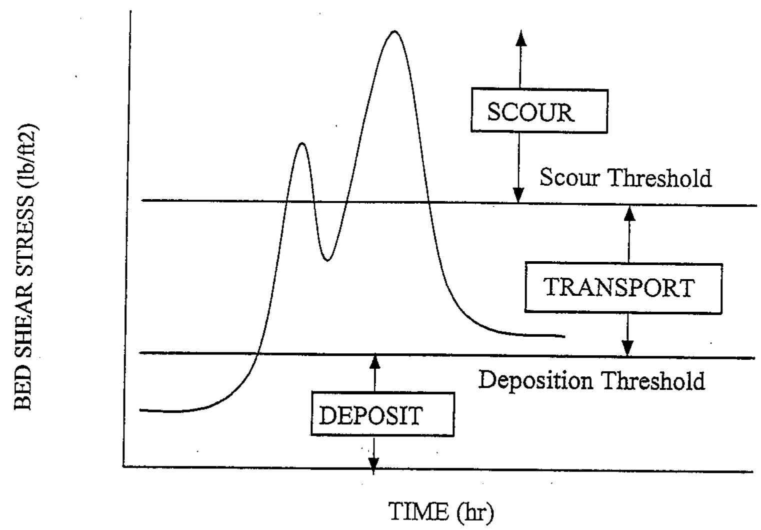


Figure 2.1 Shear Stress Variations During Storm Events in HSPF

Although the equations for shear stress and critical shear stress are well-established, parameterization for specific sites is often difficult. In Section 3 we discuss the parameterization issues related to using the USEP data and model simulations to evaluate the needed parameters – S, R, D, θ, τ_c, τ_R – and establish the baseline conditions for assessing channel stability in the Arroyo Simi Watershed.

The Study Methodology described above will be applied to the Arroyo Simi Watershed using the HSPF model application noted earlier (AQUA TERRA Consultants, 2003). In Section 2.3 (below) we provide an overview of the Arroyo Simi Watershed HSPF model to establish the foundation for the discussions in Section 3.

2.3 Arroyo Simi Watershed HSPF Model Overview

The Arroyo Simi Watershed is located primarily in Ventura County, with a small upstream portion extending into Los Angeles County. The stream flows from the hills at the east end of Simi Valley, passing west through the Cities of Simi Valley and Moorpark. The central part of the basin is a highly urbanized flat valley, which is surrounded by largely undeveloped hills and canyons. Downstream portions of the stream are called Arroyo Las Posas and Calleguas Creek, which empties into the Pacific Ocean through the Mugu Lagoon estuary. The watershed is subject to flooding and erosion, resulting in sediment deposition downstream in Mugu lagoon.

The portions of the Arroyo Simi that are considered in this study are shown in Figure 2.2 below. The principal streamflow gage at Madera Road Bridge is the outlet whose drainage area of 70.2 sq. mi. defined the initial study area. Additional areas downstream of the Madera gage, encompassing the Oak and Sycamore Canyon drainage areas, plus a short section of the main stem, were added to the model area in order to include all the USEP habitat sites.

Figure 2.2 Arroyo Simi Model Area

2.3.1 Watershed Segmentation

Whenever HSPF, or any watershed model, is applied to a watershed, the entire study area must undergo a process referred to as 'segmentation'. The purpose of watershed segmentation is to divide the study area into individual land and channel segments, or pieces, that are assumed to demonstrate relatively homogenous hydrologic/hydraulic and water quality behavior. This segmentation provides the basis for assigning similar or identical input and/or parameter values or functions to where they can be applied logically to all portions of a land area or channel length contained within a model segment. Since HSPF and most watershed models differentiate between land and channel portions of a watershed, and each is modeled separately, each undergoes a segmentation process to produce separate land and channel segments that are linked together to represent the entire watershed area.

Watershed segmentation is based on individual spatial characteristics of the watershed, including topography, drainage patterns, land use distribution, meteorologic variability, and soils conditions. The process is essentially an iterative procedure of overlaying these data layers and identifying portions of the watershed with similar groupings of these characteristics. Over the past decade, the advent of geographic information systems (GIS), and associated software tools, combined with advances in computing power, has produced automated capabilities to efficiently perform the data-overlay process.

The Arroyo Simi watershed was segmented into individual land segments in order to assign identical model parameter values to all parts of the watershed that produce the same unit response of runoff, for a uniform set of meteorologic conditions. Since the weather patterns vary across the Arroyo Simi watershed, it is necessary to also divide the land segments by meteorology to accurately reflect spatial meteorologic variability and its effect on the hydrology of the watershed.

The Arroyo Simi Basin was segmented into 42 reach drainage areas by aggregating a set of detailed subbasin boundaries provided by the County based on major tributary inflows, gages, and detention basins. These 42 reach drainage areas were aggregated into 18 separate model land segments according to topographic and meteorologic considerations. The primary factors were the locations of the rain gages, average annual precipitation based on the County isohyetal map, and differences in slope and elevation between the flat central valley and the upland rugged hills and canyons. The elevation and slopes were calculated from USGS 30-meter digital elevation models (DEMs). The final land segments are shown below in Figure 2.3; further details on the segmentation process are presented in the Study Report (AQUA TERRA Consultants, 2003).

Figure 2.3 Final Model Segmentation for the Arroyo Simi Watershed

2.3.2 River Segmentation and Characterization

The river channel network in the Arroyo Simi Watershed is the major pathway by which flow and sediment is transported from the watershed. As such, it is important to accurately represent or characterize the channel system in the HSPF model of the watershed. The final river reach segmentation (shown in Figure 2.4) was derived from consideration of river travel time, riverbed slope continuity, geo-morphological characteristics, and entry points of major tributaries.

USEP Sites

Figure 2.4 Reach Segmentation for the Arroyo Simi Watershed

The channel network was divided into stream reaches, including several detention basins with significant drainage areas. This process was the end result of considering the relative locations and data for tributary inflows, existing detailed subbasin boundaries, changes in channel slope, changes in slope of tributary areas, gage and USEP site locations, channel cross-sections, and detention basins on tributaries.

The main stem was divided into 11 reaches. Detention basins modeled accounted for another eight. The remaining reaches simulate the principal tributary canyons and drains. Short reaches of 0.25 mi or less were established at each of the 6 USEP sites, in order to more closely analyze bed shear stresses and channel stability. A list of reaches appears in Table 2.1, with their locations shown above in Figure 2.4. A detailed view of the Oak Canyon area, with multiple detention basins and USEP sites, is shown in Figure 2.5.

Figure 2.5 Oak Canyon Detention Basins and USEP Sites

The reaches are numbered using single digits for the main stem, and successive tens for each modeled tributary. Three reaches containing USEP sites were divided, with 900 added to the USEP reach number. The three sites in the extended area, including Oak and Sycamore Canyons are numbered in the 100s, and the reach downstream of Madera is assigned Reach #10.

Drainage areas were assigned by aggregation of the County detailed subbasin coverages. Two of the USEP sites (Royal, and Oak Canyon #2) had short reaches that did not span a detailed subbasin. These reaches were assigned zero incremental drainage area, with the assumption that the small area is insignificant compared to upstream contributions. The two detention basins on Oak Canyon (#102, #104), consisting of very short reaches lying along the main channel, also are assigned no incremental area.

With this segmentation complete, each reach segment is analyzed to compute the tributary areas of the land use categories and the hydraulic characteristics of the reach. HSPF uses piecewise linear function tables, called FTABLEs, to specify the geometric and hydraulic characteristics (e.g. stage-volume-discharge relationship) of the stream reaches, both for the channel and the floodplain. The table columns consist of depth, surface area, storage volume, and discharge. The first three can be computed from measured or estimated cross-sections plus reach length. The discharge may come from measured ratings or may be derived from the geometry, slope, and roughness using Manning's equation.

Table 2.1 Stream Reaches within the HSPF Model of the Arroyo Simi Watershed (Stream reaches for USEP sites are highlighted)

Reach #	Name	Incremental Drainage Area (ac)	Length (mi)
1	Arroyo Simi above White Oak Creek	2110	1.91
2	Arroyo Simi above Las Llajas Canyon	2145	1.84
3	Arroyo Simi above Meier Canyon	1445	1.67
4	Arroyo Simi above Royal Ave	421	0.46
904	Arroyo Simi Royal Ave USEP Site	0	0.19
5	Arroyo Simi above Tapo Canyon	361	0.60
6	Arroyo Simi above Dry Canyon	150	0.86
7	Arroyo Simi above Bus Canyon Drain	314	1.44
8	Arroyo Simi above Madera Rd Bridge	271	0.84
9	Arroyo Simi above Sycamore Canyon	68	0.36
10	Arroyo Simi below Sycamore, Madera USEP Site	280	0.18
11	White Oak Creek	2318	2.19
21	Upper Las Llajas Canyon	4328	3.56
22	Las Llajas Canyon Dam	0	0.18
23	Chivo Canyon	2528	3.88
24	Marr Diversion	380	0.79
25	Lower Las Llajas Canyon	780	2.33
31	Meier Canyon	3868	3.69
41	Windmill Canyon	2497	2.77
42	Lower Gillibrand Canyon	645	1.46
43	Upper Tripas Canyon	2557	1.60
44	Lower Tripas Canyon	4333	2.61
45	Upper Tapo Canyon	1326	1.84
46	Lower Tapo Canyon	1825	3.07
51	Runkle Canyon Debris Basin	954	0.04
952	Runkle Canyon USEP Site	138	0.25
52	Lower Runkle Canyon	980	1.79
61	Tapo Hills No. 1 Debris Basin	100	0.08
62	Tapo Hills No. 2 Debris Basin	129	0.19
63	Tapo Hills Diversion	146	1.35
64	Upper Dry Canyon	731	1.02
964	Dry Canyon USEP Site	55	0.22
65	Lower Dry Canyon	994	2.29
71	Erringer Road Debris Basin	299	0.16
72	Lower Erringer Road Drain	400	1.50
81	Upper Bus Canyon Drain	1580	1.74
82	Lower Bus Canyon Drain	1961	3.31
91	Upper North Simi Drain	834	1.51
92	Lower North Simi Drain	1026	1.34
101	Upper Oak Canyon	1319	1.62
102	Upper Oak Canyon Detention Basin	0	0.03
103	Middle Oak Canyon USEP #1	158	0.23
104	Oak Canyon Detention Basins No. 1 & 2	0	0.02
105	Middle Oak Canyon USEP #2	0	0.19
106	Lower Oak Canyon	569	1.67
107	Upper Sycamore Canyon	1996	1.72
108	Sycamore Canyon Dam	0	0.08
109	Lower Sycamore Canyon	857	1.76
	Total Area 50179 acres (78.4 sq mi)		

2.3.3 Land Use

The Arroyo Simi Watershed, an area of over 50,000 acres (78.4 sq mi), is predominantly a mix of urban lowlands and upland open areas, with the latter comprising approximately 70% of the total area. The balance of the basin is comprised of low-density residential (16.2%), commercial-industrial areas (6.5%), and medium- (6.2%) and high-density (1.5%) residential zones.

Land use data were derived from a GIS coverage provided by the County from a survey in 1998, shown in Figure 3.7 above. For simulation purposes, the nine categories (eight urban categories plus open space) in this coverage were aggregated into five distinct pervious land segment types: an aggregated commercial/industrial/institutional category; low, medium, and high density residential areas; and open space. The latter areas are generally mixed scrub and grasslands.

For each of the four urban categories, a single effective impervious area (EIA) fraction was calculated, which represents impervious areas whose drainage is directly connected to the stream, rather than routed to adjacent pervious areas where it may infiltrate into the soil. The EIA fractions were developed from values provided by the County for a much more detailed set of land use categories than were present in the GIS coverage. Table 2.2 shows the breakdown of the model categories into the major and minor detailed subcategories, and the EIA percentages used for each. These EIA percentages were derived from Ventura County values, literature values from studies in similar areas, and visual analyses of aerial photos for selected regions provided by the County. The total EIA of each model segment is then represented as the aggregate of the combined EIA contributions from the individual land uses.

Once the land segmentation was finalized, the land use coverage was overlaid with the drainage area segmentation, and the land use distribution for each model segment was generated. Table 2.3 shows the acreages of each land use in each model segment. The individual reaches were also assigned tributary land use areas based on the intersection of coverages.

Table 2.2 Ventura County Land Use Category EIA in Phase 2 Model

Model Land Use	Major VC Category	Minor VC Category	EIA
Open	Open Space & Recreation	All	0%
	Unclassified	All	0%
Low-density Residential	Residential: <1 unit/ac	Residential Estate	5%
	Residential: 1-4.99 units/ac	Rural 1+ acre	5%
		Very Low Density 0-2 d.u. per acre	5%
		Very Low 0-2 d.u. per acre 20000 sq ft min lot size	5%
		Low Density 2-4.5 d.u. per acre	10%
		Medium 3.26-3.7 d.u. per acre bonus range 3.8-5.0 d.u. per acre	10%
Medium-density Residential	Residential: 5-11.99 units/ac	All	25%
High-density Residential	Residential: >12 units/ac	High 10.1-15 d.u. per acre bonus range 15.1-18.75 d.u. per acre	35%
		High Node 10.1-15 d.u. per acre bonus range 15.1-18.75	35%
		Mobile Home 5.1-8.0 d.u. per acre bonus range 8.1-12.0 d.u. per acre	35%
		Very High 18.76-25.0 d.u. per acre bonus range 25.1-50.0 d.u. per acre	40%
		Very High Node 18.76-25.0 d.u. per acre bonus range 25.1-50.0	40%
Commercial & Industrial	Public Facilities & Institutions	Brandeis-Bardin Institute	10%
		Community Activity Facility Overlay	25%
		Existing Community (per area plan or community map)	25%
		Schools	35%
		Fire Station	35%
		Hospital	35%
		Law Enforcement Office	40%
		Civic Center	50%
		Library	50%
	Industrial	All	70%
	Commercial	All	50%
	Transportation & Utilities	All	70%

Table 2.3 - Arroyo Simi Model Land Use by Segment (acres)

	----------	--------Pervious		----------	-----------------		
		----Residential		----------			
Segment	Open	Low Den	Med Den	Hi Den	Commercial	Impervious	Total
Upper Arroyo Simi Steep	2525	216	283	4	333	291	3653
Upper Arroyo Simi Flat	--	444	87	118	71	192	913
Upper Las Llajas/Chivo	3708	--	--	--	--	--	3708
Middle Las Llajas/Chivo	3708	--	28	--	--	9	3746
Lower Las Llajas	1019	104	226	33	16	139	1538
Upper Meier Canyon	2870	108	--	--	--	6	2984
Southern Canyons Moderate	1863	607	137	26	207	210	3050
East Simi Valley	79	565	104	16	167	338	1269
Upper Tripas Canyon	3160	--	--	--	--	--	3160
Lower Tripas/Gillibrand	6863	9	--	--	--	0.5	6873
Middle Tapo Hills	2159	32	71	--	--	25	2287
North Simi Valley	197	1600	122	79	235	497	2730
Lower Tapo Hills	1038	186	233	1	31	125	1614
Central Simi Valley	99	1616	70	92	255	506	2637
Upper Bus/Erringer	2511	22	--	--	--	1	2534
Upper Sycamore/Oak	2345	867	553	1	12	256	4033
West Sycamore Canyon	672	164	269	81	44	199	1428
West Simi Valley	79	888	158	32	285	580	2023
Total	34898	7427	2340	484	1655	3374	50179
Percent	69.5%	14.8%	4.7%	1.0%	3.3%	6.7%	100.0%

SECTION 3.0
PARAMETERIZATION AND BASELINE SIMULATIONS

This section describes the estimation of the major parameters that are needed for application of the Study Methodology, along with generation of Baseline conditions and associated model results for comparison with the scenario alternatives. As discussed in Section 2.2, the major parameters include S, R, D, θ, τ_C, and τ_R. Section 3.1 discusses the use of the USEP data to estimate D and S, while Section 3.2 evaluates the shear and threshold parameters θ, τ_C, and τ_R. The Baseline conditions are described in Section 3.3, including the analysis of R values calculated by HSPF for the USEP sites.

3.1 USEP Data Analyses

As part of the USEP Project, field sampling and monitoring was conducted over a 2-year period for six sites within the Arroyo Simi Watershed. The six sites include two mainstem sites and four tributary sites, as follows:

Site #1: Arroyo Simi Mainstem at Madera Road Bridge (downstream from gage site)
Site #2: Dry Canyon (control site)
Site #3: Runkle Canyon
Site #4: Oak Canyon – upstream of detention basin
Site #5: Oak Canyon – downstream of detention basin
Site #6: Arroyo Simi Mainstem at Royal Avenue (upstream from gage site)

To address the USEP objective of recording changes in channel morphology, water quality, and habitat over time, the six sites were chosen in urbanized areas either on the mainstem of the Arroyo Simi or on tributaries generally downstream of detention basins. The exception to this was the Dry Canyon site which was selected as a natural or control site, without upstream detention. The locations of the six USEP sites are shown in Figure 2.3. The monitoring periods were selected to establish baseline conditions before the start of the rainy season and then numerous times during the rainy season following significant storm events. Figure 3.1 shows the timing of the sampling events in sequence compared to the storm events at the Madera site. The field work included various activities related to watershed assessment, stream reach assessment, bioassessment, water quality monitoring, flow/peak monitoring, cross-section surveying and bed sampling. The USEP work plan and data were provided in a series of quarterly reports (e.g. VCWPD, 2001) along with selected data files, for use in this study.

The primary work related to channel stability data included the bed sampling and particle size analyses, and the cross-section surveys. These were performed five to six times during the 2-year period, and the data were tabulated and analyzed for use in this study. Table 3.1 includes a summary of the results of sieve analyses of the bed samples taken at each of the six USEP sites, showing the sample dates, textural distribution, and the estimated D_{50} and D_{84} values for each site and sample. The D_{50} and D_{84} values represent the particle diameters passing 50% and 84% of the bed sample; these characteristic particle diameters are the ones often used for critical shear calculations. Table 3.2 is an example of the sieve analysis tabulation and the estimation of the D_{50} and D_{84} values through interpolation between neighboring values. The values in Table 3.2 confirm that the Arroyo Simi streams have mostly sand and gravel beds, with only the Runkle site showing silt/clay values approaching 40%; all others are less than about 20% silt/clay, and mostly 80% sand and gravel.

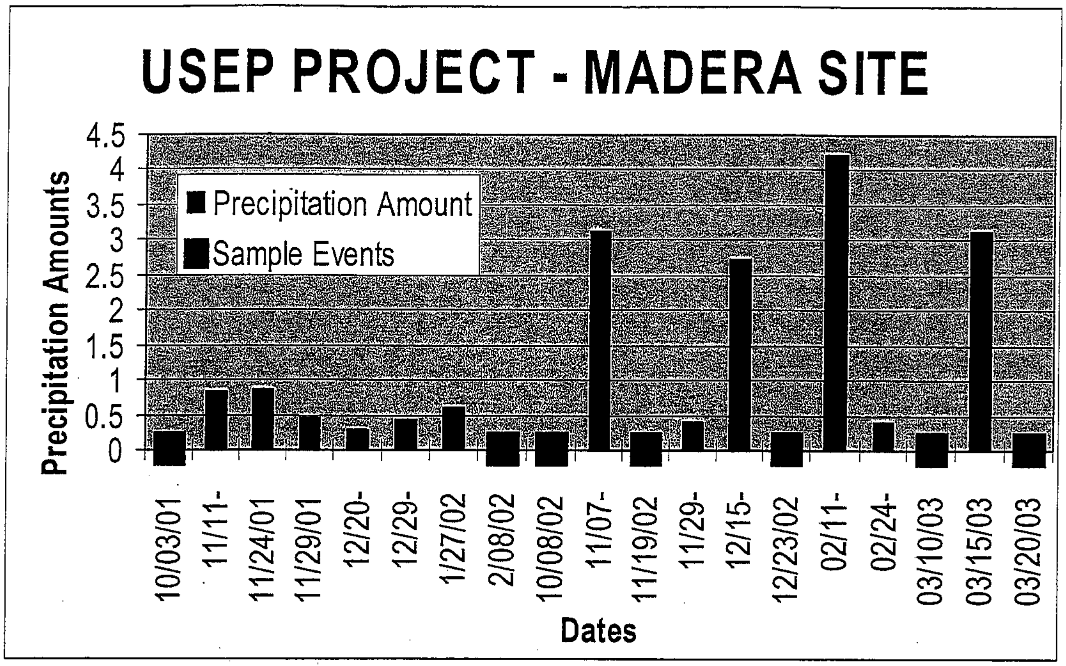


Figure 3.1 USEP Project Sampling and Storm Events at the Madera Site

Channel cross sections were measured at each USEP site at study initiation and following selected major storm events during the 2-year field study. This amounted to five cross section surveys at all sites. For each survey, three sections were usually measured – upstream, midpoint, downstream – at spacing intervals of approximately 25 to 50 feet longitudinal to the stream. Visual inspection of the plotted cross sections showed very little change for most all sites over the entire study period. Elevations of individual points along a cross section would change from survey to survey, but usually less than 0.5 to 1.0 feet. It was evident that local scour points due to an individual event would be filled in from subsequent storm events. The only major difference of note was the downstream cross section for the Madera site. Between surveys in October 2001 and January 2002, local scour in a 20-foot cross section of the stream, with an overall width of about 140 feet, dropped bed elevations about seven feet. This appears to be the result of a few small to moderate storm events (less than 1 inch rainfall) in the interim winter storm period. However, by the time of a November 2002 survey, the bed elevation was essentially restored to its October 2001 level, due to a single large storm (more than 3 inches rainfall) on November 7-9, 2002. This behavior, along with the obvious absence of significant cross-sectional changes at the other USEP sites, indicates relatively stable channel conditions for all the sites. The only qualifying condition is that the surveys were done during a relatively dry period, without many significant storm events.

Figure 3.2 shows the midpoint channel cross sections for each USEP site used to generate the FTABLE relationships required by HSPF. These cross sections, along with slope, length and roughness parameters (channel and overbank) were used with the U. S. Army Corps of Engineers HEC-RAS hydraulic model to develop the FTABLE information. For each site, the HEC-RAS model was run with a range of flow rates to produce the depth (stage), surface area, and volume data needed to define the FTABLEs and characterize the hydraulic behavior of each USEP site reach.

Table 3.1 Summary of USEP PSD Bed Sample Data (composition by percent)

Dry Canyon

Date:	Coarse Gravel	Fine Gravel	Sand	Silt/Clay	Total	D50 (mm)	D84 (mm)
2/8/2002	6.0	26.7	60.0	7.3	100.0	0.7	6.8
11/1/2002	5.7	17.4	68.4	8.5	100.0	0.5	3.0
11/19/2002	3.6	21.5	67.9	7.0	100.0	0.5	2.0
1/6/2003	10.7	14.8	63.3	11.2	100.0	0.5	15.0
3/10/2003	18.6	16.6	56.0	8.8	100.0	0.8	25.0
3/20/2003	19.7	15.2	57.4	7.7	100.0	0.6	25.0
Average	10.7	18.7	62.2	8.4		**0.6**	**12.8**

Runkle

Date:	Coarse Gravel	Fine Gravel	Sand	Silt/Clay	Total	D50 (mm)	D84 (mm)
2/8/2002	11.2	29.1	40.8	18.9	100.0	0.6	9.5
11/4/2002	23.4	25.5	11.2	39.9	100.0	1.0	25.0
11/19/2002	18.0	21.8	20.4	39.8	100.0	0.3	20.0
1/6/2003	30.3	15.7	19.3	34.7	100.0	0.5	35.0
3/10/2003	32.0	22.4	19.3	26.3	100.0	6.0	**76.2***
3/20/2003	0.0	7.3	35.0	57.7	100.0	0.1	0.6
Average	19.2	20.3	24.3	36.2		1.4	**18.3**

Oak Canyon-U/S

Date:	Coarse Gravel	Fine Gravel	Sand	Silt/Clay	Total	D50 (mm)	D84 (mm)
2/8/2002	7.0	60.4	11.8	20.8	100.0	6.0	15.0
11/4/2002	18.2	18.4	32.6	30.8	100.0	0.3	30.0
11/19/2002	11.8	36.2	33.7	18.3	100.0	0.9	17.0
1/6/2003	10.7	24.1	46.6	18.6	100.0	0.7	11.0
3/10/2003	13.1	29.5	24.5	32.9	100.0	0.7	18.0
3/20/2003	9.3	13.7	76.1	0.9	100.0	0.4	10.0
Average	11.7	30.4	37.6	20.4		**1.5**	**16.8**

Oak Canyon-D/S

Date:	Coarse Gravel	Fine Gravel	Sand	Silt/Clay	Total	D50 (mm)	D84 (mm)
11/19/2002	0.0	33.8	39.3	26.9	100.0	0.4	7.0
1/6/2003	0.0	28.5	54.1	17.4	100.0	0.4	6.5
3/10/2003	2.9	28.6	50.9	17.6	100.0	0.7	8.0
3/20/2003	3.5	29.7	52.3	14.5	100.0	0.9	6.5
Average	1.6	30.2	49.2	19.1		**0.6**	**7.0**

Simi-Royal

Date:	Coarse Gravel	Fine Gravel	Sand	Silt/Clay	Total	D50 (mm)	D84 (mm)
2/8/2002	4.5	18.9	74.8	1.8	100.0	0.5	2.5
10/31/2002	8.6	28.0	62.1	1.3	100.0	0.7	11.0
11/19/2002	8.8	22.7	63.6	4.9	100.0	0.7	9.0
1/6/2003	11.2	13.2	74.4	1.2	100.0	0.6	10.0
3/10/2003	9.1	13.7	76.6	0.6	100.0	0.5	5.0
3/20/2003	9.3	13.7	76.8	0.2	100.0	0.5	7.0
Average	8.6	18.4	71.4	1.7		**0.6**	**7.4**

Simi-Madera

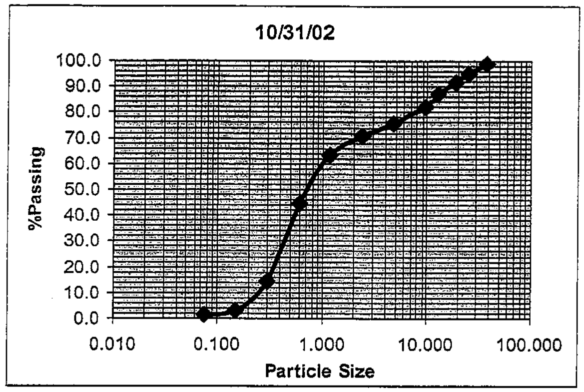
Date:	Coarse Gravel	Fine Gravel	Sand	Silt/Clay	Total	D50 (mm)	D84(mm)
2/8/2002	12.3	66.8	19.9	1.0	100.0	4.5	14.0
10/31/2002	16.2	34.5	41.5	7.8	100.0	1.3	20.0
11/19/2002	12.7	41.0	40.2	6.1	100.0	1.8	13.0
1/6/2003	22.7	32.1	41.0	4.2	100.0	3.1	23.0
3/10/2003	14.1	30.9	53.4	1.6	100.0	1.4	19.0
3/20/2003	12.3	34.7	48.4	4.6	100.0	1.9	15.0
Average	15.1	40.0	40.7	4.2		**2.3**	**17.3**

* - Outlier, not included in average

Table 3.2 Sieve Analyses and Particle Characterization for the Royal and Madera USEP Sites

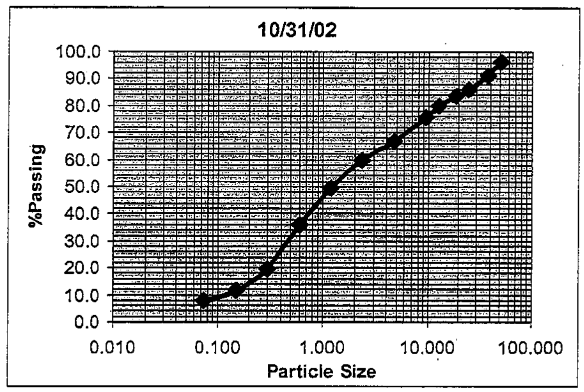
Arroyo Simi - Royal

Sample Date	Sieve	Particle Size (mm)	%Passing	Soil Classification
10/31/2002	1.5"	38.100	99.1	Coarse Gravel
	1"	25.400	95.2	
	.75"	19.050	91.4	Fine Gravel
	.5"	12.700	87.1	
	.375"	9.525	82.1	
	#4	4.750	75.6	
	#8	2.360	70.6	
	#16	1.180	63.4	Sand
	#30	0.600	44.6	
	#50	0.300	14.3	
	#100	0.150	3.0	
	#200	0.075	1.3	Silt/Clay



Arroyo Simi - Madera

Sample Date	Sieve	Particle Size (mm)	%Passing	Soil Classification
10/31/2002	2"	50.800	96.3	Coarse Gravel
	1.5"	38.100	91.1	
	1"	25.400	86.2	
	.75"	19.050	83.8	Fine Gravel
	.5"	12.700	79.8	
	.375"	9.525	75.8	
	#4	4.750	67.0	
	#8	2.360	59.6	
	#16	1.180	49.3	Sand
	#30	0.600	36.0	
	#50	0.300	19.8	
	#100	0.150	11.6	
	#200	0.075	7.8	Silt/Clay



Slopes were determined by overlaying the USEP reach endpoints with the DEM coverage, selecting the elevations of the endpoints, and calculating the slope from the elevation difference and the reach lengths (from Table 2.1). The calculated slopes are shown below in Table 3.3.

Table 3.3 Slopes for USEP Site Reaches

HSPF Reach #	USEP Site Name	Slope
952	Runkle Canyon	**0.0134**
964	Dry Canyon	**0.0077**
103	Oak Canyon #1, Upstream	**0.0109**
105	Oak Canyon #2, Downstream	**0.0050**
904	Arroyo Simi at Royal	**0.0036**
10	**Arroyo Simi below Madera**	**0.0027**

The thalweg elevations (deepest part of the channel) from the cross section surveys were also examined as a means of determining slope values. However, the relatively short spacing between the cross sections, less than 50 feet, and local bed variations often produced either extreme slopes, exceeding 10-15%, and in some cases, negative slopes. Consequently, the DEM elevations combined with the HSPF reach lengths were judged to be a better estimate of the overall channel slope, and produced values more consistent with the spatial detail in the model.

3.2 Shear Stress and Channel Stability Thresholds

As noted in Section 2.2, the Study Methodology includes evaluation of the **critical shear stress**, τ_c, which is the shear threshold at which bed material movement is initiated, and is given by

$$\tau_c = \theta\,(\gamma_s - \gamma)\,D \qquad (3.1)$$

where θ is the dimensionless Shields parameter for entrainment of a sediment particle of size D. Thus, estimation of the Shields parameter is required to apply the methodology to each of the USEP sites.

The value of Shields parameter is a complex function of particle size, shape, and packing within the streambed, along with the hydraulic nature of flow conditions, varying from hydraulically smooth to rough. Gordon et al (1992) has indicated that order of magnitude variations can be expected in natural channels, and values for sand and gravel beds can be especially problematic due to armoring conditions. As shown in Table 3.4, the Shields parameter generally ranges from 0.01 for loosely packed gravels to 0.10 for highly imbricated, or tiled, bed conditions. Based on the value ranges shown in Table 3.4 and both field observations and photos of the USEP sites, values of Shields parameter were selected for each site as listed in Table 3.5. The selection of these values was intended to allow differentiation of Shields values based on bed conditions at each site.

Table 3.6 shows the calculation of τ_c based on the above Shields values and the D50 values shown in Table 3.2, using Equation 3.1 and values of 165.4 lb/ft^3 (25.99 kN/m^3) and 62.4 lb/ft^3 (9.82 kN/m^3) for γ_s and γ, respectively. Clearly the value of τ_c is a direct function of the D50 value for each site, representing the characteristic bed particle diameter at that site. Thus, the accuracy of the τ_c values depends on how well the bed sampling procedures can provide an accurate sample representation of the bed material at a site, from which the D50 values are

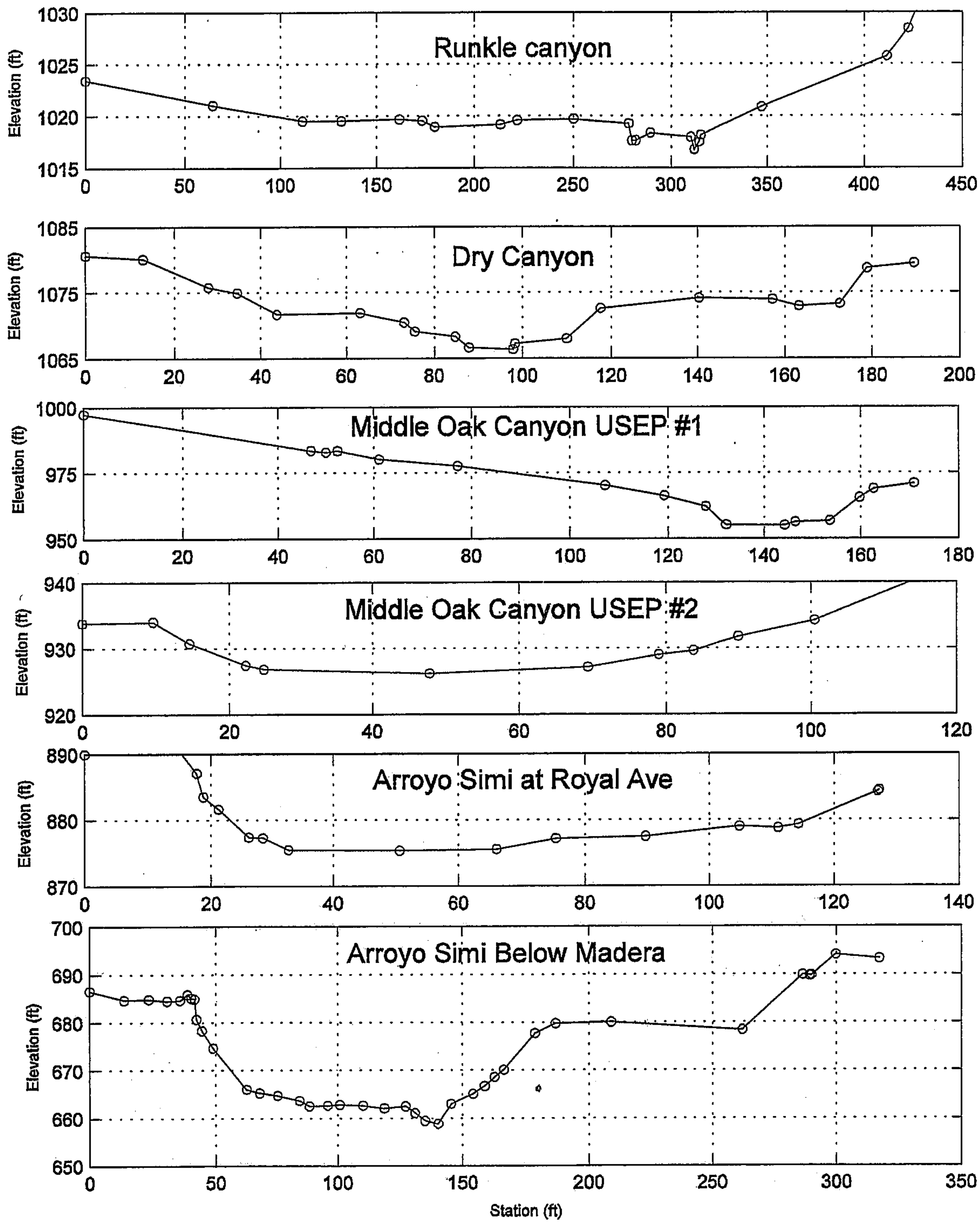


Figure 3.2 Cross Sections for USEP Sites

Table 3.4 Shields Parameters Values from Gordon et al (1992)

Streambed Condition	Shields Parameter, θ
Loosely packed: quicksands and gravels with large voids filled with water	**0.01 – 0.035**
Normal: uniform materials or a 'settled' bed with fairly random grain arrangements	**0.035 – 0.065**
Closely packed: smaller materials fill voids between larger particles	**0.065 – 0.10**
Highly imbricated: **overlapping, layered (tile-like) materials**	**> 0.10**

Table 3.5 Selected Shields Parameter Values for USEP Sites

HSPF Reach #	**USEP Site Name**	Shields Value
952	Runkle Canyon	**0.050**
964	Dry Canyon	**0.040**
103	Oak Canyon #1, Upstream	**0.050**
105	Oak Canyon #2, Downstream	**0.045**
904	Arroyo Simi at Royal	**0.035**
10	**Arroyo Simi below Madera**	**0.070**

determined. Discussion with VCWPD staff indicate that the bed samples obtained for Sieve analyses were used primarily to define relative differences between the sites and were not derived from rigorous sampling procedures. Therefore, some uncertainty in the τ_c values is introduced due to the uncertainty in the D50 values. Wolman pebble-count sampling was also performed at the USEP sites, but that procedure focuses primarily on the larger sand, gravel and cobble size fractions. A brief review of a the Wolman results indicates that larger sand gravel and cobble size particles are prevalent, especially at the Madera site and to a lesser extent at the Royal site. At the Madera site coarse gravel and cobbles sizes represented up to 20% to 40% of the pebble counts, and exposed bedrock was also noted. These conditions clearly need to be considered when assessing channel stability issues.

Table 3.6 Calculation of Critical Shear Stress (Tau) for USEP Sites

	D50, mm	D50, ft	Shields, θ	Tau Critical, τ_c	
				lb/ft^2	Pa (N/m^2)
Runkle	1.4	0.0046	0.050	0.0237	1.13
Dry Canyon	0.6	0.0020	0.040	0.0081	0.39
Oak Canyon U/S	1.5	0.0049	0.050	0.0253	1.21
Oak Canyon D/S	0.6	0.0020	0.045	0.0091	0.44
Simi - Royal	0.6	0.0020	0.035	0.0071	0.34
Simi - Madera	2.3	0.0075	0.070	0.0544	2.60

Note: 1 Pascal (Pa) = 1 N/m^2 = 0.0209 lb/ft^2

Although, the τ_c represents the threshold for bed material movement, the threshold for channel stability is generally higher, representing the fact that bed material will be scoured and moved during storm events, and then likely settle and deposit some distance downstream. Considering the inflow of upstream sediment, the joint occurrence of scour and deposition processes is a natural phenomenon for channels in a state of 'dynamic equilibrium'. Channel instability occurs when this equilibrium is upset, producing excessive bed scour, bank failures, widening and/or incising channels, etc. Consequently, as discussed in Section 2.2, the **shear stress ratio**, τ_R, described as, $\tau_R = \tau/\tau_c$, has been used to assess and evaluate channel stability conditions by numerous investigators (e.g. Johnson et al (1999), Doyle et al (2000), Cappuccitti and Page (2000)). As noted earlier, Johnson et al (1999) established a ratio threshold value of 2.5 above which a channel was considered unstable, stable at ratios less than 1.5, and transitional for intermediate values. Cappuccitti and Page (2000), for their work in Maryland, set a threshold ratio of 1.2 for a stable channel based on work by Prestegaard (2000). For gravel bed conditions, Pitlick (1992) and Simon (1996) showed that for $\tau_R > 2$ most of the bed would be in motion, and when the $\tau_R > 3$ the entire bed would be moving. Although there is uncertainty about what specific threshold value to use to define unstable conditions, τ_R values greater than 2 to 3 are generally used.

3.3 Baseline Simulations

The HSPF model of the Arroyo Simi Watershed provides the foundation for the channel stability analyses performed in this study. The model was calibrated to eight years of continuous flow data at the Royal and Madera gages from water year (WY) 1988 through WY 1995. To provide a sound basis for analyzing watershed response and channel stability issues, the calibrated model was run for a 31 years from WY 1970 through WY 2000 to establish the baseline conditions for analysis of alternative scenarios on the watershed. In this section we present the model results for the baseline conditions which will be compared to model results for the alternatives identified and discussed in Section 4.0.

3.3.1 Arroyo Simi Model Calibration

A complete description and analysis of the Arroyo Simi Watershed model setup, calibration, and validation is presented in the Study Report (AQUA TERRA Consultants, 2003). Table 3.7 shows the annual runoff volume comparisons for both the Royal and Madera gage sites for each year of the calibration period, and Table 3.8 shows some of the statistics generated by the HSPEXP calibration support system (Lumb et al., 1994) used in this effort. Figure 3.3 presents the comparison of simulated and observed flow duration curves for the calibration period.

The calibration results for the Arroyo Simi Watershed model, based on the weight-of-evidence approach described in the Study Report, demonstrates a **good to very good** representation of the observed data. This calibration approach involves the cumulative assessment of a wide range of graphical and statistical comparisons and measures of the model performance for annual runoff, daily streamflow, flow duration, water balance components, and storm simulations. Thus, the model assessment is based on numerous comparisons and tests, and not just a single statistic or graphic. The flow duration curves (Figure 3.3) demonstrate that the model closely approximates the overall watershed hydrologic response over a wide range of flow conditions. The curves for Royal demonstrate the nature of these ephemeral streams, characteristics of semi-arid climates, that maintain flows only during and immediately following storm periods. The flow duration curve for Madera is evidence of the impacts of landscape irrigation that allows a relatively continuous flow to be maintained even during the dry summer and fall. In fact, the only reason that the observed flow duration curve at Madera shows zero flow, for about 4% of the time, is due to **missing flow data** and not zero values.

In spite of the good/very good calibration, it was noted in the Study report that model could not be validated due to data problems identified with the input hourly rainfall data for numerous events, and selected 'observed/estimated' storm event data, especially for the 1998 storms. Because the WY 1998 rainfall and flow were larger than for any year during the calibration period, and it dominated the validation period model results, the model validation could not be confirmed until the data issues were resolved. This effort is ongoing as part of the current extension of the Arroyo Simi model downstream to develop a hydrologic model of the entire Calleguas Watershed (J. Laber, VCWPD, personal communication, 2003). Once the data problems are resolved, the calibration and validation at the Royal and Madera sites will be re-assessed as part of the Calleguas effort.

Based on the results presented and discussed in the Study Report, it was concluded that the HSPF application to the Arroyo Simi provides a sound hydrologic watershed model that can provide the framework for watershed management analyses and needs for flood assessments, water quality issues, and mitigation alternatives. Based on this assessment and the summary results presented here, it is appropriate to use the Arroyo Simi Watershed model as a tool for evaluating stream channel behavior, stability issues, and protection alternatives.

3.3.2 Long-Term Simulations for Baseline Conditions

To better define baseline conditions, 31-year model runs were performed from WY 1970 through WY 2000 using the model setup and parameters obtained during the calibration period of WY 1988 through WY 1995. This long-term model run provided a sound basis for performing statistical analyses of the model results that will be compared to alternative scenario runs in Section 4.0. Figure 3.4 shows the flow duration curves for Royal and Madera from the 31-year run, and Table 3.9 includes selected statistics of the model results.

It should be noted that the intent of these comparisons is only to demonstrate that the model provides long-term results that are consistent with the results obtained for the calibration period. Therefore, the long-term simulations provide a sound basis for comparing the impacts of alternative conditions to be evaluated.

The flow duration curves demonstrate this consistency, when compared with those shown in Figure 3.3 for the calibration period. The curves clearly show almost identical shapes, with the long-term simulations showing somewhat higher peak flows and longer duration low flows, than the observed curves. This is expected due to the following:

a. Land use conditions for the long-term run reflects urbanization levels in 1987-95, which would be significantly higher than earlier in the 30-year period. Increased impervious area with urbanization would lead to the higher peak flows.
b. Irrigation by landscape watering also reflects more recent practices, leading to more sustained low flows.
c. For the Madera gage site, the long-term data show more frequent periods of both missing data and some actual zero flow (i.e. less than 0.1 cfs) periods. This accounts for the observed curve dropping below 1 cfs for about 15% of the time.

The statistics in Table 3.9 also show a reasonably good simulation that is generally higher than the observed values, due to the differing conditions noted above.

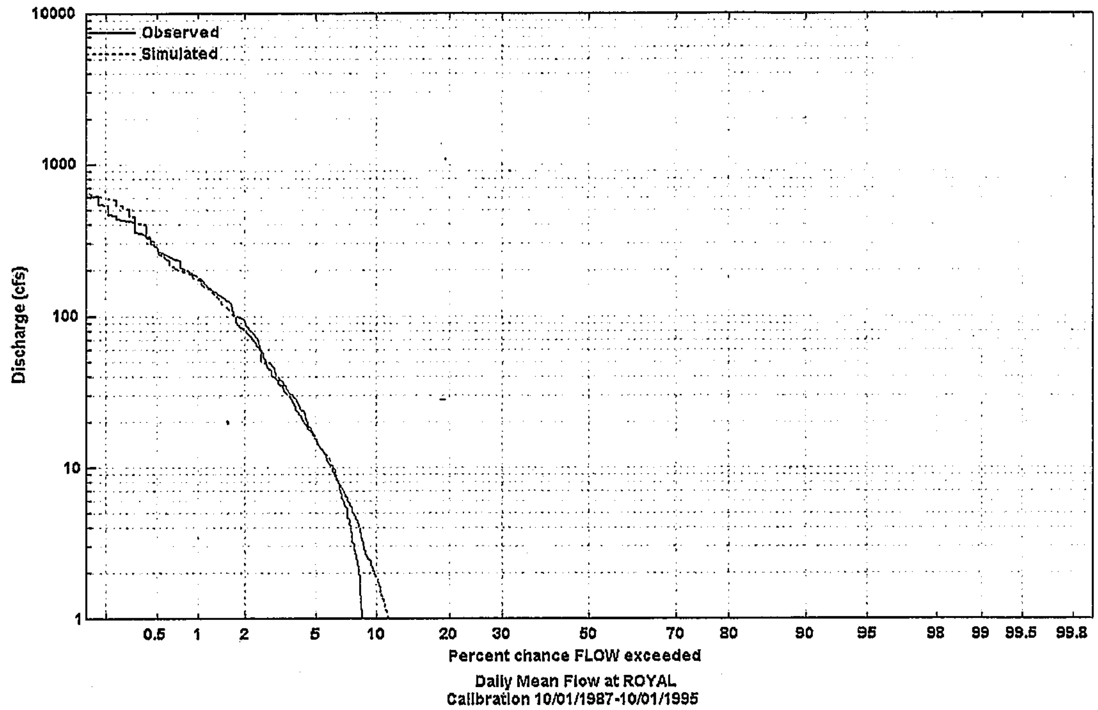
Table 3.7 Model Calibration Results at Royal and Madera Gages – Annual Rainfall and Flow (inches)

Year	Rainfall	Simulated Flow	Observed Flow	Residual	Percent Error
CALIBRATION PERIOD					
Royal					
1988	18.89	1.13	1.05	0.08	7.7%
1989	10.21	0.43	0.33	0.10	29.7%
1990	6.98	0.30	0.21	0.09	42.0%
1991	15.34	1.41	1.52	-0.11	-7.3%
1992	30.11	6.47	6.18	0.29	4.8%
1993	32.53	6.56	7.27	-0.71	-9.7%
1994	11.03	0.55	0.46	0.09	18.8%
1995	30.79	5.86	5.63	0.22	4.0%
Average	19.49	2.84	2.83	0.01	0.20%
Madera					
1988	18.02	1.89	2.24	-0.35	-15.8%
1989	10.62	1.10	1.26	-0.16	-12.9%
1990	7.25	1.00	1.23	-0.23	-18.8%
1991	14.78	2.03	2.03	0.00	-0.2%
1992	28.90	6.46	5.42	1.04	19.1%
1993	32.27	7.08	6.42	0.66	10.2%
1994	10.96	1.45	1.88	-0.43	-23.1%
1995	29.99	6.18	5.41	0.77	14.3%
Average	19.10	3.40	3.24	0.16	5.0%

Table 3.8 HSPEXP Calibration Statistics at Royal and Madera Gages

	Royal			Madera		
	Observed	Simulated	Error	Observed	Simulated	Error
CALIBRATION PERIOD						
Total Annual Flow – in	2.79	2.82	1.1 %	3.21	3.38	5.4 %
Total of 10% highest flows – in	2.79	2.80	0.3 %	2.36	2.60	9.7 %
Total of 25% highest flows – in	2.79	2.82	0.8 %	2.61	2.80	7.5 %
Total of 50% lowest flows – in	0.000	0.001	n/a	0.34	0.33	-3.3 %
Storm Statistics						
Total annual storm flow – in	1.24	1.27	2.4 %	0.95	1.04	9.0 %
Average storm peak – cfs	964.	744.	-22.9 %	1487.	1215.	-18.3 %
Summer flow (Jun-Aug) – in	0.004	0.005	31.0 %	0.21	0.24	14.0 %
Winter flow (Dec-Feb) – in	0.94	0.97	0.4 %	1.84	1.90	3.3 %

Parameterization



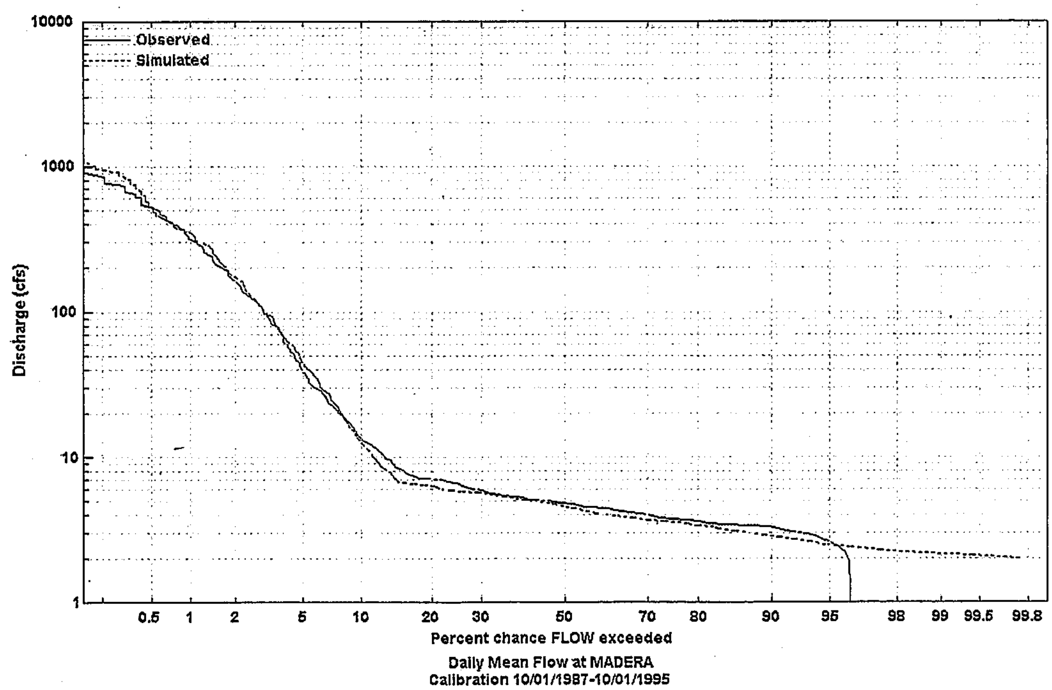


Figure 3.3 Flow Duration curves for Royal and Madera for the Calibration Period

Table 3.9 Long-Term Statistics for 31-Year Arroyo Simi Model Simulations, WY70-00

	Arroyo Simi @ Royal		Arroyo Simi @ Madera	
	Simulated	Observed	Simulated	Observed
Mean Flow, cfs	5.94	5.00	16.67	12.82
Correlation Coefficient, R	0.83		0.86	
Coefficient of Determination, R2	0.69		0.74	
Mean Error	0.94		3.85	
Percent Mean Error	15.8		23.1	
Model Fit Efficiency (NS)	0.56		0.52	

Figure 3.5 shows the results of flood frequency analyses of the annual peaks, using a Log-Pearson III distribution, at Royal and Madera, while Table 3.10 lists the flood peak values for both the Madera gage and the six USEP sites. Since these analyses are based on the 31-year long-term simulation, the flood peaks for return intervals greater than 20 years are derived from the Log Pearson distribution, and as such, are extrapolations beyond the simulated values. Since the focus of this study is primarily for storms with return intervals of about 20 years or less, these peaks for return periods of 50 and 100 years are shown for information purposes only.

The curves in Figure 3.5 show that over the 31-year simulation the model tends to under-estimate the more frequent storm peaks with return intervals of 2 to 5 years, and over-estimate those over about 50 years or more. The curves agree somewhat better for the Royal site than the Madera site. The same reasons noted above would cause differences in these curves, but the general agreement is sufficient to substantiate use of the model to assess the relative differences for scenario evaluations. In addition, the continuing work on the Calleguas Watershed model will investigate the data problems identified in the Arroyo Simi effort and lead to further refinement of the model calibration; this refinement should help to improve the overall model performance for flood peaks.

Using the results of the 31-year baseline runs, τ timeseries were analyzed for the Madera gage and all USEP sites to generate τ duration curves establishing the percent of time the τ values are exceeded. Figure 3.6 shows these curves for all the USEP sites; note that the Madera plot also shows the curve for the Madera gage site. The two curves in the figures were generated by analyzing both the daily average (dashed blue lines) and hourly (solid red lines) τ values so that we could identify any differences and assess the impact of using hourly versus daily values in subsequent analyses. The differences are relatively small, on the order of a few percent, with the hourly values generally higher than the daily ones at moderate to high flow conditions. Consequently we decided to use the hourly timeseries for all subsequent analyses.

Following the procedures presented in Section 3.2 and using the τ_c values from Table 3.6 for each USEP site, the tau duration curves were analyzed to determine the percent of time the various τ_R values were exceeded for values ranging from 1.0 to 2.5. Figure 3.7 graphically shows these analyses with the appropriate τ_R lines shown on the corresponding duration curves for Royal and Madera; the size has been expanded to clarify the procedure. Table 3.11 lists the corresponding exceedance percent for each site and τ_R values of 1.0, 1.5, 2.0 and 2.5. Using a τ_R value of 1.5 to establish a threshold for channel stability, the table shows that unstable conditions occur at these sites approximately 6 % to 14 % of the time under Baseline, or current, conditions on the Arroyo Simi Watershed. In Section 4.0, we will assess how these percentages will likely change under natural conditions, potential future urbanization levels, and selected detention basin scenarios.

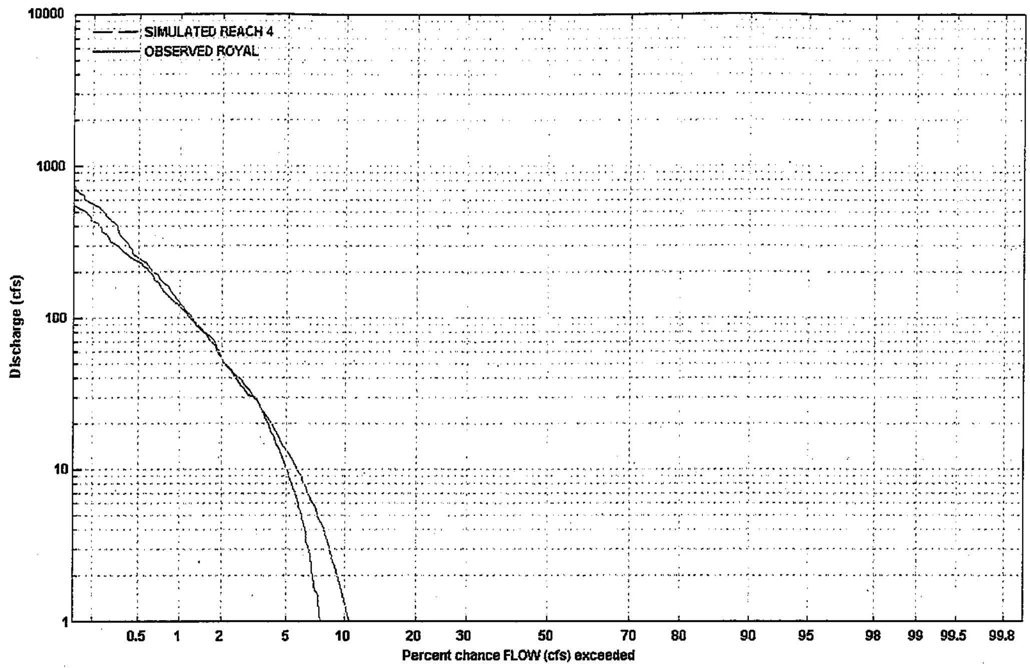
Table 3.10 Simulated Flood Frequencies for Madera Gage and USEP sites

EXCEEDENCE PROBABLITY	RECURRENCE INTERVAL	Reach 10 - Madera USEP	Reach 8 - Madera Gage	Reach 904 - Royal USEP	Reach 952 - Runkle Canyon	Reach 964 - Dry Canyon	Reach 103 - Oak Canyon #1, US	Reach 105 - Oak Canyon #2, D/S
0.99	1.01	202	164	111	0.0	0.4	9	8
0.95	1.05	359	302	205	0.1	1.0	16	15
0.90	1.11	495	424	286	0.2	1.7	22	20
0.80	1.25	741	649	433	0.4	3.4	33	29
0.67	1.50	1,097	980	646	1.0	6.6	48	42
0.50	200	1,677	1,530	991	2.5	13.4	71	63
0.43	233	2,003	1,844	1,184	3.7	18.1	84	74
0.20	5.0	4,024	3,827	2,359	16.8	58.1	159	140
0.10	10.0	6,515	6,329	3,776	47.6	129.4	244	216
0.04	25.0	11,090	11,020	6,316	151.0	312.3	388	346
0.02	50.0	15,810	15,930	8,868	325.2	560.0	525	473
0.01	100.0	21,890	22,340	12,090	658.2	956.5	691	628

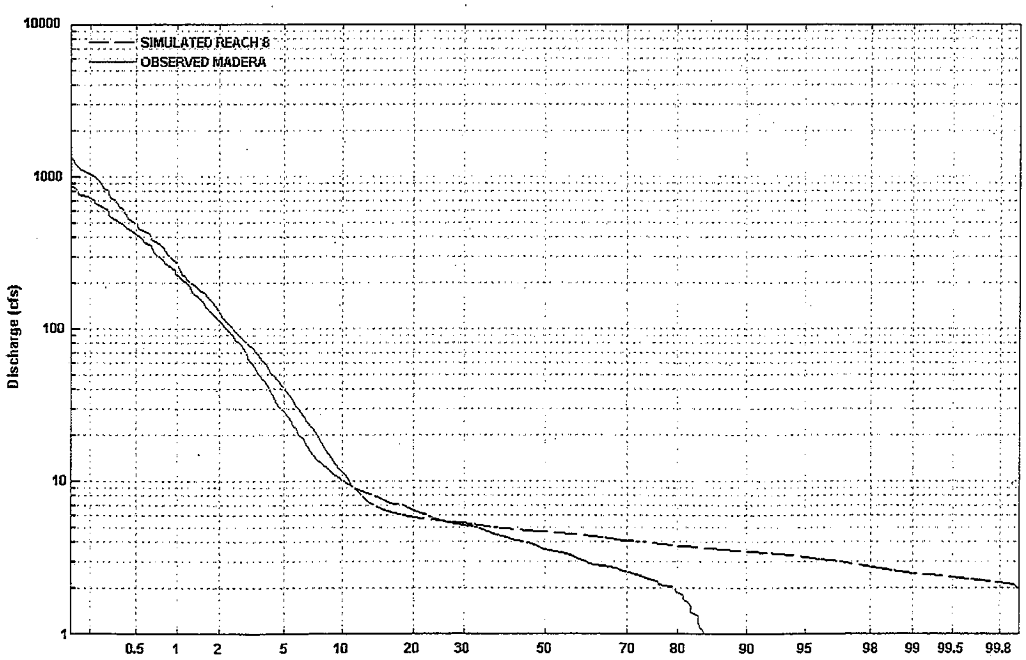
Table 3.11 Shear (Tau) Ratio Exceedance Percent for USEP Sites for Baseline Conditions

Model Reach	USEP Site	Exceedance Percent (% of Time) by Tau Ratio			
		$\tau_R > 1$	$\tau_R > 1.5$	$\tau_R > 2$	$\tau_R > 2.5$
952	**Runkle**	11.6	8.5	6.7	5.4
964	**Dry Canyon**	20.1	11.7	8.9	6.9
103	**Oak Canyon U/S**	8.4	5.9	4.5	3.6
105	**Oak Canyon D/S**	14.2	8.2	6.4	5.2
904	**Arroyo Simi - Royal**	10.7	9.4	8.5	7.8
10	**Arroyo Simi - Madera**	99.4	14.2	8.5	6.3

Parameterization



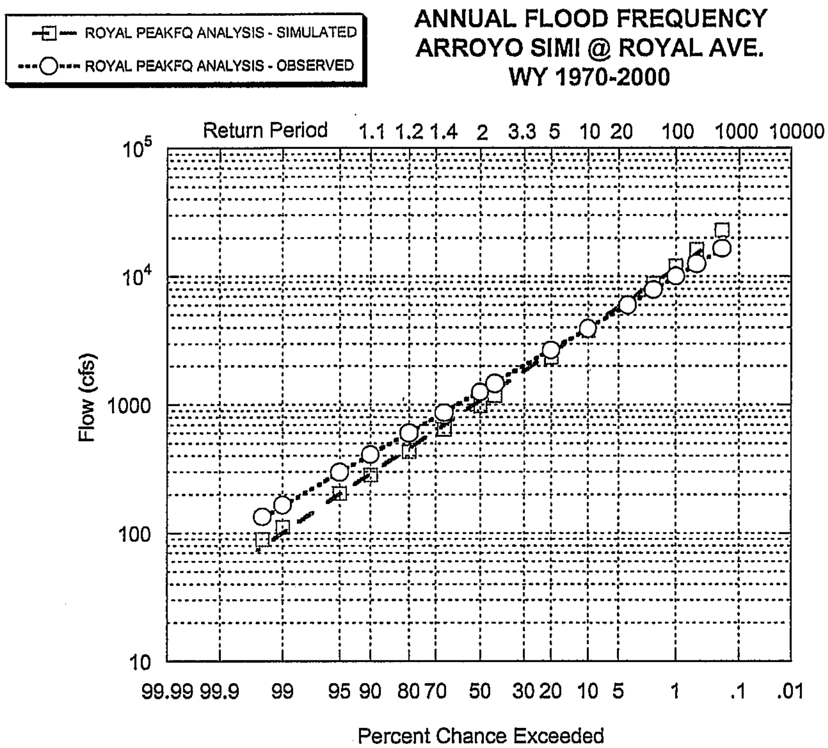
Analysis Plot for Arroyo Simi above Royal Ave
WY 1969-2000



Analysis Plot for Arroyo Simi above Madera Rd Bridge
WY 1969-2000

Figure 3.4 Flow Duration Curves for Royal and Madera for the 31-year Simulation Period

Parameterization



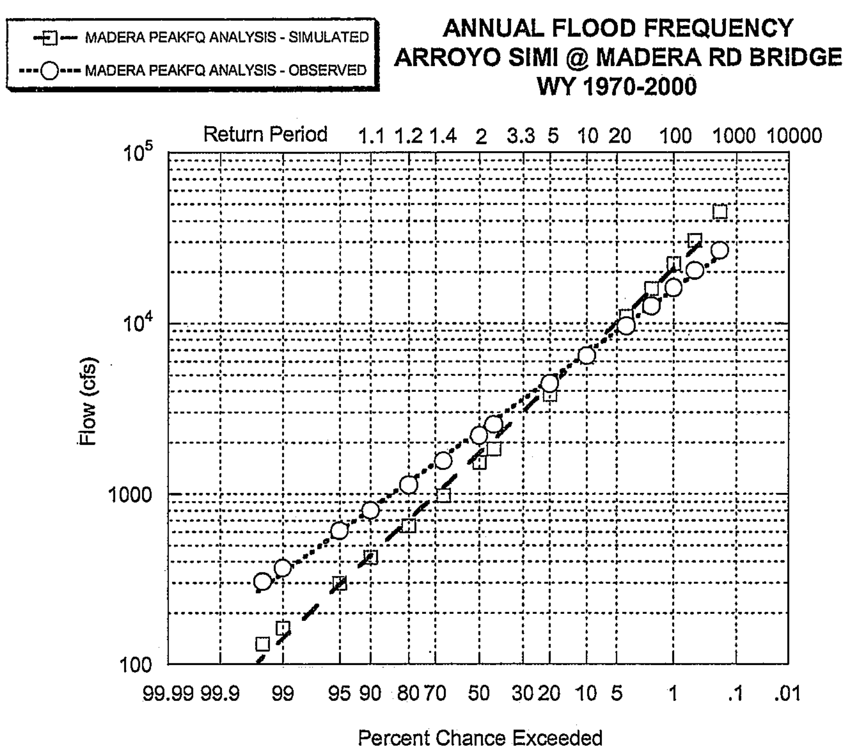


Figure 3.5 Flood Frequency Analyses for Royal and Madera

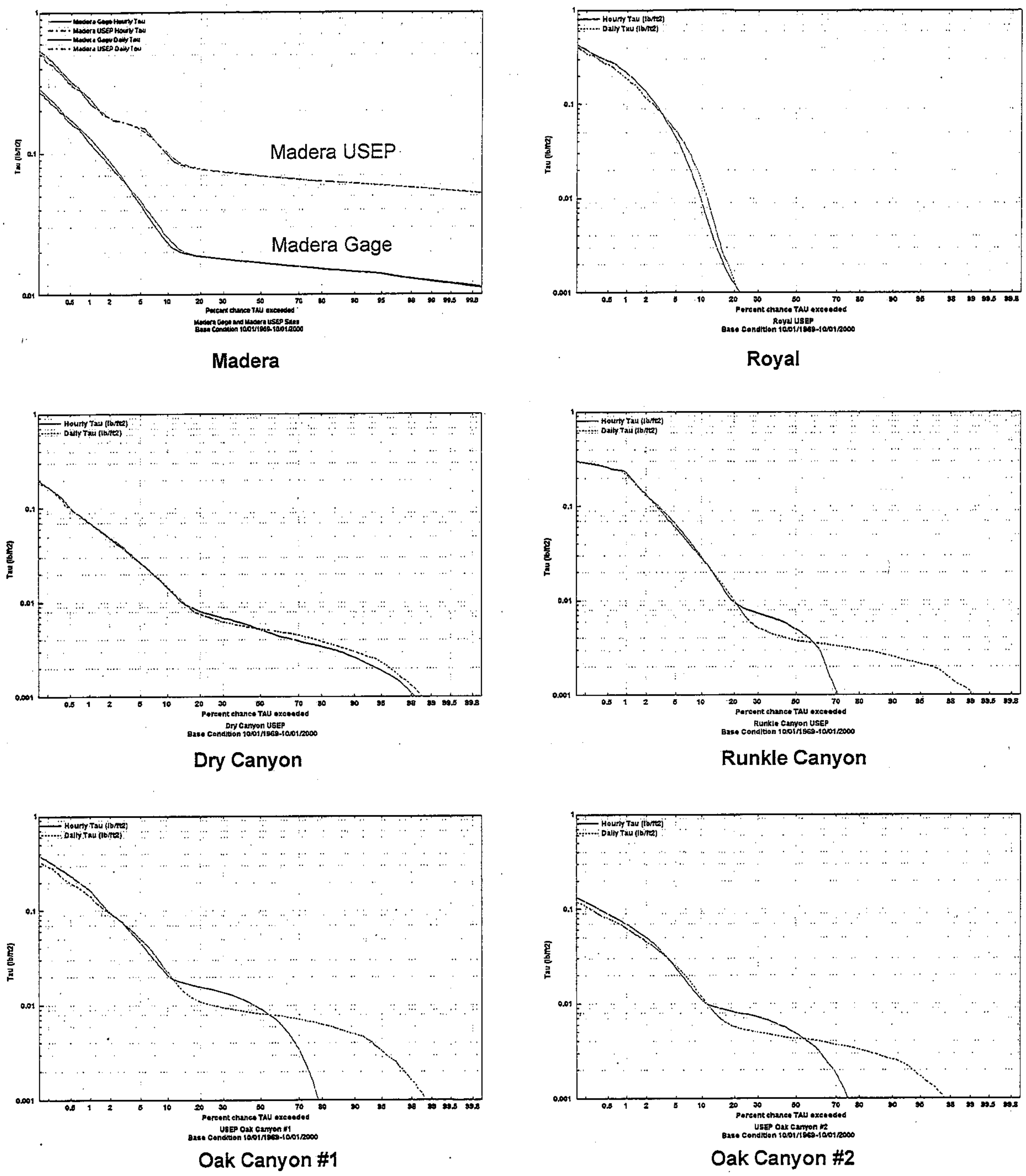
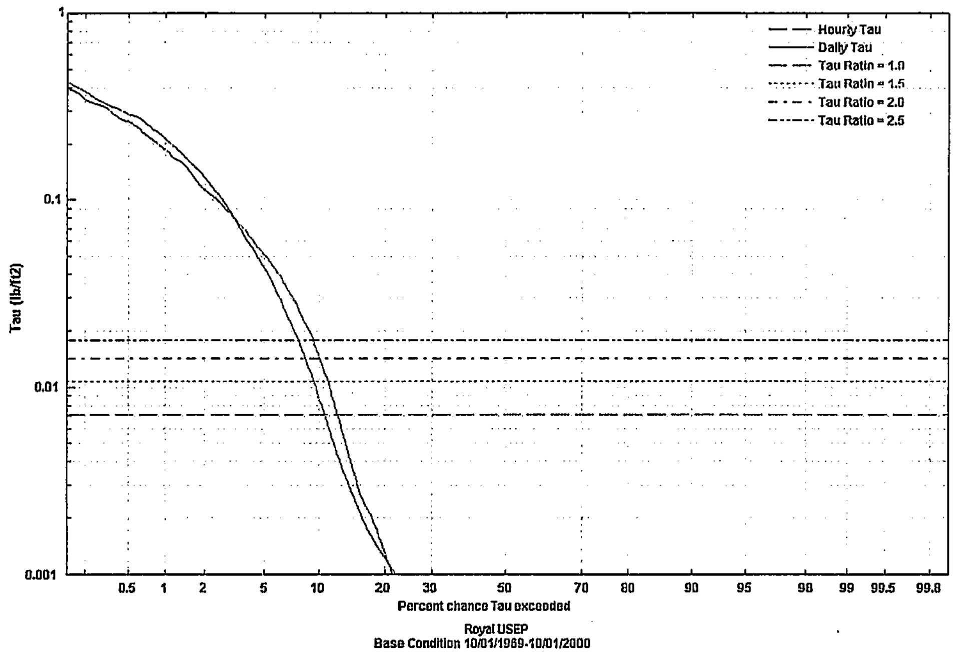


Figure 3.6 Shear Stress (Tau) Duration Curves for USEP Sites for Baseline Conditions



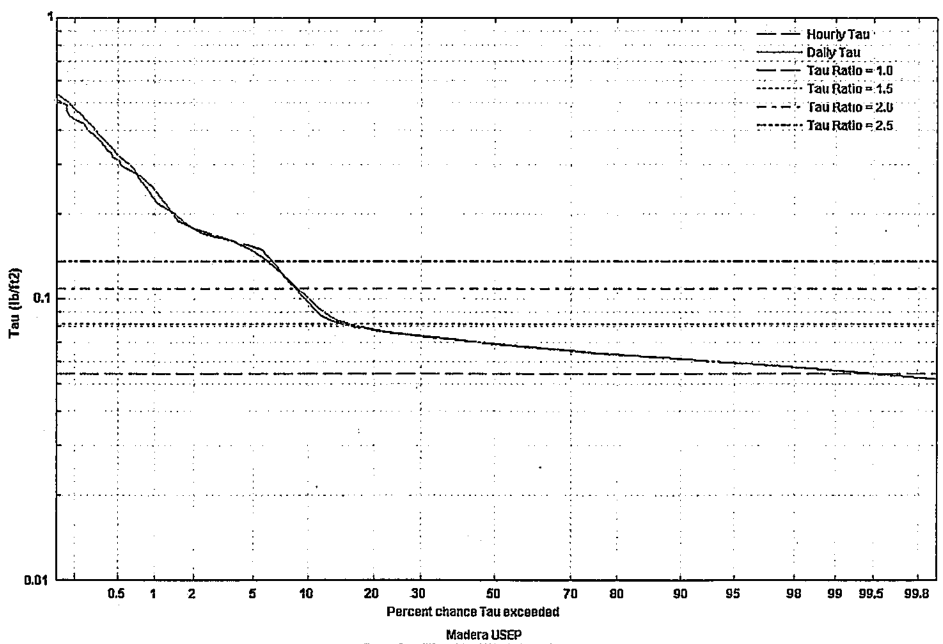


Figure 3.7 Calculation of Shear Stress (Tau) Exceedance Percent for Baseline Conditions at Royal and Madera USEP

SECTION 4.O
SCENARIO ANALYSES AND RESULTS

In order to assess the impact of urbanization and detention alternatives on the Arroyo Simi Watershed, a series of model scenarios were developed and simulated for comparison with the Baseline Conditions presented in Section 3. In conjunction with VCWPD staff, information on future urbanization levels was reviewed and areas of the watershed that would most likely experience growth were identified. To represent alternative conditions on the watershed, model inputs, parameters, and the model setup, or configuration of reaches and land segments, was examined in detail to identify those changes that would be needed from those used for the Baseline Condition. In addition, a scenario that would approximate natural, or pre-development, conditions was also simulated to help assess the level of impact represented by the Current/Baseline Condition. Thus, the following scenarios were identified and modeled:

- Natural, Pre-development
- 10% increase in urban fringe areas
- 30% increase in urban fringe areas
- 50% increase in urban fringe areas
- Detention Basins implemented with 50% increase in urban fringe areas

Below we discuss how each of these alternatives was represented by changes in the model input, parameters, and configuration, followed by a discussion of the results.

4.1 Natural Conditions

To represent natural, or pre-development, conditions on the watershed, we implemented the following changes to the Baseline model setup for the Arroyo Simi:

1. Removed all timeseries representing **groundwater pumping and dewatering**, which contributed to the mainstem below Royal.
2. Removed all **irrigation inputs** for landscape watering.
3. Removed all **detention and debris basins** included within the Baseline setup, including Las Llagas, Runkle, Tapo 1 and 2, Erringer, and Sycamore. Oak Canyon basins were not constructed until after the calibration period, and therefore were not included in the Baseline model.
4. Eliminated any **impervious areas**, which were reassigned pervious land parameter values.
5. Assigned **model parameters** for the OPEN land use category to all the urban categories, except for physical characteristics such as slope, overland flow length, etc. which remained unchanged. This included parameters related to surface roughness, vegetal interception and ET, soil moisture storages (upper zone), and interflow.

All these changes attempt to remove all the human impacts on the watershed hydrologic response, and represent how the watershed may have responded prior to all development. A basic assumption is that the OPEN land category adequately represents these conditions. In addition, the stage-discharge relationships (FTABLES) for the channelized stream reaches were left unchanged due to lack of adequate data on historic cross-sections and resources to develop the needed information. However, the channel characteristics only affect individual hourly flows in selected reaches and will have no significant impact on the overall watershed water balance.

4.2 Urbanization Scenarios

To represent projected changes in land use resulting from expected urbanization, we first reviewed a 'future' (undated) land use coverage provided by the County to assess use of its projections for these scenarios. The coverage reflected relatively small differences in urbanization, compared to current conditions, and the land category coverage was inconsistent with our Baseline/Current coverage. Further discussions with VCWPD staff led to selection of model segments on the urbanizing fringe of the current urban area, and urbanized increases of 10%, 30%, and 50% within these segments to define our urbanization scenarios. These increases represented a range from a relatively modest increase of 10% to a relatively extreme increase of 50%, in these model segments.

Figure 4.1 shows the distribution of the Baseline/Current land use within the Arroyo Simi, along with the fringe segments selected for the urbanization scenarios; note that the segment boundaries are shown in **bold, and the urban fringe segments are shaded**. Table 4.1 lists the open and urban land components (pervious and impervious) for each of the 18 model segments shown in Figure 4.1; note that the urban fringe segments are highlighted.

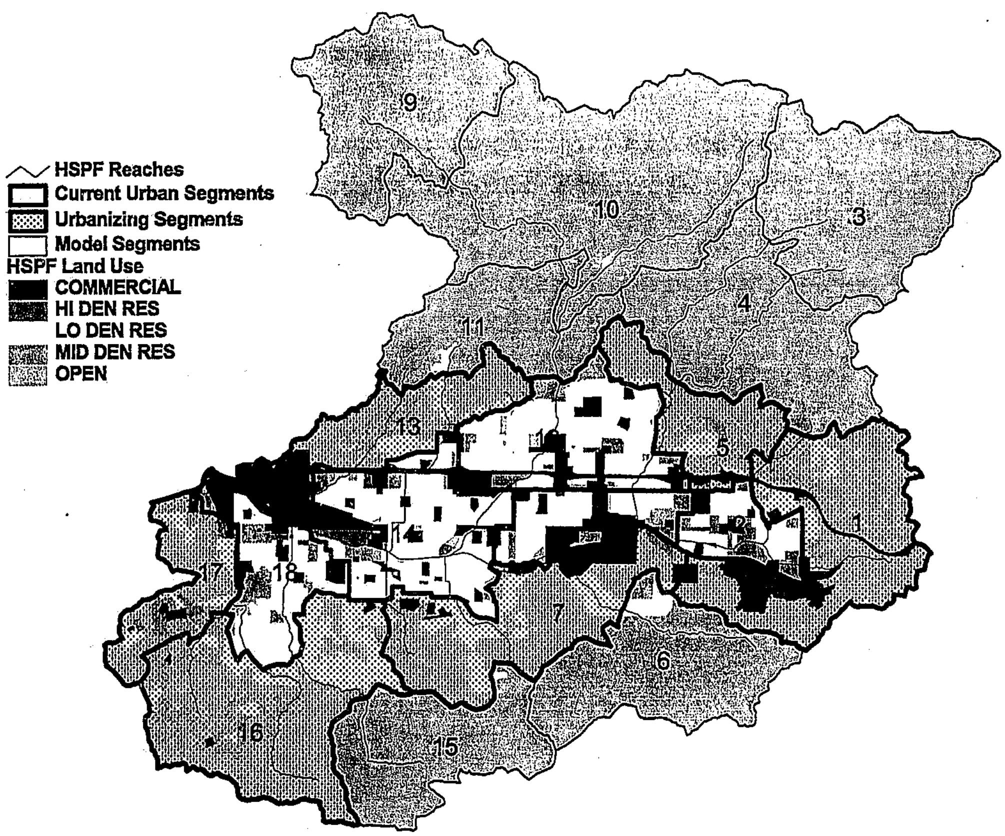


Figure 4.1 Land Use for Baseline/Current and Urban Segment Boundaries

Table 4.1 Land Use for Baseline and Urbanization Scenarios (acres)

	Model Segment	Base Condition			10% Increase			30% Increase			50% Increase		
		Open	Urban	Total	Open	Urban	Total	Open	Urban	Total	Open	Urban	Total
1	Susana Knolls - Upper Arroyo Simi Steep	2,525	1,127	3,653	2,413	1,240	3,653	2,187	1,465	3,653	1,962	1,691	3,653
2	Susana Knolls - Upper Arroyo Simi Flat	0	912	913	0	912	913	0	912	913	0	912	913
3	Las Llajas - Upper Las Llajas/Chivo - Steep	3,708	-	3,708	3,708	-	3,708	3,708	-	3,708	3,708	-	3,708
4	Las Llajas - Middle Las Llajas/Chivo - Steep	3,708	38	3,746	3,708	38	3,746	3,708	38	3,746	3,708	38	3,746
5	Las Llajas - Lower Las Llajas - Moderate	1,019	519	1,538	968	571	1,538	864	674	1,538	760	778	1,538
6	Rocketdyne - Upper Meier Canyon - Steep	2,870	114	2,984	2,870	114	2,984	2,870	114	2,984	2,870	114	2,984
7	Santa Susana - Southern Canyons Moderate	1,863	1,186	3,050	1,745	1,305	3,050	1,508	1,542	3,050	1,270	1,779	3,050
8	Santa Susana - East Simi Valley - Flat	79	1,190	1,269	79	1,190	1,269	79	1,190	1,269	79	1,190	1,269
9	Tripas - Upper Tripas Cyn - Steep	3,160	-	3,160	3,160	-	3,160	3,160	-	3,160	3,160	-	3,160
10	Tapo - Lower Tripas/Windmill/Gillibrand - Steep	6,863	10	6,873	6,863	10	6,873	6,863	10	6,873	6,863	10	6,873
11	Tapo - Middle Tapo Hills - Moderate	2,159	128	2,287	2,159	128	2,287	2,159	128	2,287	2,159	128	2,287
12	Simi Fire - North Simi Valley - Flat	197	2,533	2,730	197	2,533	2,730	197	2,533	2,730	197	2,533	2,730
13	Simi Fire - Lower Tapo Hills Moderate	1,038	575	1,614	981	633	1,614	866	748	1,614	751	863	1,614
14	Santa Susana - Central Simi Valley - Flat	99	2,504	2,637	99	2,537	2,637	99	2,537	2,637	99	2,537	2,637
15	Rocketdyne - Upper Bus/Erringer - Steep	2,511	23	2,534	2,511	23	2,534	2,511	23	2,534	2,511	23	2,534
16	Lake Bard - Upper Sycamore/Oak/Middle Bus - Steep	2,345	1,688	4,033	2,176	1,857	4,033	1,839	2,195	4,033	1,501	2,532	4,033
17	Lake Bard - West Sycamore Cyn - Moderate	672	756	1,428	597	832	1,428	445	983	1,428	294	1,134	1,428
18	Lake Bard - West Simi Valley - Flat	79	1,790	2,023	79	1,943	2,023	79	1,943	2,023	79	1,943	2,023
	Total	34,898	15,094	50,179	34,313	15,866	50,179	33,143	17,036	50,179	31,972	18,206	50,179
	% of Watershed	69.5%	30.1%	100.0%	68.4%	31.6%	100.0%	66.0%	34.0%	100.0%	63.7%	36.3%	100.0%
	% EIA		6.7%			7.0%			7.5%			7.9%	

Table 4.1 shows that even with significant growth and urban area increases of up to 50% in the fringe segments, the change in percent urban only increases from 30% for the Baseline condition to 36% for the 50% Urbanization scenario. Each scenario only produced a 2% increase in overall urban area, from 32% to 36% for the three scenarios, compared to the Baseline conditions.

4.3 Detention Scenario

A detention scenario was simulated to represent the potential impact of the use of detention basins (DB) to offset the impacts of urbanization. In discussions with VCWPD staff, the Runkle Basin was selected as a template for the storage-discharge characteristics of the DB used in our scenarios. We further modified the FTABLE to impose a 12-24 hour detention time following the

VCWPD recommendations for WQ improvement. Runkle has a drainage area of 958 acres, so we assumed a standard drainage area of 1000 acres for each proposed regional, or aggregate DB. One such DB was inserted into each of the six model segments undergoing urbanization, and the five major urban segments under current land use conditions; 1000 acres was then diverted from their normal drainage to individual stream reaches and routed to the DB prior to discharge back to the originating reaches. Since some of the segments did not contain 1000 acres of ***new*** urban area under the 50% scenario, we included some of the current or existing urban area to attatin the 1000 acre total. Thus, the drainage areas of the DBs in the detention scenario include both newly urbanized and existing urban area within each of the 11 model segments where DBs were added. Although, the model represents the DBs as single facilities, they can also represent the aggregate impacts of multiple smaller DBs at different locations to service urban areas throughout the model segment. Figure 4.2 shows the generalized location of these these DBs (red dots) along with their discharge reaches (red arrows) in the model setup.

Figure 4.2 Generalized Locations of Scenario Detention Basins

With 11 DBs, each draining 1000 acres of urban land areas, the net result is that approximately 60% of the urban land area under the 'DB plus 50%' growth scenario is controlled by the DBs. Table 4.2 shows the stage-discharge-volume relationship used to represent each of the DBs.

Table 4.2 Stage-Discharge-Volume (FTABLE) for Scenario Detention Basin

DEPTH (ft)	AREA (acres)	VOLUME (ac-ft)	DISCHARGE (cfs)	Detention Time (hr)
0	0 5	2	0	
2	0.80	6.00	0	
4	1.00	8.00	0	
6	1.20	10.00	0	
8	1.85	11.00	11	12.12
10	2.58	12.00	12	12.12
12	3.24	16.67	13	15.54
14	3.84	24.04	15	19.43
16	4.50	32.72	20	19.83
18	5.14	42.67	23	22.49
20	5.72	53.83	28	23.30
22	6.44	65.90	33	24.21
24	7.28	73.89	44	20.36
26	8.52	95.66	55	21.08
28	8.90	113.66	65	21.20
30	9.46	131.78	75	21.30
32	10.14	152.00	85	21.68
34	11.08	174.00	100	21.09
36	12.66	197.79	110	21.80
365	13.46	204.52	120	20.66
38	13.82	225.03	2715	10.05
40	14.00	252.86	8218	3.73
46	20.00	320.00	3640	1.07

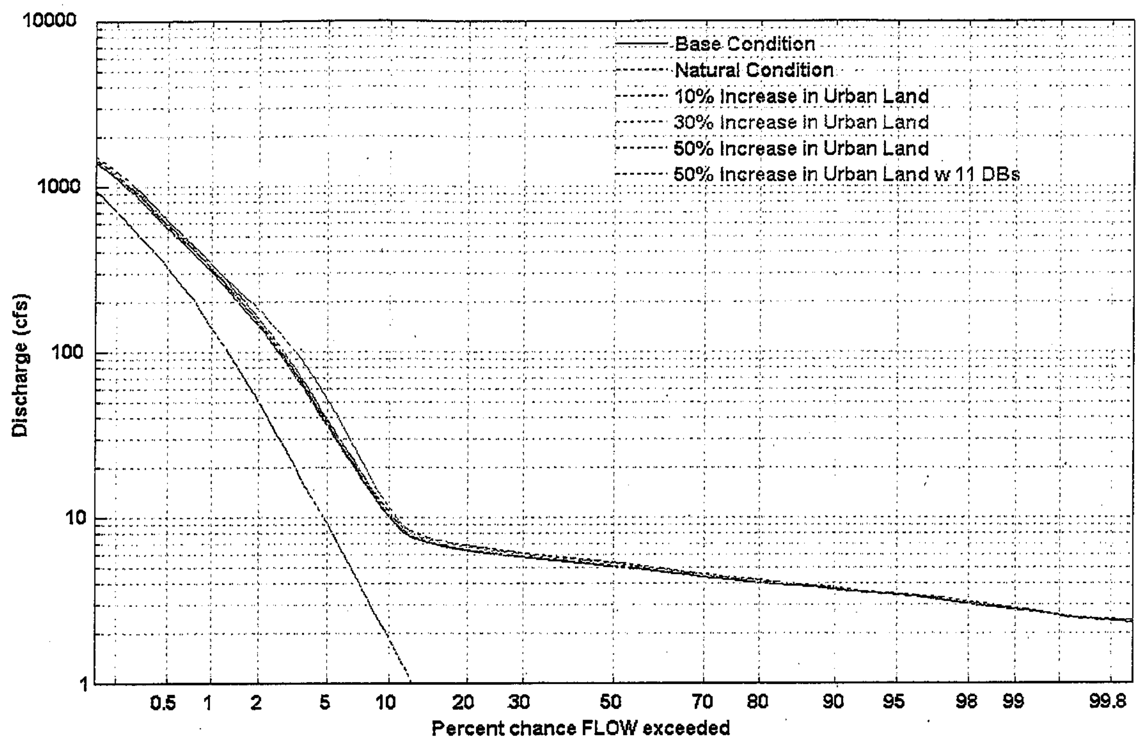
4.4 Scenario Results and Discussion

Model runs were performed for the 31-year period from October 1969 through September 2000 for each of the scenarios described above, with results analyzed and compared to those generated for the Baseline condition.

4.4.1 Flow impacts

Figures 4.3, 4.4, and 4.5 compare the hourly flow duration curves for all scenarios at the Madera USEP, Royal USEP, and Oak Canyon #2 (D/S) sites, respectively; the remaining USEP sites show similar results. The comparisons in these figures show a clear difference between Natural conditions and all the other scenarios. Also, the differences between the Baseline and

Urbanization scenarios are almost indistinguishable, even with the expanded, full-page, display of the figures. For the Detention scenario, the differences compared to the 50% Urbanization



Madera USEP - Hourly
Base Condition vs Multiple Alternatives, 10/01/1969-10/01/2000

Figure 4.3 **Flow Duration Curves for Madera USEP Site for All Scenarios**

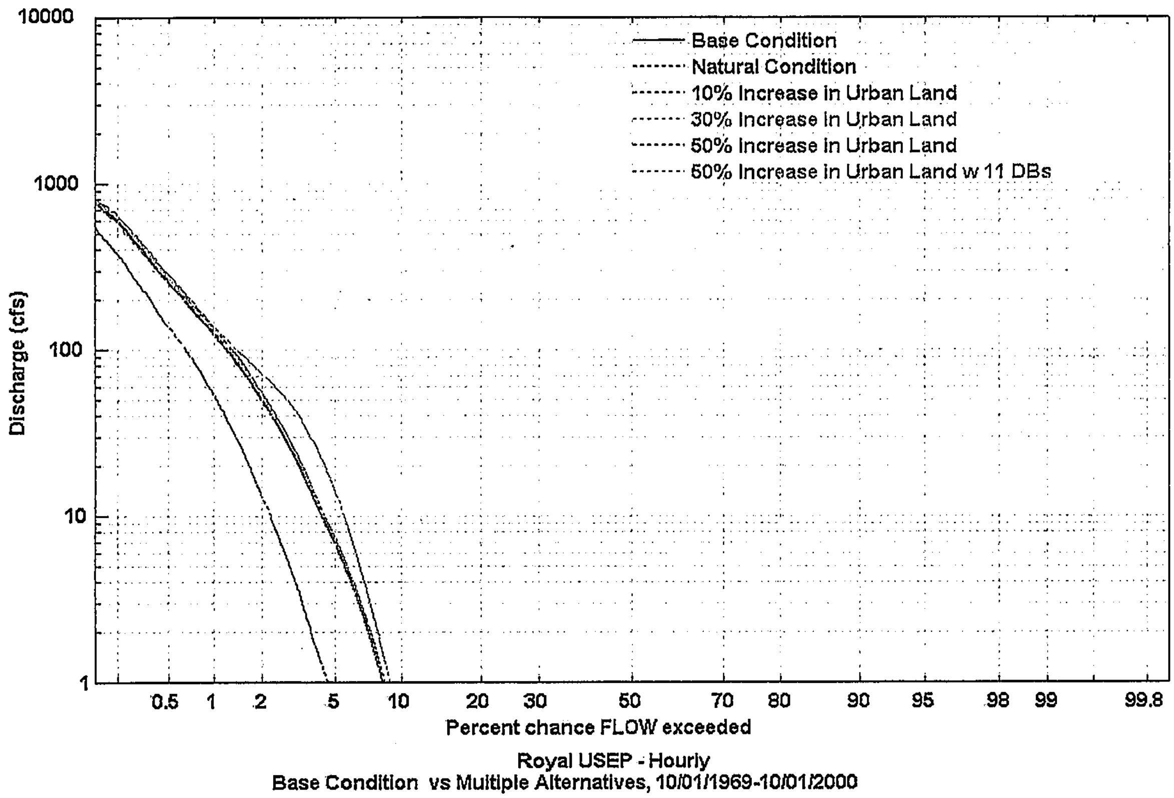


Figure 4.4 Flow Duration Curves for Royal USEP Site for All Scenarios

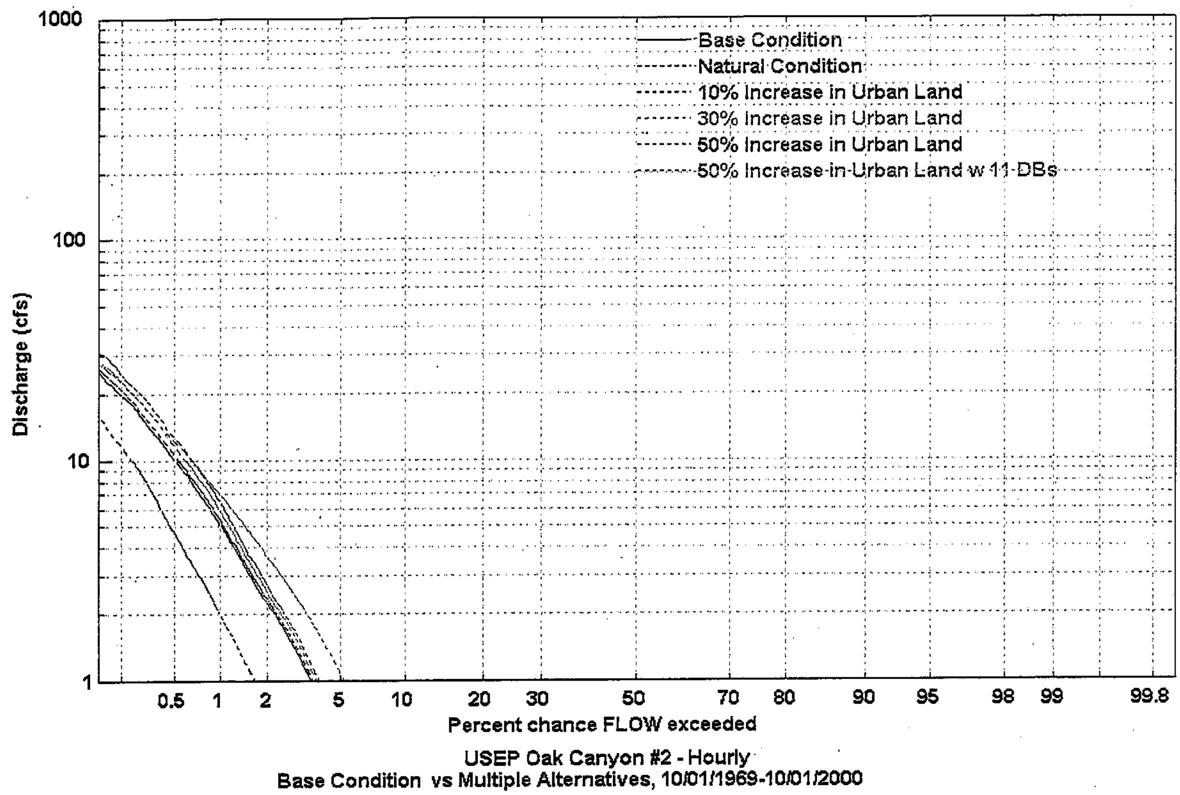


Figure 4.5 Flow Duration Curves for Oak Canyon USEP Site #2 (D/S) for All Scenarios

scenario are evident but relatively small at most sites.

Table 4.3 tabulates and compares the 2-yr, 5-yr, and 10-yr storm event peaks at all sites and scenarios, derived from a Log Pearson III analysis of the annual peaks. Table 4.3 also includes the results of the same analysis of observed peaks at Royal and Madera, for general comparison purposes.

Table 4.3 Storm Peak Flows (cfs) for all Scenarios based on Log Pearson III Analyses

		Scenario						
Location	Return Period, yr	Natural	Base	+10% Urban	+30% Urban	+50% Urban	+50% Urban w 11 DBs	Observed
ROYAL	2	98	991	1031	1111	1195	514	1256
	5	1389	2359	2425	2555	2691	1480	2646
	10	4991	3776	3852	4004	4166	2628	3915
MADERA	2	213	1677	1810	1856	1964	1044	2199
	5	1867	4024	4225	4317	4491	2770	4418
	10	5744	6515	6734	6869	7081	4741	6431
RUNKLE CANYON	2	2	3	3	3	3	3	
	5	23	17	17	17	17	17	
	10	88	48	48	48	48	48	
DRY CANYON	2	1	13	14	16	18	18	
	5	13	58	61	67	73	73	
	10	48	129	134	144	155	155	
OAK CANYON #1	2	2	71	79	93	107	107	
	5	15	159	172	199	225	225	
	10	53	244	262	297	333	333	
OAK CANYON #2	2	2	63	69	83	96	24	
	5	15	140	152	176	200	70	
	10	49	216	232	264	296	126	

Our review of the model results indicates the following observations and conclusions:

a. The differences between the Natural scenario and all the others are clearly the most dramatic, showing the impact of current urbanization levels on the flow regime within the Arroyo Simi watershed (Figures 4.3 through 4.5). The changes in the flow duration curves demonstrate that all high flows are increased, a common effect of urbanization, but low to moderate flows are also increased due to the urban irrigation that accompanies development in semi-arid regions. This is especially evident at the Madera site (Figure 4.3) where the stream changes from an ephemeral one under natural conditions, to a continuous one under Baseline conditions. In humid regions we might expect the flow duration curves to cross, with higher peak flows and lower baseflows, but that clearly is not the case here.

b. Except for the Runkle USEP site that did not drain any significant urban land for any of the scenarios, the flow duration curves for all the USEP sites demonstrate a clear shift to the right with higher flows at all levels, as shown in the above figures.

c. The relatively small differences in flow duration among the Baseline and Urbanization scenario results, almost indistinguishable in the above figures, were initially unexpected. However, further review of the urban land changes shown in Table 4.1, as discussed above, indicate only a 2% increase in overall urban land for the entire watershed for each successive urbanization level. Thus, with such a small change in urban land the small differences in flow duration are reasonable. Furthermore, Table 4.1 also shows that the %EIA only changes from 6.7% under Baseline to 7.9% for the highest urbanization level, substantiating the small impact of the changes.

d. The impacts of urbanization and detention are shown more clearly in Table 4.3 on the changes in the 2-year, 5-year, and 10-year peak flows for the various scenarios. There is a small, but consistent increase in peak flow rates from the Base to each urbanization scenario, and then a significant reduction for the Detention scenario. So, although the flow duration curves showed very small changes, the storm flow changes are more consistent with the expected impacts due to development and detention.

e. Table 4.3 also shows significant differences between the Natural and Base conditions, especially for the 2-year and 5-year peaks at Royal and Madera. For the 2-year event the peaks are higher by factors of 8 to 10 for the Base condition, and the 5-year events are higher by about a factor of 2. At Royal, the 10-year event is actually higher for the Natural condition, but this is likely due to problems in the Log Pearson III procedure for highly ephemeral sites like Royal that are dry most of the time. Figure 4.4 shows that dry conditions (i.e. less than 1 cfs) increase significantly for the Natural scenario due to the lack of urban irrigation that exists under Baseline conditions.

f. The Detention scenario was run with the 50% Urbanization conditions, with 11 DBs inserted into each of the urban segments. As noted above, the differences in the flow duration curves are relatively small, while the peak reductions shown in Table 4.3 are significant, in the range of 30% to 60% for Royal and Madera, and 50% to 75% for Oak Canyon #2; the other USEP sites were not impacted by the DB scenario due to their locations mostly above the urban/urbanizing segments. It should be noted that the reduction at Oak Canyon #2 was due to insertion of the actual Oak Canyon DBs, which were not included in the calibration period nor the other scenarios. The small impact on the flow duration curves at Royal and Madera is likely due to the fact that only 22% of the watershed would be controlled by the DBs in this scenario; i.e. 11,000 acres of drainage area controlled by DBs in the total watershed area of 50,179 acres. Close examination of the flow duration curves show that the Detention scenario does reduce the higher flows and increase the lower flows. The curves for the Detention and 50% Urbanization scenarios cross at about the 0.5 to 1.0 % exceedance values in the figures.

4.4.2 Scour and Stability Impacts

The hourly tau values were analyzed in a similar fashion to the flow values to produce tau duration plots showing the percent chance, or percent of time, tau levels are exceeded. Figures 4.6 and 4.7 show these curves for the Madera and Royal sites, respectively, for all scenarios. In addition, the tau duration plots were then analyzed to produce the percent of time that the tau ratio, i.e. $\tau_R = \tau/\tau_c$, as discussed in Section 3, is exceeded under each scenario. These values for τ_R equal to 1.5 and 2.5 are listed in Table 4.4. As noted in Section 3.2, Johnson et al (1999) established a ratio threshold value of 2.5 above which a channel was considered unstable, and stable at ratios less than 1.5, and Pitlick (1992) and Simon (1996) showed that for $\tau_R > 2$ most of the bed would be in motion, and when $\tau_R > 3$ the entire bed would be moving. Consequently, a value of 1.5 is essentially a threshold for movement, while 2.5 is considered an appropriate threshold for stability.

Review of the tau duration figures and the values of τ_R in Table 4.4 indicate the following observations:

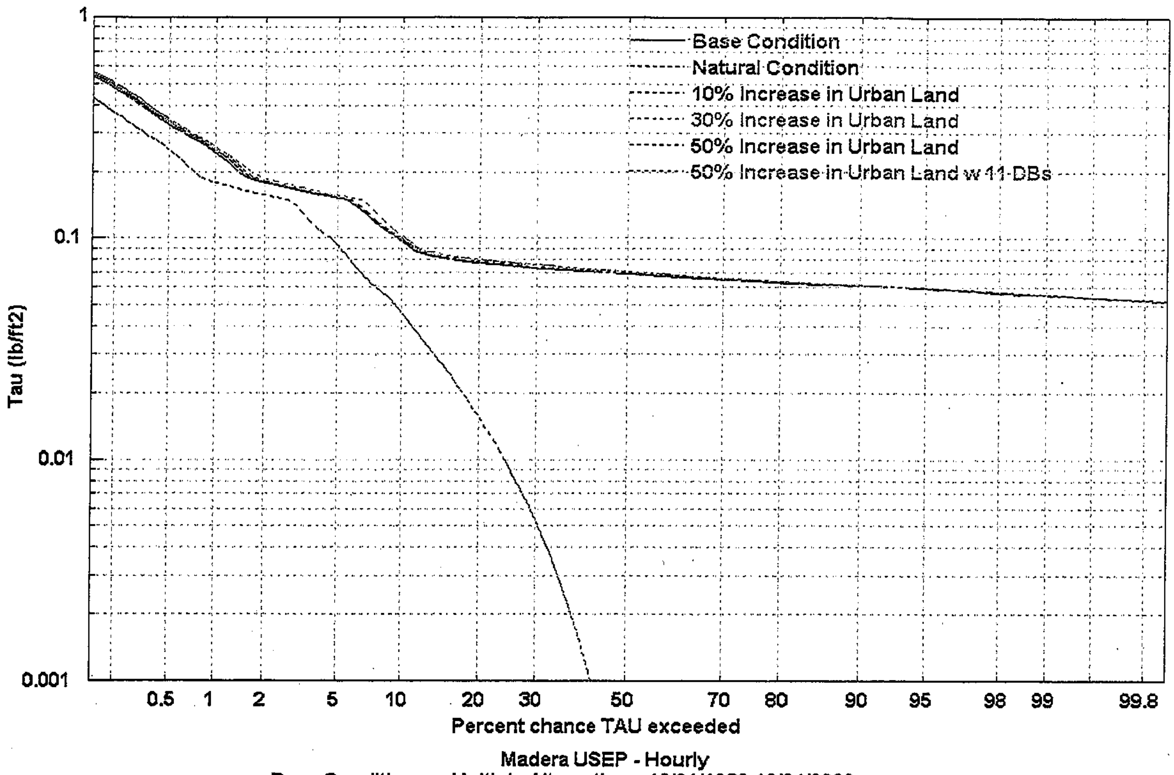
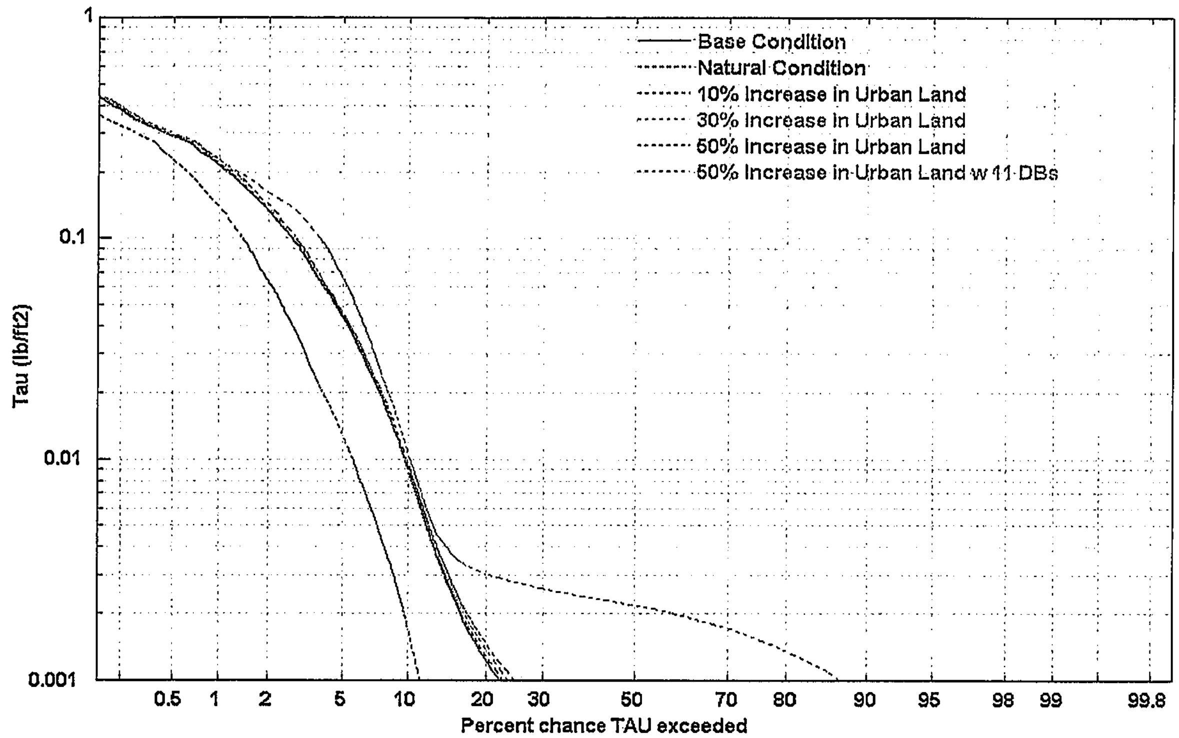


Figure 4.6 Shear Stress (Tau) Duration Curves for Madera USEP Site for All Scenarios



Royal USEP - Hourly
Base Condition vs Multiple Alternatives, 10/01/1969-10/01/2000

Figure 4.7 Shear Stress (Tau) Duration Curves for Royal USEP Site for All Scenarios

Table 4.4 Tau Ratio Exceedances (% of time) for Values of 1.5 and 2.5

Reach		Scenario					
No.	Name	Natural	Base	+10% Urban	+30% Urban	+50% Urban	+50% Urban w 11 DBs
Tau Ratio of 1.5							
952	Runkle	7.9	8.5	8.5	8.5	8.5	8.5
964	Dry Canyon	8.8	11.7	11.8	12.0	12.2	12.2
103	Oak Canyon U/S	3.3	5.9	6.0	6.2	6.4	6.4
105	Oak Canyon D/S	4.9	8.2	8.4	8.7	9.0	10.9
904	Arroyo Simi - Royal	5.4	9.4	9.5	9.6	9.6	10.0
10	Arroyo Simi - Madera	5.6	14.2	14.7	15.9	17.2	17.0
Tau Ratio of 2.5							
952	Runkle	5.2	5.4	5.4	5.4	5.4	5.4
964	Dry Canyon	4.9	6.9	7.0	7.1	7.2	7.2
103	Oak Canyon U/S	1.7	3.6	3.6	3.8	3.9	3.9
105	Oak Canyon D/S	2.8	5.2	5.3	5.5	5.7	7.4
904	Arroyo Simi - Royal	4.2	7.8	7.8	7.9	8.0	8.5
10	Arroyo Simi - Madera	3.1	6.3	6.4	6.5	6.7	7.3

a. The values at each site do not change greatly among the scenarios, i.e. across the columns, indicating relatively stable conditions or at least unchanging conditions. However, there definitely are differences.

b. The differences between the Baseline and Natural conditions are the largest for all sites except Runkle, with the Baseline conditions higher in the range of 50% to 100%, Both Royal and Madera show differences of about a factor of 2.0 or 100% higher, with Madera showing an increase of 250% for the 1.5 value of tau ratio. Runkel does not show much difference because very little urban land exists above the site even under Baseline conditions.

c. For all the Urbanization scenarios, very little change is evident as is shown by both the flow duration and the tau duration curves. Clearly, one reflects the other; if flow values show little change then the tau values will also show little change since the hydraulic radius used in the tau calculations will not vary significantly. Runkle, again shows no change due to no urbanization in the drainage area. For all the other sites, Table 4.4 shows small but consistent changes, for both ratio values, with each level of urbanization.

d. The results for the Detention scenario are mixed. There are no changes for the Runkle, Dry Canyon, and Oak Canyon Upstream (U/S) sites since the scenario DBs did not affect their drainage areas. For the other sites, the tau values and ratios mostly increased due to increases in the baseflow, or low flow, ranges as noted above in the flow duration discussion. The tau duration curves for the 50% Urbanization and Detention scenarios do cross, as was noted for the flow duration curves, but this is generally in the range of 0.5% to 1.0% of the time, and usually at tau values that are an order of magnitude or more above the values of τ_c shown earlier in Table 3.6 and Figure 3.7. So the DBs do reduce the peak tau values, as they reduced the peak flow values, but these reductions were offset by increases at lower tau and flow values.

e. Most all the values in Table 4.4 are in the general range of 5% to 15%. On an annual basis, this would correspond to 18 to 55 days per year when either unstable or bed movement conditions occur for the USEP sites studied. Considering that the wet winter period in Southern California usually extends from about mid-October through mid-March, a period of five months, these percentages would correspond to about 15%

to 35% of the time during the winter period. These values appear to be extremely high, and most likely unrealistic, and reflect the low values of τ_c calculated for the USEP sites based on the available bed material particle size data. (See further discussion in Section 5, below).

SECTION 5.0
CONCLUSIONS AND RECOMMENDATIONS

All modeling studies and procedures need a healthy dose of reality, and for the current study this 'reality' is derived from the VCWPD and USEP field data and observations. Although the modeling results and channel stability methodology appear to indicate significant time when unstable conditions occur in the Arroyo Simi watershed, the following seem to indicate the opposite:

a. The USEP data and observations collected over a 2-year period show very little change in channel cross sections at the six study sites, indicating relatively stable channels. Visual inspection of the plotted cross sections showed very little change for most all sites over the entire study period. Elevations of individual points along a cross section would change from survey to survey, but usually less than 0.5 to 1.0 feet.

b. The only major scour event observed occurred at the Madera site between surveys in October 2001 and January 2002, when local scour in a 20-foot cross section of the stream, with an overall width of about 140 feet, dropped bed elevations about seven feet. This appears to have resulted from a few small to moderate storm events (less than 1 inch rainfall) in the interim winter storm period. However, by the time of a November 2002 survey, the bed elevation was essentially restored to its October 2001 level, due primarily to a single large event with more than 3 inches of rainfall on November 7-9, 2002.. This behavior is generally indicative of the dynamic equilibrium behavior of stream channels, with alternating scour and deposition events, without major cross-sectional changes, and demonstrates relatively stable channel conditions. The only qualifying caveat is that the surveys were done during a relatively dry period and for only 2 years, but significant storm events were observed.

c. Booth and Jackson (1999) indicate that a level of 10% EIA appears to be a threshold for channel stability based on studies of numerous watersheds in the Northwest. As noted earlier, the Baseline period EIA for the Arroyo Simi watershed is about 6.7%, and even under the 50% Urbanization scenario it is less than 8%. Although this is not definitive proof, it is an indication that somewhat stable channels may be likely.

Since the flow simulations produced by the Arroyo Simi model are reasonable and consistent with the available data, the primary cause for over-stating the occurrence of unstable conditions is the calculation of extremely low values for the critical bed shear stress. These values are a direct function of the bed material particle sizes and the hydraulic radius of the channel reach. Since cross-section data at the USEP sites provided a sound basis for the hydraulic radius calculations in HSPF, and the values appeared to be reasonable, the bed material data needs to be further investigated and analyzed.

Based on the above discussion and the model results presented in Section 4, the following conclusions and recommendations are provided.

5.1 Conclusions

a. The Arroyo Simi Watershed model is shown to be a useful tool to evaluate alternative development conditions and mitigation scenarios for the Arroyo Simi watershed and other similar watersheds in the region.

b. The methodology developed to assess the frequency of channel scour and stability conditions addresses identified needs in the literature to assess these conditions over a range of flow values and storm events.

c. The methodology as applied to the Arroyo Simi USEP sites appears to over-state the occurrence of unstable conditions, primarily due to limitations in the available data on bed material particle size fractions controlling values of critical shear stress (See recommendations below).

d. Model simulations of Natural, pre-development conditions provide a reasonable projection of flow and shear stress behavior for comparison to current or Baseline conditions on the watershed. This is demonstrated at the Madera site where the stream changes from an ephemeral one under natural conditions, to a continuous one under Baseline conditions.

e. The study results also show significant differences between the Natural and Base conditions, especially for the 2-year and 5-year peaks at Royal and Madera. For the 2-year event the peaks are higher by factors of 8 to 10 for the Base condition, and the 5-year events are higher by about a factor of 2. This clearly reflects the impacts of current urbanization levels included in the Baseline scenario. If a 2-year storm is proposed as a 'development standard' it will likely need to be compared to a 'current' condition, since requiring future development to approach a 'natural' condition may lead to excessive storage requirements.

f. The Urbanization scenarios showed small but consistent impacts reflecting the relatively small increase in overall urban area and %EIA values for our scenarios. The changes in the flow duration curves demonstrate that all high flows are increased, a common effect of urbanization, but low to moderate flows are also increased due to the urban irrigation that accompanies development in semi-arid regions.

g. The impacts of urbanization and detention are shown more clearly on the changes in the 2-year, 5-year, and 10-year peak flows for the various scenarios. There is a small, but consistent increase in peak flow rates from the Base to each Urbanization scenario, and then a significant reduction for the Detention scenario. So, although the flow duration curves showed very small changes, the storm peak changes are more consistent with the expected impacts due to development and detention.

5.2 Recommendations

a. The Arroyo Simi watershed model calibration and validation should be finalized (see recommendations in Study Report (AQUA TERRA Consultants, 2003)), and the results presented herein re-assessed before major decisions are made based on the modeling analyses developed in this study. We do not foresee any major changes to the conclusions but this should be confirmed. The Calleguas modeling effort includes the Arroyo Simi sites and is scheduled for completion in mid-2004.

b. To provide an improved representation of urbanization scenarios, the % EIA values used in the Arroyo Simi model should be confirmed and/or further evaluated with aerial photos, small site surveys, or pilot studies. The current values appear reasonable based on the model calibration results, but the critical importance of accurate EIA values, for both current and future projections would help to improve confidence in the model results and the ability to represent future conditions.

c. To provide a more accurate basis for calculating the critical bed shear values, the available bed material particle size data and Wolman pebble count information should be further analyzed, and possibly additional samples taken. The USEP bed sampling procedures did not cover an extensive area at each site, and the Wolman count procedures focus on coarse sand, gravel, and cobble sizes, so some combination of the two may be needed to develop an appropriate reference particle diameter for calculating the critical shear stress value. Model results should then be re-analyzed with the resulting range of critical values to better assess channel stability conditions. This would not require additional model runs, just analyses of existing tau timeseries from the current runs.

d. Additional Urbanization and Detention scenarios should be evaluated to provide more spatially refined urbanization patterns and alternative detention basin designs and locations. Also, changes in land use distribution among urban land uses, e.g. increases in medium and high density residential compared to low density, should be considered for future scenarios. The current Baseline and Urbanization scenarios assume the same distribution of urban land categories.

e. Although detailed analysis of the proposed 2-year event as a 'Development Standard' was not possible in this study due to the limited bed sediment data, and its associated effect on over estimating unstable conditions (as noted above), and the relatively small impacts of the urbanization scenarios. However, a 'Standards' development would be a logical and necessary next step following further investigation of the recommendations noted above. Analyses of the historic 2-year peaks, from the 31-year simulations, are recommended to determine appropriate design volumes for such a design event. Once reasonable tau critical values are determined, the impacts of mitigation (e.g. detention storage) with such a design event can be determined on channel stability conditions using the current model.

f. A Development Standard based on the Arroyo Simi watershed will likely be applicable to other areas in adjacent regions. However, this should be evaluated and confirmed in conjunction with the ongoing Calleguas Watershed effort, and other regional studies, to arrive at a generally accepted standard appropriate for the Southern California region and other semi-arid climates.

g. Recent wildfires damaged significant areas of the Arroyo Simi, Calleguas, and other watersheds in Southern California in late 2003. The modeling procedures and techniques, used for comparing and evaluating alternative watershed conditions, as demonstrated in this study, would also be appropriate for assessing potential impacts of fire-damaged areas on hydrology, soil erosion, and channel stability.

SECTION 5.0
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Proposed Permit Criteria for Submittal to the Regional Board

Residential/Public Outreach Program

1. Co-permittees currently spends $0.26 per student for their countywide educational outreach campaign for school age children.

Business Program

1. Co-permittees will target small independent contractors for educational outreach and/or training.
2. Outreach material will be developed for distribution at point of sale (i.e. at paint stores, Home Depot, etc.)
3. When issuing a NOV a Co-permittee may file a cross complaint with another regulatory agency or licensing board.

Construction Program

1. Co-permittees will inspect all construction sites with active SWPCPs once prior to the wet season and once during the wet season. If a violation is found, a follow-up inspection will be performed within two weeks on the initial inspection.

Public Agency Activities – Other Facilities

Drainage System Operation and Maintenance

Program Description

Catch basins, open drainage facilities, detention/retention basins, and reinforced concrete open channels are important features of the surface water storm drainage system. Roadside ditches in rural or mountainous areas are not included in the definition of open drainage facilities.

The Co-permittees will inspect public catch basins, open drainage facilities, detention/retention basins, and reinforced concrete open channels that are part of their drainage system. These inspections do not apply to facilities that are under private or mixed ownership. Inspections will be scheduled and completed at least once each year before the wet season (Permit-defined wet season begins on October 1). Inspections will include at a minimum, the visual observation of each catch basin, open drainage facility, detention/retention basin, and concrete open channel in the system to determine if the facility has accumulations of trash, sediment, or debris that need to be removed to protect water quality or to maintain hydraulic capacity or function of the facility.

The Co-permittees will routinely clean public catch basins, open drainage facilities, detention/retention basins, and reinforced concrete open channels at least once each year, if necessary, prior to the wet season. For catch basins, open drainage facilities, improved open channels, and reinforced concrete open channels, "routine cleaning" for these facilities means the removal of accumulations of trash, sediment, or debris that would likely be washed down stream with the next runoff event. Roadside ditches in rural or agricultural areas are not included in the definition of open drainage facilities.

The Co-permittees will clean public catch basins on an as-needed basis. Catch basin cleaning will be prioritized based on experience, knowledge, and understanding of past history and watershed landuse. For catch basins, "as-needed cleaning" will occur whenever trash, sediment, or debris accumulation in the catch basin is at least 40% of capacity. Because the design of detention and retention basins includes the accommodation of multi-year accumulations of debris and sediment, "routine cleaning" of these facilities means the removal of barriers from the inlet/outlet of the facility to restore the operational design of the facility. The debris/sediment will be cleaned whenever the accumulation in the basin has filled the basin to target levels established in the facility design or subsequently adopted operation and maintenance protocols for the facility. Debris basins designed to capture debris in flows from upstream of urban areas are not considered to be detention or retention basins. Debris basins will be inspected and maintained in accordance with applicable local policies and procedures appropriate for these facilities.

During all routine and as-needed drainage facility cleaning, the Co-permittees will implement appropriate BMPs to reduce to the MEP materials in the drainage facility from being washed downstream.

Roadway Operation and Maintenance

Program Description

Street sweeping has been identified as a program that may help reduce the discharge of street and roadway pollutants to the storm drain system. While the Co-permittees may sweep public streets for many other reasons, this program implements a baseline program geared towards protection of stormwater quality. The Co-permittees are encouraged, but are not required, to continue more intensive public street sweeping programs that may be implemented in their communities for other reasons.

The Co-permittees will identify curbed streets placed in the following categories within their jurisdiction, and will implement a sweeping program for these public streets. In addition, curbed streets will be prioritized for street sweeping based on Co-permittee experience, knowledge, and understanding of past history and watershed landuse. The identified public streets, with curb and gutter, will be swept by the Co-permittee, at a minimum, in accordance with the following requirements:

- High traffic downtown or business district areas within the incorporated cities: sweep at least four times per month;
- Moderate traffic collector streets and residential areas within the incorporated cities: sweep at least six times per year; and
- Other continuously bermed public streets: sweep at least one time per year prior to the rainy season.

For the purpose of streets in the "other" category, "prior to the rainy season" will mean sweeping the public street at least once during the three month period (July, August, September) immediately prior to the wet season (Permit-defined wet season begins October 1). "Continuously bermed" will mean a public street in the permitted area where a continuous berm for storm drainage purposes exists with a defined flow line, and such berm exists on both sides of the street without breaks. These streets are usually in more rural areas of the permitted area.

To increase the efficiency of the street sweeping on public streets, Co-permittees should make an effort to encourage voluntary relocation of street-parked vehicles on scheduled sweeping days. This may be achieved by placing temporary "no stopping" and "no parking" signs, posting permanent street sweeping signs or distributing street sweeping schedules to residents and businesses.

Street maintenance activities may potentially result in pollutants being discharged to the storm drain system if appropriate protective measures are not implemented. The Co-permittees will require that roadway maintenance staff, roadway maintenance contractors, and others implement BMPs to control the discharge of pollutants to the storm drain system as a result of roadway maintenance activities.

TW

Copy

Ventura Countywide Stormwater Quality Management Program

2006 JAN 26 PM 2:25

Participating Agencies

Camarillo

County of Ventura

Fillmore

Moorpark

Ojai

Oxnard

Port Hueneme

San Buenaventura

Santa Paula

Simi Valley

Thousand Oaks

Ventura County Watershed Protection District

January 24, 2006

Mr. Jonathon Bishop, Executive Officer
California Regional Water Quality Control Board
320 West 4th Street, Suite 200
Los Angeles, CA 90013

SUBJECT: VENTURA COUNTYWIDE MUNICIPAL NPDES PERMIT PUBLIC COMMENT PERIOD – TIME EXTENSION REQUEST

Dear Mr. Bishop,

I am writing on behalf of the Ventura Countywide Municipal NPDES Stormwater Quality Management Program to express our concern with the current proposed schedule for renewal and adoption of our permit. As specified in my e-mail to Ms. Tracy Woods, dated January 13, 2006, previous discussions between Regional Board staff and the Co-permittees indicated that there would a longer period of time for the review of the draft permit and submission of comments. Due to the complexity of the issues, the prospective impact of new permit requirements, and the necessity to obtain and compile comments from twelve separate agencies, we feel strongly that a minimum period of sixty days from the release of the draft permit will be required for the members of the stormwater program to have the appropriate level of review for submission of comments.

The currently proposed thirty-day comment period, followed by a Regional Board workshop in April, appears very ambitious and nearly impossible to meet and recent discussions with Ms. Woods indicated that the Regional Board has some flexibility in this matter. Therefore, we are requesting your consideration for a longer comment timetable, preferably sixty days. At this crucial juncture, we believe that this additional time will provide for an improved comprehensive permit, a better stormwater program, and will ultimately result in real water quality benefits in Ventura County.

If you have any questions or wish to discuss further, please call me at (805) 654-5051.

Sincerely,

Gerhardt Hubner, Chair
Ventura Countywide Stormwater Quality Management Program

cc: Jeff Pratt, Director, Watershed Protection District
Ventura Countywide NPDES Stormwater Co-permittees

800 South Victoria Avenue • Ventura CA 93009-1610
805/654-2002 • FAX 805/654-335C

A017719

From: "Gerhardt Hubner" <Gerhardt.Hubner@ventura.org>
To: <twoods@waterboards.ca.gov>
Date: 2/17/2006 9:35:47 AM
Subject: Fwd: Re: Followup to Last Week's Meeting - SW Negotiation and Comments Send

Tracy,

Attached are comments and proposed revisions from Mr. Butch Britt, Director of Transportation, County of Ventura to the permit criteria previously sent to you. Please consider them in drafting the renewal of the Countywide Stormwater Permit. Let me know if you have any questions.

Thx

Gerhardt

>>> Butch Britt 2/10/2006 3:23 PM >>>
Gerhardt, I have annotated my comments on attached. Would you please address these to the board or whatever body is appropriate.

I am concerned that the regulations as drafted would extend out to the Oxnard plain, rural agricultural areas, mountainous areas, and areas in the unincorporated area where street cleaning or roadside ditch cleaning, beyond our normal practice, would be an excessive financial drain on Transportation Departement for no quantifiable benefit to water quality. We are just not the same as a city.

If you or anyone else have any questions please feel free to call.

butch/.

California Regional Water Quality Control Board
Los Angeles Region
Over 50 Years Serving Coastal Los Angeles and Ventura Counties
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Winston H. Hickox
Secretary for Environmental Protection

320 W. 4th Street, Suite 200, Los Angeles, California 90013
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Gray Davis
Governor

December 10, 2002

Certified Mail
Claim No. 7001 1140 0002 0364 8599

Sally Coleman
Manager, Stormwater Quality Section
Ventura County Flood Control District
800 South Victoria Avenue
Ventura, CA 93009-1600

Dear Ms. Coleman:

COMMENTS ON THE ANNUAL REPORT FOR THE VENTURA COUNTYWIDE STORMWATER QUALITY MANAGEMENT PROGRAM RECEIVED OCTOBER 3, 2002, PURSUANT TO MONITORING AND REPORTING PROGRAM CI 7388; NPDES PERMIT NO. CAS004002

On October 3, 2002, we received the Annual Report for Permit Year 1, Reporting Year 8 (Report), submitted to the Regional Board pursuant to Monitoring and Reporting Program CI 7388 as part of the Ventura County Municipal Storm Water NPDES Permit (Permit). We have reviewed the Report and have the following comments and suggestions for improvement:

This Report is much improved over the Annual Report from last year (reporting year 7). Most of our comments on the previous report have been addressed, with exceptions outlined below.

We find that the following areas were not adequately addressed by the report:

Program Management

Your Report must provide "an assessment of the effectiveness of Ventura County Storm Water Management Plan…and impacts on beneficial uses" (part 1.B.3). Although (as in last year's report) relative compliance with Permit requirements was discussed there is still no effective linkage to potential water-quality benefits. You did make the statement "measurable changes in water quality are not likely within the Permit term". However, this statement was not further explained or substantiated, and no prospective evaluation was offered.

This section of the Report also does not describe the Program's compliance record, or explain why some Co-permittees failed to attain the 90% performance goals given in the Stormwater Management Program (SMP). Future annual reports need to address this concern.

Programs for Industrial/Commercial Businesses

- We appreciate your submittal of the Industrial/Commercial Facilities Database (appended to the Report). However, the developed database needs a field to include the name of a contact person.
- More information needs to be provided in future reports for additional target businesses identified in the annual report, such as mobile car washing services, pressure washing services, water purification companies, and commercial equestrian facilities. Such information shall include number of such facilities, their location, operations and pollutants of concern at the facilities.
- It appears that the City of Santa Paula has not trained any staff targeted under this program for two years. Please provide an explanation and schedule for training of Santa Paula staff. It is to be recalled that Santa Paula's industrial/commercial program was noted deficient during the first Ventura Countywide Storm Water Program audit.

Programs for Construction Sites

We appreciate the listing of total enforcement actions and proportions of the type of enforcement. In the future please provide the number and type of enforcement actions for construction sites, for each Co-permittee.

Programs for Planning and Land Development

- The report indicates that Simi Valley has conditioned only 27% of the projects that are SQUIMP eligible. The report does not provide an explanation for this, nor does it indicate when the remaining 63% of projects would be fully conditioned. A report providing an explanation and timeline is due by **January 30, 2003.**
- Future reports need to address maintenance follow-up issues by creating a database of BMPs where they are currently lacking, and by reporting percentage of BMPs followed-up for maintenance in each reporting year. As you know, this is one of the concerns that were revealed during the audits of the program.

Programs for Illicit Discharge and Illegal Connection Control

We think the targeted outreach under this program (providing educational materials to those issued a building or encroachment permit, and to facilities with repeated IC/ID problems) is an effective approach.

In the future please provide the numbers and type of enforcement under this program for each Co-permittee. We also found that the database entries lacked details regarding the type of follow up taken in a particular case, and that the numbers of reportings and follow-up may not match those listed in the Report.

Public Agency Activities

The County of Ventura did not report the predominant types and likely sources of trash removed from catch basin inlets. Please include such information in future annual reports.

The City of Oxnard has not yet developed or implemented Storm Water Pollution Control Plans for three corporate maintenance yards. A response providing an explanation and timeline for the preparation of the documents is due by **January 30, 2003.**

Storm Water Management Program Budget

As discussed at the October 2002 management meeting, storm water program budget reporting is lacking in many significant areas. As agreed at the meeting, co-permittees need to immediately establish a sub-committee to standardize budget reporting. This action should prevent the reporting of untrue statements such as monitoring expenses for some co-permittees where this is not applicable.

Storm Water Monitoring Program

We appreciate the efforts expended to improve the Monitoring Report (which we received on July 15, 2002) and the monitoring section in this Report. Most of our comments on the July Monitoring Report were addressed in your response letter dated September 26, 2002. However, we still have concerns over the following issues:

- We had requested that you provide us with a professional opinion on the most sensitive species for toxicity testing. According to Southern California Coastal Water Research Project (SCCWRP's) letter to you dated 11/26/02, it appears that the sea urchin fertilization test is more sensitive to some trace metals (e.g., Cu, Cd, Zn), while the silverside test using *Menidia beryllina* is more sensitive to ammonia and some pesticides. Therefore, since both classes of pollutants have been detected in your past analyses, we encourage you to use both species to evaluate storm water toxicity in your program.

- We understand the time constraints for laboratory and data analysis of dry weather samples. We also agree that March sampling would not be representative of dry weather flows. For clarification: for the remainder of this Permit term, we expect that all wet weather data will be evaluated and presented in the July Monitoring Reports, and the only new data presented and analyzed for the October Annual Reports will be from dry weather sampling.

- You must ensure that remaining QA/QC issues are resolved.
- In the Data Analysis Conclusion (10.9.3), the Report discusses the exceedances of water quality objectives for total metals. The Report stated, "The EPA has determined that dissolved metals are more toxic than total metals and it is unclear whether exceedances of total metals objectives would have significant benefits on aquatic life." Los Angeles County, as part of the Storm Water Monitoring Coalition (SMC), is developing a project to create a methodology for toxicity testing of suspended solids in storm water. To work toward understanding the relative impact of the dissolved and particle-bound fractions of these pollutants, we suggest that Ventura County participate in this project as a member of the SMC.

Ventura River Watershed Bioassessment

It seems the Ventura River bioassessment was successfully conducted as a joint effort between staff from Ventura County, and the Sustainable Land Stewardship Institute, with a significant volunteer effort. These data provide an assessment of the previously undocumented baseline habitat conditions in the Ventura River Watershed, and may identify areas impacted by humans, by Matilija Dam, and by cattle grazing.

We expect that you will review these comments and incorporate them into the next Annual Report to be submitted by October 1, 2003.

Sincerely,

Ejigu Solomon, Chief
Ventura Storm Water Unit

cc: Bruce Fujimoto, State Water Resources Control Board
Ventura MS4 co-permittees

California Regional Water Quality Control Board
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320 W. 4th Street, Suite 200, Los Angeles, California 90013
Phone (213) 576-6600 FAX (213) 576-6640 - Internet Address: http://www.swrcb.ca.gov/rwqcb4

December 24, 2003

Ms. Darla Wise, Acting Division Manager
Water Quality/Environmental Services
Ventura County Watershed Protection District
800 South Victoria Avenue
Ventura, CA 93009-1600

Certified Mail
Return Receipt Requested
Claim No. 7002 2410 0006 3316 3091

REVIEW OF THE ANNUAL REPORT FOR THE VENTURA COUNTYWIDE STORMWATER QUALITY MANAGEMENT PROGRAM, SEPTEMBER 2003 (BOARD ORDER 00-108, NPDES PERMIT No. CAS004002).

Dear Ms. Wise:

Thank you for the Ventura Countywide Stormwater Quality Management Program (Report) for Permit Year 3, Reporting Year 9, which we received on September 30, 2003. We have reviewed the Report and the following are our comments based on our review.

We appreciate the effort you have made towards improving the Countywide Stormwater Program and its associated Report.

Chapter 2 - Program Management

- Chapter 2, Section 2.3 – In addition to Figure 2-1b, to better illustrate Co-permittees attendance record at subcommittees, separate graphs or a graph representing attendance at the 5 subcommittees and having the Y-axis for labeled total number of meetings and/or meeting dates would be helpful. This information will be important as constituent and bioassessment data are related to specific areas.

- Chapter 2, Section 2.4, pg. 2-6 – As we informed you during the first storm water program audit, as we suggested to you during the October 2002 management meeting, and as it was stated in the December 2002 comment letter on the 2002 Annual Report, you must develop a unified accounting method, so that accounting practices and associated allocation of costs (capital, operation, and maintenance) utilized by each Co-permittee be identical to the maximum extent feasible to standardize the budget reporting. An example of this non conformity as stated in the 2003 Report is: "These cities may allocate all or a portion of their street sweeping program costs (capital, operation, and maintenance) in the stormwater program budget. In addition, cities may budget the capital cost of a new sweeper under the street sweeping program or they may show it under capital costs."

- Chapter 2, Section 2.4 – Including a cost comparison of this fiscal year to previous fiscal years Annual Budgets for Storm Water Management Program per Co-permittee would be useful information.

Chapter 4 - Program For Industrial/Commercial Businesses

- Chapter 4, Section 4.2.1 – In the Report the total number of automotive facilities and food service facilities that are located in each jurisdiction shall be listed, not just the facilities visited.

- Appendix 1, Industrial/Commercial Facilities Database sheets – Not all of the jurisdictions (Camarillo, County of Ventura, Oxnard, Fillmore, Simi Valley and Thousand Oaks) have the Contact Name/Facility Contact, Contact Number, Street Number and/or Applicable SIC Code(s) boxes completed for each facility. It would be useful for the City of Santa Paula to replace Facility Contact – "Employee" with either a personnel title or employee's name.

- Appendix 1, Industrial/Commercial Facilities Database sheets – The database ought to contain information as to whether an inspected site was a nonfiler and if so, its permit status. Other useful information would be the number of inspections performed at a site with corresponding site visit dates.

- Chapter 4, Section 4.2.2, pg. 4-6 – The Report lists some Pollutants of Concern such as; ammonia and bacteria. This is not a complete list. A hierarchy list of Pollutants of Concern needs to be developed then associated with source identification. Based on a list of Pollutants of Concern source identification, each jurisdiction can develop a database of facilities that would discharge the Pollutant(s) of Concern. A list of Pollutants of Concern could be based on TMDLs and/or the TMDL development schedule, or the Ventura County Municipal Stormwater Monitoring Report's data.

- Chapter 4, Section 4.2.1 – It would be useful information to have a discussion in both a narrative and graphic format of the additional target businesses that each Co-permittee has identified to be included in its inspection/education program. The narrative on stable facilities and its associated poster is a good example of an additional target business based on Pollutants of Concern (ammonia and bacteria), as is the Pool Maintenance Guidance Fact Sheet, but the relation to what Pollutants of Concern is not stated.

• Chapter 4, Section 4.3.3 – The County of Ventura Environmental Health Departments' participation in the Business & Illicit Discharge/Illegal Connection Subcommittee's inspection program can only enhance the Subcommittee and its work. In the future, perhaps other Departments such as the Fire Department may be found to be a beneficial participant in the Subcommittee .

Chapter 5 - Program for Planning and Land Development

• Chapter 5, Section 5.2.1.d, pg. 5-8 – If the County of Ventura has significantly rewritten its watershed and storm water management elements then it needs to incorporate these into its General Plan. The Regional Board would like to be notified when the County of Ventura plans to revise its General Plan.

Chapter 6 - Program for Construction Sites

• Chapter 6, Section 6.2.3, pg. 6-9 – Construction site storm water violations are given in percents (not in whole numbers), and as a countywide total. As requested in the 2002 comments on the Report, "In the future please provide the number and type of enforcement actions for construction sites, for each Co-permittee." The Regional Board is interested in knowing each Co-permittee's compliance record. In next years Report list the number and type of enforcement actions for construction sites, for each Co-permittee.

• Chapter 6, Section 6.3.4, pg. 6-12 – A list all of the HomeOwner Associations (HOAs) in a Co-permittee's jurisdiction would be useful information.

• Chapter 6, Section 6.3.5, pg. 6-13 – It is commendable that the City of Oxnard has taken the initiative to work in coordination with one of its commercial facilities (Home Depot) to provide storm water pollution prevention training for 200 employees and fact sheets for in store distribution.

Chapter 7 - Program for Public Agency Activities

• Chapter 7, Section 7.2.2, pg. 7-12 – It would be useful information to have the total debris removed by material type and source depicted for each Co-permittee, not just Countywide.

• Chapter 7, Section 7.2.2, pg. 7-12 – Provide an explanation as to how it was determined that the material type removed from the basin was from what source, example: sediment/residential.

- Chapter 7, Section 7.2.2, pg. 7-13 – A database shall be developed listing the detention/retention basins, their locations and other structural post-construction BMPs within each Co-permittee's jurisdiction.

- Chapter 7, Section 7.2.3, pg. 7-15 – The histogram depicting street sweeping in relation to total curb miles is good, but compliance with the Permit in terms of street sweeping could be evaluated if the sweeping was broken into 3 sections as stated in the Permit: 1) High traffic downtown areas- monthly average not less than 4 times per month, 2) Moderate traffic collector streets, and residential areas- yearly average of not less than 6 times per year, 3) Bermed public streets-continuously, once per year.

Chapter 8 - Program for Illicit Discharges/Illegal Connections

- Chapter 8, Section 8.2.1, pg. 8-8 – Details as to why the City of Moorpark has not resolved 100% of its Illicit Discharges needs to be included in the Report.

- Chapter 8, Section 8.2.1.b, pg. 8-9 – It would be useful information for each Co-permittee to have a discussion in both a narrative and graphic format for the probable cause of, type of material discharged during, and source of material discharged during illicit discharges.

- Chapter 8, Section 8.2.1.c, pg. 8-12 & 13 – Enforcement procedures seem to lack consistency within a jurisdiction (for the same type of ID, different enforcement), and among jurisdictions. Most Co-permittees like to issue "warnings" routinely, while Simi Valley is notably not shy to issue NOVs. There is a need to standardize enforcement procedures in the next permit period. It was not clear what "not applicable" meant for enforcement of ID/IC.

- Chapter 8, Section 8.2.1.c, pg. 8-13 – Details for the seventeen legal actions/fines imposed by the City of Santa Paula needs to be included in the Report.

- Chapter 8, Section 8.2.1.c, pg. 8-14 – Other information that needs to be included in the enforcement database is: 1) Estimated amount of reported illicit discharge/dumping incidents, 2) To whom was the documented non-storm water discharge/connection or dumping referred to for investigation, containment and cleanup.

Chapter 9 – Water Quality and Monitoring Program

- Chapter 9, Section 9. 1.8, pg. 9-7 & 8 – The Report is to include "an assessment of the effectiveness of the Ventura County Storm Water Management Plan… and impacts on beneficial uses" (part 1.B.3). The Report contains compliance with Permit requirements and a limited discussion on monitoring data, but it does not tie in all 7 elements of the Ventura County SMP to improved water quality of its water bodies and their associated beneficial uses. There must be a linkage with the various Program and water quality benefits.

- Chapter 9, Section 9. 1.8, pg. 9-8 – It is not conclusive that Sediment/TSS is not a Pollutant of Concern. Chapter 7, pg. 7-12, depicts sediment as the largest debris material removed from catch basins Countywide. The construction section of the Report does not discuss this conclusion and its related role. As there are undoubtedly efforts by the Co-permittees to decrease sediment contributions from construction sites to stormwater runoff then this information needs to be included in the sections for Program Evaluation, Construction Sites, and included as an Appendix because, the efforts are not fully recognized in the Report.

- USGS has a new analytical method for sediment analysis called suspended-sediment concentrations (SSC) for settable solids concentration. This method of analysis was developed because it has been found that total suspended solids (TSS) data was being analyzed incorrectly. This method should be considered to quantify concentrations of suspended sediment.

Chapter 10 – Monitoring Program & Appendix C – Bioassessment Data

- Chapter 10 & Appendix C – It would be very useful to have the bioassessment data for those Ventura River sites that did poorly (0,1, and 12) to be correlated with chemical assessment by comparing them to the ME-Ventura data. It would appear that by customizing your sampling to synchronize it with the bioassessment areas or vice versa correlation of data may be more effective.

- Chapter 10, Executive Summary-5 – As stated in September 17, 2003, letter reviewing the Ventura Countywide Stormwater Monitoring Program 2002/03 Monitoring Report: "It should be noted that the silverside minnow (*Menidia beryllina*) is an East Coast species not USEPA approved for West Coast marine chronic toxicity testing. The silverside is not an appropriate choice for chronic toxicity testing and is not a recognized species to use for West Coast marine chronic toxicity testing, it does not fulfill the requirement of Ventura's Monitoring Report requirements." As it presently stands meaningful toxicity monitoring has not begun to collect baseline information; therefore it shall be carried over to the next permit. The next permit shall rewrite both the acute and chronic toxicity testing methodology. USEPA Guidance for Implementing Whole Effluent Toxicity Testing Programs shall be required, which necessitates the testing of a fish, invertebrate and plant from specific listed species.

- Chapter 10, Stormwater Monitoring Plan – It would be useful to see the bioassessment monitoring sites, land use and mass emission sites depicted on one map.

Please review our suggestions and comments, and incorporate them into the next Annual Report to be submitted by October 1, 2004.

Sincerely,

Ejigu Solomon, Chief
Ventura Storm Water Unit
Los Angeles Regional Water Quality Control Board

Terry Tamminen
Secretary for Environmental Protection

California Regional Water Quality Control Board

Los Angeles Region

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Arnold Schwarzenegger
Governor

December 7, 2004

Mr. Jeff Pratt, P.E., Director
Ventura County Watershed Protection District
800 South Victoria Avenue
Ventura, CA 93009-1600

Certified Mail
Return Receipt Requested
Claim No. 7002 2030 0002 1673 2230

REVIEW OF THE ANNUAL REPORT FOR THE VENTURA COUNTYWIDE STORMWATER QUALITY MANAGEMENT PROGRAM, OCTOBER 2004 (BOARD ORDER 00-108, NPDES PERMIT No. CAS004002).

Dear Mr. Pratt:

Thank you for the Ventura Countywide Stormwater Quality Management Program (Report) for Permit Year 4, Reporting Year 10, which we received on September 30, 2004. We have reviewed the Report and the following are our comments based on our review.

We appreciate the effort you have made towards improving the Countywide Stormwater Program and its associated Report.

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- Chapter 8, Section 8.2.1.c, pg. 8-12 & 13 – Enforcement procedures seem to lack consistency within a jurisdiction (for the same type of ID, different enforcement), and among jurisdictions. Most Co-permittees like to issue "warnings" routinely, while Simi Valley is notably not shy to issue NOVs. There is a need to standardize enforcement procedures in the next permit period. It was not clear what "not applicable" meant for enforcement of ID/IC.

- Chapter 8, Section 8.2.1.c, pg. 8-13 – Details for the seventeen legal actions/fines imposed by the City of Santa Paula needs to be included in the Report.

- Chapter 8, Section 8.2.1.c, pg. 8-14 – Other information that needs to be included in the enforcement database is: 1) Estimated amount of reported illicit discharge/dumping incidents, 2) To whom was the documented non-storm water discharge/connection or dumping referred to for investigation, containment and cleanup.

Chapter 9 – Water Quality and Monitoring Program

- Chapter 9, Section 9. 1.8, pg. 9-7 & 8 – The Report is to include "an assessment of the effectiveness of the Ventura County Storm Water Management Plan… and impacts on beneficial uses" (part 1.B.3). The Report contains compliance with Permit requirements and a limited discussion on monitoring data, but it does not tie in all 7 elements of the Ventura County SMP to improved water quality of its water bodies and their associated beneficial uses. There must be a linkage with the various Program and water quality benefits.

- Chapter 9, Section 9. 1.8, pg. 9-8 – It is not conclusive that Sediment/TSS is not a Pollutant of Concern. Chapter 7, pg. 7-12, depicts sediment as the largest debris material removed from catch basins Countywide. The construction section of the Report does not discuss this conclusion and its related role. As there are undoubtedly efforts by the Co-permittees to decrease sediment contributions from construction sites to stormwater runoff then this information needs to be included in the sections for Program Evaluation, Construction Sites, and included as an Appendix because, the efforts are not fully recognized in the Report.

- USGS has a new analytical method for sediment analysis called suspended-sediment concentrations (SSC) for settable solids concentration. This method of analysis was developed because it has been found that total suspended solids (TSS) data was being analyzed incorrectly. This method should be considered to quantify concentrations of suspended sediment.

Chapter 10 – Monitoring Program & Appendix C – Bioassessment Data

- Chapter 10 & Appendix C – It would be very useful to have the bioassessment data for those Ventura River sites that did poorly (0,1, and 12) to be correlated with chemical assessment by comparing them to the ME-Ventura data. It would appear that by customizing your sampling to synchronize it with the bioassessment areas or vice versa correlation of data may be more effective.

- Chapter 10, Executive Summary-5 – As stated in September 17, 2003, letter reviewing the Ventura Countywide Stormwater Monitoring Program 2002/03 Monitoring Report: "It should be noted that the silverside minnow (*Menidia beryllina*) is an East Coast species not USEPA approved for West Coast marine chronic toxicity testing. The silverside is not an appropriate choice for chronic toxicity testing and is not a recognized species to use for West Coast marine chronic toxicity testing, it does not fulfill the requirement of Ventura's Monitoring Report requirements." As it presently stands meaningful toxicity monitoring has not begun to collect baseline information; therefore it shall be carried over to the next permit. The next permit shall rewrite both the acute and chronic toxicity testing methodology. USEPA Guidance for Implementing Whole Effluent Toxicity Testing Programs shall be required, which necessitates the testing of a fish, invertebrate and plant from specific listed species.

- Chapter 10, Stormwater Monitoring Plan – It would be useful to see the bioassessment monitoring sites, land use and mass emission sites depicted on one map.

Please review our suggestions and comments, and incorporate them into the next Annual Report to be submitted by October 1, 2004.

Sincerely,

Ejigu Solomon, Chief
Ventura Storm Water Unit
Los Angeles Regional Water Quality Control Board

cc: Mr. Lawrence Jackson, Division Manager, Ventura County Watershed Protection District
Ms. Darla Wise, Ventura County Watershed Protection District

Program Review Report

Ventura Countywide Storm Water Quality Urban Impact Mitigation Plan (SQUIMP) Evaluation (Board Order No. 00-108; NPDES Permit No. CAS004002)

Executive Summary

The Los Angeles Regional Water Quality Control Board, with assistance from Tetra Tech, Inc., through a U.S. EPA contract, conducted a program evaluation of the Ventura Countywide Storm Water Quality Storm Water Quality Urban Impact Mitigation Plan (SQUIMP) requirements in August 2004. The primary purpose of the program evaluation was to determine each permittee's implementation of the Planning and Land Development and SQUIMP requirements described in the Ventura County Municipal Storm Water National Pollutant Discharge Elimination System (NPDES) Permit. Secondary goals included collection of information for permit reissuance and to assist all permittees in implementation of the SQUIMP requirements. The program evaluation focused on nine of the 12 co-permittees – the cities of Fillmore, Moorpark, Port Hueneme, Ojai, Oxnard, Santa Paula, Simi Valley, the County of Ventura, and the Ventura County Watershed Protection District.

This program evaluation report identifies potential permit violations, program deficiencies, and positive attributes. Program deficiencies represent areas of significant concern for successful program implementation. Positive attributes are indications of the co-permittee's overall progress in implementing a multifaceted program to address storm water discharges.

Several program deficiencies applied to some degree to all of the permittees evaluated:

- The permittees need to develop systems for tracking SQUIMP projects and BMPs.

- The permittees should begin to collect data to determine the effectiveness of BMPs approved under the SQUIMP requirements.

- The permittees should focus more proactively on pollutants of concern.

- The permittees should add projects subject to the State's Construction General Permit to the list of projects subject to SQUIMP requirements.

The following potential permit violation was identified:

- In Ventura County, at least one project was conditioned with SQUIMP requirements but failed to submit a SQUIMP plan.

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1.0 Introduction

1.1 Program Evaluation Purpose

The primary goal of the program evaluation was to determine each permittee's implementation of the Planning and Land Development and SQUIMP requirements in the NPDES permit (Board Order 00-108 and EPA NPDES Permit No. CAS004002) and the Ventura Countywide Storm Water Management Plan (Ventura County SMP). Secondary goals included the following:

- Acquire data to assist in reissuing the permit;
- Identify and document positive elements of the program that could benefit other Phase I and Phase II municipalities; and
- Review the overall effectiveness of the program.

40 CFR 122.41(i) and Part 6.H of the NPDES permit provide the authority to conduct the program evaluation.

The Program includes 12 co-permittees with the Ventura County Watershed Protection District serving as the Principal Co-permittee. The program evaluation included the Planning and Land Development programs of nine of the 12 co-permittees – cities of Fillmore, Moorpark, Port Hueneme, Ojai, Oxnard, Santa Paula, Simi Valley, the County of Ventura, and the Ventura County Watershed Protection District.

1.2 Permit History

The NPDES permit was issued on July 27, 2000, and is scheduled to expire on July 27, 2005. This is the second NPDES permit issued to the co-permittees under the storm water Phase I regulations.

1.3 Logistics and Program Evaluation Preparation

Before initiating the on-site program evaluation, Tetra Tech, Inc., conducted a review of available program materials. The goals for the file review were (1) to gain greater knowledge of the existing program, permit requirements, performance criteria, and past activities and (2) to prepare for on-site activities. The following materials were reviewed:

- Board Order 00-108, NPDES Permit No. CAS-004002;
- Ventura Countywide Storm Water Quality Management Program (November 2001);
- Storm Water Quality Urban Impact Mitigation Plan (SQUIMP);
- Technical Guidance Manual for Storm Water Quality Control Measures (July 2002);
- Annual Report for Year ending July 2003 (dated October 2003);
- County and co-permittee web sites; and
- File correspondence with the co-permittees and the permitting authority.

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On August 9-August 12, 2004, the Los Angeles Regional Water Quality Control Board (Regional Board), with assistance from Tetra Tech, Inc., conducted the program review. The program review schedule was as follows:

Monday, August 9	Tuesday, August 10	Wednesday, August 11	Thursday, August 12
• City of Oxnard • City of Ojai • City of Port Hueneme	• City of Oxnard • City of Santa Paula • City of Moorpark	• Ventura County and Ventura County Watershed Protection District • City of Fillmore • City of Simi Valley	• Ventura County and Ventura County Watershed Protection District • Outbrief (all permittees)

Upon completion of the evaluation, an exit interview was held with the co-permittees to discuss the preliminary findings. During the exit interview, the co-permittees were informed that the findings were to be considered preliminary pending further review by EPA and the Regional Board.

1.4 Planning and Land Development and SQUIMP Requirements

Part 4.C of the NPDES permit contains the requirements for Planning and Land Development Programs. There are six major requirements in this section of the permit, which are summarized below:

Part 4.C.1 - Requires the permittees to implement the approved Storm Water Quality Urban Impact Mitigation Plan (SQUIMP) by January 27, 2001. The SQUIMP was included as Attachment A of the permit, and applies to the following development categories:

- Single-Family Hillside Residences
- 100,000 Square Foot Commercial Developments
- Automotive Repair Shops
- Retail Gasoline Outlets
- Restaurants
- Home Subdivisions with 10 or more housing units
- Location within or directly adjacent to or discharging directly to an environmentally sensitive area
- Parking lots with 5,000 square feet or more of impervious parking or access surfaces or with 25 or more parking spaces and potentially exposed to storm water runoff

Each of these development categories is required to meet nine different requirements, which include:

- Control of peak storm water runoff discharge rates
- Conserve natural areas
- Minimize storm water pollutants of concern
- Protect slopes and channels
- Provide storm drain system stenciling and signage
- Properly design outdoor material storage areas
- Properly design trash storage areas

- Provide proof of ongoing BMP maintenance
- Design standards for structural or treatment control BMPs

In addition, individual project categories including 100,000 square foot commercial developments, restaurants, retail gasoline outlets, automotive repair shops, and parking lots are required to follow additional provisions described in the SQUIMP.

Part 4.C.2 - Required the permittees to develop a technical manual by July 2002. The permittees met this requirement with the publication of the *Technical Guidance Manual for Stormwater Quality Control Measures (Technical Guidance Manual)*.

Part 4.C.3 – Required the permittees to identify by January 2001 specific environmentally sensitive areas in Ventura County. A map of environmentally sensitive areas was produced by the permittees and submitted to the Regional Board.

Part 4.C.4 – Requires the permittees to make appropriate modifications to their internal planning procedures for preparing/reviewing CEQA documents.

Part 4.C.5 – Requires the permittees to annually train employees in targeted positions regarding the requirements of the SQUIMP.

Part 4.C.6 – Requires the permittees to include watershed and storm water management considerations in the appropriate elements of the permittee's General Plan whenever the elements are significantly rewritten.

1.5 Program Areas Not Evaluated

The following storm water quality management plan program areas were not evaluated during this review:

- Programs for Residents
- Programs for Industrial/Commercial Businesses
- Programs for Construction Sites
- Public Agency Activities
- Programs for Illicit Discharges/Illegal Connections
- Ordinances and Legal Authority

The following co-permittees were not evaluated during this review:

- City of Camarillo
- City of San Buenaventura
- City of Thousand Oaks

1.6 Program Areas for Additional Review

The evaluation team recommends the following program areas for additional review:

- An evaluation of each permittee's legal authority for implementing the Planning and Land Development (SQUIMP) requirements.

- A follow-up review of the County's and other citys' SQUIMP review procedures that have not received many SQUIMP projects to date.

2.0 Program Evaluation Results

Evaluation results for each co-permittee are presented below and are organized by program area. The population, relative size, growth rates, business composition, and municipal resources vary considerably among the co-permittees.

This evaluation report identifies potential permit violations, program deficiencies, and positive attributes. Program deficiencies represent areas of concern that could significantly affect program effectiveness. Positive attributes are indications of the co-permittees' overall progress in implementing a multifaceted program to address storm water discharges. The evaluation team identified only positive attributes that were innovative (i.e., beyond minimum requirements).

As indicated in Section 1.0, the evaluation team did not review all components of each co-permittee's program. Therefore, the co-permittees should not consider the enclosed list of program deficiencies, or the evaluation report itself, as a shield against undetected violations nor as a comprehensive endorsement of individual program elements. This report does not preclude or in any way limit EPA's or the Regional Board's authority to identify additional program deficiencies and potential permit violations.

The most significant potential permit violations, program deficiencies, and positive attributes identified during the evaluation are listed in the Executive Summary and are identified below with text boxes.

2.1 City of Fillmore

2.1.1 Evaluation of SQUIMP Program Management

Deficiencies Noted:

- *The City should expand their system for tracking SQUIMP projects and BMPs.*
  The City currently uses a system called "Development Activity List" to track development projects. The City should expand this system to track, for each SQUIMP project, the SQUIMP project category(ies) (i.e., restaurant, retail gasoline outlet, parking lot, etc.), the BMPs approved for that project, and information on maintenance of the BMPs such as required maintenance frequency, responsible parties, and when the last maintenance/inspection was performed.

- *The City should begin to collect data to determine the effectiveness of BMPs approved under the SQUIMP requirements.*
  In order for the City to adequately review SQUIMP plans and BMPs, information on the effectiveness of those BMPs must be available. The City should work with other permittees and manufacturers of the proprietary treatment controls typically approved for use in the City to collect data on their effectiveness in the Ventura County area. Additional information on performance of treatment control BMPs can be found in Section 5.4 of the *California Stormwater BMP Handbook for New Development and*

Redevelopment. Some examples of other programs and guidance that could be useful in this effort are listed below:

- Washington Chapter of APWA, "Protocol for the Acceptance of Unapproved Stormwater Treatment Technologies for use in the Puget Sound Watershed" (November 1999) http://mrsc.org/Subjects/Environment/water/apwa/protocol.aspx

- City of Sacramento's "Investigation of Structural Control Measures for New Development" (November 1999) http://www.sacstormwater.org/const/manuals/dl-scm99.html

- International Stormwater BMP Database http://www.bmpdatabase.org/ A document on "Urban Stormwater BMP Performance Monitoring: A Guidance Manual for Meeting the National Stormwater BMP Database Requirements" is available on this site.

- EPA's Environmental Technology Verification (ETV) Program. http://www.epa.gov/etv/index.html

2.1.2 Evaluation of SQUIMP Plan Review

Deficiencies Noted:

- *The City should focus more proactively on pollutants of concern.*

  The SQUIMP requires all projects to "minimize storm water pollutants of concern." The SQUIMP describes this as requiring the incorporation of a BMP or combination of BMPs best suited to maximize the reduction of pollutant loadings in that runoff to the maximum extent practicable. The City is not explicitly reviewing projects to ensure pollutants of concern and associated BMPs are identified in the SQUIMP projects. For each SQUIMP project reviewed, the City should ensure that pollutants of concern are clearly identified and specific BMPs to address those pollutants have been selected.

- *The City should add projects subject to the State's Construction General Permit to the list of projects subject to SQUIMP requirements.*

  Regional Board resolution R-00-02 adopts the numerical mitigation standards (i.e., SQUIMP requirements) as the minimum design criteria for review of post-construction BMPs in the Los Angeles Region for construction projects subject to coverage under the Statewide Construction Storm Water Permit. This essentially requires all construction projects disturbing at least one acre to also comply with the SQUIMP requirements. The City currently does not include these projects in its screening for projects subject to SQUIMP requirements. The City should add these projects to the categories of projects subject to SQUIMP requirements.

- *The City lacked a formal process to verify design calculation for control measures required by the SQUIMP guidelines.*

Although the SQUIMP allows permittees to accept a signed certification from a registered Civil Engineer in lieu of conducting a detailed review of BMP design, the City is encouraged to begin conducting this review themselves. This will help ensure that BMP designs meet the standards set in the *Technical Guidance Manual.* At a minimum, the City should verify that certifying engineers have been trained on BMP design for storm water quality before accepting their design without review and strongly encourage projects to submit BMP designs using the forms provided in the *Technical Guidance Manual.*

- *The City lacked a formalized plan review process to assess SQUIMP requirements.* During in-office interviews, the evaluation team discovered that the City lacked a formalized set of procedures to conduct consistent SQUIMP reviews. Although the City staff responsible for SQUIMP review was a small group, the City should develop a formal set of procedures for SQUIMP review. The City uses the "SQUIMP Summary" sheet during reviews, but should expand this to include a checklist or similar form to help document the SQUIMP review process. The checklist should also document how projects meet SQUIMP provisions applicable to all project categories and requirements for a specific project category (if applicable).

  This formal review process should also apply to larger projects that are reviewed by the City's consultant. This will provide the City with documentation and assurance that the consultant's review is consistent with how the City reviews SQUIMP projects.

2.1.3 Evaluation of SQUIMP Maintenance Program

Deficiency Noted:

- *The City lacked a formal process for tracking maintenance activities for all SQUIMP project BMPs.*
  The City lacked a formal process for verifying maintenance of all post-construction BMPs. During the evaluation, City staff explained that all post-constructions BMPs, such as bio-swales and detention basins, are maintained and inspected by the City on an annual basis. The City was unable to produce a list or map of the approved BMPs that were annexed over to the City for maintenance and it was unclear whether the City had a formal maintenance schedule for all the SQUIMP approved BMPs. The City should develop a system to track BMPs, inspections, and maintenance, including schedules for required maintenance, to ensure that post-construction BMPs are adequately operating as designed.

Positive Attribute:

- *The City requires maintenance easements for all projects that include SQUIMP designed BMPs.*
  Section E28 of the City's Standard Conditions states that "Prior to occupancy, the applicant shall annex the project into the City's Storm Drain Maintenance Assessment District and shall reimburse the City all costs associated with the

annexation." Maintenance is conducted through the City maintenance district with the developer responsible for costs that are incurred. According to City staff, the Maintenance Assessment District has been in effect prior to SQUIMP requirements and has had no problems with ensuring the maintenance of BMPs.

2.1.4 Evaluation of SQUIMP Education and Training

Deficiencies Noted:

- *The City lacks a formal process for training staff that review SQUIMP requirements.* Provision 4.C.5 requires the permittees to annually train employees in targeted positions regarding the requirements of the SQUIMP. The City conducts training during staff meetings but lacks a formal process to train applicable City staff appropriately about the review of SQUIMP plans. The City should develop a more formal training program for staff about requirements of the SQUIMP to ensure compliance with this permit provision.

2.2 City of Moorpark

2.2.1 Evaluation of SQUIMP Program Management

Deficiencies Noted:

- *The City should begin to collect data to determine the effectiveness of BMPs approved under the SQUIMP requirements.*
In order for the City to adequately review SQUIMP plans and BMPs, information on the effectiveness of those BMPs must be available. The City should proactively assess the effectiveness of the SQUIMP BMPs it approves. This could be accomplished by requiring the private landowners to track and submit data on the adequacy of the operation of their BMPs, including controls used on sites discharging storm water to impaired waters. Additional information on performance of treatment control BMPs can be found in Section 5.4 of the *California Stormwater BMP Handbook for New Development and Redevelopment*. See section 2.1.1 for several examples of other programs and guidance that could be useful in this effort.

- *The City should develop a system for tracking SQUIMP projects and BMPs.*
The City should develop a system to track, for each SQUIMP project, the SQUIMP project category(ies) (i.e., restaurant, retail gasoline outlet, parking lot, etc.), the BMPs approved for that project, and information on maintenance of the BMPs such as required maintenance frequency, responsible parties, and when the last maintenance/inspection was performed.

Positive Attributes:

- *The City effectively employs a consulting engineering firm to conduct plan review and to verify engineering (H&H) calculations for SQUIMP flow-based requirements..*

The City has contracted with the same consulting engineering firm for the past 14 years, which has provided long-term continuity and consistency for building, safety, and public works review and inspection services. The consultant staff verify all engineering calculations of submitted SQUIMP plans to ensure that post-construction flow rates do not exceed pre-development runoff conditions.

- *The City is proactive in encouraging the use of nonstructural BMPs and site design practices.*
  The City requires SQUIMP projects to achieve a 'no net increase in flow' standard with regards to pre-construction and post-construction flow rates and encourages passive, open-channel BMPs, and the preservation of open space to meet SQUIMP requirements. The City also focuses on detention and metered discharge and requires a 7-minute contact time standard for grassed swales.

2.2.2 Evaluation of SQUIMP Plan Review

Deficiencies Noted:

- *The City should focus more proactively on pollutants of concern.*
  The SQUIMP requires all projects to "minimize storm water pollutants of concern." The SQUIMP describes this as requiring the incorporation of a BMP or combination of BMPs best suited to maximize the reduction of pollutant loadings in that runoff to the maximum extent practicable. The City is not explicitly reviewing projects to ensure pollutants of concern and associated BMPs are identified in the SQUIMP projects. For each SQUIMP project reviewed, the City should ensure that pollutants of concern are clearly identified and specific BMPs to address those pollutants have been selected.

- *The City should add projects subject to the State's Construction General Permit to the list of projects subject to SQUIMP requirements.*
  Regional Board resolution R-00-02 adopts the numerical mitigation standards (i.e., SQUIMP requirements) as the minimum design criteria for review of post-construction BMPs in the Los Angeles Region for construction projects subject to coverage under the Statewide Construction Storm Water Permit. This essentially requires all construction projects disturbing at least one acre to also comply with the SQUIMP requirements. The City currently does not include these projects in its screening for projects subject to SQUIMP requirements. The City should add these projects to the categories of projects subject to SQUIMP requirements.

2.2.3 Evaluation of SQUIMP Maintenance Program

Deficiency Noted:

- *The City does not have a system in place to "ensure" that maintenance responsibilities for post-construction storm water BMPs are being met for residential developments.*
  The City does not have an easily accessible set of records (i.e., tracking system) of the BMPs in place on private property. The City relies on maintenance agreements with

commercial property owners and Covenants, Conditions, and Restrictions (C, C, & Rs) through homeowner's associations for residential developments. The City's Department of Public Works maintains a list of publicly owned/operated detention basins and performs annual inspection and maintenance (as well as after major storms), but no comparable system is in place for BMPs on private property.

Positive Attribute:

- *The City has developed a series of "phantom" or potential assessment districts that could be used to recover costs incurred by the City in the event that BMP maintenance on private property is not performed adequately.*
  The assessment districts are established on a basin-wide basis for each BMP that requires maintenance. If the private property owner(s) do not perform the necessary maintenance, the City would be able to enter the property, conduct the maintenance, and then bill (or ultimately attach a lien to) the private property owner(s) to recover the costs incurred.

2.2.4 Evaluation of SQUIMP Education and Training

Positive Attributes:

- *The City provides educational brochures and storm water-related outreach materials to homeowner's associations and to construction operators.*
  The City is currently working on incorporating storm water issues into their brochures for code compliance and has scheduled meetings with homeowner's associations (HOA) and HOA management companies to increase awareness of the responsibilities of private property owners with respect to NPDES storm water issues.

- *City staff involved in reviewing SQUIMP projects receive regular training on relevant topics.*
  During 2004, Planning and Development staff training included trash enclosures, natural versus mechanical BMPs, ensuring project plans provide adequate areas for SQUIMP controls, source control options, and standard conditions of approval. Engineering and inspection staff received training which addressed SQUIMP controls, grassy swale design criteria, BMP strategies for single family hillside residences, BMP maintenance and pollution prevention during the dry season, and rainy to dry season BMP transition.

2.3 City of Port Hueneme

2.3.1 Evaluation of SQUIMP Program Management

Deficiencies Noted:

- *The City needs to develop a system for tracking SQUIMP projects and BMPs.*
  The City should develop a system to track, for each SQUIMP project, the SQUIMP project category(ies) (i.e., restaurant, retail gasoline outlet, parking lot, etc.), the BMPs approved for that project, and information on maintenance of the BMPs such

as required maintenance frequency, responsible parties, and when the last maintenance/inspection was performed.

- *The City should begin to collect data to determine the effectiveness of BMPs approved under the SQUIMP requirements.*

In order for the City to adequately review SQUIMP plans and BMPs, information on the effectiveness of those BMPs must be available. The City should work with other permittees and manufacturers of the proprietary treatment controls typically approved for use in the City to collect data on their effectiveness in the Ventura County area. Additional information on performance of treatment control BMPs can be found in Section 5.4 of the *California Stormwater BMP Handbook for New Development and Redevelopment*. See section 2.1.1 for several examples of other programs and guidance that could be useful in this effort..

2.3.2 Evaluation of SQUIMP Plan Review

Deficiencies Noted:

- *The City should focus more proactively on pollutants of concern.*

The SQUIMP requires all projects to "minimize storm water pollutants of concern." The SQUIMP describes this as requiring the incorporation of a BMP or combination of BMPs best suited to maximize the reduction of pollutant loadings in that runoff to the maximum extent practicable. The City is not explicitly reviewing projects to ensure pollutants of concern and associated BMPs are identified in the SQUIMP projects. For each SQUIMP project reviewed, the City should ensure that pollutants of concern are clearly identified and specific BMPs to address those pollutants have been selected.

- *The City should add projects subject to the State's Construction General Permit to the list of projects subject to SQUIMP requirements.*

Regional Board resolution R-00-02 adopts the numerical mitigation standards (i.e., SQUIMP requirements) as the minimum design criteria for review of post-construction BMPs in the Los Angeles Region for construction projects subject to coverage under the Statewide Construction Storm Water Permit. This essentially requires all construction projects disturbing at least one acre to also comply with the SQUIMP requirements. The City currently does not include these projects in its screening for projects subject to SQUIMP requirements. The City should add these projects to the categories of projects subject to SQUIMP requirements.

- *Based on the assessment of both completed/built SQUIMP projects, City staff does not check or verify developer's engineering calculations for SQUIMP projects.*

Although the SQUIMP allows permittees to accept a signed certification from a registered Civil Engineer in lieu of conducting a detailed review of BMP design, the City is encouraged to begin conducting this review themselves to verify that BMPs are adequately sized and designed as specified in the *Technical Guidance Manual*. At a minimum, the City should verify that certifying engineers have been trained on BMP design for water quality before accepting their design without review and strongly encourage projects to submit BMP designs using the forms provided in the *Technical Guidance Manual.*

- *City staff could benefit from using the SQUIMP Summary developed by the Program as a checklist or reminder to ensure that each applicable project is conditioned with appropriate BMPs.*
  An appropriate checklist could be assembled from successful actual or "as built" projects that have worked best in the City, while taking into account the basis of the decision to approve the use of a given BMP (e.g., limitations of soils and the high groundwater tables and proximity to the ocean). The use of such a checklist would allow City staff to document and evaluate which SQUIMP BMPs are being required (or why a certain BMP is not being required) and what special circumstances are present guide successful BMP selection in the future.

2.3.3 Evaluation of SQUIMP Maintenance Program

Deficiency Noted:

- *BMPs and maintenance are not tracked for private development.*
  The City should develop a system to track BMPs, inspections, and maintenance including schedules for when maintenance is required to ensure that post-construction BMPs are adequately operating as designed.

2.3.4 Evaluation of SQUIMP Education and Training

Deficiency Noted:

- *City building officials, construction inspectors, and code enforcement staff need additional training and improved coordination among each other.*
  The City lacks a formal process for training staff that review SQUIMP requirements. Although the City has only a small number of staff responsible for reviewing SQUIMP projects, a more formalized training providing a consistent educational message, a high level of understanding of SQUIMP requirements, and consistent plan review process would be beneficial. It is recommended that the City develop a more formal and frequent training program for SQUIMP review staff.

2.4 City of Ojai

2.4.1 Evaluation of SQUIMP Program Management

Deficiencies Noted:

- *The City needs to develop a system for tracking SQUIMP projects and BMPs.*
  The City should develop a system to track, for each SQUIMP project, the SQUIMP project category(ies) (i.e., restaurant, retail gasoline outlet, parking lot, etc.), the BMPs approved for that project, and information on maintenance of the BMPs such as required maintenance frequency, responsible parties, and when the last maintenance/inspection was performed.

- *The City should begin to collect data to determine the effectiveness of BMPs approved under the SQUIMP requirements.*

  In order for the City to adequately review SQUIMP plans and BMPs, information on the effectiveness of those BMPs must be available. The City should work with other permittees and manufacturers of the proprietary treatment controls typically approved for use in the City to collect data on their effectiveness in the Ventura County area. Additional information on performance of treatment control BMPs can be found in Section 5.4 of the *California Stormwater BMP Handbook for New Development and Redevelopment*. See section 2.1.1 for examples of other programs and guidance that could be useful in this effort.

2.4.2 Evaluation of SQUIMP Plan Review

Deficiencies Noted:

- *The City should focus more proactively on pollutants of concern.*

  The SQUIMP requires all projects to "minimize storm water pollutants of concern." The SQUIMP describes this as requiring the incorporation of a BMP or combination of BMPs best suited to maximize the reduction of pollutant loadings in that runoff to the maximum extent practicable. The City is not explicitly reviewing projects to ensure pollutants of concern and associated BMPs are identified in the SQUIMP projects. For each SQUIMP project reviewed, the City should ensure that pollutants of concern are clearly identified and specific BMPs to address those pollutants have been selected.

- *The City should add projects subject to the State's Construction General Permit to the list of projects subject to SQUIMP requirements.*

  Regional Board resolution R-00-02 adopts the numerical mitigation standards (i.e., SQUIMP requirements) as the minimum design criteria for review of post-construction BMPs in the Los Angeles Region for construction projects subject to coverage under the Statewide Construction Storm Water Permit. This essentially requires all construction projects disturbing at least one acre to also comply with the SQUIMP requirements. The City currently does not include these projects in its screening for projects subject to SQUIMP requirements. The City should add these projects to the categories of projects subject to SQUIMP requirements.

- *The City lacks formalized procedures for screening SQUIMP projects.*

  Currently, there are two projects that have been subject to the SQUIMP review process (Ojai Valley Inn and the Los Arboles subdivision). During the evaluation team's document review it was not apparent that the two projects had been identified as SQUIMP projects and associated provisions applied as conditions to the project. It would benefit the continuity of the SQUIMP program for the City to develop a formalized guidance document to screen projects in the plan review process. The City should use the "SQUIMP summary" sheet provided in the *Technical Guidance Manual* which breaks down the SQUIMP categories, associated provision(s), and BMP selection.

Additionally, it was unclear during the in-office evaluations how the City was screening the projects to determine whether the projects were in an environmentally sensitive area (ESA). Staff explained that the maps that were provided by the county did not show local ESAs. However, the Ojai Valley Inn project was the only project identified to have the potential to impact an ESA. A more in-depth evaluation of the project revealed that there were no special conditions placed on the project to address SQUIMP requirements and the projects encroachment upon the ESA.

2.4.3 Evaluation of SQUIMP Maintenance Program

Deficiency Noted:

- *The City needs to require maintenance agreements for SQUIMP projects and develop a tracking system for SQUIMP BMPs.*
  The City is not currently requiring maintenance agreements for structural or treatment control BMPs. The City provided a copy of an "Agreement for Construction of Subdivision Improvements, Tract No. 5220" which discussed the responsibility for repair and reconstruction of defective work, however this agreement applied to the construction phase of the project and was not proof of ongoing BMP maintenance. An example of a maintenance agreement is included in Appendix C of the *Technical Guidance Manual*. The City should require SQUIMP projects with structural or treatment controls to develop and sign a similar agreement.

  The City should develop a system to track structural and treatment control BMPs and should use it as a tool to schedule inspections to periodically verify that controls are operating as designed.

2.4.4 Evaluation of SQUIMP Education and Training

Deficiencies Noted:

- *The City lacks a formal process for training staff who review SQUIMP requirements.*
  The City lacked a formal process for training city staff involved in the review of SQUIMP plans. Although the City had a small number of staff responsible for reviewing SQUIMP projects, a more formalized training providing a consistent educational message, a high level of understanding of SQUIMP requirements, and a consistent plan review process would be beneficial. The City should develop a more formal and frequent training program for SQUIMP review staff.

2.5 City of Oxnard

2.5.1 Evaluation of SQUIMP Program Management

Deficiencies Noted:

- *The City needs to expand its system for tracking SQUIMP projects and BMPs.*
  The City currently tracks projects and the types of BMPs installed in a spreadsheet. The City should consider expanding this system to also include the SQUIMP project

category(ies) (e.g., restaurant, retail gasoline outlet, parking lot, etc.) and information on maintenance of the BMPs such as required maintenance frequency, responsible parties, and when the last maintenance/inspection was performed.

- *The City should begin to collect data to determine the effectiveness of BMPs approved under the SQUIMP requirements.*

  The City reviews and approves SQUIMP plans that include proprietary treatment controls. Although the City asks engineers to design these systems to meet a specific standard, the City has not yet conducted any monitoring to assess whether these systems are effective (although the City has recently required one project to conduct monitoring during construction). The City should work with other permittees and the manufacturers of these proprietary treatment controls to collect data on their effectiveness in the Ventura County area. Additional information on performance of treatment control BMPs can be found in Section 5.4 of the *California Stormwater BMP Handbook for New Development and Redevelopment.* See section 2.1.1 for several examples of other programs and guidance that could be useful in this effort.

Positive Attribute:

- *The City's program appears to be well coordinated between plan review, inspection and maintenance programs.*

  The City appears to work closely between departments to ensure that SQUIMP projects and BMPs are adequately designed, reviewed, installed, and maintained. For example, the plan review staff distributes copies of maintenance agreements to inspection staff so that they are aware of the BMP and maintenance requirements when conducting inspections. Also, the City maintenance program coordinates closely with plan review staff to ensure that residential BMPs, which are maintained by the City, are designed for ease of maintenance.

2.5.2 Evaluation of SQUIMP Plan Review

Deficiencies Noted:

- *The City should focus more proactively on pollutants of concern.*

  The SQUIMP requires all projects to "minimize storm water pollutants of concern." The SQUIMP describes this as requiring the incorporation of a BMP or combination of BMPs best suited to maximize the reduction of pollutant loadings in that runoff to the maximum extent practicable. The City is not explicitly reviewing projects to ensure pollutants of concern and associated BMPs are identified in the SQUIMP projects. For each SQUIMP project reviewed, the City should ensure that pollutants of concern are clearly identified and specific BMPs to address those pollutants have been selected.

- *The City should add projects subject to the State's Construction General Permit to the list of projects subject to SQUIMP requirements.*

  Regional Board resolution R-00-02 adopts the numerical mitigation standards (i.e., SQUIMP requirements) as the minimum design criteria for review of post-construction BMPs in the Los Angeles Region for construction projects subject to coverage under the Statewide Construction Storm Water Permit. This essentially requires all construction projects disturbing at least one acre to also comply with the SQUIMP requirements. The City currently does not include these projects in its screening for projects subject to SQUIMP requirements. The City should add these projects to the categories of projects subject to SQUIMP requirements.

Positive Attributes:

- *The City has developed a set of specific performance standards for proprietary treatment controls BMPs to meet.*
  The City requires the engineers or manufacturers of proprietary treatment controls to document that the control will capture at least 80% of the silt that is 50 microns in size. This standard provides a consistent target for all proprietary controls to meet before they are approved for use in the City. As described above, the City is encouraged to build on this by also documenting the in-field performance of these BMPs.

- *The City performs a thorough review of SQUIMP plans and has developed written guidance on SQUIMP requirements for plan review staff.*
  The City conducts a detailed review of SQUIMP plans that includes site design aspects, source controls, and treatment controls. The City also reviews design calculations to ensure that they adequately meet City requirements. In addition, the City has developed a brief, informal guidance for plan review staff on review issues associated with construction SWPPPs and SQUIMPs. This information guidance includes a list of proprietary BMPs approved for use in the City, design issues associated with BMPs, and maintenance requirements.

- *The City has several SQUIMP projects constructed and operating which could serve as an educational tool for other cities.*
  Because of the lag time between project proposal and construction, some permittees have very few SQUIMP projects that have been built. The City of Oxnard has several well-designed SQUIMP projects already constructed that could serve as models for other cities. These include a series of swales and vegetated treatment systems at the Sysco industrial park and a vegetated filter strip, trash enclosure and fueling island BMPs at the Palm West Plaza commercial project. The City is also inspecting the construction of the Westport residential project, which includes the installation of approximately 8 StormFilter treatment units. These projects could be used to demonstrate SQUIMP design principles in the field.

2.5.3 Evaluation of SQUIMP Maintenance Program

Deficiency Noted:

- *The City needs to develop a system to track City-maintained BMPs and activities.*
  The City currently tracks City-maintained BMPs using various paper forms and documents. The City should develop a more efficient system, such as a database, to

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track these City-maintained BMPs and activities, and should use it as a tool to schedule inspections and maintenance for staff.

Positive Attributes:

- *The City maintains BMPs in residential areas while still requiring commercial/industrial property owners to maintain BMPs on their property.*
  The City generally requires storm water BMPs in residential areas to be in the public right-of-way and maintained by the City. Maintenance and assessment districts provide funding for the maintenance of residential BMPs.

- *The City requires a signed maintenance agreement that is recorded against the property.*
  Maintenance agreements include a map of the site with BMP locations identified. The City's industrial/commercial storm water inspector is provided with copies of the maintenance agreement and map, and verifies maintenance records during routine storm water inspections. The City plans to send a letter in September reminding owners of the BMPs and their required inspections and maintenance.

- *The City requires monitoring wells at restaurants to check the performance of oil and grease removal BMPs before discharge to the sanitary sewer.*
  The City's pretreatment program requires the installation of monitoring wells at restaurants that use grease removal BMPs to treat wastewater before discharging it to the sanitary sewer. This monitoring helps ensure that the grease removal devices are operating properly and do not spill into the City's MS4.

2.5.4 Evaluation of SQUIMP Education and Training

Positive Attribute:

- *The City senior storm water inspector provides training to both City staff and property owners on SQUIMP requirements and post-construction BMPs.*
  The City senior storm water inspector provides annual training to City staff involved in SQUIMP projects and also provides training to property owners before project sign-off on the maintenance requirements of the BMPs installed on-site.

2.6 City of Santa Paula

2.6.1 Evaluation of SQUIMP Program Management

Deficiencies Noted:

- *The City needs to develop a system for tracking SQUIMP projects and BMPs.*
  The City should develop a system to track, for each SQUIMP project, the SQUIMP category(ies) the project fell under (i.e., restaurant, retail gasoline outlet, parking lot, etc.), the BMPs approved for that project, and information on maintenance of the BMPs such as required maintenance frequency, responsible parties, and when the last maintenance/inspection was performed.

- *The City should begin to collect data to determine the effectiveness of BMPs approved under the SQUIMP requirements.*

In order for the City to adequately review SQUIMP plans and BMPs, information on the effectiveness of those BMPs must be available. The City should work with other permittees and manufacturers of the proprietary treatment controls typically approved for use in the City to collect data on their effectiveness in the Ventura County area. Additional information on performance of treatment control BMPs can be found in Section 5.4 of the *California Stormwater BMP Handbook for New Development and Redevelopment*. See section 2.1.1 for several examples of other programs and guidance that could be useful in this effort.

2.6.2 Evaluation of SQUIMP Plan Review

Deficiencies Noted:

- *The City should focus more proactively on pollutants of concern.*

The SQUIMP requires all projects to "minimize storm water pollutants of concern." The SQUIMP describes this as requiring the incorporation of a BMP or combination of BMPs best suited to maximize the reduction of pollutant loadings in that runoff to the maximum extent practicable. The City is not explicitly reviewing projects to ensure pollutants of concern and associated BMPs are identified in the SQUIMP projects. For each SQUIMP project reviewed, the City should ensure that pollutants of concern are clearly identified and specific BMPs to address those pollutants have been selected.

- *The City should add projects subject to the State's Construction General Permit to the list of projects subject to SQUIMP requirements.*

Regional Board resolution R-00-02 adopts the numerical mitigation standards (i.e., SQUIMP requirements) as the minimum design criteria for review of post-construction BMPs in the Los Angeles Region for construction projects subject to coverage under the Statewide Construction Storm Water Permit. This essentially requires all construction projects disturbing at least one acre to also comply with the SQUIMP requirements. The City currently does not include these projects in its screening for projects subject to SQUIMP requirements. The City should add these projects to the categories of projects subject to SQUIMP requirements.

- *The City lacked a formal process to verify design calculations for control measures required by the SQUIMP guidelines.*

Although the SQUIMP allows permittees to accept a signed certification from a registered Civil Engineer in lieu of conducting a detailed review of BMP design, the City is encouraged to begin conducting this review themselves. This will help ensure that BMP designs meet the standards set in the *Technical Guidance Manual*. At a minimum, the City should verify that certifying engineers have been trained on BMP design for water quality before accepting their design without review and strongly encourage projects to submit BMP designs using the forms provided in the *Technical Guidance Manual*.

- *The City lacked a formalized plan review process to assess SQUIMP requirements.* During in office interviews, the evaluation team discovered that the City lacked formalized set of procedures to conduct consistent SQUIMP reviews. Although the City Regulatory Compliance Specialist was knowledgeable in regards to the SQUIMP requirements and the plan review process, the City should develop a formal set of procedures for SQUIMP review. As an example, the City may develop a flow chart that would include responsible staff for the review, associated materials used in the reviews (i.e., checklists, technical guidance manuals, etc.), SQUIMP categories, associated provisions, and required BMPs.

- *The City's lacked formal standard conditions for projects requiring SQUIMP provisions.*
  During in-office evaluations, City staff explained that conditions on a project were not formal and that they were tailored specifically to each project. The City lacked a formal document that identified the City's standard conditions. The City Regulatory Compliance Specialist edits the conceptual plans as they go through the plan review process addressing storm water controls and SQUIMP provisions. Because the City had no formal process of imposing project standard conditions, it was unclear whether SQUIMP requirements were being addressed. The City should develop a process to ensure that SQUIMP provisions are required for all applicable project categories.

2.6.3 Evaluation of SQUIMP Maintenance Program

Deficiency Noted:

- *The City should develop a maintenance agreement and tracking system for SQUIMP structural and treatment control BMPs.*
  The City lacked maintenance agreements that would provide proof of proper maintenance of post-construction BMPs within the City's jurisdiction. The City was referred to Appendix C of the *Technical Guidance Manual*, which provides an example of a maintenance agreement form.

  The City should also develop a system to track maintenance and required maintenance frequency of structural and treatment control BMPs. Maintenance of BMPs owned by the City was mainly reactionary. Due to the small number of storm water controls (2 debris basins), the City was encouraged to proactively inspect the maintenance of these storm water controls rather than react to a problem. A tracking system for these controls will help ensure that both City-owned and private controls are operating as designed.

2.6.4 Evaluation of SQUIMP Education and Training

Deficiencies Noted:

- *The City lacks a formal process for training staff that review SQUIMP requirements.* Provision 4.C.5 requires the permittees to annually train employees in targeted positions regarding the requirements of the SQUIMP. The City conducts training

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during staff meetings but lacks a formal process to train City staff involved in the review of SQUIMP plans. The City should develop a more formal training program for staff on the requirements of the SQUIMP to ensure compliance with this permit provision. This training should also include Planning Department personnel.

2.7 City of Simi Valley

2.7.1 Evaluation of SQUIMP Program Management

Deficiencies Noted:

- *The City needs to develop a system for tracking SQUIMP projects and BMPs.*

  The City should develop a system to track, for each SQUIMP project, the SQUIMP category(ies) the project fell under (i.e., restaurant, retail gasoline outlet, parking lot, etc.), the BMPs approved for that project, and information on maintenance of the BMPs such as required maintenance frequency, responsible parties, and when the last maintenance/inspection was performed.

- *The City should begin to collect data to determine the effectiveness of the water quality aspects of the BMPs approved under the SQUIMP requirements.*

  Although the City has required on-site storm water detention for many years, for the City to adequately review SQUIMP plans and BMPs, information on the effectiveness of those BMPs must be available. The City should work with other co-permittees and manufacturers of the proprietary treatment controls typically approved for use in the City to collect data on their effectiveness in the Ventura County area. Additional information on performance of treatment control BMPs can be found in Section 5.4 of the *California Stormwater BMP Handbook for New Development and Redevelopment*. See section 2.1.1 for several examples of other programs and guidance that could be useful in this effort.

2.7.2 Evaluation of SQUIMP Plan Review

Deficiencies Noted:

- *The City should focus more proactively on pollutants of concern.*

  The SQUIMP requires all projects to "minimize storm water pollutants of concern." The SQUIMP describes this as requiring the incorporation of a BMP or combination of BMPs best suited to maximize the reduction of pollutant loadings in that runoff to the maximum extent practicable. The City is not explicitly reviewing projects to ensure pollutants of concern and associated BMPs are identified in the SQUIMP projects. For each SQUIMP project reviewed, the City should ensure that pollutants of concern are clearly identified and specific BMPs to address those pollutants have been selected.

- *The City should add projects subject to the State's Construction General Permit to the list of projects subject to SQUIMP requirements.*

Regional Board resolution R-00-02 adopts the numerical mitigation standards (i.e., SQUIMP requirements) as the minimum design criteria for review of post-construction BMPs in the Los Angeles Region for construction projects subject to coverage under the Statewide Construction Storm Water Permit. This essentially requires all construction projects disturbing at least one acre to also comply with the SQUIMP requirements. The City currently does not include these projects in its screening for projects subject to SQUIMP requirements. The City should add these projects to the categories of projects subject to SQUIMP requirements.

- *The City should encourage alternative BMP designs and not rely so heavily on proprietary control measures.*
  The City generally prohibits infiltration devices and discourages the use of detention in many parts of the City. The City usually refers developers to the website containing the *Technical Guidance Manual*, which generally results in the developers installing a proprietary control measure. The City should try to encourage alternative BMPs where possible, given the design limitations set by the City.

2.7.3 Evaluation of SQUIMP Maintenance Program

Deficiency Noted:

- *Tracking of projects only appears to occur through the project approval stage hindering the City's ability to verify the "as built" condition and to conduct inspections to ensure proper operation and maintenance of SQUIMP BMPs.*
  Without a database, the City must rely on individual project files, rather than a single database. The current procedures limit the ability to conduct any follow up analysis of BMPs, as well as hinder efforts to effectively track ongoing inspection and maintenance. The City should commit to implementing a BMP tracking database to help ensure that structural and treatment control BMPs are operating as designed.

2.7.4 Evaluation of SQUIMP Education and Training

Deficiency Noted:

- *The City should provide additional training to all staff involved in SQUIMPs and post-construction BMPs.*
  The various City departments involved in some aspect of SQUIMP implementation should receive additional, specific storm water training, including the interdepartmental cross training of staff and management to increase the understanding and awareness of City staff of SQUIMP responsibilities. The City should also ensure that staff involved in development planning are trained on the SQUIMP requirements and the BMPs described in the *Technical Guidance Manual*. In addition, City construction inspectors should receive training on SQUIMP requirements and BMPs in order to be able to identify potential projects that have not met the SQIUMP requirements and ensure that post-construction BMPs are adequately installed and are being properly maintained.

2.8 County of Ventura and Ventura County Watershed Protection District

The SQUIMP reviews for the County and Watershed Protection District are conducted by the same person and largely follow the same procedures, so the findings for both permittees are included in this section.

2.8.1 Evaluation of SQUIMP Program Management

Deficiencies Noted:

- *The County needs to expand its system for tracking SQUIMP projects and BMPs.*
  The County has developed a database to track development project conditions. This database should be expanded to track, for each SQUIMP project, the SQUIMP category(ies) the project fell under (i.e., restaurant, retail gasoline outlet, parking lot, etc.), the BMPs approved for that project, and information on maintenance of the BMPs such as required maintenance frequency, responsible parties, and when the last maintenance/inspection was performed.

- *The County should begin to collect data to determine the effectiveness of BMPs approved under the SQUIMP requirements.*
  In order for the County to adequately review SQUIMP plans and BMPs, information on the effectiveness of those BMPs must be available. The County should work with other co-permittees and manufacturers of the proprietary treatment controls typically approved for use in the County to collect data on their effectiveness in Ventura County. Additional information on performance of treatment control BMPs can be found in Section 5.4 of the *California Stormwater BMP Handbook for New Development and Redevelopment*. See section 2.1.1 for several examples of other programs and guidance that could be useful in this effort.

- *The County needs to ensure better coordination between the District and County Departments on SQUIMP projects.*
  Within the County, there are at least three groups with direct involvement in SQUIMP projects – the Watershed Protection District, the Planning Department and the Public Works Department's Development and Inspection Services. The County needs better coordination between these departments to ensure that SQUIMP requirements are met on all projects. For example, in some cases projects were designed with flood control BMPs without considering SQUIMP requirements. Because of the close relationship between BMPs designed to meet SQUIMP requirements and BMPs designed to meet flood control requirements, the departments responsible for these programs must work together to ensure that the requirements of both programs are met on every project.

2.8.2 Evaluation of SQUIMP Plan Review

Potential Permit Violation:

- *At least one project was conditioned with SQUIMP requirements but failed to submit a SQUIMP plan.*

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Provision C.1 of the permit requires permittees to implement the SQUIMP provisions not later than January 27, 2001. A significant expansion of an industrial facility was conditioned to comply with the SQUIMP provisions; however, this project began construction without submitting a SQUIMP plan to the County. A site visit revealed that the project had been under construction for several months with no apparent post-construction controls in place (the construction plans were not available for review). The County must ensure that all projects required to comply with the SQUIMP requirements submit acceptable SQUIMP plans and install BMPs according to the plans. The County is in the process of incorporating the Permits Plus system into their plan review process. This system should be designed to ensure that SQUIMP requirements are met before a project receives permits and can begin construction.

Deficiencies Noted:

- *The County should focus more proactively on pollutants of concern.*

The SQUIMP requires all projects to "minimize storm water pollutants of concern." The SQUIMP describes this as requiring the incorporation of a BMP or combination of BMPs best suited to maximize the reduction of pollutant loadings in that runoff to the maximum extent practicable. The City is not explicitly reviewing projects to ensure pollutants of concern and associated BMPs are identified in the SQUIMP projects. For each SQUIMP project reviewed, the County should ensure that pollutants of concern are clearly identified and specific BMPs to address those pollutants have been selected.

- *The County should add projects subject to the State's Construction General Permit to the list of projects subject to SQUIMP requirements.*

Regional Board resolution R-00-02 adopts the numerical mitigation standards (i.e., SQUIMP requirements) as the minimum design criteria for review of post-construction BMPs in the Los Angeles Region for construction projects subject to coverage under the Statewide Construction Storm Water Permit. This essentially requires all construction projects disturbing at least one acre to also comply with the SQUIMP requirements. The County currently does not include these projects in its screening for projects subject to SQUIMP requirements. The County should add these projects to the categories of projects subject to SQUIMP requirements.

2.8.3 Evaluation of SQUIMP Maintenance Program

Deficiency Noted:

- *The County needs to develop a system to track SQUIMP BMPs and activities.*

The County currently tracks maintenance of Watershed District BMPs, but does not yet have a system to track BMPs and maintenance of structural or treatment controls approved for private projects. The County should develop a more efficient system to track these BMPs and activities, and should use it as a tool to schedule inspections to periodically verify that controls are operating as designed.

Positive Attribute:

- *The County conditions projects to require submittal of maintenance records every October.*
  Although the County has not had any SQUIMP projects constructed, it does condition projects to submit maintenance records by October 1 of each year. As SQUIMP projects are built, the County will need to develop a system to track the submittal of these maintenance records and decide which BMPs the County should periodically inspect to ensure they are being maintained.

2.8.4 Evaluation of SQUIMP Education and Training

<u>Deficiency Noted</u>:

- *The County should provide additional training to all staff involved in SQUIMPs and post-construction BMPs.*
  As described above, three different County departments are involved in some aspect of SQUIMP implementation. The County should ensure that staff involved in development planning are trained on the SQUIMP requirements and the BMPs described in the *Technical Guidance Manual*. In addition, County construction inspectors should receive training on SQUIMP requirements and BMPs in order to be able to identify potential projects that have not met the SQIUMP requirements and ensure that post-construction BMPs are adequately installed.

California Regional Water Quality Control Board

Los Angeles Region

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Terry Tamminen
Secretary for Environmental Protection

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Arnold Schw... gger
Governor

December 15, 2004

Ms. Anita Kuhlman
City of Camarillo
601 Carmen Drive
Camarillo, CA 91310

Certified Mail
Return Receipt Requested
Claim No. 7002 2030 0002 1673 0359

PROGRAM REVIEW REPORT OF THE VENTURA COUNTYWIDE STORMWATER QUALITY URBAN IMPACT MITIGATION PLAN (SQUIMP)

Dear Ms. Kuhlman:

We recently conducted program evaluation of the development planning program of Board Order No. 00-108, NPDES Permit No. CAS004002. The audits (evaluations) were performed in two parts: the first part was conducted during the week of August 9, 2004 by the Los Angeles Regional Water Quality Control Board, with assistance from Tetra Tech, inc., through a USEPA contract and focused on 9 of the 12 co-permittees – the cities of Fillmore, Moorpark, Port Hueneme, Ojai, Oxnard, Santa Paula, Simi Valley, the County of Ventura, and the Ventura County Watershed Protection District.

The second part of the audit was performed on September 13, 20 and 22, 2004, and the focus of the evaluation was on the cities of Camarillo, Buenaventura and Thousand Oaks. The program evaluation report is herein enclosed.

The report identifies program deficiencies, areas needing improvement, and positive attributes of each program. Regional Board staff had given the co-permittees an opportunity to review the report and provide comments. One of the most significant comments received is the implementation of Resolution No. R-00-02 adopted by the California Regional Water Quality Control Board, Los Angeles Region, on January 6, 2000. During the audit, staff had noted that there was a wide variation among the co-permittees in the implementation of this Resolution. By this transmittal letter, I am re-iterating the need for consistent implementation of the Resolution by all the co-permittees.

We realize that NPDES Permit No. CAS004002 is soon going to be revised. We look forward to working with the co-permittees to develop and issue a revised permit. If you have any questions concerning this matter, please call Ejigu Solomon at (213) 620-2237.

Sincerely,

Jonathan S. Bishop, P.E.
Executive Officer

Enclosure

California Regional Water Quality Control Board
Los Angeles Region
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Secretary for Environmental Protection

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Arnold Schwar ger
Govern

December 15, 2004

Mr. Bert Rapp
City of Fillmore
250 Central Ave.
Fillmore, CA 93025

Certified Mail
Return Receipt Requested
Claim No. 7003 3110 0003 3258 1898

PROGRAM REVIEW REPORT OF THE VENTURA COUNTYWIDE STORMWATER QUALITY URBAN IMPACT MITIGATION PLAN (SQUIMP)

Dear Mr Rapp:

We recently conducted program evaluation of the development planning program of Board Order No. 00-108, NPDES Permit No. CAS004002. The audits (evaluations) were performed in two parts: the first part was conducted during the week of August 9, 2004 by the Los Angeles Regional Water Quality Control Board, with assistance from Tetra Tech, inc., through a USEPA contract and focused on 9 of the 12 co-permittees – the cities of Fillmore, Moorpark, Port Hueneme, Ojai, Oxnard, Santa Paula, Simi Valley, the County of Ventura, and the Ventura County Watershed Protection District.

The second part of the audit was performed on September 13, 20 and 22, 2004, and the focus of the evaluation was on the cities of Camarillo, Buenaventura and Thousand Oaks. The program evaluation report is herein enclosed.

The report identifies program deficiencies, areas needing improvement, and positive attributes of each program. Regional Board staff had given the co-permittees an opportunity to review the report and provide comments. One of the most significant comments received is the implementation of Resolution No. R-00-02 adopted by the California Regional Water Quality Control Board, Los Angeles Region, on January 6, 2000. During the audit, staff had noted that there was a wide variation among the co-permittees in the implementation of this Resolution. By this transmittal letter, I am re-iterating the need for consistent implementation of the Resolution by all the co-permittees.

We realize that NPDES Permit No. CAS004002 is soon going to be revised. We look forward to working with the co-permittees to develop and issue a revised permit. If you have any questions concerning this matter, please call Ejigu Solomon at (213) 620-2237.

Sincerely,

Jonathan S. Bishop, P.E.
Executive Officer

Enclosure

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Los Angeles Region

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Arnold Schwa ger
Governor

December 15, 2004

Mr. Mike Mathews
City of Moorpark
799 Moorpark Ave.
Moorpark, CA 93021

Certified Mail
Return Receipt Requested
Claim No. 7003 3110 0003 3258 1904

PROGRAM REVIEW REPORT OF THE VENTURA COUNTYWIDE STORMWATER QUALITY URBAN IMPACT MITIGATION PLAN (SQUIMP)

Dear Mr. Mathews:

We recently conducted program evaluation of the development planning program of Board Order No. 00-108, NPDES Permit No. CAS004002. The audits (evaluations) were performed in two parts: the first part was conducted during the week of August 9, 2004 by the Los Angeles Regional Water Quality Control Board, with assistance from Tetra Tech, inc., through a USEPA contract and focused on 9 of the 12 co-permittees – the cities of Fillmore, Moorpark, Port Hueneme, Ojai, Oxnard, Santa Paula, Simi Valley, the County of Ventura, and the Ventura County Watershed Protection District.

The second part of the audit was performed on September 13, 20 and 22, 2004, and the focus of the evaluation was on the cities of Camarillo, Buenaventura and Thousand Oaks. The program evaluation report is herein enclosed.

The report identifies program deficiencies, areas needing improvement, and positive attributes of each program. Regional Board staff had given the co-permittees an opportunity to review the report and provide comments. One of the most significant comments received is the implementation of Resolution No. R-00-02 adopted by the California Regional Water Quality Control Board, Los Angeles Region, on January 6, 2000. During the audit, staff had noted that there was a wide variation among the co-permittees in the implementation of this Resolution. By this transmittal letter, I am re-iterating the need for consistent implementation of the Resolution by all the co-permittees.

We realize that NPDES Permit No. CAS004002 is soon going to be revised. We look forward to working with the co-permittees to develop and issue a revised permit. If you have any questions concerning this matter, please call Ejigu Solomon at (213) 620-2237.

Sincerely,

Jonathan S. Bishop, P.E.
Executive Officer

Enclosure

Terry Tamminen
Secretary for Environmental Protection

California Regional Water Quality Control Board

Los Angeles Region

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Arnold Schwa gger
Governor

December 15, 2004

Mr. Bill Frank
Hawks & Assoc. (Ojai)
2259 Portola Road. # B
Ventura, CA 93003

Certified Mail
Return Receipt Requested
Claim No. 7003 3110 0003 3258 1911

PROGRAM REVIEW REPORT OF THE VENTURA COUNTYWIDE STORMWATER QUALITY URBAN IMPACT MITIGATION PLAN (SQUIMP)

Dear Mr. Frank:

We recently conducted program evaluation of the development planning program of Board Order No. 00-108, NPDES Permit No. CAS004002. The audits (evaluations) were performed in two parts: the first part was conducted during the week of August 9, 2004 by the Los Angeles Regional Water Quality Control Board, with assistance from Tetra Tech, inc., through a USEPA contract and focused on 9 of the 12 co-permittees – the cities of Fillmore, Moorpark, Port Hueneme, Ojai, Oxnard, Santa Paula, Simi Valley, the County of Ventura, and the Ventura County Watershed Protection District.

The second part of the audit was performed on September 13, 20 and 22, 2004, and the focus of the evaluation was on the cities of Camarillo, Buenaventura and Thousand Oaks. The program evaluation report is herein enclosed.

The report identifies program deficiencies, areas needing improvement, and positive attributes of each program. Regional Board staff had given the co-permittees an opportunity to review the report and provide comments. One of the most significant comments received is the implementation of Resolution No. R-00-02 adopted by the California Regional Water Quality Control Board, Los Angeles Region, on January 6, 2000. During the audit, staff had noted that there was a wide variation among the co-permittees in the implementation of this Resolution. By this transmittal letter, I am re-iterating the need for consistent implementation of the Resolution by all the co-permittees.

We realize that NPDES Permit No. CAS004002 is soon going to be revised. We look forward to working with the co-permittees to develop and issue a revised permit. If you have any questions concerning this matter, please call Ejigu Solomon at (213) 620-2237.

Sincerely,

Jonathan S. Bishop, P.E.
Executive Officer

Enclosure

California Regional Water Quality Control Board
Los Angeles Region
Over 54 Years Serving Coastal Los Angeles and Ventura Counties
Recipient of the 2001 *Environmental Leadership Award* from Keep California Beautiful

Terry Tamminen
Secretary for Environmental Protection

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Phone (213) 576-6600 FAX (213) 576-6640 - Internet Address: http://www.waterboards.ca.gov/losangeles

Arnold Schwa ;ger
Governo.

December 15, 2004

Mr. Mark Pumford
City of Oxnard
6001 S. Perkins Rd.
Oxnard, CA 93030

Certified Mail
Return Receipt Requested
Claim No. 7003 3110 0003 3258 1928

PROGRAM REVIEW REPORT OF THE VENTURA COUNTYWIDE STORMWATER QUALITY URBAN IMPACT MITIGATION PLAN (SQUIMP)

Dear Mr. Pumford:

We recently conducted program evaluation of the development planning program of Board Order No. 00-108, NPDES Permit No. CAS004002. The audits (evaluations) were performed in two parts: the first part was conducted during the week of August 9, 2004 by the Los Angeles Regional Water Quality Control Board, with assistance from Tetra Tech, inc., through a USEPA contract and focused on 9 of the 12 co-permittees – the cities of Fillmore, Moorpark, Port Hueneme, Ojai, Oxnard, Santa Paula, Simi Valley, the County of Ventura, and the Ventura County Watershed Protection District.

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Sincerely,

Jonathan S. Bishop, P.E.
Executive Officer

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Arnold Schwa ger
Governor

December 15, 2004

Ms. Carrie Mattingly
City of Port Hueneme
250 N. Ventura Rd.
Port Hueneme, CA 93041

Certified Mail
Return Receipt Requested
Claim No. 7002 2030 0002 1673 0137

PROGRAM REVIEW REPORT OF THE VENTURA COUNTYWIDE STORMWATER QUALITY URBAN IMPACT MITIGATION PLAN (SQUIMP)

Dear Ms. Mattingly:

We recently conducted program evaluation of the development planning program of Board Order No. 00-108, NPDES Permit No. CAS004002. The audits (evaluations) were performed in two parts: the first part was conducted during the week of August 9, 2004 by the Los Angeles Regional Water Quality Control Board, with assistance from Tetra Tech, inc., through a USEPA contract and focused on 9 of the 12 co-permittees – the cities of Fillmore, Moorpark, Port Hueneme, Ojai, Oxnard, Santa Paula, Simi Valley, the County of Ventura, and the Ventura County Watershed Protection District.

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Sincerely,

Jonathan S. Bishop, P.E.
Executive Officer

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Arnold Schwa gger
Governor

December 15, 2004

Ms. Vicki Musgrove
City of San Buenaventura
P.O Box 99
Ventura, CA 93001

Certified Mail
Return Receipt Requested
Claim No. 7002 2030 0002 1673 0144

PROGRAM REVIEW REPORT OF THE VENTURA COUNTYWIDE STORMWATER QUALITY URBAN IMPACT MITIGATION PLAN (SQUIMP)

Dear Ms. Musgrove:

We recently conducted program evaluation of the development planning program of Board Order No. 00-108, NPDES Permit No. CAS004002. The audits (evaluations) were performed in two parts: the first part was conducted during the week of August 9, 2004 by the Los Angeles Regional Water Quality Control Board, with assistance from Tetra Tech, inc., through a USEPA contract and focused on 9 of the 12 co-permittees – the cities of Fillmore, Moorpark, Port Hueneme, Ojai, Oxnard, Santa Paula, Simi Valley, the County of Ventura, and the Ventura County Watershed Protection District.

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Sincerely,

Jonathan S. Bishop, P.E.
Executive Officer

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Arnold Schwa ger
Governor

December 15, 2004

Mr. Rene Salas
City of Santa Paula
200S Tenth St.
Santa Paula, CA 93061

Certified Mail
Return Receipt Requested
Claim No. 7002 2030 0002 1673 0328

PROGRAM REVIEW REPORT OF THE VENTURA COUNTYWIDE STORMWATER QUALITY URBAN IMPACT MITIGATION PLAN (SQUIMP)

Dear Mr. Salas:

We recently conducted program evaluation of the development planning program of Board Order No. 00-108, NPDES Permit No. CAS004002. The audits (evaluations) were performed in two parts: the first part was conducted during the week of August 9, 2004 by the Los Angeles Regional Water Quality Control Board, with assistance from Tetra Tech, inc., through a USEPA contract and focused on 9 of the 12 co-permittees – the cities of Fillmore, Moorpark, Port Hueneme, Ojai, Oxnard, Santa Paula, Simi Valley, the County of Ventura, and the Ventura County Watershed Protection District.

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Sincerely,

Jonathan S. Bishop, P.E.
Executive Officer

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Secretary for Environmental Protection

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December 15, 2004

Mrs. Anne Schubert-Reyes
City of Simi Valley
2929 Tapo Canyon Rd.
Simi Valley, CA 93063

Certified Mail
Return Receipt Requested
Claim No. 7002 2030 0002 1673 0151

PROGRAM REVIEW REPORT OF THE VENTURA COUNTYWIDE STORMWATER QUALITY URBAN IMPACT MITIGATION PLAN (SQUIMP)

Dear Mrs. Schubert-Reyes:

We recently conducted program evaluation of the development planning program of Board Order No. 00-108, NPDES Permit No. CAS004002. The audits (evaluations) were performed in two parts: the first part was conducted during the week of August 9, 2004 by the Los Angeles Regional Water Quality Control Board, with assistance from Tetra Tech, inc., through a USEPA contract and focused on 9 of the 12 co-permittees – the cities of Fillmore, Moorpark, Port Hueneme, Ojai, Oxnard, Santa Paula, Simi Valley, the County of Ventura, and the Ventura County Watershed Protection District.

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Sincerely,

Jonathan S. Bishop, P.E.
Executive Officer

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Arnold Schwa gger
Governor

December 15, 2004

Ms. JoAnne Kelly
City of Thousand Oaks
2100 East Thosand Oaks Blvd.
Thousand Oaks, CA 91362

Certified Mail
Return Receipt Requested
Claim No. 7002 2030 0002 1673 0168

PROGRAM REVIEW REPORT OF THE VENTURA COUNTYWIDE STORMWATER QUALITY URBAN IMPACT MITIGATION PLAN (SQUIMP)

Dear Ms. Kelly:

We recently conducted program evaluation of the development planning program of Board Order No. 00-108, NPDES Permit No. CAS004002. The audits (evaluations) were performed in two parts: the first part was conducted during the week of August 9, 2004 by the Los Angeles Regional Water Quality Control Board, with assistance from Tetra Tech, inc., through a USEPA contract and focused on 9 of the 12 co-permittees – the cities of Fillmore, Moorpark, Port Hueneme, Ojai, Oxnard, Santa Paula, Simi Valley, the County of Ventura, and the Ventura County Watershed Protection District.

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Sincerely,

Jonathan S. Bishop, P.E.
Executive Officer

Enclosure

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Secretary for Environmental Protection

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December 15, 2004

Ms. Marty Robinson
County of Ventura
800S. Victoria Ave.
Ventura, CA 93009-1610

Certified Mail
Return Receipt Requested
Claim No. 7002 2030 0002 1673 0366

PROGRAM REVIEW REPORT OF THE VENTURA COUNTYWIDE STORMWATER QUALITY URBAN IMPACT MITIGATION PLAN (SQUIMP)

Dear Ms. Robinson:

We recently conducted program evaluation of the development planning program of Board Order No. 00-108, NPDES Permit No. CAS004002. The audits (evaluations) were performed in two parts: the first part was conducted during the week of August 9, 2004 by the Los Angeles Regional Water Quality Control Board, with assistance from Tetra Tech, inc., through a USEPA contract and focused on 9 of the 12 co-permittees – the cities of Fillmore, Moorpark, Port Hueneme, Ojai, Oxnard, Santa Paula, Simi Valley, the County of Ventura, and the Ventura County Watershed Protection District.

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We realize that NPDES Permit No. CAS004002 is soon going to be revised. We look forward to working with the co-permittees to develop and issue a revised permit. If you have any questions concerning this matter, please call Ejigu Solomon at (213) 620-2237.

Sincerely,

Jonathan S. Bishop, P.E.
Executive Officer

Enclosure

Program Evaluation Report

Ventura Countywide Stormwater Quality Management Program (Board Order No. 00-108; NPDES Permit No. CAS004002)

Executive Summary

The Los Angeles Regional Water Quality Control Board, with assistance from Tetra Tech, Inc., through a U.S. EPA contract, conducted a program evaluation of the Ventura Countywide Stormwater Quality Management Program (Program) in October 2001. The purpose of the Program evaluation was to determine compliance with the Ventura County Municipal Storm Water National Pollutant Discharge Elimination System (NPDES) Permit. The evaluation team reviewed the co-permittees' compliance with the NPDES permit requirements and performance criteria and conducted an in-field verification of program implementation. The program evaluation focused on five of the twelve co-permittees—the Ventura County Flood Control District (VCFCD) and the cities of Ojai, Oxnard, Santa Paula, and Simi Valley. Of these five, the VCFCD's program evaluation was limited in scope and did not cover all the areas evaluated in the cities; additional evaluation of the program may be needed in the future. The evaluation results are specific to these co-permittees and are not intended to represent the countywide program as a whole or other co-permittees not evaluated.

This program evaluation report identifies program deficiencies and positive attributes only. No specific potential permit violations were identified. Program deficiencies represent areas of significant concern for successful program implementation. Positive attributes are indications of the co-permittee's overall progress in implementing a multifaceted program to address storm water discharges. In addition, the evaluation has shown that the co-permittees have limited resources for implementing the Program. Their compliance and accomplishments should be seen in this context.

The following program deficiencies were identified as the most significant:

- A VCFCD construction site lacked erosion and sediment controls.
- Handling of hazardous materials at the Oxnard corporation yard is inadequate.
- Criteria for storm water pollution control plans (SWPCPs) for public road construction projects are lacking in Oxnard.
- Criteria are needed to determine where to place illegal dumping signs in Oxnard.
- Inspection of facilities subject to the General Industrial Permit (GIP) has yet to begin in Santa Paula.
- Storm water controls at the Santa Paula corporation yard are inadequate.
- Improved coordination is needed in the Simi Valley program.

- The Ventura Countywide Storm Water Quality Urban Impact Mitigation Plan (SQUIMP) conditioning process and on-site implementation lacks continuity in Simi Valley.
- SWPCP review and field inspections in Simi Valley focus on sediment control, not erosion control at sites visited.

Several elements of the co-permittees' programs were particularly notable:

- A countywide management committee and five subcommittees help provide program direction, consistency, and guidance to co-permittees.
- Comprehensive plan review procedures and SQUIMP conditioning are in place in the VCFCD and Oxnard.
- A sound organizational structure for storm water management is present in Oxnard.
- A source control inspector has been dedicated for construction site inspections in Oxnard.
- The evaluation has shown that the co-permittees have limited resources for implementing the Program.
- Although not reporting this information in the co-permittees annual report, the Del Norte Regional Recycling and Transfer station located in the City of Oxnard recycles tons of trash that otherwise could have impacted receiving waters.

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1.0 Introduction

1.1 Program Evaluation Purpose

The primary goal of the program evaluation was to determine the overall compliance status of selected co-permittees with conditions and requirements contained in the NPDES permit (Board Order 00-108 and EPA NPDES Permit No. CAS004002) and the Ventura Countywide Storm water Management Plan (Ventura County SMP). Secondary goals included the following:

- Acquire data to assist in reissuing the permit;
- Identify and document positive elements of the program that could benefit other Phase I and Phase II municipalities; and
- Review the overall effectiveness of the program.

40 CFR 122.41(i) and Part 6.H of the NPDES permit provide the authority to conduct the program evaluation.

The Program includes 12 co-permittees with the Ventura County Flood Control District (VCFCD) serving as the Principal Co-permittee. The program evaluation reviewed the practices and permit compliance status of five of the 12 co-permittees—the VCFCD and the cities of Ojai, Oxnard, Santa Paula, and Simi Valley.

1.2 Permit History

The NPDES permit was issued on July 27, 2000, and is scheduled to expire on July 27, 2005. This is the second NPDES permit issued to the co-permittees under the storm water Phase I regulations.

1.3 Logistics and Program Evaluation Preparation

Before initiating the on-site program evaluation, Tetra Tech, Inc., conducted a review of available program materials. The goals for the file review were (1) to gain greater knowledge of the existing program, permit requirements, performance criteria, and past activities and (2) to prepare for on-site activities. The following materials were reviewed:

- Board Order 00-108, NPDES Permit No. CAS-004002;
- Ventura County SMP (revised January 2001);
- SQUIMP;
- Annual Report for Year ending July 2001 (dated October 1, 2001);
- County and co-permittee web sites; and
- File correspondence with the co-permittees and the permitting authority.

The authority, scope, and schedule of the program evaluation were communicated to the co-permittees by written notice on October 15, 2001. On October 29-November 1, 2001, the Los Angeles Regional Water Quality Control Board (Regional Board), with assistance from Tetra

Tech, Inc., conducted the program evaluation. The evaluation schedule which was modified slightly in the field, was as follows:

Monday, October 29	Tuesday, October 30	Wednesday, October 31	Thursday, November 1
All Parties - Program evaluation kick-off. *VCFCD* - Program management, annual reporting, financial reporting, and measuring progress.	*Ojai* – Development planning, construction, illicit discharge control, and industrial and commercial businesses. *Oxnard and Simi Valley* – Development planning, construction, and public agency activities.	*Santa Paula* - Development planning, construction, illicit discharge control, and industrial and commercial businesses. *Oxnard and Simi Valley* – Illicit discharge control and industrial and commercial inspections.	*VCFCD* – Development planning, construction, and program coordination. *All Parties* - Exit interview and presentation of preliminary findings.

Upon completion of the evaluation, an exit interview was held with the co-permittees to discuss the preliminary findings. During the exit interview, the co-permittees were informed that the findings were to be considered preliminary pending further review by EPA and the Regional Board.

1.4 Program Areas Evaluated

The following program areas were evaluated:

- Program management.
- Programs for industrial and commercial businesses.
- Programs for planning and land development.
- Programs for construction sites.
- Programs for public agency activities.
- Programs for illicit discharge control.
- VCFCD overall program coordination.

1.5 Program Areas Not Evaluated

The following areas were not evaluated in detail as part of the program evaluation:

General – Countywide

- Programs for residents (public education/involvement)
- Monitoring program details (e.g., sample location, types, frequency, parameters, etc.)
- Monitoring reports (e.g., analytical methods, QA/QC or interpretations)

- Other NPDES permits issued to the permittees (e.g., industrial or construction NPDES storm water permits)

- Legal authority

- Inspection reports, plan review reports, and other relevant files. The program evaluation team did not conduct a detailed file review to verify that all elements of the programs were being implemented as described. Rather, observations by the evaluation team and statements from the co-permittees' representatives were used to assess overall compliance with permit requirements and performance criteria. A detailed file review of specific program areas could be included in a subsequent evaluation

Other Co-permittees

- County of Ventura
- City of Camarillo
- City of Fillmore
- City of Moorpark
- City of Port Hueneme
- City of San Buenaventura
- City of Thousand Oaks

1.6 Program Areas for Additional Review

The evaluation team recommends the following program areas for additional review:

Countywide

- The co-permittees not evaluated as part of this evaluation

- Procedures for reporting co-permittee program implementation results to the VCFCD

- Monitoring results, the identification of pollutants of concern, and current and future plans for addressing identified pollutants of concern

- Countywide assessment of dry-weather flows as they relate to illicit connections and illicit discharges

- Compliance assessment of those program areas with implementation deadlines of July 27, 2002, including (1) industrial and commercial business inspections, (2) placement of no dumping signs, (3) implementation of Land Development Guidelines, and (4) implementation of SWPCPs for corporation yards

City of Simi Valley

- Evaluation of overall program organization and management approach

- Verification of program continuity between development planning and development construction activities

2.0 Program Evaluation Results

Evaluation results for each co-permittee are presented below and are organized by program area. The population, relative size, growth rates, business composition, and municipal resources vary considerably among the co-permittees.

This evaluation report identifies only program deficiencies and positive attributes and not potential permit violations. Program deficiencies represent areas of concern that could significantly affect program effectiveness. Positive attributes are indications of the city's overall progress in implementing a multifaceted program to address storm water discharges. The evaluation team identified only positive attributes that were innovative (i.e., beyond minimum requirements).

As indicated in Section 1.0, the evaluation team did not review all components of each co-permittee's program. Therefore, the co-permittees should not consider the enclosed list of program deficiencies, or the evaluation report itself, as a shield against undetected violations nor as a comprehensive endorsement of individual program elements. This report does not preclude or in any way limit EPA's or the Regional Board's authority to identify additional program deficiencies and potential permit violations.

The most significant program deficiencies and positive attributes identified during the evaluation are listed in the Executive Summary and are identified below with text boxes.

2.1 Ventura County Flood Control District

The VCFCD is designated as the principal permittee for the Ventura Countywide Storm Water Management Program. An implementation agreement between the VCFCD and the co-permittees obligates the VCFCD to perform specific coordination and reporting duties, along with implementing the permit requirements in unincorporated parts of Ventura County. Programs for industrial and commercial businesses are not applicable to the VCFCD.

The following program elements were reviewed in the VCFCD, and deficiencies and positive attributes were noted.

2.1.1 Evaluation of Program Management

Deficiency Noted:

- *Improvements are needed in the countywide data management system.*
  Several deficiencies in the existing countywide data management system were identified, including the following: the inability to modify previously entered values and to continually add data; the inability to access or review submitted information until the contractor prepares and delivers the annual report; and the lack of detail of selected data elements, which results in an inability to identify and present significant differences among the co-permittees. In its current condition, the data management system is used solely to collect and compile co-permittee program implementation

data for inclusion in annual reports. The system would provide greater value if it could be used to assist the co-permittees with evaluation of their compliance with permit conditions and track overall program performance. The VCFCD acknowledged these deficiencies and plans to redesign the existing system to better accommodate the needs of the general program and co-permittees.

Positive Attributes:

- *Programs are funded in part through a benefit assessment levied on parcels of land that benefit from flood control projects and programs.*
  The legal statute requires that benefit assessments be based primarily on the proportionate storm water runoff from each parcel of land in the county, measured as a Basic Assessment Unit. Revenues from the assessments are used to finance the cost of routine operation and maintenance of flood control facilities and implementation of the countywide NPDES program. The benefit assessment is collected twice per year along with property taxes and is then distributed back to the individual cities. Although the benefit assessment does not cover the total costs for program implementation, it does provide a significant funding source for the program. The VCFCD produces an annual report, *Report on Benefit Assessment Program for Flood Control,* which describes the program in detail.

- *A countywide management committee and five subcommittees help provide program direction, consistency, and guidance to co-permittees.*
  As the principal permittee, the VCFCD provides coordination and support through the management committee and five subcommittees established on specific program areas. The management committee and subcommittees have provided invaluable assistance to all the cities in the program by developing standard forms, reports, and other information for use, saving all cities time and money, while ensuring consistency. The subcommittee structure also allows all co-permittees to share implementation successes and problems. This coordinated management committee and subcommittee structure could be a model for Phase II cities in a common area wishing to share resources and information.

2.1.2 Evaluation of Programs for Industrial and Commercial Businesses

Not Evaluated.

2.1.3 Evaluation of Programs for Planning and Land Development

Positive Attributes:

- *Comprehensive plan review procedures and SQUIMP conditioning are in place.*
  The VCFCD has a comprehensive set of procedures for plan reviews and has been aggressively implementing SQUIMP requirements on appropriate sites. The VCFCD, as part of the subcommittee process, has also developed and is using a set of sample storm water management conditions of approval for discretionary land development activities. These sample conditions, consisting of 30 conditions in five

categories, allow plan reviewers to consistently require appropriate storm water controls for proposed land development.

2.1.4 Evaluation of Programs for Construction Sites

Deficiencies Noted:

- *A VCFCD construction site lacked erosion and sediment controls.*
  The evaluation team visited a VCFCD project designed to increase the capacity and improve the stability of a flood control channel. This project lacked adequate erosion and sediment controls. Stabilized construction entrances were not provided, and a nearby storm drain inlet was not protected, which resulted in a previous discharge of a significant amount of sediment to the inlet and ultimately to the VCFCD channel. Two other construction sites had similar problems. The VCFCD needs to provide additional training for inspection and project staff on proper erosion and sediment controls and to ensure that such controls are in place and maintained at all sites.

- *Inspections appear to be inadequate to ensure compliance with approved plans*
  As described above, the VCFCD conditions development and construction projects for storm water quality management when a project is in unincorporated Ventura County or when a project in an incorporated city discharges directly to a VCFCD channel. In incorporated cities, the VCFCD inspects only the final outlet structure that discharges to the VCFCD channel and not any additional upstream controls that they might have included in the plan. It was not clear during the program evaluation whether incorporated cities are ensuring that the additional upstream VCFCD controls are being implemented. The VCFCD needs to work with the incorporated cities to ensure that all controls are implemented in accordance with the approved plan.

2.1.5 Evaluation of Public Agency Activities

Adequate.

2.1.6 Evaluation of Programs for Illicit Discharge Control

Deficiency Noted:

- *Countywide IC/ID form needs to include identification of illicit discharges*
  The countywide form the co-permittees use for Illicit Connection/Illicit Discharge (IC/ID) incident reporting does not provide for the identification of dry-weather illicit discharges as a designated category. Dry-weather flows exist throughout the county and an improved form could be helpful in assessing the frequency and magnitude of these flows and provide baseline data for prioritizing elimination. Although exempt from storm water regulations, co-permittees indicated that agricultural runoff is widespread throughout the county and is a likely contributor of pollutants of concern to the storm drain system. The IC/ID incident reporting form could also be modified to collect baseline information on such flows (e.g., including new fields for location, visual and field observations, and origin) that might enable targeted educational efforts in the future.

2.1.7 Program Evaluation

Deficiency Noted:

- *Program evaluation is based on programmatic and social indicators only, not environmental performance.*
  The countywide program, like most municipal storm water programs nationwide, relies heavily on programmatic and social indicators to determine the program's success. This information is reported annually, with each of the major program elements measured against the number of employees trained, number of subcommittee meetings attended, number of inspections conducted, and so forth. The countywide program has yet to significantly integrate water quality indicators as a measure of success. The program should use the programmatic and social indicators, **along with water quality monitoring data**, to evaluate performance and modify the Ventura County Stormwater Management Plan, as appropriate.

2.2 City of Ojai

Ojai, with a population of approximately 8,000 people, is a small, rural city north of Oxnard. It is primarily residential, with limited commercial development and very little industrial activity. Growth is low, and construction activity is limited. The city has budgeted $150,800 for storm water programs in fiscal year 2001-2002.

The following program elements were reviewed in the city of Ojai, with deficiencies and positive attributes noted.

2.2.1 Evaluation of Program Management

Positive Attributes:

- *Innovative utilization of resources.*
  As a small city with limited staff, Ojai carefully leverages its resources to meet its storm water requirements. Examples include the following: (1) youth groups assist with storm drain system maintenance and catch basin cleaning; and (2) the city contracts with the County Environmental Health Department to conduct inspections of automobile service industries.

2.2.2 Evaluation of Programs for Industrial and Commercial Businesses

Potential Deficiency Noted:

- *Food service facility inspections are not being conducted.*
  The permit requires co-permittees to inspect all automotive, food service, and other facilities subject to the State Board General Industrial Permit by July 27, 2002. The city has not yet initiated inspections of its 23 restaurants and indicated that they planned to contract with a retired county inspector to complete them in the required time frame. The city needs to complete all of the required inspections before July 27, 2002.

2.2.3 Evaluation of Programs for Planning and Land Development

Deficiency Noted:

- *Documentation of the plan review process is lacking.*
  The plan review process is not formalized and is largely the responsibility of a single individual. If the rates of development increase or staff turnover occurs, a more formalized process will be needed. Therefore, the city could benefit by documenting its plan review process.

2.2.4 Evaluation of Programs for Construction Sites

Adequate.

2.2.5 Evaluation of Public Agency Activities

Adequate.

2.2.6 Evaluation of Programs for Illicit Discharge Control

Adequate.

2.3 City of Oxnard

Oxnard is the largest city in Ventura County with a population of about 170,000 people. The city is located on the coast and occupies about 25 square miles. Significant growth is occurring in this community and industrial, commercial and residential construction is widespread. The industrial and commercial base is also significant. Oxnard has budgeted $2,269,485 for storm water programs in fiscal year 2001-2002.

The following program elements were reviewed in the city of Oxnard, with deficiencies and positive attributes noted.

2.3.1 Evaluation of Program Management

Positive Attributes:

- *A sound organizational structure for storm water management is present.*
  The organizational structure for storm water management in the city ensures interdepartmental coordination and could be a model for other Phase I and Phase II municipalities. Storm water management is largely the role of the Waste Water Division's Source Control Program, which shares some responsibilities with the Waste Water Division's Maintenance Section, Development Services Department, and Construction Services. The city holds monthly meetings to discuss the status of its existing storm water programs and future needs, and it reports the activities occurring at the countywide subcommittee meetings. Good communication and coordination among the individual departments has resulted in a comprehensive program for illicit discharge control, SQUIMP implementation, construction oversight, and industrial and commercial inspections.

2.3.2 Evaluation of Programs for Industrial/Commercial Businesses

Positive Attribute:

- *Organized and integrated industrial and commercial business inspection program.* The city's industrial and commercial business inspection program is well organized and coordinated within the Source Control Program. The city maintains a comprehensive database of applicable facilities, past inspection dates, and concise inspection reports detailing deficiencies and required remedies. Additionally, the city determines whether the inspected facility has submitted a Notice of Intent for coverage under the General Industrial Permit and periodically submits a list of potential "non-filers" to the Regional Board for their review and follow-up.

2.3.3 Evaluation of Programs for Planning and Land Development

Positive Attribute:

- *Comprehensive plan review procedures and SQUIMP conditioning.*

  The Development Services Department had been including storm water quality structural controls in plan reviews and approvals even before the development and adoption of the SQUIMP conditioning requirements. The countywide subcommittee process further standardized these procedures in the plan review and approval process. On-site field visits identified SQUIMP-compliant controls in place at applicable light industrial facilities, residential developments, and gasoline retail outlets. Coordination with Construction Services and Source Control ensures proper installation, operation, and maintenance of structural controls.

2.3.4 Evaluation of Programs for Construction Sites

Positive Attribute:

- *A source control inspector is provided to conduct construction site inspections.*

  Unique among municipal storm water programs, Source Control provides a dedicated construction inspector who works closely with Development Services and Construction Services to ensure that adequate storm water quality controls are in place during the planning, construction, and post-development phases of each project. Source Control participates in the plan review, inspects ongoing projects on a weekly basis, and works with other city construction inspectors to identify and remedy erosion and sediment control deficiencies. Also unique, Source Control inspectors often educate the tenants of newly constructed facilities on the operational and maintenance requirements of constructed water quality controls at their facilities.

2.3.5 Evaluation of Public Agency Activities

Deficiencies Noted:

- *Handling of hazardous materials at the corporation yard is inadequate.*

  The hazardous materials handling practices at the city corporation yard need improvement. Various city crews routinely collect hazardous materials and wastes discarded by residents. These materials are then left outside the gate of the hazardous materials storage area in the corporation yard. At the time of the evaluation, batteries, paints, solvents, and other miscellaneous materials were being stored outside, without cover or secondary containment. Additionally, the hazardous materials structure was open-sided, with materials stored directly adjacent to the surrounding fence. The NPDES permit prohibits the discharge of untreated storm water runoff to the storm drain system from toxic or hazardous material storage areas after July 27, 2001. The city needs to modify the structure immediately to prevent the accumulation of and contact with rainwater and provide a covered and contained area for the placement of collected hazardous materials and wastes.

- *Housekeeping practices at the corporation yard are poor.*
  Six city departments occupy the corporation yard, each maintaining responsibility for its own operations. On-site observations indicated that the adequacy of housekeeping varied from tenant to tenant, with poor housekeeping observed for several tenants. The corporation yard is scheduled to undergo a significant capital improvement project in 2002, and the city indicated than an SWPCP would be developed in conjunction with that project. The NPDES permit requires implementation of an SWPCP for corporation yards no later than July 27, 2002. Therefore, the city needs to develop and implement a comprehensive SWPCP, including housekeeping and operational practices for the entire facility. The SWPCP should also designate a single point of responsibility for the yard.

- *Criteria for SWPCPs for public road construction projects are lacking.*
  The city lacks criteria to determine whether an SWPCP is needed for public road construction projects between 1 and 5 acres. The NPDES permit requires "...implementation of an SWPCP prior to issuance of a grading permit for construction projects that will result in soil disturbance of 1 acre or more in size." The NPDES permit also states "co-permittees shall prepare and implement an SWPCP on co-permittee construction projects, as required above." Observations made during the evaluation and discussions with the city's Senior Construction Supervisor indicate that while best management practices (BMPs) are routinely implemented, the development and implementation of SWPCPs has been sporadic. The city indicated that the failure to develop and implement SWPCPs for all applicable projects is largely due to misunderstandings regarding "line and grade" exemptions in the State Board Construction General Permit and a lack of criteria for determining applicable acreage for linear projects. The "line and grade" exemptions are not applicable to these projects and the State Water Resources Control Board (State Board) has developed guidance for determining the site acreage for linear projects. The city needs to obtain the State Board's guidance and needs to develop and implement SWPCPs for all projects greater than 1 acre.

  For projects subject to a bid process, the city needs to require the development of an SWPCP and should consider including specific sediment and erosion control measures in the job specifications to ensure that contractors provide adequate funds for erosion and sediment controls. Alternatively, the city could include a set cost for applicable controls to provide a level cost structure for all bidders. Job specifications without an SWPCP might result in construction projects that do not contain adequate erosion and sediment controls.

2.3.6 Evaluation of Programs for Illicit Discharge Control

Deficiency Noted:

- *Criteria are needed to determine where to place illegal dumping signs.*

The city is required to place signs with prohibitive language discouraging illegal dumping at public access points to creeks and other relevant water bodies and channels by July 27, 2002. On-site tours of selected open channels and water bodies in the city indicated that the city lacks criteria to determine (1) applicable water bodies, (2) public access points, and (3) the frequency and location of signage. At the time of the evaluation, no signs had been placed within the city. The IC/ID subcommittee is working on the prohibitive language for the signs but had yet to focus on placement considerations. Criteria are likely needed in other communities in the county as well.

2.4 City of Santa Paula

Santa Paula is 14 miles east of Ventura, approximately in the center of Ventura County. Santa Paula is an older, built-out city with most development occurring as in-fill development. There is limited industrial and commercial activity within the city limits. The city is about 4 square miles in size and has a population of 28,500. Santa Paula budgeted $326,959 for storm water programs in fiscal year 2001-2002.

The following program elements were reviewed in the city of Santa Paula, with positive attributes and deficiencies noted.

2.4.1 Evaluation of Program Management

Adequate.

2.4.2 Evaluation of Programs for Industrial and Commercial Businesses

Deficiency Noted:

- *Inspection of facilities subject to the General Industrial Permit has yet to begin.*

The permit requires co-permittees to inspect automotive, food service, and other facilities subject to the State Board General Industrial Permit by July 27, 2002. At the time of the evaluation, the city had conducted a small portion of the automotive and food service inspections, but it has yet to initiate inspections of other facilities subject to the General Industrial Permit. The city is preparing to meet this requirement by compiling a list of applicable industrial facilities. The city needs to finalize its list and complete all of the required inspections prior to July 27, 2002.

2.4.3 Evaluation of Programs for Planning and Land Development

Deficiency Noted:

- *Documentation of the plan review process is lacking.*

The plan review process is not formalized and if the rates of development increase or staff turnover occurs, a more formalized process will be needed. Therefore, the city could benefit by documenting its plan review process.

Positive Attribute:

- *There is coordination during preliminary plan review.*
  To address cross-departmental issues early in the planning process, preliminary plan reviews, which are similar to Design Advisory Committee reviews in larger cities, are conducted by four departments (Public Works, Planning, Fire, and Building) before a formalized development plan is distributed to the appropriate city departments for review and approval. Individuals participating in the preliminary plan reviews are trained in the selection and implementation of appropriate storm water quality controls. This process ensures coordination and implementation of appropriate storm water quality controls for new development projects.

2.4.4 Evaluation of Programs for Construction Sites

Deficiency Noted:

- *Erosion and sediment controls for single-family home construction are lacking.*
  A number of the active construction projects in the city are small, single-family developments conducted by the landowner without the involvement of a dedicated builder or contractor. Erosion and sediment controls at many of these sites were nonexistent, and the city was having difficulty ensuring that adequate controls are used. The city should develop a plan for improved compliance at these sites.

2.4.5 Evaluation of Public Agency Activities

Deficiencies Noted:

- *Storm water controls at the corporation yard are inadequate.*
  The corporation yard next to the city's wastewater treatment plant had significant storm water concerns that need to be addressed. Although there was no runoff present during the evaluation, it appeared that runoff from the facility runs directly through the area where vehicles are maintained, resulting in a possible source of pollutants to the storm drain system. The permit prohibits the discharge of untreated storm water runoff to the storm drain system from vehicle maintenance and repair facilities after July 27, 2001, and requires an SWPCP to be developed for the yard by no later than July 27, 2002. The city needs to immediately address the storm water problems present in the yard and develop and implement an SWPCP prior to July 27, 2002.

- *A new Storm Water Pollution Prevention Plan (SWPPP) is needed for the wastewater treatment plant.*
  Although this observation is not directly related to the NPDES permit, the evaluation team noted that the SWPPP for the wastewater treatment plant was old and needed to be updated. Additionally, the sludge handling practices at the site need improvement

because the sludge drying beds exhibited evidence of past overflows that could contaminate runoff from the site.

2.4.6 Evaluation of Programs for Illicit Discharge Control

Adequate.

2.5 City of Simi Valley

Simi Valley is in eastern Ventura County and has a population of about 115,000. Significant growth is occurring in this community and industrial, commercial and residential construction is widespread. The industrial and commercial base is also significant. The city reported an annual storm water budget of $1,268,200 for the 2001-2002 fiscal year.

The following program elements were reviewed in the City of Simi Valley, with positive attributes and deficiencies noted.

2.5.1 Evaluation of Program Management

Deficiency Noted:

- *Improved coordination is needed.*
  The industrial and commercial businesses, IC/ID, and public agency activity program elements are located under the Source Control directorate in the city's Department of Public Works. The Planning and Land Development and Construction Site program elements are administered through the City Engineer's office, also within the Department of Public Works. Enhanced coordination between the two groups (and perhaps among other city programs) would improve the effectiveness of the Simi Valley storm water management program. This could be accomplished either through organizational changes or by other mechanisms.

2.5.2 Programs for Industrial and Commercial Businesses

Deficiency Noted:

- *Improved data management is needed.*
  The city would benefit from having its list of applicable businesses entered into a relational database (which could still be exported to a spreadsheet for reports) to handle the variety of fields necessary to manage data for storm water, hazardous materials, and pretreatment. City staff indicated that such software had been recently purchased and installed, but that they had not yet been trained in its use.

Positive Attribute:

- *An integrated industrial and commercial business inspection program is in place.*
  The industrial and commercial education and site inspection program occurs in conjunction with hazardous waste and pretreatment inspections, where applicable. This approach allows inspectors to combine other inspection responsibilities, such as pretreatment inspections, with their storm water inspections. Although the permit requirement is to inspect applicable businesses once every 2 years, the Source Control

Group's goal is to perform inspections of all applicable businesses annually. Educational outreach efforts administered as part of the inspection process are also commendable.

2.5.3 Evaluation of Programs for Planning and Land Development

Deficiency Noted:

- *The SQUIMP conditioning process and on-site implementation lacks continuity.*
  The planning and development process initially relies on a Development Advisory Committee (DAC), which provides for comprehensive evaluation of development proposals at the conceptual stage by appropriate elements of city government. This approach is sound and has been proven to be an effective method for getting storm water issues identified early in the process, which benefits all concerned parties. After preliminary evaluation by the DAC, the interactive process among the developer and city reviewers continues. This process may ultimately result in the submission of an acceptable preliminary drainage study along with a conceptual development plan that might eventually be approved by the City Planning Commission and/or the City Council. SQUIMP conditioning occurs at this early stage and, assuming the city approves the conceptual plan, it enters the plan check review process. At this point there appears to be a lack of continuity between the SQUIMP conditioning process and the plan check review and inspection process as the need for and design of the SQUIMP compliant controls and BMPs is often not communicated to city staff tasked with on-site construction supervision and inspection. This lack of continuity has appeared to result in the construction of flood control structures instead of the water quality controls envisioned by the SQUIMP.

- *There is a lack of understanding regarding SQUIMP standards.*
  SQUIMP training has been provided by the Principal Co-permittee and numerous discussions/training sessions have been held among the countywide development planning subcommittee. However, planning and development review staff in the City Engineer's Office indicated that they still "need adequate standards" to get the development community on board with pollutant-specific water quality BMPs in accordance with the SQUIMP. Adequate standards do exist in the SQUIMP and city staff need to meet with planning department staff from other Ventura County cities and/or meet with the Regional Board to remedy their apparent lack of understanding on this issue.

2.5.4 Evaluation of Programs for Construction Sites

Deficiencies Noted:

- *Construction site erosion and sediment controls are not consistent with plans.*
  The evaluation team observed that "as-built" construction and postconstruction erosion and sediment controls do not match the controls specified in the approved plans. For example, on one of the sites visited during the program evaluation, a construction crew was observed cleaning off a portable cement mixer without using the dedicated concrete wash water area. The city should verify through inspection

that construction site BMPs specified in plans are actually being implemented and should enforce compliance with the plans.

- *SWPCP reviews and field inspections focus on sediment control, not erosion control*

Erosion control BMPs, particularly on slopes, were lacking at one of the two sites visited. At the other site, erosion control BMPs were being used but had not been identified in the SWPCP. The emphasis of the construction site review/inspection program appears to be sediment control rather than erosion control. At one of the construction sites, the city inspector conducting an inspection in conjunction with evaluation team visit, stated that he was concerned only with keeping sediment off the city streets by ensuring a properly designed and maintained construction entrance. The city needs to revise its construction inspection activities to ensure that both proper erosion and sediment control BMPs are installed and maintained on all construction sites and needs to enhance the training program for city construction inspectors.

2.5.5 Evaluation of Public Agency Activities

Adequate:

- *Source control staff are located at the corporation yard.*

The Source Control Program's offices are co-located with the city corporation yard. Source Control Program staff are readily available to train and otherwise heighten awareness about storm water issues with city crews and employees working at the corporation yard.

2.5.6 Evaluation of Programs for Illicit Discharge Control

Adequate.

Winston H. Hickox
Secretary for Environmental Protection

California Regional Water Quality Control Board
Los Angeles Region

Over 50 Years Serving Coastal Los Angeles and Ventura Counties
Recipient of the 2001 *Environmental Leadership Award* from Keep California Beautiful

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Gray Da
Govern

June 28, 2002

Sally Coleman
Ventura County Flood Control District
800 South Victoria Avenue
Ventura, CA 93009-1600

SECOND ROUND PROGRAM EVALUATION REPORT FOR THE VENTURA COUNTYWIDE MUNICIPAL STORM WATER PERMIT (BOARD ORDER NO. 00-108, NPDES NO. CAS004002)

Dear Ms. Coleman:

From May 13 to May 16, Los Angeles Regional Water Quality Control Board (LARWQCB) staff, with assistance from one State Board staff conducted an evaluation of the Ventura Countywide Storm Water Quality Management Program. The purpose of the program evaluation was to determine the level of compliance with the permit requirements of Order No. 00-108. The co-permittees whose programs were evaluated were the Cities of Camarillo, Fillmore, Moorpark and Thousand Oaks.

Please find attached an Evaluation Report summarizing the results of the evaluation. Throughout the evaluation, our four teams were grateful for the cooperation on the part of all the staff in the various departments of the four cities. As expected, the evaluation has shown areas of programmatic strength that need to be maintained and enhanced, and deficiencies that you need to immediately address. We request that a corrective action plan (CAP) be developed by August 15, 2002 that focuses on noted deficiencies with an implementation or correction timeline. We also request that each of the co-permittees include the developed CAP and the progress thereof in their Storm Water Quality Management Plan and self-audit reports that they annually submit to the Principal Permittee.

We anticipate that co-permittees will continue to build the notable attributes of their programs that have been documented during the evaluation, and also to correct the deficiencies. We look forward to discussing with you the program evaluation report. Please call Ejigu Solomon at (213) 620-2120 if you have any questions.

Sincerely,

Dennis A. Dickerson
Executive Officer

Enclosure

cc: Thomas Huetteman, USEPA
Bruce Fujimoto, Storm Water Section, SWRCB

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Program Evaluation Report

Round 2- Programs of the Cities of Camarillo, Fillmore, Moorpark and Thousand Oaks

Ventura Countywide Storm Water Quality Management Program (Board Order No. 00-108; NPDES Permit No. CAS004002)

Executive Summary

In October 2001, LARWQCB staff, with assistance from Tetra Tech, Inc., through a USEPA contract, conducted the first round program evaluation in the Cities of Ojai, Oxnard, Santa Paula, and Simi Valley. In May, 2002, staff from the Los Angeles Regional Water Quality Control Board (LARWQCB) with the assistance of one staff from State Water Resources Control Board conducted a second round program evaluation of the Ventura Countywide Storm Water Quality Management Program (Program). The program evaluation for this permit term will conclude with round 3 consisting of the programs of the cities of Buenaventura, Port Hueneme and the program of Ventura County Flood Control District. The final round is planned to be performed in Fall 2002.

The purpose of the program evaluation was to determine the level of compliance with the Ventura County Municipal NPDES Permit. The evaluation teams reviewed the co-permittees compliance with the NPDES permit requirements and performance criteria and conducted an in-field verification of program implementation. The evaluation results of each round are specific to the co-permittees in that round, and are not intended to represent the countywide program as a whole or other co-permittees.

This report identifies program elements as adequate, deficient, or positive, and includes comments and suggestions for improvement when applicable. Program deficiencies are not necessarily permit violations, but represent areas of significant concern that must be corrected immediately. The co-permittees must prepare action plans in the coming months detailing how they plan to correct deficiencies and implement missing components. Positive attributes are indications of the co-permittee's progress and innovation in implementing a multifaceted program to address storm water issues.

Several elements of the co-permittees' programs were notable. Examples include:

- Adequate plan review procedures and storm water quality urban impact mitigation plan (SQUIMP) conditioning are in place in all four cities
- Industrial/commercial inspections by City of Thousand Oaks inspectors, and by Ventura County Environmental Health Department (VCEHD) inspectors are thorough and beneficial to the regulated community
- Public outreach programs and programs for residents are positive elements of storm water management in all four cities.

As in round 1, this program evaluation has also indicated that a lack of resources impedes full program implementation. The following program deficiencies were identified as the most significant:

- Moorpark needs to incorporate post-construction storm water regulations when the City's General Plan is updated
- Moorpark needs to prepare a written illicit connection and illegal discharge control (IC/ID) plan
- Amount of trash/debris removed from city catch basins needs to be recorded and categorized by the City of Moorpark
- The City of Fillmore must immediately start using LARWQCB approved checklist for industrial/commercial focused inspections
- The City of Thousand Oaks must ensure notices of intent (NOIs) are present in storm water pollution prevention plans (SWPPPs) at construction sites
- The City of Thousand Oaks must ensure bid documents for small capital projects have provisions for erosion and sediment control
- The City of Camarillo must develop a post-construction BMP maintenance scheduled inspection program
- City of Camarillo construction inspectors must conduct a more focused outreach, followed by enforcement, on concrete washout spills.

City parks are under the jurisdiction of special districts in at least two of the Ventura County cities, and therefore are not directly subject to the Program. The co-permittees and the Principal Permittee need to devise a plan to address storm water issues at parks as Public Agency Activity.

Finally, during our program reviews in both October 2001 and last month, we have observed implementation of many best management practices (BMPs), which have ranged from employee training at cities as well as at restaurant and industrial/commercial facilities, to plan review and oversight of new SQUIMPs (Stormwater Quality Urban Impact Plans) - to name only a few. We would like to take this opportunity to commend the Ventura County Flood Control District, as principal permittee, and the co-permittees on their significant efforts to implement storm water BMPs, and to partner with the Regional Board to protect water quality.

1.0 Introduction

1.1 Program Evaluation Purpose

The primary goal of the program evaluation was to determine the compliance status of selected co-permittees with conditions and requirements contained in the NPDES permit. Secondary goals included the following:

- Acquire data to assist during permit reissuance, and
- Identify and document unique elements that could benefit other Phase I and II municipalities

40 CFR 122.41 (i) and Part 6. H of the NPDES permit provide the authority to conduct the program evaluation.

The program includes twelve co-permittees with the Ventura County Flood Control District (VCFCD) serving as the Principal Co-permittee.

1.2 Permit History

The first Ventura municipal permit was issued in 1994. The current NPDES permit was issued on July 27, 2000, and is scheduled to expire on July 27, 2005. Thus, it is the second NPDES permit issued to the co-permittees under the storm water Phase I regulations.

1.3 Logistics and Program Evaluation Preparation

Before initiating the on-site program evaluation, LARWQCB and State Board staff conducted a review of available program materials. The goals of the review were (1) to gain greater knowledge of the existing program, permit requirements, and (2) to prepare for audit activities. The following materials were reviewed:

- Board Order 00-108, NPDES Permit No. CAS-004002, dated July 27, 2000.
- Evaluation Protocol provided by USEPA, dated April 15, 2002
- Long Beach Audit Report, dated August 24, 2001.
- Round 1 Ventura Audit Report, dated February 14, 2002.

The authority, scope, and schedule of the program evaluation were communicated to the co-permittees by a letter dated May 1, 2002. On May 14-16, 2002, LARWQCB staff with staff from State Water Resources Control Board conducted the program evaluation, using a team approach as shown below:

City of Camarillo

Ivar Ridgeway, Environmental Scientist
Carlos Urrunaga, Environmental Scientist
Matt Yeager, Associate Engineering Geologist

City of Fillmore

Enrique Loera, Water Resources Control Engineer
Matt Yeager, Associate Engineering Geologist

City of Moorpark

Sean Lee, Water Resources Control Engineer
Enrique Loera, Water Resources Control Engineer
Tracy Woods, Environmental Scientist

City of Thousand Oaks

Ejigu Solomon, Senior Engineering Geologist
Greg Gearheart, Water Resources Control Engineer

Upon completion of the evaluation, an out-brief was held with representatives of the co-permittees to discuss preliminary findings. During the discussion, the co-permittees were informed that the findings were to be considered preliminary pending further review.

1.4 Program Areas Evaluated

The following program areas were evaluated:

- Program management
- Program for residents and public education
- Program for industrial and commercial businesses
- Program for land development planning and construction
- Program for public agency activities
- Program for illicit discharge and illicit connection control

1.5 Program Areas Not Evaluated

The following areas were not evaluated in detail as part of this program evaluation:

- Monitoring program details
- Monitoring reports
- Other NPDES permits issued to the co-permittees
- Legal authority
- Inspection reports, plan review reports, and other relevant files. The program evaluation teams did not conduct a detailed file review to verify that all elements of the programs were being implemented as described. Rather, observations by the evaluation teams and statements from the co-permittees' representatives were used to assess overall compliance with permit requirements and performance criteria. A detailed file and plan review of specific programs may be included in a subsequent evaluation.

2.1 City of Camarillo

The fourth largest city in Ventura County, Camarillo is home to approximately 63,335 residents. Occupying just over 19 square miles of land, agriculture has played a major role in the historical development of Camarillo. Due to a moderate growth of its population, Camarillo is experiencing moderate construction activity, and has expanding industrial activity in the high tech and specialty products fields.

The following program elements were reviewed in the City of Camarillo, with areas of concern and positive attributes noted.

2.1.1 Evaluation of Programs for Public Information/Participation

Positive:

- The City of Camarillo's Storm Water Program is innovative in seeking solutions to problems. Examples include the following: (1) the City has installed pet waste receptacles in parks and public right-a-ways, and enacted a city ordinance against the improper disposal of pet waste; (2) educational materials are distributed by City staff to industries with significant potential to contribute pollutants to storm water, e.g. mobile detailers, carpet cleaning operations. (The City ties in storm water Best Management Practice (BMP) guidance with the issuance of business licenses, by distributing BMP information literature to businesses filing for a license). Countywide educational materials and surveys are also effectively distributed at festivals and other events.

2.1.2 Evaluation of Programs for Illicit Discharge and Improper Disposal Control

Positive:

- The City of Camarillo continuously updates its storm drain mapping system, and is making efforts to use geographic information system (GIS) for storm drain mapping in the near future. Camarillo utilizes numeric labeling of storm drains for identification. The City uses a work order database system for the tracking of calls reporting illicit connections/illicit discharges, and submits educational material to residents who are illicit dischargers. The City has made hazardous waste disposal readily available for the public (twice a month). The City has an adequate spill response system, a written IC/ID plan. In 2001, forty-eight ID incidents were reported to the City, and City staff responded to all incidents.

2.1.3 Evaluation of Programs for Industrial/Commercial Businesses

Positive:

- The City of Camarillo inspects the majority of auto repair facilities and industrial facilities annually. The city utilizes a VCEHD inspector who is very knowledgeable regarding the storm water pollution concerns of auto repair shops and associated facilities. The City has fifty auto services and two hundred food service facilities, and about 60% of these facilities have been inspected. The City's progression of enforcement actions is well thought out and effective.

2.1.4 Evaluation of Programs for Planning and Land Development

Adequate:

- The development/redevelopment planning process in the City of Camarillo is well managed. For example, the pre-construction/pre- site plan meeting allows potential problems to be identified early. Strong cooperation between the various departments involved in the planning process allows potential problems missed by one department to be discovered by another department before a project is approved and construction commences. Countywide flow and volume design criteria are used in conditioning projects, and there is a follow-up of the transition from planning to construction.

Deficient:

- Camarillo does not address maintenance inspections of private post-construction storm water controls. Maintenance inspections must be an integral part of planning and land development program.

2.1.5 Evaluation of Programs for Construction Sites

Positive:

- The City of Camarillo conducts daily inspections of active construction sites, currently numbering ten, with aggressive enforcement of storm water regulations, including the ability to issue stop-work orders. The City keeps thorough documentation of violations, for example, the inspection forms have a section to note verbal warnings issued in the field. The City utilizes innovative enforcement strategies to insure that construction sites remain in compliance. In addition to the City's standard enforcement methods, City inspectors use alternative enforcement actions, such as the cessation of routine building inspections until violations are corrected.

Deficient:

- Camarillo conducts daily inspections of active construction sites, but less frequent, more focused inspections may need to be periodically scheduled. To support this concern is the following example:
  During the audit, a Home Depot construction site was visited where we observed concrete material from apparent washout in an inappropriate washout area. Camarillo inspectors were unaware of this practice, in spite of daily inspections.

2.1.6 Evaluation of Public Agency Activities

Positive:

- The City of Camarillo has made a significant effort to make the public aware of its household hazardous waste disposal program. The City, in lieu of solely using chemical abatement for weed control, makes an effort to use mechanical abatement and mulching of slopes, to reduce pollutants in storm runoff.

- An independent special district, Pleasant Valley Recreation and Parks, has responsibility for the maintenance of City parks. The City needs to develop a plan to ensure that City parks fall under the Public Agency program of storm water.

Deficient:

- Although the City of Camarillo plans to pave the entire corporate yard, including areas that are currently gravel, the current concrete washout area needs improvement. The observed concrete washout does not have the capability to properly contain the volume of concrete wash water being generated.

2.2 City of Fillmore

Fillmore is located in central Ventura County on State Highway 126, north of the City of Moorpark, with a population of approximately 13,000. Land uses are primarily residential, with a few industrial and commercial areas and adjacent agricultural lands. The City has experienced recent growth, including residential and commercial developments, and one residential site is still under construction.

The following program elements were reviewed in the City of Fillmore, with deficiencies and positive attributes noted.

2.2.1 Evaluation of Program Management

Positive:

- *The City has a proactive attitude and seeks innovative approaches.*
  Fillmore has a small staff and several departments contribute to implementation of the storm water program. The City engineer has conditioned new developments with BMPs, such as biofilters, for storm water treatment since the early 1990's, and works to evaluate the effectiveness of these BMPs. Storm drain inlet stenciling has been accomplished in part through the use of the Boy Scouts. Two flood control basins have been retrofitted to retain and biologically treat dry weather flows from the storm drain system. Finally, the City's general plan is under revision and there are plans to include new language related to storm water management.

2.2.2 Evaluation of Public Information/Participation

Positive:

- The City is proactive in informing businesses about training opportunities. A local radio station sends out messages about environmental concerns and storm water interests. The County brochures are distributed at local festivals.

2.2.3 Evaluation of Programs for Industrial and Commercial Businesses

Positive:

- *Restaurant inspections were thorough.*
  The City contracts with OMI, a consulting company, that operates the City's wastewater treatment plant and conducts restaurant inspections. The inspector is thorough and also inspects grease traps or grease interceptors. There are sixty food services in Fillmore, and all facilities have been inspected at least once.

Deficient:

- There was not a complete inspection program for industrial facilities. Three different authorities (fire department, VCEHD, and Building & Safety) may inspect these facilities, but none of the inspections included specific storm water compliance checks. Currently the inspectors are using a checklist, but the checklist does not include storm water questions. During our site visit, the inspectors did not know what to look for regarding storm water. The program presently lacks focus and is not proactive in identifying potential non-filers. The City and its contractors must immediately use the checklist approved by LARWQCB and provided to co-permittees.

2.2.4 Evaluation of Programs for Planning and Land Development

Positive:

- All projects, except single family residential homes, are reviewed for storm water impacts (In 2001, six projects were reviewed.)
- Standard Conditions of approval include storm water treatment measures, and Special Conditions of approval include requirements for maintenance of storm water pollution prevention measures.

2.2.5 Evaluation of Programs for Construction Sites

Adequate:

- Plan reviewers check to see if a project has submitted an NOI to the State as part of standard conditions unless the project is smaller than five acres. Inspections of construction sites are conducted daily. Enforcement actions available to the inspectors include written notices of violations and stop work orders. Education measures for construction sites operators are on going as they negotiate conditions and as inspections take place.

2.2.6 Evaluation of Public Agency Activities

Positive:

- The City has recently moved its corporate yard to a new facility. The new facility will allow most materials and activities to be covered and not exposed to storm water. The site also includes biofilters for the runoff and interior discharges lead to a clarifier.

2.2.7 Evaluation of Programs for Illicit Discharge Control
Adequate:

- Suggestion for improvement:

  All reporting of IC/ID and follow-up should be more clearly documented and a more dependable record keeping system should be established. There were two reports of ID in 2001.

2.3 City of Moorpark

The City of Moorpark is located in eastern Ventura County; it is about 12 square miles in size and has a population of approximately 30,000. It is primarily residential, with limited commercial development and industrial activity. At this time, growth is moderate and construction activity is limited.

The following program elements were reviewed in the City of Moorpark, with positive, adequate, and deficient attributes noted.

2.3.1 Evaluation of Program Management
Suggestion for Improvement:

- *Improved data management is needed for all storm water associated programs.* The city would benefit from having at least its catch basins, construction sites, and businesses subject to the General Industrial Permit, entered into a database such as, Access. Information pertaining to these structures and facilities needed for record keeping, reports, and compliance could easily be obtained from one source. This would enable the City to more easily integrate information related to these structures and facilities with other storm water, community, and City programs. For example: debris removed from catch basins could be categorized and entered. This would provide information required for the Annual Storm Water Report and Assessment, and provide a more complete assessment of the city's waste stream, which would benefit the City's Source Reduction and Recycling Element.

2.3.2 Evaluation of Programs for Public Education
Positive:

- *The City works cooperatively with its neighboring cities to utilize resources.* The City coordinates with Cities of Simi Valley and Thousand Oaks to announce the dates of their individual and collective Household Hazardous Waste Collection Days.

- Moorpark produces a quarterly newsletter with names and numbers for the public to contact for storm water management information.

2.3.3 Evaluation of Programs for Industrial and Commercial Businesses

Adequate:

- Food service facility inspections by City staff is adequate (all 55 food services in the City have been inspected)

Deficient:

- *No storm water follow-up inspections.*
  The City has not been performing storm water inspections after receiving Hazardous Material inspection reports from the County Health Department.

2.3.4 Evaluation of Programs for Planning and Land Development

Positive:

- *Effective coordination among the City's Departments.*
  There is effective coordination between the City's Public Works Department and the Community Development Department. This has led to implementation of a pollution ordinance, review of all grading projects for post-construction storm water controls, a requirement for construction sites one acre and more to submit an NOI to the State, and planning procedures for preparing and reviewing environmental documents.

Deficient:

- *General Plan is not updated.*
  The City's General Plan has not been updated to reflect storm water related new development requirements. The General Plan was last updated in January 2001.

2.3.5 Evaluation of Programs for Construction Sites

Positive:

- *Proactive construction site inspections.*
  With an aggressive approach to performing storm water construction inspections, the City's inspectors are effective in the areas of enforcement and follow-up inspections. The City inspectors have a comprehensive understanding of all five construction sites with NOIs , including knowledge of site personnel, and the specific activities that have occurred and are occurring at construction sites.

- *Site superintendents are notified of training opportunities.*
  All site superintendents are notified of training opportunities when the City learns of these events so that they will have the opportunity to attend and implement the knowledge obtained at construction sites.

Deficient:

- *Sediment/Erosion Control*
  The City is not requiring construction sites to implement effective erosion control measures on all slopes within a site. Field inspections appear to focus on sediment control, not erosion control. At one of the two sites visited, it was evident by the observation of rills, that erosion control BMPs on all slopes within the site had not been implemented during the rainy season. At the present time, the only type of erosion control BMP that the City requires is a vegetative cover, which is not effective until the vegetation is permanently established. The City needs to revise its construction inspection activities to ensure that both proper erosion and sediment control BMPs are installed and maintained on all construction sites.

2.3.6 Evaluation of Public Agency Activities

Adequate:

- *The City's Department of Public Works has a Master Plan of Drainage report.*
  All of the City's catch basins and storm drains are mapped, numbered and stenciled. Catch basins are inspected each year and cleaned as needed on a schedule (at least one time each year prior to the wet season).

- *There is an effective and organized street sweeping procedure/plan.*
  The City streets have been broken into zones and then grouped based on their need for cleaning. Grouped zones are cleaned every week or bi-weekly; beginning July 1 every street will be swept every week, above and beyond the once a week permit requirement for high traffic areas.

Positive:

- *An innovative BMP has been designed for the City's waste bin in its yard.*
  An awning has been designed and is currently being built to cover the maintenance yard's roll-off waste bin.

Deficient:

- *Debris collected from catch basin cleaning is not categorized or recorded.* Debris collected from catch basins is not categorized for the City's input into the County's Annual Storm Water Report and Assessment. Currently, catch basin debris is collected as an aggregate and brought to a landfill for disposal, and the disposal receipt is submitted to the City for a record of weight. Cleaning and maintenance of catch basins is not entered into a database, only recorded and tracked by paper.

- *The City's maintenance yard has no BMPs on-site.* The maintenance yard needs to have BMPs on-site to ensure that water from the washing of its three trucks does not leave the yard. The City has had 23 months to comply with permit requirements for corporate yards to install BMPs. However, it's made no progress to date, and faces a deadline of July 27, 2002 to have BMPs fully in place.

- *The City's vector control staff that are applying pesticides need to be certified.* The City must ensure that their vector control staff applying pesticides to waters within the city including the Ventura County's Flood Control District's channels have been certified by the California Department of Food and Agriculture, or are under the direct supervision of a certified pesticide applicator. It is recommended that the City consider seeking coverage and the new General Permit for pesticide application on waterways.

2.3.7 Evaluation of Programs for Illicit Discharge Control

Positive:

- *The City has a collection center for used oil.* A gas station in the City has been certified as used oil collection center for its residents to use. The City gives out oil pans that can be brought into its used oil collection center for recycling.

Adequate:

- The County's public outreach material is distributed over the counter and at special events.

- The City's spill response and prevention plan appears to be adequate.

Suggestion for Improvement:

- The City's plan needs to be written down so that all City employees can know what to do in case of an emergency when key staff are not available.

- *It does not appear that the City has a procedure/plan for illicit discharges or connections.*
  Although the City reported responding to 14 illicit discharges in 2001, the City needs to write down its procedure/plan for illicit discharge and illicit connections to help its staff in the detection, investigation and remedy of illicit discharges and connections.

2.4 City of Thousand Oaks

Thousand Oaks is located in southwest Ventura County and is home to approximately 121,000 residents. The following storm water management program elements were reviewed with areas of adequacy, deficiency and positive attributes noted.

2.4.1 Evaluation of Program Management

Adequate:

- The Resource Management Division of the Public Works Department is the primary City department that has responsibility for storm water management. Resource Management organizes a storm water program that is exemplary. However, other departments that have responsibility for projects that potentially could impact storm water, such as the Departments of Wastewater Treatment, Capital Projects, and Development, may benefit from a more enhanced coordination spearheaded by Resource Management.

Positive:

- The network of "ex-storm water staff" that are now in key positions in other City departments is found to be a positive attribute. For example, the person in charge of construction inspectors used to be the plan reviewer for storm water requirements. Likewise, the person who is now the chemist (and in charge of the SWPPP) at the wastewater treatment plant used to be the industrial inspector. This network building significantly enhances the ability of Resource Management Division to positively influence all affected departments.

2.4.2 Program for Industrial/Commercial Businesses

Positive:

- The industrial/auto service/restaurant education and site inspection program takes place in conjunction with hazardous waste and pretreatment inspections. The City's inspections are complimented in some cases by VCEHD inspections. During the audit, we accompanied City inspectors on an auto service, restaurant, and an UPS facilities inspections. The inspections were detailed, and very helpful to the regulated community. The City's "Storm Water Quality Management Regulations" dated October 1999 explicitly require compliance with local ordinances. Immediately after the audit, the City forwarded to the Regional Board a list of non-filers in the City. This information was not due until July 27, 2002, and has been helpful to the Regional Board in expediting non-filer enforcement.

2.4.3 Program for Planning and Land Development

Adequate:

- The City has a systematic database containing information on project location, size, and post-construction best management practices (BMPs). The Plan Check group or the Planning Commission determine projects needing to be conditioned for SQUIMP. Generally, unless a project is a tenant improvement, most development and redevelopment greater than 500 square feet is potentially subject to conditioning. A pre-construction site plan review conference is mostly required, and County-adopted flow and volume design criteria are uniformly applied. Seventeen projects were conditioned for SQUIMPs in 2001.

- Currently, City staff verify field implementation of approved projects and BMPs. The City has the option of holding bond money on projects that are at variance with approved plans. In the future, the City will need to augment staff to verify and enforce scheduled maintenance of BMPs. The City database should also add a field for BMP maintenance information, and should include precise coordinates for future location of post-construction BMPs using GIS.

2.4.4 Construction Site Evaluation

Deficient:

- A City/Caltrans ramp improvement project at Borchard Rd. lacked a copy of the NOI at the site. Also, a concrete washout, decommissioned after the audit, was located right by a storm drain inlet making a spill very likely to impact receiving waters.

- At Olson Rd., approximately half a mile of sewer line was being installed. The bid document did not have adequate erosion and sediment control provisions.

2.4.5 Evaluation of Public Agency Activities

Adequate:

- The maintenance yard contains street maintenance, landscape, purchasing, utilities, and fleet services, and is exceptionally clean and well maintained. Scraps of metals and pipes exposed to precipitation outside without a cover were either to be covered, or placed inside. The Hill Canyon Treatment Plant, which is currently under expansion, has an adequate SWPPP. A few locations at the plant need signage to solidify storm water management awareness. Also, the City should consider designing an emergency sewage-overflow BMP that requires no mechanical or electrical control. The site is suitable for allowing an overflow at any point on the property to gravity flow on the surface or in the MS4 to the flow equalization basins (FEBs)-bypassing the creek, which runs directly through the middle of the plant. This might be useful for a large overflow that is not immediately noticed or an electrical failure that inhibits staff' ability to quickly turn valves and start pumps to move the runoff to this downstream point.

- Two independent special districts maintain City parks: Conejo Recreation and Parks District and Conejo Open Space Conservation Agency. Neither of these entities is a co-permittee, nor has a memorandum of understanding (MOU) with the City on storm water issues. The City needs to develop a plan to ensure City parks fall under the Public Agency program of storm water management.

2.4.6 Evaluation of Program for Illicit Connection and Illicit Discharge (IC/ID)

Positive:

- In anticipation of the July 2002 deadline, Thousand Oaks has prepared a list of fifteen locations for illegal dumping sign postings at designated access points. All city outfalls are mapped, and the City has a written plan and manual on IC/ID. The City has also an adequate spill response system, with spill containment supplies. Thousand Oaks breaks down illicit discharges by who reports them and by source. For 2000-01, construction activities accounted for 36% of all illicit discharges followed by vehicle/equipment leaks at 19%. One hundred nineteen illicit discharge incidents were reported for the year.

2.4.7 Program for Residents/Public Education

Positive:

- In addition to distributing Countywide outreach materials, the City has prepared and distributes its own educational materials, such as the "*Environmental Program Guide, 2002.*" Using website hits, school appearances, newspaper distribution and newsletters, the City tracks its allotted impressions per permit requirements.
- The City has an annual compost work shop day, a community enhancement program where grants are awarded to non-profit groups, and a neighborhood/community cleanup day. Also, Thousand Oaks has environmental programs that contribute to improved water quality, such as electronics collection, household hazardous waste collection, business hazardous waste collection, free bulky item pick up and a free landfill day. Most of these are actions above and beyond current permit requirements.

3.0 Conclusion

The evaluation teams have gained valuable knowledge about storm water program implementation. Co-permittees have made progress over the last decade in improving storm water program implementation. However, there is room for improvement that can be accomplished by rectifying noted deficiencies and implementing required changes.

For the remainder of the permit term, we will be focusing on criteria that show how this improvement in program implementation has translated into water quality improvement.

We trust that the co-permittees will immediately focus on correcting the deficiencies and inadequacies indicated in this report.

California Regional Water Quality Control Board
Los Angeles Region
Over 50 Years Serving Coastal Los Angeles and Ventura Counties
Recipient of the 2001 *Environmental Leadership Award* from Keep California Beautiful

Winston H. Hickox
Secretary for Environmental Protection

Gray Davis
Governor

320 W. 4th Street, Suite 200, Los Angeles, California 90013
Phone (213) 576-6600 FAX (213) 576-6640 - Internet Address: http://www.swrcb.ca.gov/rwqcb4

December 6, 2002

Sally Coleman
Ventura County Flood Control District
800 South Victoria Avenue
Ventura, CA 93009-1600

THIRD AND FINAL ROUND PROGRAM EVALUATION REPORT FOR THE VENTURA COUNTYWIDE MUNICIPAL STORM WATER PERMIT (BOARD ORDER NO. 00-108, NPDES NO. CAS004002)

Dear Ms. Coleman:

From November 12 to November 15, Los Angeles Regional Water Quality Control Board (LARWQCB) staff conducted an evaluation of the Ventura Countywide Storm Water Quality Management Program. The purpose of the program evaluation was to determine the level of compliance with the permit requirements of Order No. 00-108. The co-permittees whose programs were evaluated were the Cities of Port Hueneme and Ventura, and the County of Ventura.

Please find attached an Evaluation Report summarizing the results of the evaluation. Throughout the evaluation, our three teams were grateful for the cooperation on the part of all the staff in the various departments of the three co-permittees. As expected, the evaluation has shown areas of programmatic strength that need to be maintained and enhanced, and deficiencies that need to be immediately addressed. We request that a corrective action plan (CAP) be developed by **January 30, 2003** that focuses on noted deficiencies with an implementation or correction timeline. We also request that each of the co-permittees include the developed CAP and the progress thereof in their self-audit reports that they annually submit to the Principal Permittee and in the Storm Water Quality Management Plan.

We anticipate that the co-permittees will continue to build the notable attributes of their programs that have been documented during the evaluation, and also to correct the deficiencies. Please call Ejigu Solomon at (213) 620-2120 if you have any questions.

Sincerely,

Dennis A. Dickerson
Executive Officer

Enclosure

cc: Kathi Moore, Clean Water Act Compliance Office, USEPA
Bruce Fujimoto, Storm Water Section, SWRCB

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December 6, 2002

Mr. Robert L. Hunt, City Manager
City of Port Hueneme
250 N. Ventura Road
Port Hueneme, CA 93041

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December 6, 2002

Ms. Vicki Musgrove
City of San Buenaventura
P.O. Box 99
Ventura, CA 93301

THIRD AND FINAL ROUND PROGRAM EVALUATION REPORT FOR THE VENTURA COUNTYWIDE MUNICIPAL STORM WATER PERMIT (BOARD ORDER NO. 00-108, NPDES NO. CAS004002)

Dear Ms. Musgrove:

From November 12 to November 15, Los Angeles Regional Water Quality Control Board (LARWQCB) staff conducted an evaluation of the Ventura Countywide Storm Water Quality Management Program. The purpose of the program evaluation was to determine the level of compliance with the permit requirements of Order No. 00-108. The co-permittees whose programs were evaluated were the Cities of Port Hueneme and Ventura, and the County of Ventura.

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Sincerely,

Dennis A. Dickerson
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Enclosure

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Program Evaluation Report

Programs of the Cities of Port Hueneme, Ventura and the County of Ventura

Ventura Countywide Storm Water Quality Management Program (Board Order No. 008; NPDES Permit No. CAS004002)

Executive Summary
Over the course of a year, LARWQCB staff, with assistance of staff from 2 other agencies, have conducted a municipal audit of the Ventura Countywide Storm Water Quality Management Program. In October 2001, LARWQCB staff, with assistance from Tetra Tech, Inc. through a USEPA contract, conducted the first round program evaluation in the Cities of Ojai, Oxnard, Santa Paula, and Simi Valley. In May 2002, staff from LARWQCB, with assistance of one staff from State Water Resources Control Board, conducted a second round program evaluation. The third and final round of audit was conducted from November 12 through 15, 2002 in the Cities of Port Hueneme and Ventura, and in the County of Ventura.

The purpose of the program evaluation was to determine the level of compliance with the Ventura Countywide Municipal NPDES Permit. The evaluation teams reviewed the co-permittees' compliance with the NPDES permit requirements and performance criteria and conducted an in-field verification of program implementation. The evaluation results of each round are specific to the co-permittees in that round, and do not represent the countywide program as a whole or other co-permittees.

This report identifies program elements as positive, adequate, or improvement necessary, and includes comments and suggestions where applicable. Positive attributes are indications of the co-permittees' progress and innovation in implementing a multifaceted program to address storm water issues. Where we determine that improvements are needed to specific programs, such determinations do not necessarily represent permit violations, but rather are areas of significant concern that must be corrected immediately. The co-permittees must prepare action plans in the coming months detailing how they plan to make program improvements and implement missing components.

A few elements of the co-permittees' programs were notable. Examples include:

- Development Planning: Adequate plan review procedures and storm water quality urban impact mitigation plan (SQUIMP) conditioning are in place for all three co-permittees.

- Inspections: Two of the municipalities contract with the Ventura County Environmental Health Department (Health Department) to inspect restaurants and automotive service facilities. The inspection team at the Health Department is showing strong leadership in its approach to ensuring compliance, through thorough

inspections and an ability to clearly communicate storm water problems and cost-effective BMP solutions to operators at restaurants and automotive service facilities.

- Public Outreach: Educational programs for residents are positive elements of storm water management by all three co-permittees.

As in rounds 1 and 2, this program evaluation has also indicated that a lack of resources impedes full program implementation, such as ensuring maintenance of post-construction best management practices (BMPs). The following program shortfalls were identified as the most significant:

- As the details will show for each co-permittee, construction site compliance needs more focused attention by all co-permittees.
- The City of Port Hueneme needs to prepare a written illicit connection and illegal discharge (IC/ID) control plan. The City of Ventura needs to finalize its draft plan immediately.
- The County of Ventura must ensure that piles of scrap metals and other equipment at its maintenance yards are covered and/or contained, so that exposure of pollutants to storm water is prevented or minimized.
- The County of Ventura must train staff of the capital projects group (who are in the water resources and engineering services section about their role in controlling storm water pollution).

Finally, during our program reviews over the last year, we have observed upgraded best management practices (BMPs) and improved coordination among city/county departments. We hope through the feedback of these audit reports, the co-permittees have been able to identify the areas of their programs that need improvement. To that effect, we are encouraged by the quick compliance with CAPs in past audits.

We would like to take this opportunity to commend the Ventura County Flood Control District, as principal permittee, and the co-permittees on their significant efforts to implement storm water BMPs, and to partner with the Regional Board to protect water quality.

1.0 Introduction

1.1 Program Evaluation Purpose

The primary goal of the program evaluation was to determine the compliance status of selected co-permittees with conditions and requirements contained in the NPDES permit. Secondary goals included the following:

- Acquire data to assist during permit reissuance; and
- Identify and document unique elements that could benefit other Phase I and II entities

40 CFR 122.41 (i) and Part 6. H of the NPDES permit provides the authority to conduct the program evaluation.

The program includes twelve co-permittees with the Ventura County Flood Control District (VCFCD) serving as the Principal Co-permittee.

1.2 Permit History

The first Ventura municipal permit was issued in 1994. The current NPDES permit was issued on July 27, 2000, and is scheduled to expire on July 27, 2005. Thus, it is the second NPDES permit issued to the co-permittees under the storm water Phase I regulations.

1.3 Logistics and Program Evaluation Preparation

Before initiating the on-site program evaluation, LARWQCB staff conducted a review of available program materials. The goals of the review were to (1) gain greater knowledge of the existing program, permit requirements; and (2) prepare for audit activities. The following materials were reviewed:

- Board Order 00-108, NPDES Permit No. CAS004002, dated July 27, 2000
- Evaluation Protocol provided by USEPA, dated April 15, 2002
- Ventura Countywide Storm Water Quality Management Program Annual Report for Permit Year 2, Reporting Year 8, dated September 30, 2002
- Long Beach Audit Report, dated August 24, 2001
- Round 1 Ventura Audit Report, dated February 14, 2002
- Round 2 Ventura Audit Report, dated June 28, 2002

The authority, scope, and schedule of the program evaluation were communicated to the co-permittees by a letter dated October 28, 2002. On November 12-15, 2002, LARWQCB staff conducted the program evaluation, using a team approach as shown below:

City of Port Hueneme

Kristie Chung, Water Resources Control Engineer
Enrique Loera, Water Resources Control Engineer

City of Ventura

Matt Yeager, Associate Engineering Geologist
Jeff Mack, Environmental Specialist

County of Ventura

Ejigu Solomon, Senior Engineering Geologist
Sean Lee, Water Resources Control Engineer

Upon completion of the evaluation, an out-brief was held with representatives of the co-permittees and the various departments to discuss preliminary findings. During the discussion, the co-permittees were informed that the findings were to be considered preliminary pending further review.

1.4 Program Areas Evaluated

The following program areas were evaluated:

- Program management
- Program for residents and public education
- Program for industrial and commercial businesses
- Program for land development planning and construction
- Program for public agency activities
- Program for illicit connection and illegal discharge control

1.5 Program Areas Not Evaluated

The following areas were not evaluated in detail as part of this program evaluation:

- Monitoring program
- Monitoring reports
- Other NPDES permits issued to the co-permittees
- Storm water budgeting and reporting
- Legal authority
- Inspection reports, plan review reports, and other relevant files. The program evaluation teams did not conduct a detailed file review to verify that all elements of the programs were being implemented as described. Rather, observations by the evaluation teams and statements from the co-permittees' representatives were largely used to assess overall compliance with permit requirements and performance criteria.

A detailed file review and plan review of specific programs along with other important details may be included in a subsequent evaluation.

2.1 City of Port Hueneme

Port Hueneme is located south of Oxnard with a population of 23,500 people. The city is fully contained by Oxnard and the Pacific Ocean, and it is almost completely developed. Although there are only 3 industrial storm water permittees in the City, this number is not indicative of the level of industrial activity, as the naval operations are not yet subject to storm water permit requirements, and as the entire port area is enrolled under the general permit as only 1 entity.

The following elements were reviewed in the City of Port Hueneme, with positive attributes and deficiencies noted.

2.1.1 Evaluation of Programs for Public Outreach/Participation

Positive:

- In addition to distributing Countywide outreach materials, the City prepares and distributes a biannual magazine that includes phone numbers for household hazardous waste collection sites, information on electronics and construction and demolition debris collection.
- The City is also looking into modifying County educational tools such as "Pollution Prevention House" with "The TidePool Cruiser" which is a tool that targets children up to the junior high level.
- The City's public works department has a weekly standby schedule in case of an after-hour emergency. Residents are able to call public works, city hall or the police department, and they contact the employee on duty.

2.1.2 Evaluation of Programs for Industrial and Commercial Businesses

Adequate:

- There are 3 industrial, 2 automotive and 34 food service facilities in the City. These are inspected once a year and all information is entered into a database.

Improvement Needed:

Although facilities are inspected once a year, the City must consider additional follow-up for those facilities that warrant further inspections. To support this concern are the following examples:

- During the audit, Baker's Square was visited. The auditors observed: Evidence of prior wash-down around the back entrance of the restaurant, the area around the trash

A017830

dumpsters and around the opening to the grease interceptor was greasy, a milky, white puddle was observed around the opening to the grease interceptor.

- During the last city visit a few months ago, the manager was going to organize a training session for his employees; however, when auditors spoke with the assistant manager during the audit, he was unaware of any training.

- An automotive facility was also visited. The auditors observed material stored outdoors, which seemed to have been stored in the same area for a long time. The metal was rusty and some fluid drums were stored without proper cover and/or containment.

2.1.3 Evaluation of Programs for Planning and Land Development

Adequate:

- The City has set SQUIMP conditions that apply to development/redevelopment projects. Also, as part of the review process, further conditions may be included to ensure compliance with applicable Permits.

- Project plans must incorporate the requirements of the SQUIMP, Ventura County Municipal Storm Water NPDES permit (Board Order No. 00-108; NPDES Permit NO. CAS004002) and PHMC Sections 7454. (a). (5). Structural or treatment control BMPs shall meet the design standards referred to in the Ventura County Storm Water Quality Management Program Technical Guidance Manual. Proof of intent to maintain BMPs is required, which includes the developer's signed statement accepting responsibility for all post construction BMPs until the time the property is transferred. However, as in most programs of Ventura co-permittees, maintenance follow-up is an issue that needs to be addressed.

2.1.4 Evaluation of Programs for Construction Sites

Adequate:

- The City of Port Hueneme conducts daily inspections of 2 active construction sites. The City's enforcement ranges from verbal warnings, stop-work orders and as a last resort, the City has the ability to complete the work for the contractors and charge them directly. However, this final step has never been done, due to the contractors' compliance with Permit requirements.

Improvement Needed:

- No educational materials are distributed for construction operators on erosion and sediment control BMPs, waste management/material handling BMPs, and over all storm water pollution prevention plan requirements.

2.1.5 Evaluation of Public Agency Activities

Positive:

- Overhead coverage is provided for all materials stored outside of the yard. The City has a storm water pollution control plan on-site for its maintenance yard.

Adequate:

- The City has an effective and organized street sweeping procedure/plan. The City streets have been broken into zones and are cleaned either weekly or bi-weekly, depending if it is a low traffic or high traffic area.

- All catch basins are inspected quarterly and cleaned annually in October, before the rainy season. If during any quarterly inspection, the catch basin were more than 40% full, the catch basin would be cleaned at that time.

2.1.6 Evaluation of Program for Illicit Connection/Illegal Discharge Control

Adequate:

- There is an effective mapping system for storm drainpipes, outfalls and storm drain inlets. These maps are available on all road vehicles.

- Spill containment kits are found in each utility vehicle as well as all refuse trucks in case of hydraulic oil spill.

Improvement Needed:

- All non-storm water discharges are prohibited under city ordinance 638, the City needs to make sure that it is strictly enforced. See subsection 2.1.2., above.

- The City lacks a formal written procedure for illicit connection/illegal discharge control.

- During the audit, an illegal discharge was observed at the city's maintenance yard. The interceptor on-site overflowed while an emergency pump was being tested during its regular scheduled maintenance. The slightly foul smelling water was overflowing out of the front driveway, onto the street, and into the storm drain, located about 20 feet south of the driveway. Once the inspectors observed the discharge, the city called the wastewater division who came to the yard with the combination truck to pump out the interceptor. The City needs to replace its old interceptor.

2.2 City of Ventura

The City of Ventura is located in northwest Ventura County, and has a population of 102,300. It covers an area of 20.5 square miles.

2.2.1 Evaluation of Programs for Public Outreach/Participation

Positive

- The City has developed a wide variety of outreach materials in addition to those provided through the principal co-permittee. Materials are provided to the public through home and garden shows, police events, county fairs, chamber of commerce events, and in a cable television show. Storm water information was also distributed by the trash pickup company in the billing process, and a column called "Ask the Director" is run weekly in the *Ventura County Star* dealing with environmental issues.

- The City has outreach targeted to children in elementary schools (especially 2nd, 3rd and 5th grade), including a "pollution prevention" house, and a staff member that visits schools as "Captain Hydro". The City has also posted storm water signs near the beach, provided oil recycling information to boaters, developed an outreach program for horse manure management, and spent $22,000 on publicly available "mutt mitts" for control of dog waste. The City has also fostered volunteer involvement in biological monitoring of the Ventura River watershed.

2.2.2 Evaluation of Public Agency Activities

Positive

- Staff at the corporate yard are knowledgeable and demonstrated a strong commitment to effective program implementation.

- The City has a comprehensive map of its MS4, including a numbering system for catchbasins. All catchbasins are inspected annually and cleaned when they are at least 40% full of trash by an independent contractor, as required by the permit. The City is developing a priority list of "high polluter" catchbasins that may require more frequent attention.

- The street sweeping program provides more frequent sweeping than required by the Permit for moderate traffic areas (sweeping is done 12 times a year versus the permit requirement of 6 times a year). The City meets permit requirements for high traffic in downtown areas by sweeping once a week.

- The corporation yard is well equipped with storm water BMPs. Extensive overhead coverage has been provided for the fueling station, equipment storage and maintenance and for storage of hazardous materials. There are two wash stations at two locations. Several insert-type-filtering devices have been installed in storm drain inlets at the yard, and these are being evaluated for maintenance requirements. An exterior storm drain inlet protection device has also been installed at several inlets and is being evaluated.

- The City has implemented an Integrated Pest Management Plan for all public parks and landscaped areas. Pesticide use is minimal and innovative approaches are encouraged.

Suggested Improvement:

- Minor soil erosion was observed from roof drain outfalls and on one slope along the access road to the waste disposal area. The City has already ordered a fabric blanket to protect the slope, but the roof drains need to be modified to minimize the soil erosion.

- One maintenance staff person expressed a reluctance to report illegal discharges observed in the field in the course of his maintenance activities. We suggest that the City conduct focused training regarding staff responsibilities for reporting illegal discharges.

2.2.3 Evaluation of Programs for Planning and Land Development

Adequate

- All required development projects are reviewed and conditioned for storm water quality as specified in the SQUIMP.

- Standard conditions of approval require compliance with the VCSQMP, including SQUIMP requirements where applicable. A maintenance plan for storm water quality BMPs is also required. However, as in most programs of Ventura co-permittees, maintenance follow-up is an issue that needs to be addressed.

- Proposed projects receive a multi-level review, including pre-application and development advisory committee meetings. Pre-construction meetings, usually at the development field site, are also required.

- The General Plan for the City is currently under revision, and storm water quality considerations are being incorporated into the Plan where appropriate.

2.2.4 Evaluation of Program for Construction Practices Compliance

There are about 22 construction sites in the City, only 7 of which are 5 acres or greater. Developers at each of these 7 sites had filed Notice of Intent (NOIs).

Improvement Needed:

- The frequency and effectiveness of construction inspections are not adequate as a projects enter a mature phase of brick and mortar activity. Two large construction sites for residential housing were observed by the team to be in non-compliance with the General Construction Activity Storm Water Permit. The City had issued a series of progressive enforcement notices, but a referral to the Regional Board for additional inspection presence had not been initiated. Effective pre-construction plan screening is not fully supplemented with cross-trained personnel during the mature phase of activities.

2.2.5 Evaluation of Program for Industrial and Commercial Businesses

Positive

- The City has made a strong effort to develop a comprehensive list of facilities and create a database for inspection and follow-up. All targeted facilities are visited and notified of NPDES requirements. About 36 non-filers have been identified, provided outreach materials, and referred to the Regional Board.

- The inspection staff were very knowledgeable and conducted thorough inspections of an auto repair facility, a restaurant and an industrial facility as part of the audit. The industrial facility was chosen by the audit team and the City had no prior knowledge.

2.2.6 Evaluation of Program for Illicit Connection/Illegal Discharges and Improper Disposal

Adequate

- The required mapping of the MS4 is complete, and is available on a GIS. A prohibition exists for illegal discharges, and field screening is on going. Investigation procedures are in place as a draft form, and revisions may be forthcoming. Sewage system overflow, and spill response and prevention plans, are in effect. Public awareness and reporting programs are in place. A strong used oil and filter collection program is in operation City wide. Spill sorbents are carried in inspectors' trucks. Discharges from improperly designed BMPs are treated as illegal discharges, and corrected.

2.3 County of Ventura

The County of Ventura encompasses 1,873 square miles, and is bordered to the west and southwest by 43 miles of the Pacific Ocean. The County's population totals 742,000; however, most residents live in one of the County's 10 incorporated cities, with only 86,873 residents in the unincorporated areas. Growth continues in many of these unincorporated areas, as evidenced by a high level of construction activity.

The scope of this portion of the audit was limited to the County's management of storm water in the unincorporated areas. The Ventura County Flood Control District has assumed some limited responsibility for storm water management in unincorporated Ventura County, while most responsibility lies with other County departments.

The following program elements were reviewed in the County of Ventura, with areas of concern and positive attributes noted.

2.3.1 Evaluation of Program for Public Outreach/Participation

Positive:

- The County provides effective and innovative storm water program education to the public. Examples of the County's strengths include: (1) distribution of a total of 3,760 educational materials at festivals and other events; (2) promotion of educational radio scrips and essay contests for school children; and (3) data management for recording and tracking numbers of distributed outreach materials is efficient.
- The County has one full time, dedicated employee performing environmental outreach.

2.3.2 Evaluation of Program for Illicit Connection/Illegal Discharge and Improper Disposal Control

Adequate:

- The County has a clear set of written procedures (Illicit Discharge/Illegal Dumping Program and Response Protocol) in place for spill response and prevention. The Risk Management Department in the County has a contract with a private company, Black Gold, to clean up all spills.
- The Mitigation Section recently reported to the Flood Control District an illicit connection discharging into a County open channel at a food processor/grower site. Flood Control staff took prompt action to correct the violation, and the audit team witnessed the corrective action in progress.
- In 2002, a total of 15 IC/ID incidents were reported to the County and County staff responded to all incidents.

Improvement Needed:

- The County does not have a map of storm drainpipes, outfalls, and storm drain inlets.

2.3.3 Evaluation of Program for Construction Sites

Positive:

- There are currently 4 large construction sites (five acres or greater) and about 150 small sites. The permit requires the co-permittee to inspect sites with storm water pollution control plans for storm water quality requirements a minimum of once during the rainy season. However, in 2002, the County conducted approximately 128 inspections of construction sites, issued two Field Memos, 12 Non-Compliance letters, and two Stop Work Notices with thorough documentation of violations. The County holds routine pre-construction site meeting with appropriate construction site engineers discussing storm water BMPs to ensure that construction sites remain in compliance.

Improvement Needed:

During the audit, the evaluation team visited Skylark Investment site in Malibu, Pardee construction site in Oak Park, and the County's capital project site, Juvenile Justice Complex in El Rio. The Pardee site was chosen by Regional Board staff.

- At the Pardee site, effective erosion control BMPs and housekeeping practices for a few exposed slopes and concrete wastes were not in place. But, overall, the site has shown significant improvement when compared with compliance problems observed by Regional Board staff in the past..

- At the Skylark Investment site, effective erosion and sediment control BMPs were not in place, and a concrete washout station was not effective. Jutte netting ordered for slope stabilization was reportedly delayed due to the recent port strike, and a pile of jutte netting waiting to be used was observed by the audit team. Consequently, adequate controls are not in place for this rainy season.

- At the Juvenile Justice Complex site, trash, poor housekeeping practices for concrete wastes, and ineffective storm drain inlet protection BMPs were observed. In addition, the County inspector at the site has not been properly trained in storm water regulations and BMPs. The Engineering Services Division, which has oversight over capital projects, currently has seven capital projects in the County. Due to time constraints, the audit team was able to visit two completed linear projects and the on going Juvenile Justice Complex site. The County will need to schedule focused inspections and should consider weekly inspections, and provide needed training for capital projects inspectors.

2.3.4 Evaluation of Program for Planning and Land Development

Positive:

- The development/redevelopment planning process in the County is well managed through the database system of Land Development Projects conditioned by VCFCD. During project conditioning for SQUIMP, the County identifies those industrial/commercial projects that need to apply for the State General Industrial Permit and notifies them of the requirement. There is adequate coordination between the Planning Division and Flood Control, which has resulted in an efficient project conditioning system. However, as in most programs of Ventura County co-permittees, BMP maintenance follow-up is an issue that needs to be addressed.

2.3.5 Evaluation of Program for Industrial/Commercial Business

Positive:

- The County utilizes a geographic information system (GIS) to locate numerous non-filers, and distributes storm water education outreach materials. The County referred 17 non-filer industrial sites to the Regional Board. The County utilizes VCEHD inspectors who are very knowledgeable regarding storm water pollution concerns at automotive services and restaurants. In 2002, the County inspected 44 automotive facilities and 6 restaurants, completing 100% of its target.

2.3.6 Evaluation of Public Agency Activities

Adequate:

- The County has a written protocol for Pesticides, Fertilizers, and Herbicides application in place and the Storm Water Pollution Control Plan (SWPCP) was thoroughly prepared and available at the site.

Positive:

- The Pollution Prevention Center managed by the County accepts an average of 8,000 pounds of waste for recycling per event from residents and a few small businesses. There were about nine such events in 2001. The center serves residents in the Cities of Ojai, Fillmore, and Santa Paula.

Improvement Needed:

- During the audit, the evaluation team visited the El Rio Corporation Maintenance Yard. This yard houses fleet administration, parks, road maintenance, information systems, flood control, and weights and measures. The fueling and wash stations are properly covered and well managed. However, the audit team observed a few piles of exposed rusted metals and one painting area without effective structural BMPs. The smaller maintenance yard at Moorpark has also some piled metal without overhead coverage. Effective structural BMPs must be implemented at both maintenance yards for preventing storm water contact with potential pollutant sources.

6.0 Conclusion

We believe both the co-permittees and Regional Board staff have gained valuable knowledge about storm water program management over the course of the last three municipal audits. Based on our experience, we see effective storm water program management in those cities or county programs where there is an adequate level of coordination between and across departments. This departmental coordination includes training, joint inspections and case referrals.

The Ventura County storm water management program has come a long way. One challenge for the remaining part of this permit term and beyond is some elements of the planning development program. Flow and volume design criteria are uniformly applied in all co-permittee programs in conditioning projects. However, as pointed out at the out-brief of the third audit, there are a few challenges remaining. Determining the appropriateness of BMPs for drainage size, soil types, target pollutants and the likes are the future challenge. The State BMP Task Force's upcoming documents will surely be a resource in this regard. Ensuring approved BMPs are regularly maintained is another challenge that needs immediate attention.

We hope that together we will continue to make improvements in implementing the program and protecting water quality.

VENTURA COUNTYWIDE STORMWATER QUALITY MANAGEMENT PROGRAM

REPORT OF WASTE DISCHARGE

PREPARED BY VENTURA COUNTY WATERSHED PROTECTION DISTRICT

JANUARY 2005

A017840

Ventura Countywide Stormwater Quality Management Program

Participating Agencies

Camarillo

County of Ventura

Fillmore

Moorpark

Ojai

Oxnard

Port Hueneme

San Buenaventura

Santa Paula

Simi Valley

Thousand Oaks

Ventura County Watershed Protection District

January 26, 2005

Mr. Jonathan Bishop
California Regional Water Quality Control Board
Los Angeles Region
320 W. 4th Street
Los Angeles, CA 90013

Subject: **Submittal – Report of Waste Discharge**
Application of Renewal of the Municipal NPDES Permit

Dear Mr. Bishop:

NPDES Permit CAS004002 issued on July 27, 2000 requires submittal of a Report of Waste Discharge (ROWD) in accordance with Title 23, California Code of Regulation, not later than 180 days in advance of permit expiration. The Ventura County Watershed Protection District (Principal Co-permittee) on behalf of the Ventura Countywide Stormwater Quality Management Program, submits the enclosed ROWD for re-issuance of the Ventura Countywide Municipal Storm Water NPDES Permit.

The ROWD includes a summary of the past five-year permit's activities and accomplishments as well as a draft permit that outlines the Co-permittees' objectives and goals for the next five years. The draft permit incorporates the Co-permittees' experience with storm water management and proposes activities that have proven to be successful in pollution prevention and water quality enhancement as well as strategies and requirements from other recent southern California adopted permits (e.g., San Diego, Riverside and Long Beach). In addition, the draft proposed permit:

- maintains the stringent standards of the current Ventura Countywide Municipal Storm Water Permit
- recognizes the past efforts of the Co-permittees
- provides for compliance with the NPDES permit so long as the actions are conducted within the permit time frame
- is consistent with federal and state laws, regulations and guidance, and
- furthers watershed management efforts

If you have any questions, feel free to contact me at (805) 654-2040.

Sincerely,

Jeff Pratt

Jeff Pratt
Director
Ventura County Watershed Protection District

Enclosure
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VENTURA COUNTYWIDE STORMWATER QUALITY MANAGEMENT PROGRAM

REPORT OF WASTE DISCHARGE

PREPARED BY VENTURA COUNTY WATERSHED PROTECTION DISTRICT

JANUARY 2005

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SECTION ONE
INTRODUCTION

PROGRAM DESCRIPTION

The Ventura County Watershed Protection District (VCWPD), the County of Ventura, and the Cities of Camarillo, Fillmore, Moorpark, Ojai, Oxnard, Port Hueneme, San Buenaventura, Santa Paula, Simi Valley, and Thousand Oaks (hereinafter referred to separately as Co-permittees) have joined together to form the Ventura Countywide Stormwater Quality Management Program to control the discharge of stormwater and urban runoff from municipal separate storm sewer systems (MS4). Order No. 94-082 adopted by the California Regional Water Quality Control Board (RWQCB), Los Angeles Region, on August 22, 1994, issued the first National Pollutant Discharge Elimination System (NPDES) Permit to the Ventura County Co-permittees. Order No. 00-108, adopted by the RWQCB on July 27, 2000, re-issued the NPDES Permit, and is hereafter referred to as the Permit.

This Report of Waste Discharge (ROWD) is an application for renewal of the 2000 Permit (NPDES No. 00-108). Each of the Co-permittees affirmed their intent to participate in this application for renewal of the countywide MS4 permit. The 2000 Permit expires on July 27, 2005 and requires that this ROWD be submitted no later than January 27, 2005 (180 days in advance of the expiration date). The 2000 Permit specifies that the ROWD shall be "in accordance with Title 23, California Code of Regulation".

The ROWD is comprised of a summary of the Ventura Countywide Stormwater Quality Management Program, which includes a description of Ventura County watersheds and Program accomplishments, and a draft permit outlining the activities and goals for the Program.

The Ventura Countywide Stormwater Quality Management Program (the Program) was established pursuant to Section 402(p) of the Federal Clean Water Act (CWA), which requires that a NPDES Permit regulate all point source discharges of pollutants into Waters of the United States, including discharges from municipal separate storm sewer systems (MS4s). The NPDES Permit for the Ventura County Co-permittees covers the urban areas of the county and regulates discharges from municipal storm drain systems in Ventura County. Figure 1-1, located on page 2, shows the area covered by the Ventura County Stormwater Management Plan (SMP).

The 2000 Permit recognizes that there are areas of Ventura County within the Los Angeles Regional Board area that are not subject to current federal stormwater regulation, are not under the jurisdiction of the State of California, or not under the jurisdiction of the Co-permittees. Such areas or entities include:

- Federal and state lands, including, but not limited to, military bases, national forests, hospitals, colleges and universities, and highways;
- Utilities and special districts;
- Native American tribal lands;

- Non-urbanized areas; and
- Agricultural lands

These areas are excluded from coverage under the 2000 Permit and should continue as such. However, the Co-permittees anticipate that other stormwater dischargers within Ventura County (including some of the areas or entities just listed) may be permitted separately under Phase II of the federal stormwater regulations. Other stormwater dischargers may be issued Waste Discharge Requirements (WDRs) by the Los Angeles Regional Board through the authority under the Porter-Cologne Act, through the Total Maximum Daily Load (TMDL) program, or through other regulatory programs.

The SMP was developed in late 2000 to outline Permit implementation activities. During the term of the next 5-year permit (2005 Permit), the Co-permittees will be revising the SMP to include components developed during the term of the 2000 Permit and to address requirements of the 2005 Permit. The monitoring program will also be revised and will be incorporated into the SMP.

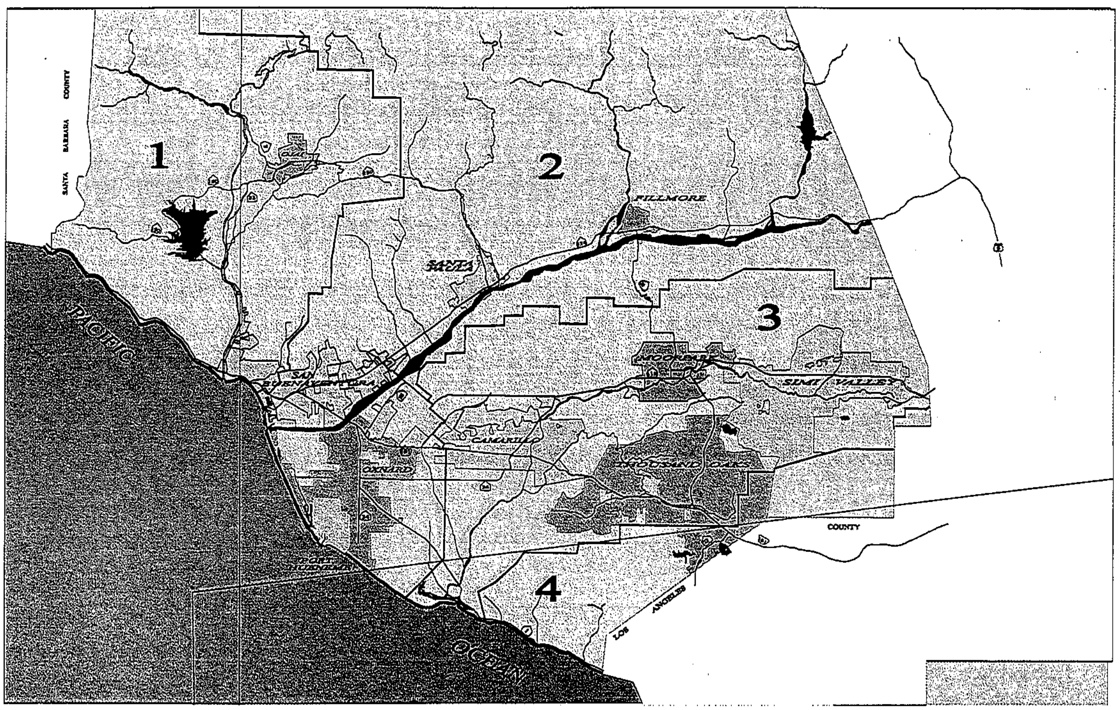


Figure 1-1
AREA COVERED BY THE STORMWATER MANAGEMENT PLAN

SECTION TWO
VENTURA COUNTY WATERSHEDS

SURFACE WATER BODIES

The area subject to permit requirements includes all areas within the boundaries of the cities as well as unincorporated areas of Ventura County defined as urban by the U.S. Census Bureau. Municipal storm drain systems in this area discharge either directly into the Pacific Ocean or one of five major water bodies:

WATER BODU	RECEIVES MUNICIPAL STORM DRAIN DISCHRGES FROM:
Ventura River	City of Ojai, City of San Buenaventura (part), unincorporated Ventura County (part)
Santa Clara River	City of Fillmore, City of Oxnard (part), City of San Buenaventura (part), City of Santa Paula, unincorporated Ventura County (part)
Callgeuas Creek	City of Camarillo, City of Moorpark, City of Simi Valley, City of Thousand Oaks (part), unincorporated Ventura County
Malibu Creek	City of Thousand Oaks (part), unincorporated Ventura County
Bays/Estuaries	City of Oxnard (part), City of Port Hueneme, City of San Buenaventura (part)

The beneficial uses of these surface water bodies include: municipal and domestic water supply, agricultural water supply, industrial service water supply, industrial process water supply, groundwater recharge, water contact recreation, non-contact water recreation, warm freshwater habitat, cold freshwater habitat, wildlife habitat, and preservation of rare and endangered species. Several of these surface water bodies have been identified by the State of California as "impaired" because they do not meet water quality standards for designated beneficial uses.

LAND USE

Ventura County's population has grown from approximately 669,016 in 1990 to approximately 753,000 in 2000. The areas of most significant growth in population include the cities of Oxnard, Simi Valley, and Thousand Oaks. The long-range population growth forecast indicates that the population of the permitted area will increase to approximately 915,000 by 2020.

Land use within the region includes open space, residential, commercial, light industry, heavy industrial and agriculture. The agricultural land uses includes citrus and fruit orchards; row crops such as strawberries; alfalfa, irrigated and dry pasturelands, application of biosolids, composting; poultry and dairies. However, during the 2000 permit term, the conversion of agricultural lands and open space to other "developed" land uses has been ongoing and will continue.

The County and City Co-permittees each own, operate, and maintain a MS4 within their respective jurisdiction. VCWPD is a regional agency that owns, operates, and maintains a MS4 countywide, with facilities located within the jurisdictional boundaries of the Co-permittees. The Permit regulates these MS4s.

The MS4s in the permitted area of Ventura County, hereinafter referred to as a storm drain system, is defined as:

"...the conveyance or system of conveyance (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains) owned or operated by a Co-permittee, that is designed or used for collecting or conveying storm water, which is not a combined sewer, and which is not part of a Publicly Owned Treatment Works (POTW) as defined at 40 CFR 122.2."

For the purposes of each Co-permittee, the length of their storm drain system is the total length of all storm drain systems owned and operated by the Co-permittee. The length of each storm drain system is the centerline distance, in linear feet, between the downstream end and upstream end of each storm drain system. The downstream end is defined as the point of discharge to the waters of the United States, or to a MS4 that is not owned or operated by the Co-permittee. The upstream end is defined as the point of entry to any storm drain system.

Table 1 (shown below) summarizes the length of the storm drain facilities owned, operated, and maintained by each Co-permittee.

CO-PERMITTEE AGENCIES	OPEN CHANNEL SOFT SIDE AND BOTTOM	OPEN CHANNEL HARD SIDE OR BOTTOM	OPEN CHANNELS HARD SIDE AND BOTTOM	UNDERGROUNG STORM DRAINS	DITCHES	GUTTERS	OTHER STORM DRAIN	TOTAL LENGTH
Principal Co-permittee								
VCWPD	409,728	307,296	204,864	102,432	N/A	N/A	N/A	1,024,320
Co-permittees								
City of Camarillo				400,000	32,178	2,956,800	1,095	3,390,073
County of Ventura	29,568	22,176	14,784	7,392	N/A	N/A	N/A	73,920
City of Fillmore			300	35,500	1,000	316,800		353,600
City of Moorpark				136,000	10,000	940,000	22	1,086,022
City of Ojai			7,920	31,680		337,920		377,520
City of Oxnard	63,360	15,840	26,400	211,200		2,112,000		2,428,800
City of Port Hueneme	5,000			66,000		440,000		511,000
City of San Buenaventura	9,477		9,869		76,603		1,708	97,657
City of Santa Paula	582			96,817	18,174	633,600		749,173
City of Simi Valley	4,000		1,000	553,115		3,146,880		3,704,995
City of Thousand Oaks		534		790,164		5,533,440		6,324,138

▪ *Table 1: Storm Drain System in linear feet*

SECTION THREE
PROGRAM ACCOMPLISHMENTS

PROGRAM MANAGEMENT AND ADMINISTRATION

During the term of the 2000 Permit, the Principal Co-permittee and Co-permittees have operated under an Implementation Agreement that sets forth the responsibilities of the Principal Co-Co-permittee and Co-permittees are identified below.

Principal Co-permittee (VCWPD) responsibilities include:

- Comply with the requirements of the Permit within its own jurisdictional boundaries (including the review of projects connected to VCWPD storm drain systems)
- Operate and maintain those storm drains owned and operated by VCWPD, including those located within the jurisdiction of the Co-permittees
- Coordinate Permit activities
- Serve as liaison between the Co-permittees and the RWQCB. This includes:
  1) Set time schedules for the performance of activities
  2) Prepare regulatory reports and seek Co-permittee review
  3) Forward Co-permittee information to the RWQCB
  4) Arrange for public review, when needed
  5) Update Co-permittees on RWQCB and EPA regulations
  6) Arrange for collection and payment of Permit renewal fee
- Secure services of consultants with concurrence of Co-permittees
- Manage the stormwater quality monitoring program
- Convene the Management Committee and subcommittee meetings
- Assign Co-permittees to subcommittees
- Attend subcommittee meetings
- Manage the countywide educational and outreach program

Co-permittee responsibilities:

- Comply with the requirements of the Permit within their own jurisdictional boundaries
- Provide Permit submittals to the Principal Co-permittee
- Develop a program to address the following within its jurisdictional boundaries:
  1) Implementation of controls to reduce pollution from industrial/commercial and residential areas

2) Implementation of structural/non-structural controls on land development and construction sites

3) Implementation of controls to reduce pollution from maintenance activities

4) Elimination of illegal connections and improper disposal of hazardous materials or wastes

5) Inspection, monitoring and control programs for industrial facilities

6) Implementation of public awareness and training programs

VCWPD, as Principal Co-permittee provides for the overall program management and coordination with the RWQCB. To oversee program development and provide guidance, senior staff from all Co-permittee agencies attend a Management Committee, chaired by VCWPD. The Management Committee reviews materials developed by the subcommittees, provides comments and approves or rejects program activities. Approved program materials are distributed to all Co-permittees for their use in implementing local stormwater program activities.

Five subcommittees composed of Co-permittee staff from various departments or contracted representatives meet as needed to discuss program implementation activities, develop program materials and advise and make recommendations to the Management Committee.

Each Co-permittee serves on one or more subcommittee. Subcommittee assignments are based on city populations. The subcommittees include the following:

- Programs for Residents
- Programs for Industrial/Commercial Businesses and Illicit Discharges (one subcommittee covers two program areas)
- Programs for Planning and Land Development
- Programs for Construction Sites
- Programs for Public Agency Activities

PUBLIC EDUCATION AND OUTREACH

The Co-permittees have developed and implemented a Program for Residents of Ventura County that is a combination of educational outreach tools and activities to increase the knowledge of target audiences about the impacts of stormwater pollution and potential solutions to reduce the problems caused; to change the behavior of target audiences in implementing appropriate solutions; and to involve and engage the different communities throughout the County in mitigating the impacts of stormwater pollution on rivers, stream and the ocean.

Through a unified and coordinated effort, the Co-permittees aim to:

- Change the mind-set of a large, diverse population while educating target audiences about solutions to stormwater pollution
- Create synergy by implementing an integrated countywide campaign and by unifying multiple pollution prevention efforts

- Maximize impact of educational campaigns by targeting more than one audience
- Build bridges and forge partnerships that integrate city and jurisdictional programs

The public education program uses numerous outreach methods to reach audiences of all ages and interests. Table 2 (shown below) presents the various outreach methods for different audiences.

AUDIENCE	OUTREACH METHODS
Residents: General Public	• Pamphlets • Brochures • Radio • TV/Cable • Utility Bill Inserts • Direct Mail • Advertisements • Community Events • Presentations • Surveys
New Home Owners	• Brochures • Tear-off Fact Sheets
Groundskeepers; Home Gardens	• Focused Brochures • Workshops
Commercial; Industrial	• Brochures • Posters
Students	• Classroom Presentations • Radio • Videos • Workbook Materials • Brochures • Radio Script Contests
General Contractors; Construction Contractors	• Focused Brochures • Workshops • Information at Public Permit Counters • Community Events
Architects; Developers	• Focused Brochures • Information at Public Permit Counters • Workshops

Table 2: Public Education and Outreach Methods

To leverage limited resources, the Co-permittees have frequently partnered with various groups and/or events (Building Industry Association, Ventura County Environmental & Energy Resources Department, CREEC Network, Coastal Cleanup Commission, and the Ventura County Science Fair) to promote conservation, pollution prevention and environmental awareness. The education program also expands outreach opportunities by working with entities such as the Ventura County Farm Bureau to promote proper use of pesticides and herbicides and source control Best Management Practices (BMPs).

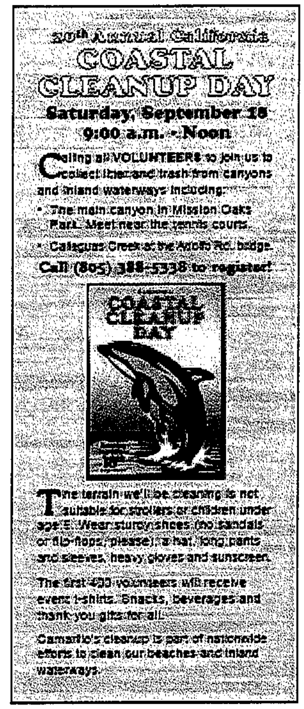
The public education program includes an Internet website that provides information to residents and businesses about storm water pollution problems and offers simple pollution prevention activities (BMPs) to help keep local rivers, streams and ocean clean. The website also provides county residents contact information for reporting illicit discharges or clogged catch basins. The website address is: www.vcstormwater.org.

Recent outreach material has included:

- BMP fact sheet and poster for horse owners and the equine industry
- A general outreach brochure that provides BMPs for new home owners and the contractors they may hire to perform work for them
- Educational brochure for industrial facilities on the State General Industrial Permit requirements and program

PROGRAM HIGHLIGHTS

COASTAL CLEANUP DAY ANNUAL EVENT



Since 1996, the Co-permittees have joined with the California Coastal Commission in their Coastal Cleanup Day program, which takes place every year on the third Saturday of September. Coming at the end of the summer beach season and near the start of the school year, Coastal Cleanup Day is a great way for families, students, service groups and neighbors to join together to help clean and beautify local beaches and inland waterways.

Each year, the Co-permittees continue to expand the scope and success of this event by increasing the number of beach and inland waterways cleaned and encouraging additional volunteer turnout. This past year, Coastal Cleanup Day took place on September 20, 2004. This permit year, a total of 2,220 volunteers participated and helped remove a total 14,632 pounds of trash and 1,919 pounds of recyclables from local beaches and inland waterways.

This volunteer program continues to be a huge success, not only in cleaning local sensitive environments but also in creating a heightened awareness on proper trash disposal and its benefit to stormwater quality.

RADIO SCRIPT CONTEST

Starting in 1998, the Co-permittees have targeted countywide middle school students to write scripts concerning stormwater pollution prevention for public service announcements. Of those scripts submitted, the top three are recorded for local radio stations.

Winning scripts are aired as part of the Countywide Radio Script Campaign to educate local residents on the importance of stormwater pollution prevention. The campaign is held every other year. In previous years, some of the scripts were aired on local television stations, including local cable television channels in the cities of Moorpark and San Buenaventura. In an effort to reach the widest audience possible, the Co-permittees utilized six local radio stations (including one Spanish language) and 15 television stations that serve a large, mixed population (including sport network channels).

PET WASTE CAMPAIGN

The Pet Waste Program was developed by the Co-permittees to educate pet owners on pet waste contributions to bacterial contamination of the ocean and streams. In 1999, the Co-permittees installed 75 dispensers and ordered 170,400 pet waste bags to dispose of pet waste in public areas. This program has been a huge success with the demand for more dispensers and pet waste bags growing annually.

This past year, VCWPD purchased an additional 35 dispensers and 699,000 pet waste bags for Co-permittee use to bring the total number of dispensers to 357 countywide. Due to the high demand in key locations, some Co-permittees have purchased additional pet waste bags (886,000) to keep dispensers stocked all year long for a total of 1,585,000.

As part of the Pet Waste Program, VCWPD developed and distributed a pet waste flyer, entitled "What's the Scoop?" which provides pet owners with tips for a healthy pet and a healthier environment. The flyer educates pet owners on the connection between pet waste carried down gutters and storm drains and bacterial pollution, which can contribute to beach closures. In addition the flyer emphasizes pollution prevention practices, such as carrying a pooper-scooper or plastic bag to pick up pet waste, and proper disposal to the sanitary sewer or place in a designated receptacle; and telling friends and neighbors about the ill effects of animal waste on the environment. Co-permittees distribute these flyers at pet stores, veterinary offices, and at outreach events. The flyer has been a big success, and was published in both English and Spanish.

VENTURA COUNTYWIDE FAIR

The annual Ventura Countywide Fair presents a wonderful opportunity for the Co-permittees to interact with residents and provide information on the Countywide Stormwater Management Program. The Co-permittees have used a variety of outreach tools at the Fair, including the Pollution Prevention House, an interactive walk-through display. The text and outreach materials used in the House address stormwater pollution prevention, recycling, pest management and water conservation practices.

In 2003, the Co-permittees showcased the TidePool Cruiser at the Fair. This mobile unit shows an up-close view of the storm drain, a marine touch tank and a general store that makes the connection between what is placed in the storm drain and its impact on marine life.

In addition to staffing the display, the Co-permittees survey Fair attendees on stormwater issues. A total of 4,897 surveys were completed over the two-week event. Survey results are analyzed to refine future public outreach efforts.

VENTURA COUNTY SCIENCE FAIR

The Ventura County Science Fair is an annual event, where fifth through twelfth grade students participate in a countywide competition for the best science project in their age group. As Principal Co-permittee, VCWPD coordinates the participation of the Co-permittees as judges in this event. The Co-permittees select three student projects for a special category Stormwater Quality Award. The projects are selected based on their relevancy to stormwater issues and level of understanding of stormwater on water quality. This past year, the City of Fillmore secured donations for the winning entries.

TIDEPOOL CRUISER

Over the past two years, some Co-permittees have utilized the TidePool Cruiser in their elementary school educational outreach efforts. This program is designed to teach children (and by extension their parents) about the hazards of non-point source stormwater pollution. In an innovative, hands-on and exciting manner participants learn of the connection between the introduction of pollutants through the storm drain system and their impact on the marine environment. In addition, solutions are provided and suggestions made on how the students can reduce pollution from littering beaches and fouling local rivers, streams and ocean.

QUARTERLY CITY NEWSLETTERS

Recently, some Co-permittees have started to include stormwater issues in additional city-specific materials. For example, this past year, the cities of Camarillo, Moorpark and Port Hueneme published several stormwater related articles in their city's quarterly newsletter. These articles provide local residents with stormwater pollution prevention tips and keeps them informed on local water quality projects and progress made on their behalf to improve their local environment. The cities of Camarillo, Moorpark and Port Hueneme should be commended for this innovative endeavor to use additional tools to provide stormwater education and pollution prevention techniques.

MOBILE SATELLITE CITY HALL

Over the past two years, the City of Oxnard has hosted a Mobile Satellite City Hall in centralized city locations in an ongoing effort to educate a greater number of local residents on stormwater pollution prevention methods and on the importance of taking ownership of their local environment. These events provide Oxnard residents with the opportunity to voice their water quality concerns to city department/division appointed representatives, citywide enhancement staff, city council members, neighborhood council executive boards and business community representatives. This innovative approach of providing educational outreach to the general public has been extremely successful in promoting a positive environmental awareness, sound stormwater pollution prevention practices and illicit discharge identification/abatement throughout the city's targeted demographic areas.

CITY CORPS STORM DRAIN KEEPER PROGRAM

In an effort to improve water quality and the aesthetics of local waterways, the City of Oxnard has entered into an agreement with Oxnard City Corps to maintain Oxnard West, "J" Street Drain and Oxnard Industrial Drain. Oxnard City Corps is a program that seeks at-risk youth within Oxnard and provides them with needed job skills. Money from SEP funds was utilized to form the Storm Drain Keeper Program.

The program's primary activities focus upon: continuous patrolling of open channel storm drains and removal of trash, excess sediment, vegetation and graffiti from the storm drains. On a quarterly basis the City Corps also assists the City of Oxnard monitor the water quality in numerous storm drains and storm drain channels. In addition, City Corps has played an important role in promoting sound stormwater pollution prevention techniques to the general public during such city events as the Water Fair and Earth Day. City Corps has removed several tons of trash and debris from channels and has made a positive impact in minimizing the trash and pollutants that are carried with it into receiving water bodies.

VOLUNTEER PROGRAMS

Several Co-permittees have established volunteer programs to address stormwater and water quality issues. For example, the City of Camarillo has continued their successful household hazardous waste disposal program, where residents can dispose of their waste at city collection events held one weekend a month. Additionally, the City of Port Hueneme has developed an "Adopt a Storm Drain"

Program, which allows individuals to select an area of interest and help the local environment by periodically cleaning a storm drain(s).

The City of Simi Valley has organized a "Neighborhood Council Arroyo Cleanup Event" for the past two years. This cleanup event is held in addition to the city's annual participation in Coastal Cleanup Day and is a huge success with local volunteers demonstrating more ownership and responsibility for their local environment and waterways.

Last year, the City of Santa Paula held its first Annual Santa Paula Beautiful Event. This clean up event targeted local streets, parks, parkways and public open spaces. Over 100 residents volunteered their time and collected 624 tons of trash.

The City of San Buenaventura continued their "Partners in Progress for a Beautiful Ventura" program where committed volunteers work together to collect trash along the beach. This program offers the unique opportunity for one-on-one interaction between local residents and city representatives. The city continues to stress environmental stewardship and pollution prevention measures to their residents with very positive results.

In addition, the City of Thousand Oaks, through their Community Enhancement Program, has awarded over $30,000 to non-profit groups for various projects including several creek cleanup events. This program also funds the City's participation in the Adopt-a-Highway program where more than 4.5 tons of trash was collected from city freeway ramps this past year. Additional clean up efforts along the Highway 23/101 interchange removed a further 2 tons of litter. This progressive and innovative program also provides free dumpsters to qualifying neighborhoods. This program is especially noteworthy for it not only removes unsightly and offensive trash but also provides an easy way for residents to dispose of unwanted items and discourage the illicit dumping of trash.

These activities and programs underscore the Co-permittees commitment to water quality and to effect change and improvement in the streams, rivers and channels of Ventura County.

COMMERCIAL/INDUSTRIAL PROGRAM

The Co-permittees have developed and implemented a Program for Industrial/Commercial Businesses that incorporates educational outreach and a site visit/inspection program designed to increase the knowledge of target audiences about the impacts of stormwater pollution and potential solutions to reduce problems caused; to change the behavior of target audiences through implementation of appropriate solutions; and to involve and engage the various business communities throughout the County in mitigating impacts of stormwater pollution on our rivers, streams and ocean.

Recent program activities include an extensive public educational outreach program to target industrial facilities potentially subject to the State General Industrial Permit. The Co-permittees targeted facilities using a variety of resources:

- State Water Resources Control Board (SWRCB) database of facilities covered by the General Industrial Permit
- Hazardous materials inventories maintained by fire or environmental health departments

- List of facilities subject to local wastewater utility's industrial pretreatment programs
- City business license records
- Commercially available business listings (e.g. the Dun & Bradstreet database)
- Telephone book business listings
- Non-filers database
- Letters/Use surveys/Mailer with response requested/Checklist, etc.

This program has been hugely successful with a total of 984 facilities countywide educated on the State General Industrial Permit program. As part of this educational outreach the Co-permittees identified a total of 365 potential non-filers. This information has been crucial to the RWQCB's efforts to administer and enforce their program.

In addition, the Co-permittees have focused on maximizing their stormwater message by reaching larger audiences through the Program's website (www.vcstormwater.org). The Co-permittees provide additional information and guidance for the business community on practical solutions for stormwater pollution prevention by providing a series of Clean Business Program Fact Sheets on the website. These fact sheets address the following topics and activities:

- Storm Drains and Discharge Points
- Building and Grounds Maintenance
- Building Repair, Remodeling and Construction
- Maintenance and Cleaning of Floors and Outside Impervious Surfaces
- Materials Loading, Unloading and Storage
- Vehicle and Equipment Fueling
- Vehicle and Equipment Operation, Maintenance and Repair
- Vehicle and Equipment Washing and Cleaning
- Waste Management and Disposal
- Waste Recycling and Disposal Reference Guide

PROGRAM HIGHLIGHTS

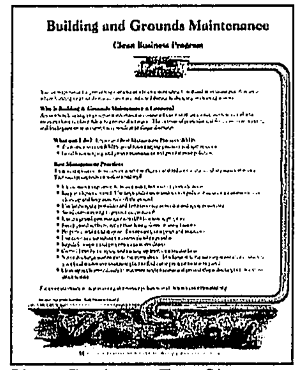
CLEAN BUSINESS FACT SHEETS

In 2002, the Co-permittees focused on maximizing their stormwater message by targeting those business activities that have the highest potential to contribute pollutants to the storm drain system. The Co-permittees sought to provide additional information and guidance to the business community on practical solutions for stormwater pollution prevention in those areas/activities that can be most problematic.

The Co-permittees developed a series of Clean Business Program Fact Sheets, which addressed the following topics and activities:

- Building & Grounds Maintenance

- Building Repair, Remodeling & Construction
- Maintenance & Cleaning of Floors and Outside Impervious Surfaces
- Materials Loading, Unloading & Storage
- Vehicle & Equipment Fueling
- Vehicle & Equipment Washing & Cleaning
- Waste Management & Disposal
- Waste Recycling & Disposal Reference Guide


Building and Grounds Maintenance

Clean Business Program

Clean Business Fact Sheet

These fact sheets have been posted on the Program's website (www.vcstormwater.org). In addition, the Co-permittees provide these fact sheets during routine inspections and when appropriate.

COORDINATION WITH EHD FOR COUNTYWIDE CONSISTENCY

The Co-permittees continued to emphasize consistency among inspection programs, both in terms of requirements and procedures countywide. The Co-permittees appreciate the importance of providing a "level playing field" for the business community, and of requiring compliance in a similar, and clear manner. In order to facilitate countywide consistency, the Co-permittees meet regularly to discuss coordination of efforts and strategies for the inspection program at the Business & Illicit Discharge/Illegal Connection Subcommittee. As a part of this effort the Co-permittees encourage the participation of the County of Ventura Environmental Health Department (EHD) in these discussions and to provide comments and guidance in the development of educational materials.

EHD plays an important role in the Co-permittees' efforts to inspect and assure compliance with stormwater regulations in the business community countywide. EHD conducts stormwater inspections of automotive service facilities on the behalf of several Co-permittees, and also performs the County unincorporated program for food service inspections. Implementation of these program elements requires the Co-permittees to spend significant time and resources on communication, coordination, and comprehensive training, both for Co-permittee staff as well as EHD inspection staff.

Although the Co-permittees need the flexibility to develop inspection programs that are appropriate for local conditions, the Co-permittees have worked hard to incorporate similar baseline elements in their individual programs. To define these baseline elements, the Co-permittees continue to discuss standards and approaches for conducting inspection activities. The Co-permittees continue to work on coordination and providing the business community of Ventura County a fair and congruent inspection program.

JOINT INDUSTRIAL SITE INSPECTIONS

This past year VCWPD, in coordination with the RWQCB, targeted several state permitted industrial sites for a joint inspection program. With recent regulatory changes that require Co-permittees to visit and educate industrial operators these facilities are now subject to several layers of regulation. The Co-permittees recognize the potential for problems with these facilities being subjected to different inspection agencies and the likelihood of industrial operators receiving different direction and feedback on how to best implement stormwater pollution prevention measures and meet state permit compliance. In order to avoid this situation and ensure continued countywide consistency with respect to BMP selection and implementation, VCWPD staff with RWQCB inspectors visited several state permitted industrial facilities sites for joint inspections. These inspections provided both VCWPD and the RWQCB an opportunity to see the other in action and the chance to discuss at length their style, method and primary concerns at industrial facilities.

The results of these joint inspections were discussed in detail at the Business Subcommittee meetings where the Co-permittees were able to evaluate the best way to not only ensure a consistent countywide approach but also the best method to streamlining the regulatory process for the industrial community. These discussions are on-going with the Co-permittees committed to protecting stormwater quality in Ventura County and implementing an inspection program that is efficient and responsive to the industrial business community.

PLANNING & DEVELOPMENT PROGRAM

The Co-permittees have developed and implemented a Program for Planning and Land Development that addresses the planning of development projects. This program describes the minimum standards that the Co-permittees follow to implement their own development planning programs in compliance with Permit requirements.

The goal of this program is intended to assure that appropriate post-construction BMPs are included in priority planning development and redevelopment project plans and designs to:

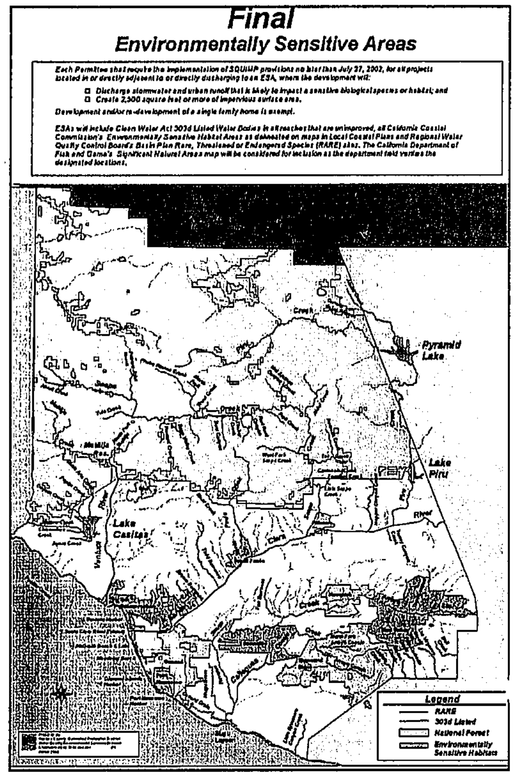
- Minimize impacts from stormwater and urban runoff on the biological integrity of natural drainage systems and water bodies in accordance with requirements under CEQA (Cal. Pub. Resources Code § 13369, SWA §402(p), CWA § 404, CZARA § 6217(g), ESA § 7, and local government ordinances
- Maximize the percentage of pervious surfaces to allow percolation of stormwater into the ground
- Minimize the quantity of stormwater directed to impervious surfaces and the MS4
- Properly design and maintain treatment control BMPs in a manner that does not promote the breeding of vectors
- Provide for appropriate permanent measures to reduce stormwater pollutant loads in stormwater from development sites

The Co-permittees recognize that development and redevelopment projects have the potential to discharge pollutants to stormwater. Therefore, the Co-permittees approach stormwater concerns early in the project development process when options for pollution control are greatest and the cost to incorporate these controls into new projects is least.

In planning and reviewing a development project, the Co-permittees consider three key questions with respect to stormwater quality control: (1) what kind of water quality controls are needed?; (2) where should controls be implemented?; (3) what level of control is appropriate? In an effort to provide guidance and countywide consistency in answering these important questions, the Co-permittees developed and have implemented a Development Standards Technical Manual. The manual includes guidance for implementing the Stormwater Quality Urban Impact Mitigation Plan

(SQUIMP) as well as detailed information for the selection, design and maintenance of post-construction BMPs.

In order to provide sound guidance in the Technical Manual, the Co-permittees developed and implemented a study to evaluate "post-development peak stormwater runoff discharge rates to maintain or reduce pre-development downstream erosion." The Urban Stream Erosion Prevention Model (USEP) objective was to setup, calibrate and validate the USEPA Hydrologic Simulation Program in a small watershed (upper reaches of Arroyo Simi) for 'current/recent' hydrologic conditions. The study's results have provided the Co-permittees with peak flow criteria for designing BMPs for projects subject to SQUIMP requirements and has been included in the Technical Manual.



In addition, each Co-permittee has reviewed their internal planning procedures for preparing and reviewing California Environmental Quality Act (CEQA) and National Environmental Quality Act (NEPA) documents and has linked stormwater quality mitigation conditions to legal discretionary project approvals. Furthermore, the Co-permittees have identified environmentally vulnerable areas where more stringent stormwater quality control measures are warranted. All projects located in or directly adjacent to or directly discharging to an ESA where development would:

- Discharge stormwater and urban runoff that is likely to impact a sensitive biological species or habitat; and
- Create 2,500 square feet or more of impervious surface area

are subject to SQUIMP provisions and conditioning. As well as required by the Permit, these protective measures emphasize the Co-permittees commitment to mitigating water quality degradation caused by human activities.

PROGRAM HIGHLIGHTS

ENVIRONMENTALLY SENSITIVE AREAS

Some areas, due to their plant or animal life or their habitats, are at risk to water quality degradation caused by human activities and may require special consideration. The Permit requires identification of these areas [referred to as Environmentally Sensitive Areas (ESAs)] for the purpose of conditioning development projects planned in these vulnerable areas.

The Permit required the identification of ESAs by January 27, 2001. The Co-permittees submitted a list of criteria for the purpose of defining ESAs in Ventura County to the RWQCB by the permit deadline. This definition was rejected by the RWQCB and deemed insufficient. In November 2001, the Co-permittees submitted a revised definition of ESAs with the modified SMP. Again, the RWQCB deemed the definition incomplete and requested further refinements.

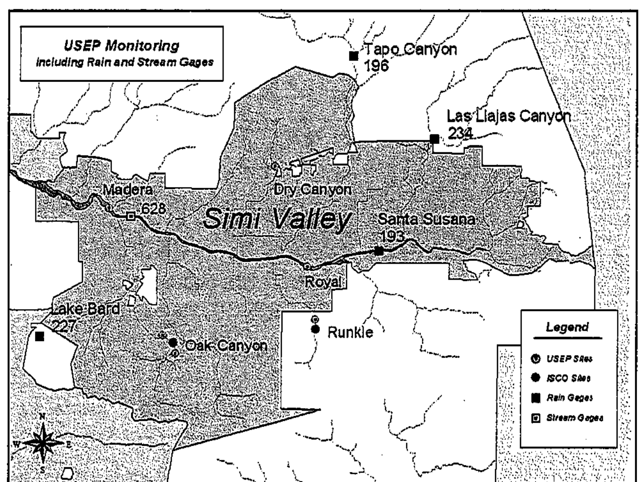
On July 1, 2002, the Co-permittees again submitted a revised approach for ESA designations. This approach required the implementation of SQUIMP provisions for all projects located in or directly adjacent to or directly discharging to an ESA, where development would:

- Discharge stormwater and urban runoff that is likely to impact a sensitive biological species or habitat; and
- Create 2,500 square feet or more of impervious surface area

ESAs were defined as Clean Water Act 303(d) listed water bodies in all reaches that are unimproved and all California Coastal Commission's *Environmentally Sensitive Habitat Areas* as delineated on maps in Local Coastal Plans and Regional Water Quality Control Board's Basin Plan Rare, Threatened or Endangered Species (RARE) sites. The California Department of Fish and Game's *Significant Natural Areas* map would be considered for inclusion as the department field verifies the designated locations. The Co-permittees and the RWQCB have now finalized the ESA designations. In addition, the Co-permittees have created a countywide map depicting these areas and have made it available to all interested parties.

USEP STUDY

As areas undergo urban development, surfaces that allow stormwater to percolate into the ground are usually made less pervious and alterations to natural drainage systems are constructed to convey stormwater runoff from urbanized areas. These alterations result in increases of both runoff volume and runoff rates in natural streams and rivers. Several reports and case studies on mostly perennial steams suggest that increased runoff volume and velocity from urbanization in watersheds with natural channels may contribute to channel enlargement (stream erosion) either through widening of the stream banks, down cutting of the streambed, or a combination of both. This change of the natural channel morphology may trigger instream habitat degradation.



Map of USEP Monitoring Locations

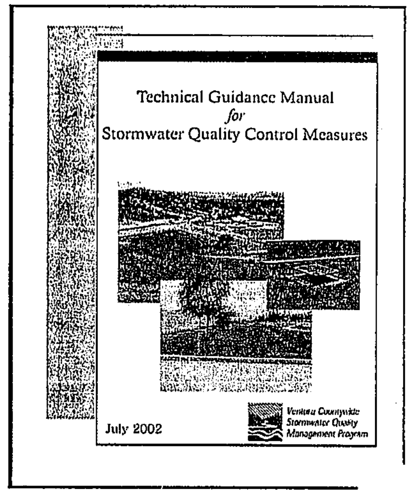
In order to better understand how urbanization and development impacts streams in Ventura County, the Co-permittees developed and implemented a study "to control the post-development peak stormwater runoff discharge rates to maintain or reduce pre-development downstream erosion." The Urban Stream Erosion Prevention Model (USEP) aimed to setup, calibrate and validate the USEPA Hydrologic Simulation Program in a small watershed (upper reaches of Arroyo Simi) for 'current/recent' hydrologic conditions. Due to some initial grant funding delays, the USEP study was temporarily slowed. However, the Co-permittees did have some preliminary data to establish design criteria for controlling post-development erosion. This interim peak flow criteria was included in the Technical Guidance Manual and submitted to the RWQCB.

After two years of study the Co-permittees have finalized the USEP Report. The study's results allowed the Co-permittees to re-evaluate the use of the information available from the model on flow-duration, flow velocity distributions, bed/bank shear stress calculations, etc. for assessing flood control facilities, streambed/bank protection efforts and urbanization impacts. Most significantly, the study assisted the Co-permittees in determining that the interim peak flow criteria for designing BMPs for projects subject to SQUIMP requirements originally included in the Technical Guidance Manual is the most appropriate.

This project illustrates the commitment and dedication the Co-permittees have in addressing real stormwater issues and implementing sound scientifically proven methods for resolving those issues. In addition, this project is the first of its kind in southern California and therefore will benefit many other regions in California, with potential application in other states.

DEVELOPMENT STANDARDS – TECHNICAL MANUAL

Protection of water quality requires that BMPs be designed in accordance with criteria sufficient to meet the requirements of the stormwater quality management program, without causing collateral, negative impacts elsewhere in the environment. In addition, science and technology of stormwater quality management continues to evolve. Therefore, it is necessary to develop BMP design criteria and then periodically update the criteria to reflect the current state of knowledge and available technologies.



Technical Guidance Manual

In 2002, the Co-permittees were required to develop and implement a Technical Guidance Manual to address BMP design criteria protocols. The manual was required to include:

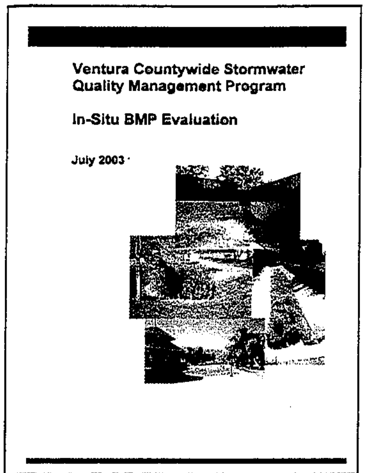
- Specifications for treatment control BMPs and structural BMPs based on the flow-based and volume-based water quality design criteria in the SQUIMP
- Criteria that can be implemented consistently throughout the permit area
- Criteria for the control of discharge rates and duration for the purposes of maintaining or reducing pre-development downstream erosion and for protection stream habitat

In July of 2002, the Planning and Land Development Subcommittee with the assistance of Larry Walker and Associates, completed preparation of the Technical Guidance Manual for submittal to the RWQCB by the permit deadline (July 27, 2002).

The Manual addresses SQUIMP requirements of the NPDES permit and specifies design storm volumes and flows, and identifies various site, source, and treatment control BMPs applicable to Ventura County and the SQUIMP project categories (e.g. automobile repair shops, restaurants, commercial development, etc.). Ultimately the Manual provides design guidance for site design (e.g. reduction of impervious areas), source and treatment control BMPs. Fact sheets were developed for each BMP and provide detail descriptions of the BMPs and where applicable design criteria. For the treatment control BMPs, a step-by-step design process (including electronic design worksheets) was developed and typical design details provided. In addition, guidance was provided regarding the effectiveness of the BMPs, operation and maintenance requirements, and design examples. Revisions to the Manual were provided in November 2002 and February 2003. This manual is applied Countywide and provides for a consistent and equitable approach to land development within Ventura County.

BMP EVALUATION STUDY

In addition to monitoring stormwater discharges, the Co-permittees implemented an In-Situ BMP Evaluation study. Many new and redevelopment projects have been conditioned by the Co-permittees to mitigate stormwater impacts with the use of a variety of Best Management Practices (BMPs). The Co-permittees realized that in order to assess the effectiveness of these measures to protect water quality an evaluation of BMPs was needed. In October 2002, the Co-permittees hired a consultant to evaluate a series of BMPs in different locations throughout the County. Unlike other BMP studies, this evaluation goes beyond simply verifying the appropriateness of the BMP for a given situation. Rather, this study evaluates whether the BMP has been installed properly, if it is being properly maintained and if the BMP is having the desired results.


Ventura Countywide Stormwater
Quality Management Program

In-Situ BMP Evaluation

July 2003

BMP Report Cover

In July of 2003, the Planning and Land Development Subcommittee with the assistance of Camp, Dresser and McKee, completed preparation of the BMP Evaluation Study Report. The study's preliminary findings include design, construction, and operation and maintenance recommendations.

The Co-permittees intend to extend this study in the near future to increase their database and thus realize more meaningful results. Ultimately, study results will be used by the Co-permittees to evaluate the need for modifying BMP design criteria for increasing BMP effectiveness and mitigation of stormwater impacts.

COUNTYWIDE SQUIMP TRAINING

With the adoption of Permit CAS004002, the Co-permittees recognized the need for more in-depth training on the new SQUIMP requirements. On behalf of the Co-permittees, VCWPD provided two half-day SQUIMP Workshops in January 2002. The workshops targeted civil engineers, planners and municipal staff routinely involved with land development project design and review. Presentations by the RWQCB, VCWPD, Larry Walker and Associates (LWA), and Camp Dresser and McKee (CDM) were given. The presentation topics included the SQUIMP from a regulatory perspective, a general overview of the SQUIMP in Ventura County, making the connection between BMPs and Pollutants of Concern (POCs), and BMP Design using SQUIMP criteria. Total attendance was 150 people. VCWPD plans to offer a similar workshop and solicit the participation and attendance of the architectural community next year (Spring 2005).

CONSTRUCTION ACTIVITIES

The Co-permittees have developed and implemented a Program for Construction Sites that addresses the implementation of BMPs to control pollution of runoff from construction activities. Construction projects covered under this program include any action proposed by a property owner/developer which requires the issuance of a building or grading permit and includes construction activities such as clearing, grading, excavation, road construction, structure construction, or structure demolition that results in soil disturbance.

Construction projects have the potential to significantly affect stormwater quality. The goal of the Program for Construction Sites is to assure that appropriate BMPs are incorporated during all phases of construction. BMPs appropriate for construction activities are organized into four major categories:

- **Erosion Control:** Measures that prevent erosion and keep soil particles from entering stormwater, lessening the eroded sediment that must be trapped, both during and at the completion of construction
- **Sediment Control:** Feasible methods of trapping eroded sediments so as to prevent a net increase in sediment load in stormwater discharges from the site
- **Site Management:** Methods to manage the construction site and construction activities in a manner that prevents pollutants from entering stormwater, drainage systems or receiving waters
- **Materials and Waste Management:** Methods to manage construction materials and wastes that prevent their entry into stormwater, drainage systems or receiving waters

These BMPs address multiple construction activity-related pollutants and focus on erosion and sediment control practices, source control, education, good house-keeping, BMP evaluation/maintenance, proper waste management and good site planning.

Prior to receiving a grading permit, the Co-permittees require a Storm Water Pollution Control Plan (SWPCP) be submitted for projects that are located in a hillside areas, or will result in soil disturbance of one acre or more, or is within or discharging directly to or directly adjacent to an Environmentally Sensitive Area (ESA). In addition, the Co-permittees require all construction projects subject to the State General Construction Permit to submit proof of filing a Notice of Intent (NOI) prior to issuing a grading permit.

The Co-permittees inspect all construction sites with SWPCPs to determine if the SWPCP is adequately implemented. The SWPCP remains in effect until the construction site is stabilized and all construction activity is completed. The SWPCP includes identification of potential pollutant sources and the design, placement and maintenance of BMPs to effectively prevent the entry of pollutants from the construction site to the storm drain system. In addition, the Co-permittees require that construction projects include the following requirements:

- Sediments generated on the project site shall be retained using structural drainage controls
- No construction-related materials, wastes, spills, or residues shall be discharge from the project site to streets, drainage facilities or adjacent properties by wind or runoff
- Non-stormwater runoff from equipment and vehicle washing and any other activity shall be contained at the project site
- Erosion from slopes and channels will be eliminated, by implementing BMPs, including but not limited to, limiting grading during the wet season, inspecting graded areas during rain events, planting and maintaining vegetation on slopes and cover erosion susceptible slopes

In recent years, the Co-permittees have hosted several countywide General Construction Permit Compliance training workshops. These workshops have focused on State General Construction Permit compliance, and Storm Water Pollution Prevention Plan (SWPPP) development and implementation. Many of these training events have been coordinated with other governmental and construction industry representatives, including the Association of General Contractors (AGC), State Water Resources Control Board (SWRCB), Los Angeles Regional Water Quality Control Board

(RWQCB), and the Association of Public Work Agencies (APWA). These events targeted both Co-permittee staff as well as members of the local construction/developer community. Widely successful, these training events reinforce the Co-permittees' belief that education is one of the primary tools to creating stormwater awareness and changing behavior.

Most recently, the Co-permittees recognized the need for a "New Homeowner" brochure to assist developers, Home Owner Associations (HOAs) and residents with their efforts to prevent non-stormwater discharges. Last year alone, the Co-permittees distributed 6,000 of these new brochures to homeowners, developers and Home Owner Associations (HOAs).

PROGRAM HIGHLIGHTS

GENERAL CONSTRUCTION PERMIT COMPLIANCE WORKSHOP/TRAINING

Over the term of the permit, the Co-permittees have emphasized the need for training and education of their inspection staff. The Co-permittees have participated in a variety of events over the past five years. Activities include:

- Associated General Construction Training
- Association Public Works Agency Construction Training
- Building Industry Association Stormwater Seminar
- Pollution Prevention for Concrete Products Workshop
- NPDES Wet Weather Compliance Training Seminar

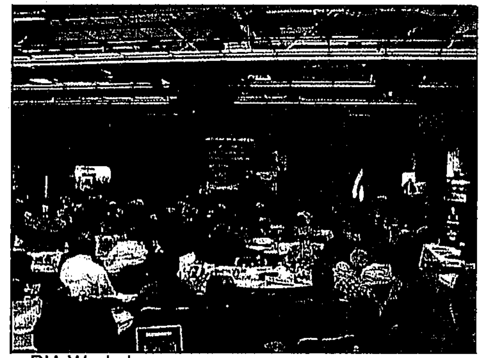
AGC Training

VCWPD in coordination with the Associated of General Contractors of California (AGC) hosted two one-day workshops on how to comply with the General Construction Permit and BMP implementation. Presentations by the SWRCB, the RWQCB, and VCWPD were given on the regulatory foundation for the permit, Co-permittee responsibilities for implementing the permit, and the ease with which construction sites could achieve compliance with the permit. The event was a huge success with participation from municipal staff, local development and construction community and engineering consulting firms. A total of 270 people attended, and assisted in a field demonstration of BMP application and maintenance.

APWA Construction Training

VCWPD in coordination with the Association of Public Work Agencies and the RWQCB hosted a one-day workshop that covered stormwater regulations and how to comply with the General Construction Permit. The workshop outlined the General Construction Permit and how to comply with its requirements. Approximately 50 people attended the event. The workshop's success reinforced the Co-permittees' belief that education is one of the primary tools to creating stormwater awareness and changing behavior. Thus, the Co-permittees will continue to target additional audiences for educational outreach and plan to hold training workshops as needed.

BIA Stormwater Seminar



BIA Workshop

On behalf of the Co-permittees, VCWPD participated in a daylong seminar, entitled New Stormwater Regulations and Construction/Development Projects that drew more than 270 participants in Downey, California. Presentations focused on Regional Water Board construction/development requirements, municipal construction/development requirements and potential legal actions for non-compliance. In addition to VCWPD, representatives from the RWQCB, Los Angeles County Stormwater Program, Orange County Stormwater Program, and San Bernardino Stormwater Program were present.

As a result of the recent significant changes in water quality regulations incorporated in the General Construction Permit, the Co-permittees strongly believe participation in such events is crucial to educating the construction/development community and achieving widespread compliance. The Co-permittees will continue to take advantage of similar opportunities to further stormwater awareness and facilitate compliance with permit requirements.

Pollution Prevention for Concrete Products Workshop

The Co-permittees receive a large number of illicit discharge reports related to concrete washout activities, and agreed that a workshop targeting concrete supply companies, local contractors and handymen would be appropriate. VCWPD in coordination with the City of Thousand Oaks held a one-day workshop that covered stormwater regulations and appropriate BMPs for working with concrete products. The workshop emphasized prevention of non-stormwater discharges (source control), appropriate cleaning methods, material storage, and proper disposal. A total of 57 people attended the event. The workshop's success reinforced the Co-permittees' belief that education is one of the primary tools to creating stormwater awareness and changing behavior. Thus, the Co-permittees will continue to target additional audiences for educational outreach and plan to hold training workshops as needed.

NPDES Wet Weather Compliance Training Seminar

Since 2000, the City of Oxnard has hosted an annual NPDES Wet Weather Compliance Training Seminar on how to comply with General Construction Permit requirements and stormwater regulations. This comprehensive seminar was designed to motivate and educate land developers, superintendents, subcontractors, engineers, consultants, public works inspectors, and any individual who has the potential to generate or prevent stormwater pollution and/or is directly responsible for the preparation, implementation and compliance inspection of the Storm Water Pollution Prevention Plan (SWPPP).

Training focuses on the implementation of Best Management Practices (BMPs) during various construction activities to adequately prevent the discharge of non-stormwater pollutants or sediment-laden water into the storm drain system and consequently the ocean. In addition, the seminar emphasizes general NPDES Permit prohibitions and requirements that each construction site of one acre or greater must comply with year round. This past year's training was a huge success with 70 attendees. The City of Oxnard should be commended for their unwavering commitment to provide such training venues, which are crucially to successfully training the construction/development community and achieving compliance. The seminar's on-going success is evident in the notable changes at construction sites and has reinforced the city's belief that education is the key for achieving stormwater compliance.

PHASE II

As a result of recent significant changes in water quality regulations, the Co-permittees in coordination with the RWCB notified and provided educational outreach to construction sites that were now subject to the General Construction Permit when Phase II went into affect (March 2003). The Co-permittees strongly believe that education and outreach to the construction community is crucial to engaging the construction/development community and achieving permit compliance. The Co-permittees will continue to take advantage of similar opportunities to further stormwater awareness and facilitate compliance with permit requirements.

JOINT CONSTRUCTION SITE INSPECTIONS

This last year VCWPD, in coordination with the RWQCB, targeted several state permitted construction sites for a joint inspection program. With recent regulatory changes that require construction sites of one acre or more to obtain a State General Construction Permit, more and more construction projects are now subject to several layers of regulation. The Co-permittees recognize the potential for problems with these construction sites being subjected to different inspection agencies and the possible likelihood of developers, contractors, and local homeowners receiving different direction and feedback on how to best implement stormwater pollution prevention measures at their sites. In order to avoid this situation and ensure continued countywide consistency with respect to BMP selection and implementation, VCWPD staff, with RWQCB inspectors, visited several state permitted construction sites for joint inspections. These inspections provided both VCWPD and the RWQCB an opportunity to see the other in action and the chance to discuss at length their style, method, and primary concerns at construction sites.

The results of these joint inspections were discussed in detail at the Construction Subcommittee meetings where the Co-permittees were able to evaluate the best way to not only ensure a consistent countywide approach but also the best method for streamlining the regulatory process for the construction community. These discussions are on going with the Co-permittees committed to protecting stormwater quality in Ventura County and implementing an inspection program that is efficient and responsive to the construction community.

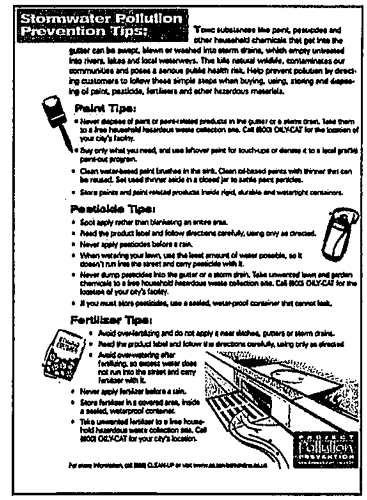
NEW HOMEOWNER BROCHURE DEVELOPMENT

In 2003, the Co-permittees begin to discuss the need for a "New Homeowner" brochure to assist developers, Home Owner Associations (HOAs) and residents with their efforts to prevent non-stormwater discharges. A significant number of illicit discharges can occur in owner-occupied homes in a phased development project. Illicit discharges may result from concrete and masonry work, painting activities, landscaping and gardening and minor construction in and around the home. The Construction Subcommittee in coordination with the Residential/Public Outreach Subcommittee developed a brochure to address these issues. The Co-permittees finalized and distributed 6,000 of these new brochures to homeowners, developers and Home Owner Associations (HOAs) this permit year.

The Co-permittees are also encouraging the developer community to prepare their own brochures and incorporate notices and warnings regarding stormwater pollution prevention requirements into contractual agreements, CC&Rs and other new owner documents.

HOME DEPOT EMPLOYEE TRAINING

The City of Oxnard in coordination with Home Depot provides storm water pollution prevention training to local Home Depot employees. This training emphasizes best management practices for many common pollutants of concern (pesticides, fertilizers/nutrients, paint and hazardous material) purchased at Home Depot. By providing simple solutions to the employees for the prevention of stormwater pollution, the City of Oxnard effectively arms an additional 200 people that can educate local residents on stormwater pollution prevention. The city also provides Home Depot employees with 225 "Ask Me How to Prevent Pollution" buttons in an effort to prompt customers to ask questions.



Pollution Prevention Fact Sheet

In addition, the city distributes Pollution Prevention Fact Sheets to be placed in the paint aisles and the garden center. These fact sheets detail basic techniques and methods that homeowners can incorporate in their home improvement projects to prevent stormwater pollution. The fact sheets included tear sheets that local residents could remove and take home as friendly reminders of how easily they can help to better their environment. This proactive outreach by the City of Oxnard is to be commended.

MUNICIPAL FACILITIES AND ACTIVITIES

A significant portion of the Co-permittees' activities includes the operation and maintenance of municipal infrastructure. These activities have the potential to impact stormwater quality and as such, the Co-permittees have developed and implemented a Program for Public Agencies. This program addresses the implementation of BMPs to control pollutant discharges to the storm drain system from Co-permittees activities and facilities to the maximum extent practicable (MEP).

In order to address the Co-permittees' potential impact on stormwater, the following activities have been targeted:

- Activities at Co-permittees Corporation Yards
- Drainage System Operation and Maintenance Activities
- Roadway Operation and Maintenance Activities
- Pesticide, Herbicide and Fertilizer Application and Use
- Training of Municipal Staff

Therefore the Co-permittees have developed and implemented Storm Water Pollution Control Plans (SWPCPs) for each of their respective corporate yards. Each SWPCP is a unique plan for each facility and include the following:

- Facility Assessment

- Best Management Practice Selection
- Plan Documentation and Implementation
- Evaluation
- Employee Training

In addition, the Co-permittees have implemented an inspection and cleaning program for their catch basins and other drainage facilities. The Co-permittees have also developed and implemented a street sweeping program and schedule that reflects traffic use and frequency.

The Co-permittees have developed and adopted a standardized protocol for the routine and non-routing application of pesticides, herbicides (including pre-emergents) and fertilizers. The standardized protocol includes the following minimum requirements to control the discharge of pollutants to stormwater as a result of pesticide, herbicide and fertilizer applications:

- Prohibit the application of pesticides, herbicides and fertilizers during rain events
- Prohibit the application of pesticides, herbicides and fertilizers within one day of a rain event forecasted to be greater than 0.25 inches except for application of pre-emergents
- Prohibit the application of pesticides, herbicides and fertilizers after a rain event where water is leaching or running from the application area

Each Co-permittee has targeted staff based on the type of stormwater quality and pollution issues that they could encounter during the performance of their regular maintenance activities. Training methods ranged from informal meetings to formal classroom training or self-guided training. The Co-permittees also train their staff on prevention, detection and investigation of illicit discharges and illegal connections.

Recently the Co-permittees have stressed the importance of integrated pest management (IPM) to weed management. With increasing regulations on the use of pesticides and the growing awareness of environmental impacts from pesticide use, the Co-permittees have begun exploring alternatives and implementing BMPs that mitigate their impacts on local ecosystems. The Co-permittees have found that they could incorporate these strategies with only minor modifications to their maintenance activities. The Co-permittees continue to take forward, progressive approaches to their responsibilities.

PROGRAM HIGHLIGHTS

TOURS OF CO-PERMITTEES' CORPORATION YARDS

The Public Infrastructure Subcommittee meets on a monthly basis to discuss permit compliance issues and protection of stormwater as it relates to government activities. Subcommittee members take this opportunity to share ideas and discuss new and innovative BMPs for the protection of stormwater quality. Presentations by Subcommittee members and guest speakers allow members to share experiences, successful BMP

practices and new technology and ideas. Participation in these meetings has been instrumental in the many new stormwater protection improvements at corporation facilities throughout Ventura County.

As an educational exercise, some of the Subcommittee meetings included site visits to other government corporation yard facilities located throughout Ventura County. These visits provide the Co-permittees with the unique opportunity to see first hand how potential problems were identified and corrected. This exercise has fostered a growing dialogue among the Co-permittees and has been such a great success that the Co-permittees plan to continue this activity next permit year.

Tour of City of Thousand Oaks' Corporate Yard

CORPORATE YARD SWPCP INSPECTION FORM

In 2002, the Co-permittees developed and implemented Storm Water Pollution Control Plans (SWPCPs) at their corporate yards. Once implemented, the permit requires annual inspections of the corporate yards to evaluate the implementation and effectiveness of the SWPCP. In order to facilitate this process, the Public Infrastructure Subcommittee began discussions on what components of the SWPCP should be evaluated and how best to conduct inspections. As a product of these discussions, the Subcommittee developed a model inspection form that the Co-permittees could implement at their yards. The Co-permittees readdress these annual inspections at subcommittee meetings, where they discuss the successes and lessons learned that may be incorporated in future inspections.

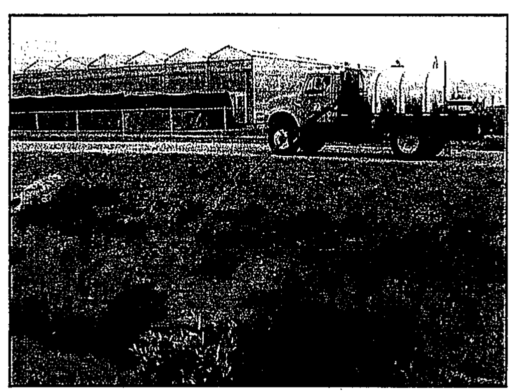
REGIONAL BOARD AUDIT OF CO-PERMITTEES' CORPORATION YARDS

This past year, each of the Co-permittees underwent an audit inspection of their corporation yards by the RWQCB to evaluate compliance with stormwater requirements. Tetratech, Inc. assisted RWQCB in conducting the audits, which included, but was not limited to, inspection of areas used for outdoor storage, vehicle washing, vehicle maintenance, fueling operations, and chemical storage. Housekeeping practices, along with availability and implementation of a SWPCP were also evaluated.

When appropriate, individual Co-Permittees were required to submit a Compliance Schedule for correcting any noted deficiencies. These were due to RWQCB by the end of April 2004. Corresponding Final Compliance Reports were submitted in May 2004. While all items noted by the auditors were minor and easily rectified, the Co-permittees were energized by the opportunity to further enhance their efforts to mitigate stormwater pollution at their facilities. All of the Co-Permittees were in compliance with the schedule set by RWQCB and should be commended for their speedy and comprehensive response to the audit findings.

AQUATIC PESTICIDE NPDES PERMIT

In March 2001, the Ninth Circuit Court of Appeals determined that discharges of pollutants from the use of aquatic pesticides to waters of the United States require coverage under an NPDES permit (General Permit No. CAG 990003). Coverage under this General Permit is for public entities that discharge pollutants to water bodies associated with the application of aquatic pesticides for resource or pest management. This permit is required regardless if the public entity is already



Aquatic Pesticide Spraying

covered by a municipal NPDES permit. This General Permit applies to aquatic pesticide applications directly into a water body and/or directly to organisms in the water or on the water surface with the purpose and intent of killing the target aquatic organisms. The impacts of these chemicals may not be limited to the target organisms – other plants and aquatic life in the treatment area may be impacted. Due to water movement at the treatment locations, the residual pesticides can be carried to adjacent areas while concentrations in the water are still high enough to cause adverse impacts to not only aquatic organisms but also to other beneficial uses such as, irrigation, ground water recharge and recreation.

During 2003, VCWPD contracted with Larry Walker Associates (LWA) to continue the implementation of a cooperative regional monitoring program with the cities of Camarillo, Port Hueneme and San Buenaventura to meet the requirements of the original General Permit. A 2003 calendar year annual report was submitted to the RWQCB January 2004.

An updated version of the Aquatic Pesticide Permit for the control of aquatic weeds (General Permit No. CAG 990005) was adopted May 2004. In response to the updated General Permit, VCWPD again contracted with LWA to file a Notice of Intent (NOI) to seek coverage under the permit. The other cooperative agencies opted to discontinue aquatic pesticide application for the coming year and did not submit NOIs for coverage under the updated General Permit. Per the requirements of the updated General Permit, VCWPD submitted an Aquatic Pesticide Application Plan (APAP) to the RWQCB July 2004. VCWPD initiated the implementation of the water quality monitoring program detailed in the APAP during the 2004 aquatic pesticide application season.

ALTERNATIVE WEED MANAGEMENT

The requirement for a General Permit for aquatic pesticide applications prompted many of the Co-permittees to review and evaluate their current maintenance activities for maintaining their drainage systems. Several Co-permittees attended one of the several seminars hosted by the Ventura County Environmental and Energy Resources Department on Integrated Pest Management (IPM) approach to weed management. These seminars provided the Co-permittees alternative less-toxic approaches to weed control. Some Co-permittees found that they could incorporate these strategies with only minor modifications to their maintenance activities.

With increasing regulations on the use of pesticides and the growing awareness of environmental impacts from pesticide use, the Co-permittees will continue to explore alternatives and implement BMPs that mitigate their impacts on the local ecosystem. The Co-permittees forward, progressive approach is praiseworthy.


CONTROLLING
WEEDS
IN YOUR GARDEN

IPM seminar handout

COUNTYWIDE PUBLIC AGENCY ACTIVITIES TRAINING WORKSHOP

In May 2003, VCWPD provided a training session on stormwater regulations and how they relate to municipal activities at the Maintenance Superintendents Training and Equipment Workshop. This training event was open to all Co-permittee municipal staff countywide and was well attended. The Co-permittees recognize not only the need to provide such training but believe that by performing countywide training events, there is greater consistency in the implementation of stormwater regulations and activities and limited resources are leverage to their best benefit.

The Co-permittees have developed and implemented a Program for Illicit Discharges/Illegal Connection Response that is a combination of educational outreach tools and enforcement activities to increase the knowledge of target audiences about the impacts of stormwater pollution; to change behavior of target audiences; and to involve and engage different communities throughout the County in mitigating the impacts of stormwater pollution on our rivers, streams and oceans.

To meet the goals and objectives of this program, the Co-permittees have developed a comprehensive approach, which includes the following:

- Illicit discharge elimination
- Illegal connection elimination
- Public reporting
- Education and outreach

A primary goal of the Co-permittees is to detect and eliminate illicit discharges and illegal connections to the storm drain system to reduce pollutants to the MEP. Therefore the Co-permittees:

- Investigate, contain and clean up incidental spills/overflows
- Prohibit non-stormwater discharges to the storm drain system
- Observe the storm drain system to identify illegal connections during scheduled infrastructure maintenance
- Remove all illegal connections to the storm drain system through voluntary action or enforcement proceedings

In order to implement this program effectively, the Co-permittees recognize the importance of an informed public and an easy mechanism for reporting any suspected illicit discharges, illegal dumping and/or illegal connections. Thus, the Co-permittees have aggressively targeted various communities for education on stormwater quality management and the importance of eliminating or mitigating non-stormwater discharges to local stream and channels. In addition to providing extensive training to municipal staff the Co-permittees have developed and distribute public outreach materials (including brochures, posters, stickers, and refrigerator magnets) at local community events, public schools and countywide training workshops. Prominently displayed on the outreach material is a Stormwater Hotline where residents, business owners/managers, developers/contractors and others can report prohibited discharges, dumping or connections to the storm drain system.

ADDITIONAL CATEGORIES FOR MATERIAL TYPE

During the 2002-03 permit term, the Co-permittees realized that the number of categories that had been traditionally used to characterize the material type (Hazardous Material, Sewage, Wastewater) resulting from an illicit discharge were limited and often resulted in many illicit discharges being characterized as "other". In order to better describe the material involved, the Co-permittees discussed at length the typical types of illicit discharges that occur within their jurisdictions and what material is often involved. These discussions were very helpful in clarifying the fact that the Co-permittees often had different ideas and opinions on how to describe these events. After much discussion the Co-permittees agreed on an additional four categories for material type. To ensure accurate reporting, the Co-permittees agreed that definitions for each class of "material type" would keep any guesswork in describing these events to an absolute minimum.

Table 3 (shown on page 29) details the categories used by the Co-permittees to describe the material type of an illicit discharge. The definitions of these various categories are solely for facilitating the Co-permittees with their characterization of material type for annual report consistency. The Co-permittees are aware that these definitions are by no means all-inclusive nor necessarily how another agency or person would define these categories.

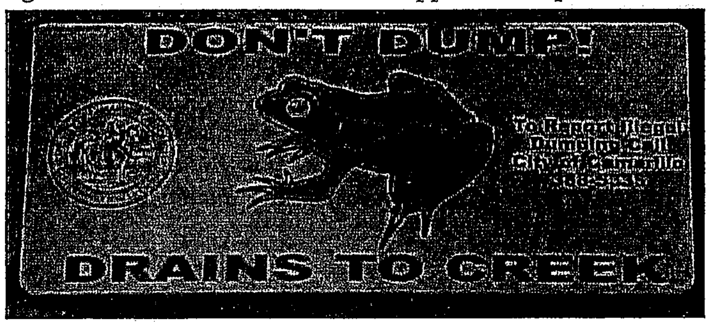
The Co-permittees used a variety of resources in helping to define these categories including the Ventura County Environmental Health website, the RWQCB website and the Environmental Protection Agency's glossary of terms and educational outreach materials.

TYPE	DEFINITION
Hazardous Material	By-products of society that can pose a substantial or potential hazard to human health or environment when improperly managed. Posses at least one of the four following characteristics (ignitability, corrosivity, reactivity, or toxicity), or is identified as a listed waste (e.g. oil, used anti-freeze, hydraulic fluid)
Sewage	The waste and wastewater produced by residential and commercial sources and discharged into sewers, includes the sludge produced by Publicly Owned Treatment Works.
Wastewater	The spent or used water from a home, community, farm or industry that contains dissolved or suspended matter.
Building Materials	Any debris associated with construction activities used to construct a building and/or stand/alone facility, such as plaster, dry-wall, nails, wood, etc.
Landscape Debris	Excessive eroded soils, sediment and/or organic materials.
Animal Wastes	Discharge from confinement facilities, kennels, pens, recreational facilities, stables, show facilities and residential yards.
Litter/Trash	Synthetic consumer by-products
Other	Any remaining materials that do not fit into the above mentioned categories.

▪ *Table 3: Material Type Categories for Illicit Discharges*

CITY OF CAMARILLO STORM DRAIN CURB MARKERS

In addition to marking their storm drain inlets with a pollution prevention message, the City of Camarillo has implemented the use of storm drain curb markers with a phone number to report illicit discharges. This creative combination of two permit-required activities (provide an illicit discharge reporting number to the public and stencil storm drains with a "no dump" message) is to be commended. Consequently, the city has experienced a significant increase in the number of reports of suspicious substances in the gutter and drain. This resourceful approach has proven a great success for the city in their efforts to improve illicit discharge reporting and the city plans to implement the markers citywide.



Example of Storm Drain Curb Marker

CITY OF SAN BUENAVENTURA ILLICIT DISCHARGE HOTLINE

The City of San Buenaventura has implemented an innovative means to provide city employees and residents with a tool to report illicit discharges. The city distributed a static-cling windshield sticker that displays the city's Illicit Discharge Hotline phone number to all city vehicles along with a flyer that describes illicit discharges and encourages employee participation in this program. The Hotline is staffed by a full-time inspector dedicated to improving stormwater quality and responds to all employee and resident illicit discharge reports. The city has empowered their entire municipal field staff with the tools and knowledge to combat stormwater pollution and should be commended for their pioneering efforts.

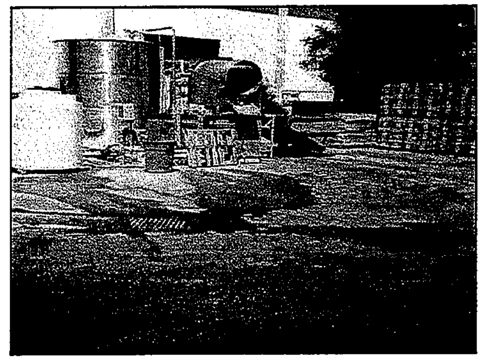
POLLUTION PREVENTION FOR CONCRETE PRODUCTS WORKSHOP

Static-cling Windshield Sticker

VCWPD in coordination with the City of Thousand Oaks held a one-day workshop that covered stormwater regulations and appropriate BMPs for working with concrete products. The workshop was coordinated with the Program for Construction sites and emphasized prevention of non-stormwater discharges (source control), appropriate cleaning methods, material storage, and proper disposal. For more information regarding this event, see Section 3: Construction Sites (shown on page 21).

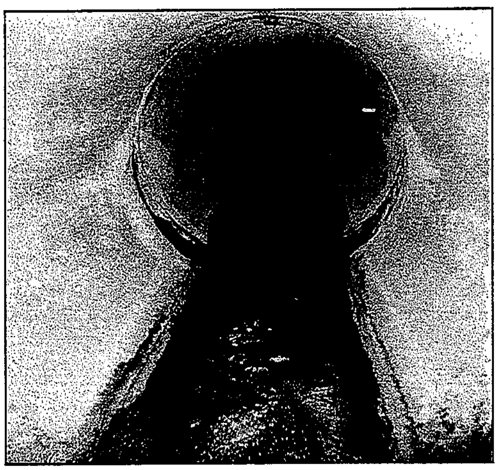
FROZSUN FOOD FACILITY ENFORCEMENT ACTION

In 2002, the City of Oxnard during a routine inspection of Frozsun Foods facility (Oxnard) discovered that a seal on the bypass valve had been cut and the valve was in the open position. This allowed process wastewater to be discharged without treatment. In addition, containment drums that had been installed in the storm drain catch basins were removed and submersible pumps that directed wastewater back to the treatment system were inoperable. This condition allowed untreated strawberry waste to enter the storm drain system.



Evidence of illicit discharge to storm drain system

The City inspectors documented the prohibited discharge and issued a Notice of Violation. Due to the magnitude of the violation the City Attorney's office initiated enforcement proceedings against Frozsun. Frozsun eventually settled the matter out of court for a substantial monetary penalty.



Evidence of strawberry waste discharged to storm drain system

Section 4

Draft Permit

DRAFT PERMIT

STATE OF CALIFORNIA
CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LOS ANGELES REGION

ORDER NO. XXXX NPDES PERMIT NO. CASXXXXXXX
WASTE DISCHARGE REQUIREMENTS
FOR
MUNICIPAL STORM WATER AND URBAN RUNOFF DISCHARGES
WITHIN
VENTURA COUNTY WATERSHED PROTECTION DISTRICT,
COUNTY OF VENTURA, AND THE CITIES OF VENTURA COUNTY

The California Regional Water Quality Control Board, Los Angeles Region (hereinafter the Regional Board), finds that:

1. **CO-PERMITTEES ARE DISCHARGES OF URBAN RUNOFF**: Each of the entities in Table 1 below, hereinafter the Co-permittees or Discharger, have joined together to form the Ventura Countywide Storm Water Quality Management Program to discharge wastes under waste discharge requirements contained in Order No. XX-XXX, adopted by this Board on July 27, 2005. The Discharger discharges or contributes to discharges of storm water and urban runoff from municipal separate storm sewer systems (MS4s), also called storm drain systems, into receiving waters of the Santa Clara River, Ventura River, Calleguas Creek and other coastal watersheds within Ventura County.

Table 1. Municipal Co-permittees

1. City of Camarillo	7. City of San Buenaventura
2. City of Fillmore	8. City of Santa Paula
3. City of Moorpark	9. City of Simi Valley
4. City of Ojai	10. City of Thousand Oaks
5. City of Oxnard	11. County of Ventura
6. City of Port Hueneme	12. Ventura County Watershed Protection District

2. The Regional Board may require a separate National Pollutant Discharge Elimination System (NPDES) permit for any entity that discharges storm water into coastal watersheds of Ventura County. Such entity can be any State or Federal agency, State or Federal facility, real estate development, waste disposal facility, special district, private interest, etc. Pursuant to 40 CFR 122.26(a), the Regional Board will give these entities the option to become a Co-permittee, after obtaining the concurrence of the Co-permittees, or obtain an individual storm water discharge permit.

3. **NATURE OF DISCHARGE**: Storm water discharges consist of surface water runoff generated from various land uses in all hydrologic drainage basins which discharge into waters of the State. The quality of these discharges varies and is affected by hydrology, geology, land use, season and sequence and duration of hydrologic events. The primary pollutants of concern currently identified by the Program for these discharges are total Nitrogen, total DDT, chlorpyrifos, copper, total coliform, ammonia. zinc and lead.

4. In general, the substances that are found in urban storm water runoff can harm human health and aquatic ecosystems. In addition, the high volumes of storm water discharges from MS4s in areas of urbanization can significantly impact aquatic ecosystems due to physical modifications such as bank erosion and widening of channels. It is anticipated that, due to the nature of storm water events (i.e., large volumes of water and high velocities) that there will be short-term, reversible impacts to beneficial uses that are not directly related to water quality.

5. Water quality assessments conducted by the Regional Board identified impairment, or threatened impairment, of beneficial uses or water bodies in the Ventura Coastal Watersheds. These impairments include many of the pollutants of concern identified by the program. These impairments are identified on the Federal 303(d) list of impaired water bodies.

6. **PERMIT BACKGROUND**: The Discharger has filed a report of waste discharge (ROWD) and has applied for renewal of its waste discharge requirements and an NPDES permit to discharge wastes to surface waters.

7. The Ventura Countywide Storm Water Quality Management Program also includes the Storm Water Monitoring Plan. To date, the monitoring program has consisted of land-use based, receiving water, and mass emission monitoring with a bio-assessment monitoring program for the Ventura River. The Discharger also participates in the Regional Monitoring Program established for southern California municipal programs under the guidance of the Southern California Coastal Water Research Project (SCCWRP).

8. The Regional Board has reviewed the ROWD and has determined it to be complete under the reapplication policy for MS4s issued by the USEPA on July 1996.

9. PERMIT COVERAGE: The area subject to permit requirements includes all areas within the boundaries of the cities as well as unincorporated areas of Ventura County defined as urban by the U.S. Census Bureau. Municipal storm drain systems in this area discharge either directly into the Pacific Ocean or one of the five major watersheds:

Watershed	**Receives Municipal Storm Drain Discharges From:**
Ventura River	City of Ojai, City of San Buenaventura (part), unincorporated Ventura County (part)
Santa Clara River	City of Fillmore, City of Oxnard (part), City of San Buenaventura (part), City of Santa Paula, unincorporated Ventura County (part)
Calleguas Creek	City of Camarillo, City of Moorpark, City of Simi Valley, City of Thousand Oaks (part), unincorporated Ventura County (part)
Malibu Creek	City of Thousand Oaks (part), unincorporated Ventura County (part)
Bays/Estuaries	City of Oxnard (part), City of Port Hueneme, City of San Buenaventura (part)

10. This permit is intended to develop, achieve and implement a timely, comprehensive, cost-effective storm water pollution control program to minimize pollutants to the maximum extent practicable in storm water discharges from the permitted areas in Ventura County to the waters of the United States.

11. The Co-permittees lack legal jurisdiction over storm water discharges into their respective MS4s from agricultural activities, State and Federal facilities, utilities and special districts, Native American tribal lands, wastewater management agencies and other point and non-point source discharges otherwise permitted by or under the jurisdiction of the Regional Board. The Regional Board recognizes that the Co-permittees should not be held responsible for such facilities and/or discharges. Similarly, certain activities that generate pollutants present in urban runoff are beyond the ability of the Co-permittees to eliminate. Examples of these include operation of internal combustion engines, atmospheric deposition, brake pad wear, tire wear, residues from lawful application of pesticides, nutrient runoff from agricultural activities and leaching of naturally occurring minerals from local geography.

12. **FEDERAL AND STATE REGULATIONS**: The Water Quality Act of 1987 added Section 402(p) to the Federal Clean Water Act (CWA). This section requires the U.S. Environmental Protection Agency (USPEA) to establish regulations setting forth NPDES requirements for storm water discharges. The first phase of these requirements was directed at municipal separate storm drainage systems (MS4s) serving a population of 100,000 or more and storm water discharges associated with industrial activities, including construction activities. Other dischargers, including municipalities with a population of less than 100,000 for which the USEPA Administrator or the State determines that the storm water discharge contributes to a violation of a water quality standard or is a significant contributor of pollutants to waters of the United States, may also be subject to NPDES requirements. On November 16, 1990, USEPA published these final regulations in the Federal Register under Part 122 Code of Federal Regulations.

13. The CWA allows the USEPA to delegate its NPDES permitting authority to states with an approved environmental regulatory program. The State of California is a delegated State. The Porter-Cologne Water

Quality Control Act (California Water Code) authorizes the State Water Resources Control Board (State Board), through the Regional Boards, to regulate and control the discharge of pollutants into waters of the State and tributaries thereto.

14. Section 6217(g) of the Coastal Zone Act Reauthorization Amendments of 1990 (CZARA) requires coastal states with approved coastal zone management programs to address non-point pollution impacting or threatening coastal water quality. CZARA addresses five sources of non-point pollution: agriculture, silviculture, urban, marinas and hyrdomodification. This NPDES permit addresses the management measures required for the urban category, with the exception of septic systems. The Regional Board addresses septic systems through the administration of other programs.

15. The State Water Resources Control Board (State Board) adopted a revised Water Quality Control Plan for Ocean Waters of California (Ocean Plan) on July 23, 1997. The Ocean Plan contains water quality objectives for the coastal waters of California.

16. This Regional Board adopted a revised Water Quality Control Plan (Basin Plan) for the Los Angeles Region on June 13, 1994. The Basin Plan, with is incorporated into this Order by reference, specifies the beneficial uses of Ventura County water bodies and their tributary streams and contains both narrative and numerical water quality objectives for these receiving waters. The following beneficial uses are identified in the Basin Plan and apply to all or portions of each watershed covered by this Permit:
    a. Municipal and domestic supply
    b. Agriculture supply
    c. Industrial service supply
    d. Industrial process supply
    e. Ground water recharge
    f. Freshwater replenishment
    g. Navigation
    h. Hydropower generation
    i. Water contact recreation
    j. Non-contact water recreation
    k. Ocean commercial and sport fishing
    l. Warm freshwater habitat
    m. Cold freshwater habitat
    n. Preservation of Areas of Special Biological Significance
    o. Saline water habitat
    p. Wildlife habitat
    q. Preservation of rare and endangered species
    r. Marine habitat
    s. Fish migration
    t. Fish spawning
    u. Shellfish harvesting

17. To facilitate compliance with federal regulations, the State Water Resources Control Board (State Board) has issued two statewide general NPDES permits; one for storm water from industrial sites [NPDES No. CAS000001, General Industrial Activities Storm Water Permit (GIASP) and the other for storm water from construction sites [NPDES No. CAS000002, General Construction Activity Storm Water Permit (GCASP). The GCASP was issued on August 27, 2004. The GIASP was reissued on April 17, 1997. Facilities discharging storm water associated with industrial activities and construction projects with a disturbed area of one acre or more are required to obtain individual NPDES permits for storm water discharges, or be covered by these statewide general permits by completing and filing a Notice of Intent (NOI) with the State Board. The USEPA guidance anticipates coordination of the state-administered programs for industrial and construction activities with the local agency program to reduce pollutants in storm water discharges to the MS4.

18. The State Board, on October 28, 1968, adopted Resolution No. 68-16, "Maintaining High Quality Water" which established an anti-degradation policy for State and Regional Boards.

19. The State Board, on June 17, 1999, adopted Order No. WQ 99-05, which specifies standard receiving water limitations language to be included in all municipal storm water permits issued by the State and Regional Boards.

20. California Water Code (CWC) Section 13263(a) requires that waste discharge requirements issued by Regional Boards shall implement any relevant water quality control plans that have been adopted; shall take into consideration the beneficial uses to be protected and the water quality objectives reasonably required for that purpose; other waste discharges; and the need to prevent nuisance.

21. California Water Code Section 13370 *et seq.* requires that waste discharge requirements issued by the Regional Boards comply with provisions of the Federal Clean Water Act and its amendments.

22. **PUBLIC NOTIFICATION**: This action to adopt and issue waste discharge requirements and an NPDES permit for this discharge is exempt from the provisions of the California Environmental Quality Act (CEQA), Chapter 3 (commencing with Section 21100) of Division 13 of the Public Resources Code in accordance with Section 13389 of the California Water Code.

23. The Regional Board has notified the Discharger and interested agencies and persons of its intent to issue waste discharge requirements for this discharge and has provided them with an opportunity to submit their written views and recommendations.

24. The Regional Board, in a public hearing, heard and considered all comments pertaining to the discharge and to the tentative requirements.

25. This Order shall serve as a National Pollutant Discharge Elimination System (NPDES) Permit, pursuant to Section 402 of the Federal Clean Water Act, or amendments thereto, and shall take affect on August 11, 2005 provided the Regional Administrator of the USEPA has no objections.

IT IS HEREBY ORDERED that the Co-permittees, in order to meet the provisions contained in Division 7 of the California Water Code and regulations adopted thereunder, and the provisions of the Clean Water Act and regulations adopted thereunder, shall comply with the following:

A. PROHIBITIONS – DISCHARGES

1. Discharges into and from MS4s in a manner causing a condition of pollution, contamination, or nuisance (as defined in CWC § 13050), in waters of the state are prohibited.
2. Discharges from MS4s, which are a major cause or contributor to exceedances of receiving water quality objectives for surface water are prohibited.
3. Discharges from MS4s containing pollutants of concern that have not been reduced to the maximum extent practicable (MEP) are prohibited.

B. PROHIBITIONS – NON-STORM WATER DISCHARGES

1. Each Co-permittee shall effectively prohibit all types of non-storm water discharges into its Municipal Separate Storm Sewer System (MS4) unless such discharges are either authorized by a separate NPDES permit; or not prohibited in accordance with B.2. and B.3. below.
2. Pursuant to 40 CFR 122.26(d)(2)(iv)(B)(1), the following categories of non-storm water discharges need only be prohibited from entering an MS4 if such categories of discharges are identified by the Co-permittee as a significant source of pollutants to waters of the United States.
   a. Diverted stream flows
   b. Rising ground waters
   c. Uncontaminated ground water infiltration [as defined at 40 CFR 35.2005(20)] to MS4s
   d. Uncontaminated pumped ground water
   e. Foundation drains
   f. Natural springs
   g. Water from crawl space pumps
   h. Footing drains
   i. Air condition condensation
   j. Flows from riparian habitats and wetlands
   k. Water line flushing
   l. Landscape irrigation
   m. Discharges from potable water sources
   n. Irrigation water

o. Lawn watering
p. Individual residential car washing
q. Dechlorinated swimming pool discharges, and
r. Discharges or flows from emergency fire fighting activities

3. If any of the above categories of non-storm water discharges are determined to be a significant source of pollutants by the Regional Board Executive Officer, the Co-permittee shall either:
   a. Prohibit the discharge category from entering its MS4; or
   b. Not prohibit the discharge category and implement or require the responsible party(ies) to implement BMPs which will reduce pollutants to the MEP
4. The Regional Board Executive Officer may authorize the discharge of additional categories of non-storm water, after consideration of antidegradation policies and upon presentation of evidence that the non-storm water discharge will not be a source of pollutants. This evidence may include the implementation of BMPs to control pollutants.

C. RECEIVING WATER LIMITATIONS

1. Discharges from MS4s that cause or contribute to the violation of water quality standards or water quality objectives are prohibited.
2. Discharges from the MS4 of storm water or non-storm water for which a Co-permittee is responsible shall not cause or contribute to a condition of nuisance.
3. Each Co-permittee shall comply with this Order through timely implementation of control measures and other actions to reduce pollutants in the discharges in accordance with the Ventura County SMP and other requirements of this Order including any modifications. The SMP shall be designed to achieve compliance with receiving water limitations. If exceedance(s) of water quality objectives or water quality standards persist, notwithstanding implementation of the SMP and other requirements of this Order, the Co-permittee shall assure compliance with discharge prohibitions and receiving water limitations by complying with following procedure:
   a. Upon a determination by either the Discharger or the Regional Board that discharges are causing or contributing to an exceedance of an applicable water quality standard(s), the Co-permittees shall promptly notify and thereafter submit a report to the Regional Board that describes BMPs that are currently being implemented, to prevent or reduce pollutants that are causing or contributing to the exceedances of water quality standard(s). This report may be included with the Annual Storm Water Report, unless the Regional Board directs an earlier submittal. The report shall include an implementation schedule. The Regional Board may require modifications to the report.
   b. Submit any modifications to the report required by the Regional Board within 30 days of notification.
   c. Within 30 days following the approval of the report, the Co-permittee shall revise the SMP and monitoring program to incorporate the approved, modified suite of BMPs, implementation schedule and any additional monitoring required.
   d. Implement the revised SMP and monitoring program according to the approved schedule.

   So long as the Discharger has complied with the procedures set forth above and are implementing the revised SMP, the Co-permittees does not have to repeat the same procedure for continuing or recurring exceedance(s) of the same receiving water limitations unless directed by the Regional Board to do so.

D. LEGAL AUTHORITY

1. Each Co-permittee shall possess the necessary legal authority to prohibit non-storm water discharges and control the contribution of pollutants to the storm drain system from storm water discharges, including, but not limited to:
   a. Prohibit illicit discharges and illicit connections and require the removal of illicit connections
      i. Prohibit the discharge of wash waters to the MS4 when gas stations, auto repair garages, or other types of automotive service facilities are cleaned
      ii. Prohibit the discharge of runoff to the MS4 from mobile auto washing, steam cleaning, mobile carpet cleaning, and other such mobile commercial and industrial operations
      iii. Prohibit the discharges of runoff to the MS4 from areas where repair of machinery and equipment which are visibly leaking oil, fluid or antifreeze is undertaken
      iv. Prohibit the discharge of runoff to the MS4 from storage areas of materials, containing grease, oil or other hazardous substances and uncovered receptacles containing hazardous materials
      v. Prohibit the discharge of chlorinated swimming pool water and filter backwash to the MS4

vi. Prohibit the discharge of untreated runoff from the washing of toxic materials from paved or unpaved areas to the MS4
vii. Prohibit washing impervious surfaces in industrial/commercial areas which results in a discharge of untreated runoff to the MS4, unless specifically required by State or local health and safety codes; and
viii. Prohibit the discharge from washing out of concrete trucks, pumps, tools and equipment to the MS4.

b. Prohibit spills, dumping or disposal of materials other than storm water;
   i. Litter, landscape debris and construction debris
   ii. Any state or federally banned pesticide, fungicide or herbicide
   iii. Food wastes
   iv. Fuel and chemical wastes, animal wastes, garbage, batteries and other materials which have potential adverse impacts on water quality
c. A mechanism to control, through interagency agreement, the contribution of pollutants from one portion of the MS4 to another portion of the MS4
d. Require compliance with conditions in ordinances, permits, contracts or orders; and
e. Carry out all inspections, surveillance and monitoring procedures necessary to determine compliance and non-compliance with permit conditions including the prohibition on illicit discharges to the MS4.
f. Each Co-permittee shall amend an existing agency-specific storm water and urban runoff ordinance if necessary to be able to enforce all requirements of this Order.

E. VENTURA COUNTYWIDE STORMWATER QUALITY MANAGEMENT PLAN IMPLEMENTATION, MONITORING AND REPORTING

General Requirements

(1) The Discharger shall, at a minimum, adopt and implement the elements of the Ventura County SMP that are consistent with the terms of this permit.

(2) The Ventura County SMP shall, at a minimum, comply with applicable requirements of 40 CFR 122.26(d)(2). The Ventura County SMP shall be implemented so as to reduce the discharges of pollutants in storm water to the maximum extent practicable.

(3) Each Co-permittee shall be responsible for implementation of relevant portions of the Ventura County SMP within its jurisdictional boundaries. The Principal Co-permittee shall be responsible for program coordination as described in the Ventura County SMP as well as compliance with relevant portions of the permit within its jurisdiction.

Modifications

(1) The Discharger shall modify the Ventura County SMP to make it consistent with the requirements herein. The revised Ventura County SMP will be submitted to the Regional Board Executive Officer for approval no later than 180 days after adoption of this Order.
(2) The Regional Board Executive Officer may approve changes to the Ventura County SMP, except as noted above, either:
   i. Upon petition by the Discharger or interested parties and after providing for and considering public comment, or
   ii. As deemed necessary by the Regional Board Executive Officer following notice to the Discharger and after providing for and considering public comment

The Discharger may modify the Ventura County SMP at the direction of the Regional Board Executive Officer, to incorporate regional provisions. Such provisions may include watershed-specific requirements for watersheds shared by the Discharger with other MS4 programs.

The Discharger may modify the Ventura County SMP to comply with waste load allocations developed and approved pursuant to the process for the designation and implementation of Total Maximum Daily Loads (TMDLs) for impaired water bodies. All NPDES-regulated storm water discharges that implement Waste Load Allocations (WLAs) in TMDLs shall be expressed in the form of best management practices (BMPs).

The Ventura Countywide Stormwater Quality Management Plan (SMP) describes in detail all group activities and entity-specific activities. The SMP also describes management measures and how they are organized; lists tasks required to accomplish these measures, the schedule for implementation and specific goals. The schedule and tasks are projected for the 5-year permit period and consist of the following elements:

- **E.1 Program Management**
- **E.2 Programs for Residents**
- **E.3 Programs for Industrial/Commercial Businesses**
- **E.4 Programs for Land Development**
- **E.5 Programs for Construction Sites**
- **E.6 Programs for Co-permittee Public Agency Activities; and**
- **E.7 Programs for Illicit Discharge Control**
- **E.8 Countywide Stormwater Monitoring Program**

E.1 Program Management

Each Co-permittee shall collaborate with all other Co-permittees regulated under this Order to address common issues, promote consistency and to plan and coordinate activities required under this Order.

A. Management Structure

(1) The Co-permittees are separate legal entities and have the authority to develop, administer, implement and enforce storm water quality management programs within their own jurisdiction. The Ventura County SMP defines certain storm water discharge requirements that apply to the Discharger, and others that apply to specific Co-permittees. Each Co-permittee is responsible for compliance with relevant portions of this permit within their jurisdiction.

(2) All Co-permittees shall be represented at the Management Committee Meetings:

- There are currently five subcommittees, which were developed during the first two permit cycles: Residents, Business/Illicit Discharges, Planning and Land Development, Construction, and Public Infrastructure. The Management Committee will schedule subcommittee meetings as needed. Co-permittees shall be represented at all assigned subcommittee meetings.

B. VCWPD is the Principal Co-permittee for permit implementation while the remaining entities, including the County of Ventura and the ten cities are designated as Co-permittees. The following Implementation Agreement exists between the Principal Co-permittee and the Co-permittees:

As the Principal Co-permittee, VCWPD will:

- Coordinate PERMIT activities
- Prepare the Principal Co-permittee annual budget for Co-permittee review
- Advise Co-permittees of meetings with the LARWQCB regarding the countywide NPDES program
- After consultation with the Co-permittees and representing the interests of the Co-permittees, serve as an advocate between the Co-permittees and the LARWQCB
- Set time schedules for countywide meetings and submittals to LARWQCB
- Prepare, modify and submit regulatory reports
- Forward Co-permittee information to the LARWQCB
- Arrange for public review, when needed
- Update Co-permittees on LARWQCB and USEPA regulations
- Submit Report of Waste Discharge (ROWD) application and Stormwater Management Plan (SMP) and negotiate new Permit after consultation with the Management Committee
- Secure services of consultants for Principal Co-permittee activities as needed
- Coordinate billing with County of Ventura Environmental Health Department (EHD) and other organizations that provide countywide services

- Provide standardized formats for NPDES countywide databases required to be submitted to the LARWQCB and provide this data to the Co-permittees
- Upon annual approval by the Management Committee, pay memebership fees and represent Co-permittees at Southern California Coastal Water Research Project (SCCWRP) and California Stormwater Quality Association (CASQA) meetings and share information with Co-permittees
- Manage and implement the stormwater quality monitoring program as required in the Permit
- Convene the Management Committee and subcommittee meetings. Chair meetings and provide agendas, meeting minutes and handouts
- Attend subcommittee meetings
- Manage countywide public outreach program as defined in the Stormwater Management Plan (SMP)

All Co-permittees will:

- Comply with the requirements of the permit within their own jurisdictional boundaries
- Prepare and provide to the Principal Co-permittee permit-required submittals
- Develop programs to address:
  - Implementation of controls to reduce pollution from commercial, industrial and residential areas
  - Implementation of structural/non-structural controls on land development and construction sites
  - Implementation of controls to reduce pollution from maintenance activities
  - Elimination of illegal connections, including discouragement of improper disposal, encouragement of spill prevention and containment and implementation of appropriate spill response
  - Inspection monitoring and control programs for industrial facilities
  - Implementation of public awareness and training program

C. Within its own jurisdiction, each Co-permittee is responsible for adoption and enforcement of storm water pollution prevention ordinances, implementation of self-monitoring programs and Best Management Practices (BMPs) and conducting applicable inspections. Based upon a countywide model, each Co-permittee has adopted a Storm Water Quality Ordinance applicable to their jurisdiction. This is in addition to the "Control of Water Quality, Soil, Erosion and Sedimentation of New Agricultural Hillside Developments" adopted by the Ventura County Board of Supervisors on March 20, 1984.

D. Annual Storm Water Report and Assessment – The Principal Co-permittee shall submit by October 1 of each year beginning the Year 2006, an Annual Storm Water Report and Assessment (Annual Report) documenting the status of the general program and individual tasks contained in the Ventura County SMP (SMP) as well as the results of the monitoring and reporting program. The Annual Report shall cover each fiscal year from July 1 through June 30 and shall include information necessary to assess the Discharger's compliance status relative to this Order and the effectiveness of implementation of permit requirements on storm water quality. The Annual Report shall include any proposed changes to the SMP as approved by the Management Committee.

E. Each Co-permittee shall also comply with standard provisions, reporting requirements and notifications contained in Attachment A of this Order.

F. Pursuant to California Water Code section 13267, each Co-permittee shall comply with the Annual Reporting Requirements contained in Attachment B of this Order.

E.2 Programs for Residents

Each Co-permittee shall implement a residential educational outreach program. At a minimum the residential outreach program shall address:

E.2.A. Public Reporting

E.2.B. Stencil Program
E.2.C. Education and Outreach

A. Public Reporting

Co-permittees shall identify staff to serve as the public reporting contact person(s) for reporting clogged catch basin inlets and illicit discharges/dumping and general storm water management information within 180 days after adoption of this Order. Once identified, the public reporting contact person(s) information shall be included in the government pages of the telephone book. Designated staff will be provided with relevant storm water quality information including resident/educational outreach program activities, preventative storm water pollution control information and contact information for responding to illicit discharges/illegal dumping.

B. Stencil Program

Co-permittees shall mark storm drain inlets within their jurisdiction with a legible "no dumping" message. In addition, signs with prohibitive language discouraging illegal dumping shall be posted at designated public access points to creeks, other relevant water bodies and channels.

C. Education and Outreach

Each Co-permittee shall conduct educational activities within its jurisdiction and participate in appropriate regional events.

Each Co-permittee shall distribute outreach materials to the general public and school-aged children at appropriate public counters and events. Outreach material shall include information such as proper disposal of litter, green waste, and pet waste, proper vehicle maintenance techniques, proper lawn care and water conservation practices.
All of the Co-permittees shall jointly insure that a minimum of 2.1 million impressions per year are made on the general public about storm water quality via print, local TV access, local radio and other appropriate media.

E.3. Programs for Industrial/Commercial Businesses

Each Co-permittee shall implement an industrial/commercial educational site inspection program. At a minimum the industrial/commercial program shall address:

E.3.A. Source Identification
E.3.B. Inspection of Commercial Sites and Sources
E.3.C. Enforcement of Commercial Sites and Sources
E.3.D. Targeted Industrial Facilities
E.3.E. Database of Commercial and Targeted Industrial Facilities
E.3.F. Staff Training

A. Source Identification

Each Co-permittee shall develop an inventory of the following commercial sites/sources listed below.

(1) Automobile service facilities
(2) Food service facilities

B. Inspection of Commercial Sites and Sources

Co-permittees shall inspect the above-mentioned facilities in its jurisdiction once every two years. During site visits, Co-permittees shall:

- Consult with a representative of the facility to explain applicable storm water regulations
- Distribute and discuss applicable BMP and educational materials

- Conduct a site walk-through to inspect for, at a minimum, evidence of illicit discharges and storm water educational programs for employees

Co-permittees shall revisit these facilities where evidence of an active illicit discharge is found within six months of the inspection.

C. Enforcement of Commercial Sites and Sources

Co-permittees shall revisit auto and food service facilities where evidence of an active illicit discharge is found within six months of the inspection. If necessary, Co-permittees will begin enforcement action to remove sources of active illicit discharges.

D. Targeted Industrial Facilities

Each Co-permittee shall conduct a site visit and complete a site visit checklist and distribute educational materials to industrial facilities within their jurisdiction that are potentially subject to the State General Industrial Permit (General Industrial Permit) but are known to have not filed a Notice of Intent (NOI) within two years of adoption of this Order. After which each Co-permittee shall redistribute educational program materials to these facilities once every two years. Educational materials shall provide information on the specific requirements of the General Industrial Permit, including which facilities must file a NOI with the State Board and maintain a Storm Water Pollution Prevention Plan (SWPPP) on site, and a description of illicit discharges. Educational materials shall describe the types of discharges prohibited, how to prevent illicit discharges, what to do in the event of an illicit discharge and potential enforcement actions the facility may be subject to, including penalties that can be assessed.

E. Database of Commercial and Targeted Industrial Facilities

Co-permittees shall provide an annual update to a database that lists those commercial/industrial facilities targeted under this program component. The database shall include the facility name, site address, facility contact, applicable industrial code(s) and NPDES storm water permit coverage status.

F. Staff Training

Co-permittees shall annually train their employees in targeted positions (whose jobs or activities directly affect storm water quality, or those who response to questions from the public), including inspection staff, regarding the requirements of the storm water management program.

E.4. Programs for Land Development

Each Co-permittee shall minimize the short and long-term impacts on receiving water quality from new development and redevelopment. In order to reduce pollutants and runoff flows from new development and redevelopment to the maximum extent practicable, each Co-permittee shall at a minimum:

E.4.A. Development Project Approval Process
E.4.B. Revise Environmental Review Process
E.4.C. Staff Training
E.4.D. Conduct Education Efforts Focused on New Development and Redevelopment

A. Development Project Approval Process

(1) Stormwater Quality Urban Impact Mitigation Plan (SQUIMP)
The Co-permittees during the last permit term (2000-05) adopted and implemented the Ventura Countywide Stormwater Quality Urban Impact Mitigation Plan (SQUIMP) to address conditions and requirements for new development and significant redevelopment by the private sector (Attachment C).

At a minimum, appropriate elements of the SQUIMP are included as project requirements for the following development categories:

a. Single-family hillside residences
b. 100,000s square foot commercial developments
c. Automotive repair shops
d. Retail gasoline outlets
e. Restaurants
f. Home subdivisions with 10 or more housing units
g. Locations within, or directly adjacent to or discharging directly to an environmentally sensitive area (ESAs); and
h. Parking lots of 5,000 feet or more or with 25 or more parking spaces and potentially exposed to storm water

(2) Environmentally Sensitive Areas (ESAs)
The Co-permittees were required during the last permit term (2000-05) to identify specific environmentally sensitive areas (ESAs) in Ventura County for the application of SQUIMP requirements and submit to the Regional Board for approval. In August 2003, the Regional Board approved the Co-permittees' designation of ESAs within Ventura County. Environmentally Sensitive Areas (ESAs) include Clean Water Act 303(d) Listed Water Bodies in all reaches that are unimproved, all California Coastal Commission's Environmentally Sensitive Habitat Areas as delineated on maps in Local Coastal Plans and Regional Water Quality Control Board's Basin Plan Rare, Threatened or Endangered Species (RARE) sites.

(3) Downstream Erosion
SQUIMP requirements include the control of post-development peak storm water runoff discharge rates to maintain or reduce pre-development downstream erosion and to protect stream habitat. The Co-permittees have adopted the following numeric sizing criteria for structural treatment BMPs to be implemented for all SQUIMP development projects:

Volume

Volume-based BMPs shall be designed to mitigate (infiltrate, filter or treat) the volume necessary to capture and treat 80 percent or more of the average annual runoff volume from the site at the design drawdown period specified in the *Ventura County Technical Guidance Manual for Stormwater Quality Control Measures* Fact Sheet for the proposed treatment control measures

OR

Flow

Flow-based BMPs shall be designed to mitigate (infiltrate, filter or treat) 10% of the 50-year design flow rate

This criteria has been included in the Co-permittees' Technical Guidance Manual for Stormwater Quality Control Measures (July 2002).

(4) Technical Guidance Manual for Stormwater Quality Control Measures
During the last permit term (2000-05) the Co-permittees developed and implemented a technical manual to address specifications for treatment control BMPs and structural BMPs based on the flow-based and volume-based water quality design criteria listed above and criteria for the control of discharge rates and erosion. The Co-permittees will continue to implement this manual and update it as needed

B. Revise Environmental Review Process

(1) To the extent feasible, the Co-permittees shall revise their internal planning procedures for preparing/reviewing CEQA documents and for linking storm water quality mitigation conditions to legal discretionary project approvals.

C. Staff Training

Co-permittees shall annually train their employees in targeted positions (whose jobs or activities are engaged in development planning) regarding the requirements of the SQUIMP.

D. Conduct Education Efforts Focused on New Development and Redevelopment

Co-permittees shall discuss storm water controls at construction sites and distribute educational materials targeted to the construction community during meetings, inspections and as appropriate.

E.5. Programs for Construction Sites

Each Co-permittee shall implement a Construction Program within its jurisdiction to reduce pollutants in runoff from construction sites during all construction phases. At a minimum the construction program shall address:

E.5.A. Construction and Grading Approval Process
E.5.B. BMP Implementation
E.5.C. Inspection of Construction Sites
E.5.D. Enforcement of Construction Sites
E.5.E. Non-compliant Sites
E.5.F. Staff Training
E.5.G. Educational Outreach

A. Construction and Grading Approval Process

Co-permittees shall require the preparation, submittal and implementation of a Storm Water Pollution Prevention Plan (SWPPP) prior to issuance of a grading permit for construction projects that: will result in soil disturbance of one acre or more in size; is within or discharging directly to or directly adjacent to an environmentally sensitive area, or is located in a hillside area. Each Co-permittee shall require those projects, which meet one of the above-mentioned criteria to implement measures to ensure that pollutants from the site will be reduced to the maximum extent practicable.

B. BMP Implementation

SWPPPs shall include appropriate construction site BMPs selected from the California Stormwater Quality Association BMP Handbook. In addition, Co-permittees shall ensure the following minimum requirements are met, to the maximum extent practicable at all construction sites:

(1) Sediments generated on the project site shall be retained using structural drainage controls
(2) No construction-related materials, wastes, spills or residues shall be discharged from the project site to city-accepted streets, drainage facilities connected to the municipal storm drain system or adjacent properties by wind or runoff
(3) Non-storm water runoff from equipment and vehicle washing and any other activity shall be contained at the project site
(4) Erosion from construction slopes and channels will be mitigated, by implementing BMPs, including, but not limited to, limiting of grading scheduled during the wet season, inspecting graded areas during rain events, planting and maintenance of vegetation on slopes and covering erosion susceptible slopes

a. In consideration of the nature of construction sites as a "work in progress", activities that require removal of BMPs to install better or permanent BMPs, based on the status of the construction shall not violate these requirements as long as subsections 1 through 3 are met above.
b. Plans should be provided in the SWPPP indicating at what stage of the construction such changes will be implemented, the areas of the project that will be affected, and any mitigation to be implemented to ensure subsections 1 through 3 remain effective during the "work in progress."

The SWPPP must include the rationale used for selecting or rejecting BMPs. The project architect, or engineer of record, or authorized qualified designee, must sign a statement of the SWPPP to the effect:

"As the architect/engineer of record, I have selected appropriate BMPs to effectively minimize the negative impacts of this project's construction activities on storm water quality. The project owner and contractor are aware that the selected BMPs must be installed, monitored and maintained to endure their effectiveness. The BMPs not selected for implementation are redundant or deemed not applicable to the proposed construction activity."

The landowner shall sign a statement to the effect:

"I certify that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, to the best of my knowledge and belief, the information submitted is true, accurate and complete. I am aware that submitting false and/or inaccurate information, failing to update the SWPPP to reflect current conditions, or failing to properly and/or adequately implement the SWPPP may result in revocation of grading and/or other permits or other sanctions provided by the law."

The SWPPP certification shall be signed by the landowner as follows:

(1) For a corporation: by a responsible corporate officer which means (a) president, secretary, treasurer or vice president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision-making functions for the corporation, or (b) the manager of the construction activity if authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures;
(2) For a partnership or sole proprietorship: by a general partner of the proprietor; or
(3) For a municipality or other public agency: by an elected official, a ranking management official (e.g., County Administrative Officer, City Manager, Director of Public Works, City Engineer, District Manager), or the manager of the construction activity if authority to sign SWPPPs has been assigned or delegated to the manager in accordance with established agency policy.

Co-permittees shall require proof of filing a Notice of Intent for coverage under the State General Construction Activity Storm Water Permit prior to issuing a grading permit for all projects requiring coverage under the state general permit.

C. Inspection of Construction Sites

Co-permittees shall inspect sites with SWPPPs for storm water quality requirements during routine inspections a minimum of once during the wet season.

D. Enforcement of Construction Sites

Each Co-permittee shall enforce its ordinances (grading, storm water, etc.) and permits (construction, grading, etc.) at construction sites as necessary to maintain compliance with this Order.

E. Non-compliant Sites

For inspected sites that have not adequately implemented their SWPPP, a follow-up inspection to ensure compliance will take place within two weeks. If compliance has not been achieved and the site is covered under the General Construction Permit, the Regional Board shall be notified.

F. Staff Training

Co-permittees shall annually train employees in targeted positions (whose jobs or activities are engaged in construction activities including construction inspection staff) regarding the requirements of the storm water management program.

G. Educational Outreach

Each Co-permittee shall discuss storm water controls at construction sites and distribute educational materials targeted to the construction community during meetings, inspections, and as appropriate.

E.6. Programs for Co-permittee Public Agency Activities

Each Co-permittee shall implement a Program for Public Agency Activities to prevent or reduce pollutants in runoff from municipal land use areas and activities. At a minimum the public agency activity program will address:

- E.6.A. Pollution Prevention
- E.6.B. Maintenance of Catch Basins, Open Drainage Facilities and Detention/Retention Basins
- E.6.C. Management of Pesticides, Herbicides and Fertilizers
- E.6.D. Development and Implementation of Storm Water Pollution Prevention Plans for Corporate Yards
- E.6.E. Staff Training

A. Pollution Prevention

Each Co-permittee shall implement pollution prevention methods in its Program for Public Agency Activities and shall require their use by appropriate municipal departments and personnel, where appropriate.

(1) Co-permittees shall prohibit the discharge of untreated storm water runoff to the storm drain system from toxic or hazardous material storage areas.
(2) Co-permittees shall prohibit the discharge of untreated storm water runoff to the storm drain system from fueling areas, and repair/maintenance areas for vehicle maintenance and repair facilities.
(3) Co-permittees shall require that all vehicle/equipment wash areas must be self-contained, or covered, or equipped with a clarifier or other pretreatment facility, and properly connected to a sanitary sewer. This provision does not apply to fire fighting vehicles.
(4) Co-permittees shall conduct street sweeping on curbed public streets in their jurisdiction according to the following schedule:
   a. A monthly average not less than four times per month in high traffic downtown areas
   b. A yearly average of not less than six times per year in moderate traffic collector streets and residential areas
   c. In addition, Co-permittees will sweep continuously bermed public streets once per year prior to the wet season

(5) Co-permittees shall prevent street saw cutting and paving during a storm event of 0.25 inches or greater (except during emergency conditions).
(6) Co-permittees shall prohibit discharge of untreated runoff from temporary or permanent street maintenance material and waste storage areas

B. Maintenance of Catch Basins, Open Drainage Facilities and Detention/Retention Basins

(1) Each Co-permittee shall implement a schedule of maintenance activities designed to reduce pollutant discharges from its catch basins, open drainage facilities and detention/retention basins.
(2) The maintenance activities shall include:
   a. Inspect catch basins, open drainage facilities, and detention/retention basins at least one time each year prior to the wet season.
   b. At any time, clean any catch basin that is determined by the responsible Co-permittee to be 40% full of accumulated waste (e.g. sediment, trash, debris and other pollutants)
   c. All reinforced concrete open channels shall be cleaned at least once each year prior to the wet season

C. Management of Pesticides, Herbicides and Fertilizers

Last permit term, the Co-permittees developed and implemented a standard protocol for the routine and non-routine application of pesticides, herbicides (including pre-emergents) and fertilizers. This protocol includes measures to prevent pesticides, fertilizers and herbicides from entering the storm drain system and discharging to receiving waters. It also outlines Co-permittees' responsibilities, environmental conditions, pollution prevention and spill control, protocols for aquatic pesticide application, training requirements, and storage and disposal protocols. The Co-permittees will continue to implement this protocol and update it as needed.

The Co-permittees shall ensure that staff applying pesticides are either certified by the California Department of Food and Agriculture or are under the supervision of a certified pesticide applicator.

D. Development and Implementation of Storm Water Pollution Prevention Plans for Corporate Yards

Each Co-permittee shall maintain and revise as necessary a Storm Water Pollution Control Plan for their designated corporate yards. Co-permittees shall annually inspect these corporate yards and implement the minimum requirements of the SWPCP in all designated corporate yards.

E. Staff Training

Co-permittees shall annually train their employees in targeted positions (whose jobs and activities affect storm water quality) regarding the requirements of the storm water management program.

E.7. Programs for Illicit Discharge Control

Each Co-permittee shall implement an Illicit Discharge Detection and Elimination Program containing measures to seek and eliminate illicit discharges and connections. At a minimum, the program shall address:

E.7.A. Illicit Discharges and Connections Investigation/Inspection
E.7.B. Enforcement
E.7.C. Staff Training

A. Illicit Discharges and Connections Investigation/Inspection

Each Co-permittee shall investigate the cause, determine the nature and estimated amount of reported illicit discharge/dumping incidents and refer documented non-storm water discharge/connections or dumping to the appropriate agency for investigation, containment and/or cleanup.

B. Enforcement

Each Co-permittee shall take appropriate action including issuance of an enforcement order that will result in the cessation of all documented illicit discharges and/or elimination of all document illicit connections within six months after the Co-permittee gains knowledge of the discharge/connection.

C. Staff Training

Each Co-permittee shall annually train its employees in targeted positions (whose jobs and activities affect storm water quality) on how to identify and report illicit discharges.

E.8. Countywide Stormwater Monitoring Program

The Co-permittees shall implement the Countywide Monitoring Plan, as described below, which addresses discharge characterization (outfall monitoring), receiving water and watershed monitoring. To achieve this, the Co-permittees shall implement at a minimum:

E.8.A. Land Use Monitoring
E.8.B. Participation in Watershed Management Planning and Special Studies
E.8.C. Watershed Management Model
E.8.D. Monitoring Protocols and Record Keeping

A. Land Use Monitoring

(1) The Co-permittees shall conduct land use monitoring as shown in the summary table below:

Monitoring Station	Minimum Number of Events (per year)	Sample Type	Constituents[1]
A-1, Wood Road	1	Automated composite and grab samples	Metals Organics Conventional Inorganics Microbiological Acute Toxicity and TIEs[2]
R-1, Swan Street[3]	1	Automated composite and grab samples	Metals Organics Conventional Inorganics Microbiological Acute Toxicity and TIEs[2]
I-2, Ortega Street[3]	1	Automated composite and grab samples	Metals Organics Conventional Inorganics Microbiological Acute Toxicity and TIEs[2]

[1] The list of specific constituents, analytical methods, detection limits and holding time is included in Attachment D.

[2] A Toxicity Identification Evaluation (TIE) shall be performed when acute toxicity results are greater than 1Tua. Freshwater acute toxicity test shall be conducted on Ceriodaphnia dubia.

B. Participation in Watershed Management Planning and Special Studies

(1) The Co-permittees shall participate in appropriate water quality meetings of watershed management planning, including the Santa Clara River Enhancement and Management Plan, the Calleguas Creek Watershed Management Plan, and the Steelhead Restoration and Recovery Plan.

(2) The Co-permittees shall participate with the Southern California Coastal Water Research Plan (SCCWRP) in storm water studies, as set forth in the signed Memorandum of Agreement.
(3) The Co-permittees shall participate in the development and implementation of volunteer monitoring programs in the Ventura Coastal watersheds.

C. Watershed Management Model

An update of the Watershed Management Model (WMM) may be required by the RWQCB Executive Officer based on the needs of TMDL development. The RWQCB will assist the Co-permittees in identifying fund sources to assist in the implementation of this requirement, if invoked.

D. Monitoring Protocols and Record Keeping

(1) Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity.
(2) The Co-permittees shall retain records of all monitoring information, including all calibration and maintenance of monitoring instrumentation, copies of all reports required by this Order, and records of all data used to complete the Report of Waste Discharge and application of for this Order, for a period of at least five (5) years from the date of the sample, measurement, report or application. This period may be extended by request of the RWQCB or EPA at any time and shall be extended during the course of any unresolved litigation regarding this discharge.
(3) Records of monitoring information shall include:
    (i) The date, exact place and time of sampling or measurement
    (ii) The individual(s) who performed the sampling or measurements
    (iii) The date(s) analyses were performed
    (iv) The individual(s) who performed the analyses
    (v) The analytical techniques or methods used, and
    (vi) The results of such analyses
(4) All sampling, sample preservation and analyses must be conducted according to test procedures under CFR 40 Part 136, unless other test procedures have been specified in this Order.
(5) All chemical, bacteriological and bioassay analyses shall be conducted at a laboratory certified for such analyses by an appropriate governmental regulatory agency.
(6) If no flow occurred during the reporting period, the annual report shall so state.
(7) For any analyses performed for which no procedure is specified in the EPA guidelines or in this Monitoring Program, the constituent or parameter analyzed and the method or procedure used must be specified in the annual report.
(8) Whenever feasible, all MDLs shall be less than California Toxic Rule and Ocean Plan standards. If this is not feasible, the Co-permittees shall use analytical methods with the lowest MDL.
(9) The RWQCB Executive Officer or the RWQCB, consistent with 40 CFR 122.41 may approve changes to the Monitoring Program after providing the opportunity for public comment, either:
    (i) By petition of the Co-permittees or by petition of interested parties after the submittal of the Annual Report. Such petition shall be filed not later than 60 days after the Annual report submittal date, or
    (ii) As deemed necessary by the RWQCB Executive Officer following notice to the Co-permittees

Modification
The Regional Board Executive Officer or the Regional Board consistent with 40 CFR 122.42 may approve changes to the Ventura County Monitoring Program, after providing the opportunity for public comment either:

a. By petition of the Permittee or by petition of interested parties, after the submittal of the Annual Storm Water Report and Assessment. Such petition shall be filed, not later than 60 days after the Annual Storm Water Report and Assessment submittal date, or
b. As deemed necessary by the Regional Board Executive Officer following notice to the Permittee.

The above monitoring program or subsequent modification thereto, shall become effective when Order no. XXXX is adopted. All reports shall be signed by a responsible officer or duly authorized representative (as specified in 40 CFR Section 122.22) of the Co-permittees and submitted under penalty of perjury.

ATTACHMENT A

STANDARD PROVISIONS

1. The discharger shall comply with all provisions and requirements of this Order.

2. Should the discharger discover that it failed to submit any relevant facts or that it submitted incorrect information in a report, it shall promptly submit the missing or correct information.

3. This Order includes the Annual Reporting Requirements (Attachment B), and Storm Water Quality Urban Impact Mitigation Plan (SQUIMP) (Attachment C), which are a part of the permit and must be complied with in the same manner as with the rest of the requirements of this Order.

4. Public Review
   a. All documents submitted to the Regional Board in compliance with the terms and conditions of this Order shall be made available to members of the public pursuant to the Freedom of Information Act (5 U.S.C. Section 552 (as amended) and the Public Records Act (California Government Code Section 6250 *et seq.*).
   b. All documents submitted to the Executive Officer for approval shall be made available to the public for a 30-day period to allow for public comment.

5. Duty to Comply [40 CFR 122.41(a)]
   a. The discharger must comply with all of the terms, requirement and conditions of this Order. Any violation of this Order constitutes a violation of the Clean Water Act, its regulations and the California Water Code, and is grounds for enforcement action, Order termination, Order revocation and reissuance, denial of an application for reissuance; or a combination thereof.
   b. A copy of these waste discharge specifications shall be maintained by the discharger so as to be available during normal business hours to discharger employees and members of the public.
   c. Any discharge of wastes at any point(s) other than specifically described in this Order is prohibited, and constitutes a violation of the Order.

6. Duty to Mitigate [40 CFR 122.41(d)]
   The discharger shall take all reasonable steps to minimize or prevent any discharge that has a reasonable likelihood of adversely affecting human health or the environment.

7. Inspection and Entry [40 CFR 122.41(i)]
   The Regional Board, USEPA and other authorized representative shall be allowed:
   a. Entry upon premises where a regulated facility is located or conducted, or where records are kept under conditions of this Order
   b. Access to copy any records that are kept under the conditions of this Order
   c. To inspect any facility, equipment (including monitoring and control equipment), practices or operations regulated or required under this Order; and
   d. To photograph, sample, and monitor for the purpose of assuring compliance with this Order, or as otherwise authorized by the Clean Water Act and the California Water Code

8. Proper Operation and Maintenance [40 CFR 122.41(e)]
   The discharger shall at all times properly operate and maintain all facilities and systems of treatment and (and related appurtenances) that are installed or used by the discharger to achieve compliance with this Order. Proper operation and maintenance includes adequate laboratory controls and appropriate quality assurance procedures. This provision requires the operation of backup or auxiliary facilities or similar system that are installed by a discharger only when necessary to achieve compliance with the conditions of this Order.

9. Signatory Requirements [40 CFR 122.41(k)]
   Except as otherwise provided in this Order, all applications, reports or information submitted to the Regional Board shall be signed by the Director of Public Works, City Engineer or authorized designee under penalty of perjury.

10. Reopener and Modification [40 CFR 122.41(f)]
    a. This Order may only be modified, revoked or reissued prior to the expiration date by the Regional Board, in accordance with the procedural requirements of the Water Code and Title 23 of the California Code of Regulations for the issuance of waste discharge requirements, and upon prior notice and hearing to:
       i. Address changed conditions identified in the required reports or other sources deemed significant by the Regional Board
       ii. Incorporate applicable requirements or statewide water quality control plans adopted by the State Board or amendments to the Basin Plan
       iii. Comply with any applicable requirements, guidelines and/or regulations issued or approved pursuant to CWA Section 402(p); and/or
       iv. Consider any other federal, or state laws or regulations that became effective after adoption of this Order
    b. After notice and opportunity for a hearing, this Order may be terminated or modified for cause, including, but not limited to:
       i. Violation of any term or condition contained in this Order
       ii. Obtaining this Order by misrepresentation, or failure to disclose all relevant facts; or
       iii. A change in any condition that requires either a temporary or permanent reduction or elimination of the authorized discharge
    c. This Order may be modified, revoked and reissued or terminated for cause.
    d. The filing of a request by the discharger for a modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not stay any condition of this Order
    e. This Order may be modified to make corrections or allowances for changes in the permitted activity listed in this section, following the procedures at 40 CFR Part 122.63, if processed as a minor modification. Minor modifications may only:
       i. Correct typographical errors; or
       ii. Require more frequent monitoring or reporting by the discharger

11. Severability
    The provisions of this Order are severable, and if any provision of this Order or the application of any provision of this Order to any circumstances is held invalid, the application of such provision to other circumstances and the remainder of this Order shall not be affected.

12. Duty to Provide Information [40 CFR 122.41(h)]
    The discharger shall furnish, within a reasonable time, any information the Regional Board or USEPA may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this Order. The discharger shall also furnish to the Regional Board, upon request, copies of records required to be kept by this Order.

13. Twenty-four Hour Reporting
    a. The discharger shall report any noncompliance that may endanger health or the environment. Any information shall be provided orally within 24 hours from the time the discharger becomes aware of the circumstances. A written submission shall also be provided within five days of the time the discharger becomes aware of the circumstances. The written submission shall contain a description of the noncompliance and its cause; the period of noncompliance, including exact dates and times, and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and step taken or planned to reduce, eliminate and prevent reoccurrence of the noncompliance.
    b. The Regional Board may waive the required written report on a case-by-case basis.

14. Bypass [40 CFR 122.41(m)]
    Bypass (the intentional diversion of waste streams from any portion of a treatment facility) is prohibited. The Regional Board may take enforcement action against the discharger for bypass unless:
    a. Bypass was unavoidable to prevent loss of life, personal injury or severe property damage. (Severe property damage means substantial physical damage to property, damage to the treatment facilities that causes them to become inoperable, or substantial and permanent loss of natural resources that can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production).
    b. There were no feasible alternatives to bypass, such as the use of auxiliary treatment facilities, retention of untreated waste, or maintenance during normal periods of equipment downtime. This condition id not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass that could occur during normal periods of equipment downtime or preventive maintenance.
    c. The discharger submitted a notice at least ten days in advance of the need for a bypass to the Regional Board; or
    d. The discharger may allow a bypass to occur that does not cause effluent limitations to be exceeded, but only if it is for essential maintenance to assure efficient operation. In such a case, the above bypass conditions are not applicable. The discharger shall submit notice of an unanticipated bypass as required.

15. Upset [40 CFR 122.41(n)]
    a. A discharger that wishes to establish the affirmative defense of an upset in an action brought for non compliance shall demonstrate, through properly signed, contemporaneous operating logs, or other relevant evidence that:
        i. An upset occurred and that the discharger can identify the cause(s) of the upset
        ii. The permitted facility was being properly operated by the time of the upset
        iii. The discharger submitted notice of the upset as required; and
        iv. The discharger complied with any remedial measures required
    b. No determination made before an action of noncompliance, such as during administrative review of claims that noncompliance was caused by an upset, is final administrative action subject to judicial review.
    c. In any enforcement proceeding, the discharger seeking to establish the occurrence of an upset has the burden of proof

16. Property Rights [40 CFR 122.4(g)]
    This Order does not convey any property rights of any sort, or any exclusive privilege.

17. Enforcement
    a. Violation of any of the provisions of the NPDES permit or any of the provisions of this Order may subject the violator to any of the penalties described herein, or any combination thereof, at the discretion of the prosecuting authority; except that only one kind of penalties may be applied for each kind of violation. The Clean Water Act provides the following:

        <u>Criminal Penalties</u>
        i. *Negligent Violations*
        The CWA provides that any person who negligently violates permit conditions implementing sections 301, 302, 306, 307, 308, 318, or 405 of the Act is subject to a fine of not less than $2,500 nor more than $25,000 per day of violation, or by imprisonment for not more than 1 year, or both.
        ii. *Knowing Violations*
        The CWA provides that any person who knowingly violated permit conditions implementing sections 301, 302, 306, 307, 308, 318 or 405 of the Act is subject to a fine of not less than $5,000 nor more than $50,000 per day of violation, or by imprisonment for not more than 3 years, or both.

iii. *False Statement*
The CWA provides that any person who knowingly makes any false material statement, representation or certification in any application,, record, report, plan or other document filed of required to be maintained under the Act or who knowingly falsifies, tampers with, or renders inaccurate, any monitoring device or method required to be maintained under the Act, shall upon conviction, be punished by a fine of not more than $10,000 or by imprisonment for not more than 2 years, or both. If a conviction is for a violation committed after a first conviction of such person under this paragraph, punishment shall be by a fine of not more that $20,000 per day of violation, or by imprisonment of not more than 4 years, or by both.

Civil Penalties

i. The CWA provides that any person who violates a permit condition implementing sections 301, 302, 306, 307, 308, 318 or 405 of the Act is subject to a civil penalty not to exceed $27,500 per day for each violation.

b. The California Water Code provides that any person who violated a waste discharge requirement provision of the California Water Code is subject to civil penalties of up to $5,000 per day, $10,000 per day, or $25,000 per day of violation; or when the violation involves the discharge of pollutants, is subject to civil penalties of up to $10 per gallon per day or $25 per gallon per day of violation; or some combination thereof, depending on the violation or combination violations.

18. Need to Halt or Reduce Activity not a Defense [40 CFR 122.41(c)]
It shall not be a defense for a discharger in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this Order.

19. This Order may be modified, revoked, or reissued, prior to the expiration date as follows:
    a. To address changed conditions identified in the required technical reports or other sources deemed significant by the Regional Board
    b. To incorporate applicable requirements or statewide water quality control plans adopted by the State Board, or amendments to the Basin Plan
    c. To comply with any applicable requirements, guidelines, or regulations issued or approved under Section 402(p) of the CWA, if the requirement, guideline, or regulation so issued or approved contains different conditions or additional requirements not provided for in this Order. The Order as modified or reissued under this paragraph shall also contain any other requirements of the CWA than applicable; or
    d. Any amendments under the Clean Water Act

20. Regional Board No. 00-108 is hereby rescinded.

21. This Order expires on DATE. The discharger must submit a Report of Waste Discharge (ROWD) in accordance with Title 23, California Code of Regulation, not later than 180 days in advance of such date as application for reissuance of waste discharge requirements.

ATTACHMENT B

ANNUAL REPORTING REQUIREMENTS

1. The Co-permittees shall submit by October 1, 2005 the Annual Storm Water Report and Assessment for the period July 1, 2004 through June 30, 2005 documenting the status of the general program up to permit reissuance and the results of analyses from the monitoring program.
2. The Co-permittees shall submit by October 1 of each year beginning the year 2005, an Annual Storm Water Report and Assessment documenting the status of the general program and individual tasks contained in the Ventura County Storm Water Management Plan (SMP) and an integrated summary of the results of analyses from the monitoring program described under *E.8.Countywide Stormwater Monitoring Program.*

The Annual Storm Water Report and Assessment shall include any proposed changes to the Ventura County SMP as approved by the Management Committee. The Annual Storm Water Report and Assessment shall cover each fiscal year from July 1 through June 30. At a minimum, the annual report will include the following:

<u>Program Management</u>

A. A comparison of the program implementation results to performance standards established in the Ventura County SMP.
B. Status of compliance with permit requirements including implementation dates for all time-specific deadlines. If permit deadlines are not met, the Co-permittees shall report the reasons why the requirement was not met, how the requirements will be met in the future, including projected implementation date.
C. An assessment of the effectiveness of Ventura County SMP requirements to reduce storm water pollution. This assessment will be based upon the specific record-keeping information requirements in each major section of the permit, monitoring data and any other data the Co-permittees has, or is aware of that provides information on program effectiveness.
D. An analysis of the data to identify areas of the Program coverage which cause or contribute to exceedances of water quality standards or objectives, predominate land uses in these areas and potential sources of pollutants in those areas.
E. Discussion of the compliance record and the corrective actions taken or planned that may be needed to bring the discharge into full compliance with the waste discharge requirements.
F. The Discharger shall prepare annually a storm water budget update on the resources applied to the storm water program. This budget report shall include an annual update identifying the storm water budget for the following year using (estimated percentages and written explanations where necessary) for the specific categories noted below:
   i. Program management
   ii. Illicit connections/illicit discharge
   iii. Industrial/Commercial program activities
   iv. Development planning/development construction
   v. Construction inspection activities
   vi. Co-permittee Public Agency Activities
      1. Operations and maintenance
      2. Municipal street sweeping
      3. Fleet and public agency facilities
      4. Landscape and Recreational Facilities
   vii. Capital costs
   viii. Public information and participation
   ix. Monitoring program
   x. Other

Program for Residents

A. Number of storm drain inlets and signs in the Co-permittees' systems that are marked or posted with a no dumping message. Percent of total system marked/signed.
B. Description of activities distributing brochures, community outreach efforts and educational programs including an estimate of the number of impressions made per year about storm water quality via prnt, local TV access, local radio, meetings or other appropriate media.

Programs for Industrial/Commercial Businesses

A. Number of commercial and industrial facilities targeted under the program. During the past year, the number of commercial and industrial site visits conducted and the number of outreach contacts made.
B. An annual update of a database of commercial and industrial facilities targeted under this program. The database shall include the facility name, site address, facility contact, applicable industrial code(s) and NPDES storm water permit coverage status, if applicable.
C. The percentage of targeted staff trained annually.

Programs for Land Development

A. The percentage of SQUIMP development projects reviewed for storm water and conditioned to meet SQUIMP requirements in the previous year.
B. Description of activities on distributing brochures, outreach efforts, including an estimate of the number of contacts made to the land development community about stormwater quality via print, meetings or other appropriate venues.
C. The percentage of targeted staff trained annually.

Programs for Construction Sites

A. Number of construction projects requiring SWPPPs in the past year and the percentage of projects in categories requiring the submittal of a SWPPP for which SWPPPs were completed.
B. Description of the Co-permittees' inspection activities, including the number and type of enforcement actions, applicable to storm water compliance, taken at construction sites during the past year.
C. Description of the outreach program to the construction community and assessment of its effectiveness. This assessment should include a discussion of the number of inspections, site visits or other meetings conducted.
D. The percentage of targeted staff trained annually.

Programs for Co-permittee Public Agency Activities

A. A summary of which at a minimum includes the quantity, predominant types and likely sources of trash removed from catch basin inlets.
B. A summary of the total curb miles of streets swept annually and the percentage of total curb miles swept annually as a function of total curb miles.
C. The percentage of targeted staff trained annually.

Programs for Illicit Discharge Control

A. Number of reports of illicit discharges that Co-permittees responded to, percentage that were identified as actual illicit discharges, and percentage of the actual illicit discharges where the incident was either cleaned up, referred to another responsibly agency and/or follow-up education with the discharger was conducted.
B. For groups of identified illicit discharge where the probable cause and type of material can be established, provided the probable cause and type of material.
C. Number of illegal connections identified in the past year.
D. Number of illegal connections eliminated in the past year.

E. Number and type of enforcement actions taken by each Co-permittee for storm water illicit discharges and/or illegal connections taken in the past year.
F. An annual update of a database of identified illicit discharges and illegal connections that includes the date of the incident, the source type, type of material, date of conclusion/clean up/removal/follow up/ education and enforcement action taken, if appropriate.
G. The percentage of targeted staff trained annually.

Countywide Stormwater Monitoring Program

A. The Co-permittees shall submit a Storm Water Monitoring Report as part of the Annual Storm Water Report and Assessment on October 1, 2005 and annually on October 1, thereafter. The report shall include:
   i. Status of implementation of the monitoring program.
   ii. Results of the monitoring program.
   iii. A general interpretation of the results.
   iv. Both tabular and graphical summaries of the monitoring data obtained during the previous year.

3. All applications, reports or information submitted to the RWQCC shall be signed and certified pursuant to EPA regulations 40 CFR 122.41(k).
4. Co-permittees submittals to the Principal Co-permittee shall also be signed and certified pursuant to EPA regulations 40 CFR 122.41(k).
5. The Co-permittees shall mail the original of each annual report to:

INFORMATION TECHNOLOGY
CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LOS ANGELES REGION
320 W. 4th STREET, SUITE 200
LOS ANGELES, CA 90013

A copy of the annual report shall also be mailed to:

REGIONAL ADMINISTRATOR
ENVIRONMENTAL PROTECTION AGENCY
REGION 9
75 HAWTHORNE STREET
SAN FRANCISCO, CA 94105

ATTACHMENT C

VENTURA COUNTYWIDE STORMWATER QUALITY URBAN IMPACT MITIGATION PLAN

BACKGROUND

The Ventura Countywide Stormwater Quality Management Program (Program) was established pursuant to Section 402(p) of the Federal Clean Water Act, which requires that all point source discharges of pollutants into waters of the United States, including discharges from municipal storm drain systems, be regulated by a National Pollutant Discharge Elimination System (NPDES) permit. The requirement to implement a program for development planning is based on, federal and state statutes including: Section 402(p) of the Clean Water Act, Section 6217 of the Coastal Zone Act Reauthorization Amendments of 1990 ("CZARA") and the California Water Code. The Clean Water Act amendments of 1987 established a framework for regulating storm water discharges from municipal, industrial, and construction activities under the NPDES program. The primary objectives of the municipal storm water program requirements are to:

1. Effectively prohibit non-storm water discharges; and
2. Reduce the discharge of pollutants from storm water conveyance systems to the Maximum Extent Practicable (MEP statutory standard)

The SQUIMP was developed as part of the municipal storm water program to address storm water pollution from new development and redevelopment by the private sector. This SQUIMP contains a list of the minimum required Best Management Practices (BMPs) that shall be used for a designated project. Additional BMPs may be required by ordinance or code adopted by the Co-permittees and applied generally or on a case-by-case basis. The Co-permittees are required to implement the requirements set herein in their own jurisdiction. Developers shall incorporate appropriate SQUIMP requirements into the project plans for the projects covered by the SQUIMP requirements. Each Co-permittee will approve the project plan as part of the development plan approval process.

All projects that fall into one of eight categories are identified in the Ventura Countywide Municipal Permit as requiring SQUIMPs. These categories are:

- Single-Family Hillside Residences
- 100,000 Square Foot Commercial Developments
- Automotive Repair Shops
- Retail Gasoline Outlets
- Restaurants
- Home Subdivisions with 10 or more housing units
- Location within or directly adjacent to or discharging directly to an environmentally sensitive area
- Parking lots with 5,000 square feet or more impervious parking or access surfaces or with 25 or more parking spaces and potentially exposed to storm water runoff

DEFINITIONS

"100,000 Square Foot Commercial Development" means any commercial development that creates at least 100,000 square feet or impermeable area, including parking areas.

"Automotive Repair Shop" means a facility that is categorized in any one of the following Standard Industrial Classification (SIC) codes: 5013, 5014, 5541, 7532-7534, or 7536-7539.

"Best Management Practice (BMP)" means any program, technology, process, siting criteria, operational methods or measures or engineered systems, which when implemented prevent, control, remove or reduce pollution.

"Commercial Development" means any development on private land that is not heavy industrial or residential. The category includes, but is not limited to: hospitals, laboratories and other medical facilities, educational institutes, recreational facilities, plant nurseries, multi-apartment buildings, car wash facilities, mini-malls and other business complexes, shopping malls, hotels, office buildings, public warehouses, and other light industrial complexes.

"Designated Public Access Points" means any pedestrian, bicycle, equestrian or vehicular point of access to jurisdictional channels in the area of Ventura County subject to permit requirements.

"Directly Adjacent" means situated within 200 feet of the contiguous zone required for the continued maintenance, function, and structural stability of the environmentally sensitive area.

"Directly Connected Impervious Area (DCIA)" means the area covered by a building, impermeable pavement, and/or other impervious surfaces, which drains directly into the storm drain without first flowing across permeable land area (e.g. lawns).

"Directly Discharging" means outflow from a drainage conveyance system that is composed entirely or predominately of flows from the subject, property, development, subdivision, or industrial facility and not commingled with the flows from adjacent lands.

"Environmentally Sensitive Area" means an areas "in which plant or animal life or their habitats are either rare or especially valuable because of their special nature or role in an ecosystem and which would be easily disturbed or degraded by human activities and developments" (California Public Resources Code §30107.5)

Areas subject to storm water mitigation requirements area: areas designated as an Area of Special Biological Significance (ASBS) by the State Water Resources Control Board, an area designated as a significant natural resource by the California Resources Agency, or an area identified by the discharger as environmentally sensitive for water quality purposes, based on the Regional Board Basin Plan and Clean Water Act Section 303(d) Impaired Water-bodies List for the County of Ventura.

"Hillside" means property located in an areas with known erosive soil conditions, where the development contemplates grading on any natural slope that is twenty-five percent or greater.

"Infiltration" means the downward entry of water into the surface of the soil.

"New Development" means land disturbing activities; structural development, including construction or installation of a building or structure, creation of impervious surface; and land subdivision.

"Parking Lot" means land area or facility for the temporary parking or storage of motor vehicles used personally, for business or for commerce with an impervious surface area of 5,000 square feet or more, or with 25 or more parking spaces.

"Redevelopment" means, but is not limited to, the expansion of a building footprint or addition or replacement of a structure; structural development including an increase in gross floor area and/or exterior construction or remodeling; replacement of impervious surface that is not part of a routing maintenance activity; land disturbing activities related with structural or impervious surfaces. Redevelopment of one of the eight identified SQUIMP categories that result in the creation or addition of 5,000 square feet or more of impervious surfaces is subject to the requirements for storm water mitigation. If the creation or addition of impervious surfaces is fifty percent or more of the existing impervious surface area, then storm water runoff from the entire areas (existing and additions) must be considered for purposed of storm water mitigation. If the creation or additions is less than fifty percent of the impervious areas, then storm water runoff from only the addition areas needs mitigation.

"Restaurant" means a stand-alone facility that sells prepared foods and drinks for consumption, including stationary lunch counters and refreshment stands selling prepared foods and drinks for immediate consumption (SIC Code 5812).

"Retail Gasoline Outlet" means any facility engaged in selling gasoline and lubricating oils.

"Source Control BMP" means any schedules of activities, structural devices, prohibitions of practices, maintenance procedures, managerial practices or operational practices that aim to prevent storm water pollution by reducing the potential for contamination at the source of pollution.

"Storm Event" means a rainfall event that produces more than 0.1 inch of precipitation and that, which is separated from the previous storm event by at least 72 hours of dry weather.

"Structural BMP" means any structural facility designed and constructed to mitigate the adverse impacts of storm water and urban runoff pollution (e.g. canopy, structural enclosure). The category may include both Treatment Control BMPs and Source Control BMPs.

"Treatment" means the application of engineered systems that use physical, chemical or biological processes to remove pollutants. Such processes include, but are not limited to, filtration, gravity settling, media absorption, biodegradation, biological uptake, chemical oxidation and UV radiation.

"Treatment Control BMP" means any engineered system designed to remove pollutants by simple gravity settling of particulate pollutants, filtration, biological uptake, media absorption or any other physical, biological or chemical process.

CONFLICTS WITH LOCAL PRACTICES

Where provisions of the SQUIMP requirements conflict with established local codes, (e.g., specific language of signage used on storm drain stenciling), the Co-permittees may continue the local practice and modify the SQUIMP to be consistent with the code, except that to the extent that the standards in the SQUIMP are more stringent than those under local codes, such more stringent standards shall apply.

SQUIMP PROVISIONS APPLICABLE TO ALL CATEGORIES AS APPROPRIATE

REQUIREMENTS

1. PEAK STORM WATER RUNOFF DISCHARGE RATES

The discharger shall control the post-development peak storm water runoff discharge rates to maintain or reduce pre-development downstream erosion, and to protect stream habitat.

SQUIMP category projects, excluding single-family hillside residences that directly discharge to unlined receiving streams shall implement the following design criteria:

a. 2-year post development discharge rates shall not exceed the predeveloped discharge rates for the 2-year frequency storm event.
b. Peak flows shall be determined using the procedures set forth in the latest edition of the *Hydrology Manual* and Direct Runoff curves produced by Ventura County Public Works Agency, Watershed Protection District. Additional information is provided in the Ventura Countywide Stormwater Quality Management Program's Technical Guidance Manual for Stormwater Quality Control Measures.

2. CONSERVE NATURAL AREAS

If applicable, the following items are required and shall be implemented in the site layout during the subdivision design and approval process, consistent with applicable General Plan and Local Area Plan policies:

- Concentrate or cluster Development on portions of a site while leaving the remaining land in a natural undisturbed condition
- Limit clearing and grading of native vegetation at a site to the minimum amount needed to build lots, allow access, and provide fire protection
- Maximize trees and other vegetation at each site by planting additional vegetation, clustering tree areas, and promoting the use of native and/or drought tolerant plants
- Promote natural vegetation by using parking lot islands and other landscaped areas
- Preserve riparian areas and wetlands

3. MINIMIZE STORM WATER POLLUTANTS OF CONCERN

Storm water runoff from a site has the potential to contribute oil and grease, suspended solids, metals, gasoline, pesticides, and pathogens to the storm water conveyance system. The development shall be designed so as to minimize, to the maximum extent practicable, the introduction of pollutants of concern that may result in significant impacts, generated from site runoff of directly connected impervious areas (DCIA), to the storm water conveyance system. Pollutants of concern consist of any pollutants that exhibit one or more of the following characteristic: current loadings or historic deposits of the pollutant are impacting the beneficial uses of a receiving water, elevated levels of the pollutant are found in sediments of a receiving water and/or have the potential to bioaccumulate in organisms therein, or the detectable inputs of the pollutant are at concentrations or loads considered potentially toxic to humans and/or flora and fauna. The storm water pollutants of concern currently identified by the Program are total and fecal coliform, mercury, PAHs. DDT and byproducts, diazinon, sediment/TSS, chlorpyrifos, copper, lead, thallium, bis(2-ethylhexyl)phthalate and phosphorous. The program may amend the list of pollutants of concern as additional information becomes available.

In meeting this specific requirement, "minimization of the pollutants of concern" will require the incorporation of a BMP or combination of BMPs best suited to maximize the reduction of pollutant loadings in that runoff to the Maximum Extent Practicable (MEP). Those BMPs best suited for that purpose are those listed in the *Ventura County Technical Guidance Manual for Stormwater Quality Control Measures*.

Examples of BMPs that can be used for minimizing the introduction of pollutants of concern generated from site runoff are identified in Table 2.

4. PROTECT SLOPES AND CHANNELS

Project plans shall include BMPs consistent with local codes and ordinances and the SQUIMP to decrease the potential of slopes and/or channels from eroding and impacting storm water runoff.

- Convey runoff safely from the tops of slopes and stabilize disturbed slopes
- Utilize natural drainage systems to the Maximum Extent Practicable
- Control or reduce or eliminate flow to natural drainage systems to the Maximum Extent Practicable
- Stabilize permanent channel crossings
- Vegetate slopes with first consideration given to native or drought tolerant species
- Install energy dissipaters, such as riprap at the outlets of new storm drains, culverts, conduits, or channels that enter unlined channels in accordance with applicable specifications to minimize erosion, with the approval of all agencies with jurisdiction, e.g., the U.S. Army Corps of Engineers and the California Department of Fish and Game.

5. PROVIDE STORM DRAIN SYSTEM STENCILING AND SIGNAGE

Storm drain stencils are highly visible source controls that are typically placed directly adjacent to storm drain inlets. The stencil contains a brief statement that prohibits the dumping of improper materials into the storm water conveyance system. Graphical icons, either illustrating anti-dumping symbols or images of receiving water fauna, are effective supplements to the anti-dumping message.

- All storm drain inlets and catch basins within the project area shall be stenciled with prohibitive language (such as: "DON'T DUMP! DRAINS TO OCEAN")
- Signs and prohibitive language and/or graphical icons, which prohibit illegal dumping, shall be posted at designated public access points along channels and creeks within the project area
- Legibility of stencils and signs shall be maintained

6. PROPERLY DESIGN OUTDOOR MATERIAL STORAGE AREAS

Outdoor material storage areas refer to storage areas or storage facilities solely for the storage of materials. Improper storage of materials outdoors may provide an opportunity for toxic compounds, oil and grease, heavy metals, nutrients, suspended solids, and other pollutants to enter the storm water conveyance system. Where proposed project plans include outdoor areas for permanent storage of materials that may contribute pollutants to the storm water conveyance system, the following Structural or Treatment BMPs are required:

- Materials with the potential to contaminate storm water shall be (1) placed in an enclosure such as, but not limited to, a cabinet, shed, or similar structure that prevents contact with runoff or spillage to the storm water conveyance system; or (2) protected by secondary containment structures such as berms, dikes, or curbs.
- The storage area shall be paved and sufficiently impervious to contain leaks and spills.
- The storage area shall have a roof or awning to minimize collection of storm water within the secondary containment area.

7. PROPERLY DESIGN TRASH STORAGE AREAS

A trash storage area refers to an area where a trash receptacle or receptacles are located for use as a repository for solid wastes. Loose trash and debris can be easily transported by the forces of water or wind into nearby storm drain inlets, channels and/or creeks. All trash container areas shall meet the following Structural or Treatment Control BMP requirements (individual single-family residences are exempt from these requirements):

- Trash container areas shall have drainage from adjoining roofs and pavement diverted around the area(s)
- Trash container areas shall be screened or walled to prevent off-site transport of trash

8. PROVIDE PROOF OF ONGOING BMP MAINTENANCE

Improper maintenance is one of the most common reasons why water quality controls will not function as designed or systems to fail entirely. It is important to consider who will be responsible for maintenance of a permanent BMP and what equipment is required to perform the maintenance properly. As part of project review, if a project applicant has included or is required to include, Structural or Treatment Control BMPs in project plans, the Co-permittee shall require that the applicant provide verification of maintenance provisions through such means as may be appropriate, including, but not limited to legal agreements, covenants, CEQ mitigation requirements and/or Conditional Use Permits.

For all properties, the verification will include the developer's signed statement, as part of the project application, accepting responsibility for all structural and treatment control BMP maintenance until the time the property is transferred and, where applicable, a signed agreement from the public or private entity assuming responsibility for Structural or Treatment Control BMP maintenance. The transfer of property to a private or public owner shall have conditions requiring the recipient to assume responsibility for maintenance of any Structural or Treatment Control BMP included in the sales or lease agreement for that property. The condition of transfer shall include a provision that the property owners conduct maintenance inspection of all Structural or Treatment Control BMPs at least once a year and retain proof of inspection. For residential properties where the Structural or Treatment Control BMPs are located within a common area, which will be maintained by a homeowner's association, language regarding the responsibility for maintenance shall be included in the project's conditions, covenants and restrictions (CC&Rs). Printed educational materials will be required to accompany the first deed transfer to highlight the existence of the requirement and to provide information on what storm water management facilities are present, signs that maintenance is needed, how the necessary maintenance can be performed, and assistance that the Co-permittee can provide. The transfer of this information shall also be required with any subsequent sale of the property.

If Structural or Treatment Control BMPs are located within a public area proposed for transfer, they will be the responsibility of the developer until they are accepted for transfer by the appropriate public agency. Structural or Treatment Control BMPs proposed fro transfer shall meet design standards adopted by the public entity for the CMP installed and should be approved by the appropriate public agency prior to installation.

9. DESIGN STANDARDS FOR STRUCTURAL OR TREATMENT CONTROL BMPs

Structural or Treatment Control BMPs selected for use at any project covered by this SQUIMP shall meet the design standards of this Section unless specifically exempted.

Volume-based and flow-based design standards may be used separately or in combination to equivalent treatment of storm water discharges. Volume-based criteria should be used in the sizing of detention/retention or infiltration structures; flow-based criteria should be used on swales, catch basin devices, or wetlands. Other, BMP-specific criteria may be applicable. Project applicants should refer to the *Ventura County Technical Guidance Manual for Stormwater Quality Control Measures* for further information.

Volume-based BMPs shall be designed to mitigate (infiltrate, filter or treat) the volume necessary to capture and treat 80 percent or more of the average annual runoff volume from the site at the design drawdown period specified in the *Ventura County Technical Guidance Manual for Stormwater Quality Control Measures* Fact Sheet for the proposed treatment control measures.

Flow-based BMPs shall be designed to mitigate (infiltrate, filter or treat) 10% of the 50-year design flow rate.

Limited Exclusion

Where the land area for development or redevelopment is less than 5,000 square feet, restaurants are excluded from the numerical Structural or Treatment Control BMP design standard requirement only.

10. PROVISIONS APPLICABLE TO INDIVIDUAL PRIORITY PROJECT CATEGORIES

REQUIREMENTS

A. 100,000 SQUARE FOOT COMMERCIAL DEVELOPMENTS

1. PROPERLY DESIGN LOADING/UNLOADING DOCK AREAS
Loading/unloading dock areas have the potential for material spills to be quickly transported to the storm water conveyance system. To minimize this potential, the following design criteria are required:
    - Cover loading dock areas or design drainage to minimize run-on and runoff of storm water
    - Direct connections to storm drains from depressed loading decks (truck wells) are prohibited

2. PROPERLY DESIGN REPAIR/MAINTENANCE BAYS
Oil and grease, solvents, car battery acid, coolant and gasoline from the repair/maintenance bays can negatively impact storm water if allowed to come into contact with storm water runoff. Therefore, design plans for repair bays shall include the following:
    - Repair/maintenance bays shall be indoors or designed in such a way that does not allow storm water run-on or contact with storm water runoff.
    - Design a repair/maintenance bay drainage system to capture all washwater, leaks and spills. Connect drains to a sump for collection and disposal. Direct connection of the repair/maintenance bays to the storm drain system is prohibited. If required by local jurisdiction, obtain an Industrial Waste Discharge Permit.

3. PROPERLY DESIGN VEHICLE/EQUIPMENT WASH AREAS
The activity of vehicle/equipment washing/steam cleaning has the potential to contribute metals, oil and grease, solvents, phosphates and suspended solids to the storm water conveyance system. Include in the project plans, an area for washing/steam cleaning of vehicles and equipment. The area in the site design shall be:
    - Self-contained and/or covered, equipped with a clarifier, or other pretreatment facility and properly connected to a sanitary sewer

B. RESTAURANTS

1. PROPERLY DESIGN EQUIPMENT/ACCESSORY WASH AREAS
The activity of outdoor equipment/accessory washing/steam cleaning has the potential to contribute metals, oil and grease, solvents, phosphates and suspended solids to the storm water

conveyance system. Include in the project plans an area for the washing/steam cleaning of equipment and accessories. This area shall be:

- Self-contained, connected to a grease interceptor, and properly connected to a sanitary sewer
- If the wash area is to be located outdoors, it shall be covered, paved, have secondary containment, be connected to a grease interceptor and be connected to the sanitary sewer.

C. RETAIL GASOLINE OUTLETS

1. PROPERLY DESIGN FUELING AREA

Fueling areas have the potential to contribute oil and grease, solvents, car battery acid, coolant and gasoline to the storm water conveyance system. The project plans shall include the following BMPs:

- The fuel dispensing area shall be covered with an overhanging roof structure or canopy. The canopy's minimum dimensions shall be equal to or greater than the area within the grade break. The canopy shall not drain onto the fuel dispensing area, and the canopy downspouts shall be routed to prevent drainage across the fueling area.
- The fueling dispensing area shall be paved with Portland cement concrete (or equivalent smooth impervious surface) and the use of asphalt concrete shall be prohibited.
- The fuel dispensing area shall have a 2% to 4% slope to prevent ponding and shall be separated from the rest of the site by a grade break that prevents run-on of storm water to the extent practicable.
- At a minimum, the concrete fuel dispensing area shall extend 6.5 feet (2.0 meters) from the corner of each fuel dispenser, or the length at which the hose and nozzle assembly may be operated plus 1 foot (0.3 meters), whichever is less.

D. AUTOMOTIVE REPAIR SHOPS

1. PROPERLY DESIGN FUELING AREA

Fueling areas have the potential to contribute oil and grease, solvents, car battery acid, coolant and gasoline to the storm water conveyance system. Therefore, design plans, which include fueling areas, shall contain the following:

- The fuel dispensing area shall be covered with an overhanging roof structure or canopy. The canopy's minimum dimensions shall be equal to or greater than the area within the grade break. The canopy shall not drain onto the fuel dispensing area, and the canopy downspouts shall be routed to prevent drainage across the fueling area.
- The fueling dispensing area shall be paved with Portland cement concrete (or equivalent smooth impervious surface) and the use of asphalt concrete shall be prohibited.
- The fuel dispensing area shall have a 2% to 4% slope to prevent ponding and shall be separated from the rest of the site by a grade break that prevents run-on of storm water to the extent practicable.
- At a minimum, the concrete fuel dispensing area shall extend 6.5 feet (2.0 meters) from the corner of each fuel dispenser, or the length at which the hose and nozzle assembly may be operated plus 1 foot (0.3 meters), whichever is less.

2. PROPERLY DESIGN REPAIR/MAINTENANCE BAYS

Oil and grease, solvents, car battery acid, coolant and gasoline from the repair/maintenance bays can negatively impact storm water if allowed to come into contact with storm water runoff. Therefore, design plans for repair bays shall include the following:

- Repair/maintenance bays shall be indoors or designed in such a way that does not allow storm water run-on or contact with storm water runoff.
- Design a repair/maintenance bay drainage system to capture all wash-water, leaks and spills. Connect drains to a sump for collection and disposal. Direct connection of the repair/maintenance bays to the storm drain system is prohibited. If required by local jurisdiction, an Industrial Waste Discharge Permit should be obtained.

3. PROPERLY DESIGN VEHICLE/EQUIPMENT WASH AREAS
The activity of vehicle/equipment washing/steam cleaning has the potential to contribute metals, oil and grease, solvents, phosphates and suspended solids to the storm water conveyance system. Include in the project plans, an area for washing/steam cleaning of vehicles and equipment. The area in the site design shall be:
- Self-contained and/or covered, equipped with a clarifier, or other pretreatment facility and properly connected to a sanitary sewer

4. PROPERLY DESIGN LOADING/UNLOADING DOCK AREAS
Loading/unloading dock areas have the potential for material spills to be quickly transported to the storm water conveyance system. To minimize this potential, the following design criteria are required:
- Cover loading dock areas or design drainage to minimize run-on and runoff of storm water
- Direct connections to storm drains from depressed loading docks (truck wells) are prohibited

E. PARKING LOTS

1. PROPERLY DESIGN PARKING AREA
Parking lots contain pollutants such as heavy metals, oil and grease, and polycyclic aromatic hydrocarbons that are deposited on parking lot surfaces by motor vehicles. These pollutants are directly transported to surface waters. To minimize the offsite transport of pollutants, the following design criteria are required:
- Reduce impervious land coverage of parking areas
- Infiltrate runoff before it reaches the storm drain system
- Treat runoff before it reaches the storm drain system

2. PROPERLY DESIGN TO LIMIT OIL CONTAMINATION AND PERFORM MAINTENANCE
Parking lots may accumulate oil, grease and water insoluble hydrocarbons from vehicle drippings and engine system leaks.
- Treat to remove oil and petroleum hydrocarbons at parking lots that are heavily used (e.g., fast food outlets, lots with 25 or more parking spaces, sports event parking lots, shopping malls, grocery stores, discount warehouse stores)
- Ensure adequate operation and maintenance of treatment systems, particularly sludge and oil removal, and system fouling/plugging prevention control

11. WAIVER

A Co-permittee may, through adoption of an ordinance or code incorporating the treatment requirements of the SQUIMP, provide for a waiver from the requirement if impracticability for a specific property can be established. A waiver for impracticability shall be granted only when all other Structural or Treatment Control BMPs have been considered and rejected as infeasible. Recognized situations of impracticability include, (i) extreme limitations of space for treatment on a redevelopment project, (ii) unfavorable or unstable soil conditions at a site to attempt infiltration, and (iii) risk of ground water contamination because a known unconfined aquifer lies beneath the land surface or an existing or potential underground source of drinking water is less than 10 feet from the soil surface. Any jurisdiction for impracticability shall be separately petitioned by the Co-permittee and submitted to the Regional Board for consideration. The Regional Board may consider approval of the waiver justification or may delegate the authority to approve a class of waiver justifications to the Regional Board Executive Officer. The supplementary waiver justification becomes recognized and effective only after approval by the Regional Board or the Regional Board Executive Officer. A waiver granted by a Co-permittee to any development or redevelopment project may be revoked by the Regional Board Executive Officer for cause and with proper notice upon petition.

If a waiver is granted for impracticability, the Co-permittee shall require the project proponent to transfer the savings in cost, as determined by the Co-permittee, to a storm water mitigation fund operated by a public agency or a non-profit entity to be used to promote regional or alternative solutions for storm water pollution in the watershed.

12. LIMITATION ON USE OF UNFILTRATION BMPs

Three factors significantly influence the potential for storm water to contaminate ground water. They are (i) pollutant mobility, (ii) pollutant abundance in storm water, (iii) and soluble fraction of pollutant. The risk of contamination of groundwater may be reduced by pretreatment of storm water. A discussion of limitations and guidance for infiltration practices is contained in, *Potential Groundwater Contamination from Intentional and Non-Intentional Storm Water Infiltration, Report No. EPA/600/R-94/051, USEPA (1994).*

The distance of the groundwater table from the infiltration BMP may also be a factor in determining the risk of contamination. A historic high water table distance separation of ten feet depth in California presumptively poses negligible risk for storm water not associated with industrial activity or high vehicular traffic except in cases where groundwater basins are unconfined. Unconfined groundwater basins and vulnerable unconfined aquifers are areas that have been identified by the County of Ventura Public Works Agency, Water Resources Division and the Regional Board as areas where the application of infiltration BMPs should be limited to those that provide pre-treatment to ensure groundwater is protected from pollutants of concern.

Infiltration BMP are not recommended for areas of industrial activity or areas subject to high vehicular traffic (25,000 or greater average daily traffic (ADT) on main roadway or 15,000 or more ADT on any intersecting roadway) unless appropriate pretreatment is provided to ensure groundwater is protected and the infiltration BMP is not rendered ineffective by overload.

13. ALTERNATIVE CERTIFICATION FOR STORM WATER TREATMENT MITIGATION

In lieu of conducting detailed BMP review to verify Structural or Treatment Control BMPs adequacy, a Co-permittee may elect to accept a signed certification from a Civil Engineer or a Licensed Architect registered in the State of California, that the plan meets the criteria established herein. The Co-permittee is encouraged to verify that certifying person(s) have been trained on BMP design for water quality, not more than two years prior to the signature date. Training conducted by an organization with storm water BMP design expertise (e.g., University, American Society of Civil Engineers, American Society of Landscape Architects, American Public Works Association, or the California Water Environment Association) may be considered qualifying.

ATTACHMENT D

DEFINITIONS

The following are definitions for terms applicable to this Order:

1. "**Anti-degradation policies**" means the *Statement of Policy with Respect to Maintaining High Quality Water in California (*State Board Resolution No. 68-16), which protects surface and ground waters from degradation. In particular this policy protects water bodies where existing quality is higher than that necessary for the protection of beneficial uses including the protection of fish and wildlife propagation and recreation on in the water.

2. "**Applicable Standards and Limitations**" means all State, interstate and federal standards and limitations to which a "discharge" or a related activity is subject under the CWA, including "effluent limitations", water quality standards, standards of performance, toxic effluent standards or prohibitions, "best management practices" and pretreatment standards under sections 301, 302, 303, 304, 306, 307, 308, 403 and 404 of CWA.

3. "**Best Management Practices (BMPs)**" are methods, measures or practices designed and selected to reduce or eliminate the discharge of pollutants to surface waters from point and nonpoint source discharges including storm water. BMPs include structural and nonstructural controls, and operation and maintenance procedures, which can be applied before, during and/or after pollution producing activities.

4. "**CWA**" means the Clean Water Act (formerly referred to as the Federal Water Pollution Control Act or Federal Water Pollution Control Act Amendments of 1972) Public Law 92-500 as amended by Public Law 95-217, Public Law 95-576, Public Law 96-483 and Public Law 77-117, 33 U.S.C. 1251 et seq.

5. "**Construction**" means constructing, clearing, grading or excavation that results in soil disturbance. Construction includes structure teardown. It does not include routine maintenance to maintain original line and grade, hydraulic capacity, or original purpose of facility, nor does it include emergency construction activities required to immediately protect public health and safety.

6. "**Co-permittee**" shall mean any of the following public entities; the Ventura County Watershed Protection District (VCWPD), the County, or the City of Camarillo, Fillmore, Moorpark, Ojai, Oxnard, Port Hueneme, San Buenaventura, Santa Paula, Simi Valley, or Thousand Oaks. Each Co-permittee is responsible for compliance with the terms of this Order.

7. "**Designated Public Access Points**" means any pedestrian, bicycle, equestrian or public vehicular point of access to jurisdictional channels in the area of Ventura County subject to permit requirements.

8. "**Development**" shall mean any construction, rehabilitation, redevelopment or reconstruction of any public or private residential project (whether single-family, multi-unit or planned unit development); industrial, commercial, retail and other non-residential projects, including public agency projects; or mass grading for future construction.

9. "**Directly Adjacent**" means situated within 200 feet of the contiguous zone required for the continued maintenance, function, and structural stability of the environmentally sensitive area.

10. "**Director**" shall mean the Director of Public Works of the County and Person(s) designated by and under the Director's instruction and supervision.

11. "**Directly Discharging**" means outflow from a drainage conveyance system that is composed entirely or predominantly of flows from the subject, property, development, subdivision, or industrial facility, and not commingled with the flows from adjacent lands.

12. "**Discharge**" when used without qualification means the "discharge of a pollutant".

13. **"Discharge of a Pollutant"** means" Any addition of any "pollutant" or combination of pollutants to "waters of the United States" from any "point source" or, Any addition of any pollutant or combination of pollutants to the waters of the "contiguous zone" or the ocean from any point source other than a vessel or other floating craft which is being used as a means of transportation. The term discharge includes additions of pollutants into waters of the United States from: surface runoff which is collected or channeled by man; discharges through pipes, sewers, or other conveyances owned by a State, municipality, or other person which do not lead to a treatment works; and discharges through pipes, sewers or other conveyances leading into privately owned treatment works. This term does not include an addition of pollutants by any "indirect Discharger."

14. **"Effluent limitation"** means any restriction imposed by the Regional Board on quantities, discharge rates, and concentrations of "pollutants" which are "discharged" from "point sources" into "waters of the United States", the waters of the "contiguous zone" or the ocean.

15. **"Environmental Protection Agency"** or **"EPA"** means the United States Environmental Protection Agency.

16. **"Environmentally Sensitive Area"** means any area "in which plant or animal life or their habitats are either rare or especially valuable because of their special nature or role in an ecosystem and which would be easily disturbed or degraded by human activities and developments" (California Public Resources Code §30107.5). Areas subject to storm water mitigation requirements are: areas designated as an Area of Special Biological Significance (ASBS) by the State Water Resources Control Board, an area designated as a significant natural resource by the California Resources Agency, or an area identified by the Discharger as environmentally sensitive for water quality purposes, based on the Regional Board Basin Plan and Clean Water Act Section 303(d) Impaired Water bodies List for the County of Ventura.

17. **"Facility or Activity"** means any NPDES "point source" or any other facility or activity (including land or appurtenances thereto) that is subject to regulation under the NPDES program.

18. **"Hillsides"** means property located in an area with known erosive soil conditions, where the development contemplates grading on any natural slope that is 25% or greater and where grading contemplates cut or fill slopes.

19. **"Illicit Connection"** shall mean any man-made conveyance that is connected to the storm drain system without a permit or through which prohibited non-storm water flows are discharged, excluding roof-drains and other similar type connections. Examples include channels, pipelines, conduits, inlets or outlets that are connected directly to the storm drain system.

20. **"Illicit Discharge"** means any discharge to the storm drain system that is prohibited under local, state or federal statutes, ordinances, codes or regulations. The term illicit discharge includes all non-storm water discharges except discharges pursuant to an NPDES permit, discharges that are identified in Section B of this Order and discharges authorized by the Regional Board Executive Officer.

21. **"Infiltration"** means the downward entry of water into the surface of the soil.

22. **"Maximum Extent Practicable"** means the standard for implementation of storm water management programs to reduce pollutants in storm water. MEP generally emphasizes pollution prevention and source control BMPs primarily and considers economic factors and is therefore less stringent than technology-based limits.

23. **"MS4"** see Municipal Separate Storm Sewer System.

24. **"Municipal Separate Storm Sewer System"** means a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, manmade channels or storm drains) owned by a State, city, town or other public body, that is designed or used for collecting or conveying storm water, which is not a combined sewer and which is not part of a publicly owned treatment works. Commonly referred to as an "MS4".

25. "**National Pollutant Discharge Elimination System (NPDES)**" means the national program for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcing permits and imposing and enforcing pretreatment requirements under sections 307, 402, 318, and 405 of CWA. The term includes an "approved program."

26. "**NPDES**" means the National Pollutant Discharge Elimination System.

27. "**New Development**" means land disturbing activities; structural development, including construction or installation of a building or structure, creation of impervious surfaces; and land subdivision.

28. "**Non-storm Water Discharge**" means discharge other than storm water runoff or snowmelt.

29. "**Nuisance**" means anything that meets all of the following requirements: (1) is injurious to health, or is indecent or offensive to the senses, or an obstruction to the free use of property, so as to interfere with the comfortable enjoyment of life or property; (2) affects at the same time an entire community or neighborhood, or any considerable number of persons, although the extent of the annoyance or damage inflicted upon individuals may be unequal; (3) occurs during, or as a result of, the treatment or disposal of wastes.

30. "**Parking Lot**" means land area or facility for the parking of commercial or business or private motor vehicles.

31. "**Permit**" means an authorization, license, or equivalent control document issued by EPA or an "approve State" to implement the requirements of 40 CFR Parts 122, 123 and 124. "Permit" includes an NPDES "general permit" (§122.28). Permit does not include any permit, which has not yet been the subject of final agency action, such as a "draft permit" or a "proposed permit".

32. "**Pollutants of Concern**" means a prioritized list of pollutants identified in the Ventura County SMP as requiring additional investigation.

33. "**Potable Water Sources**" means flows from drinking water storage, supply and distribution systems including flows from system failures, pressure releases, system maintenance, well development, pump testing fire hydrant flow testing; and flushing and dewatering of pipes, reservoirs, vaults and wells.

34. "**Priority Pollutants**" are those consultants referred to in 40 CFR 401.15 and listed in the EPA NPDES Application Form 2C, pp.V-3 through V-9.

35. "**Rain Event**" means any rain event greater than 0.1 inch in 24 hours.

36. "**Redevelopment**" means, but is not limited to, the expansion of a building footprint or addition or replacement of a structure; structural development including an increase in gross floor area and/or exterior construction or remodeling; replacement of impervious surface that is not part of a routine maintenance activity; land disturbing activities related with structural or impervious surfaces. Redevelopment of one of the eight identified SQUIMP categories that result in the creation or addition of 5,000 square feet or more of impervious surfaces is subject to the requirements for storm water mitigation. If the creation or addition of impervious surfaces is fifty percent or more of the existing impervious surface area, then storm water runoff from the entire area (existing and additions) must be considered for purposes of storm water mitigation. If the creation or additions is less than fifty percent of the existing impervious area, then storm water runoff from only the addition area needs mitigation.

37. "**Regional Administrator**" means the Regional Administrator of the Regional Office of the Environmental Protection Agency or the authorized representative of the Regional Administrator.

38. "**Side Walk Washing**" means pressure washing of paved pedestrian walkways with average water usage of 0.006 gallons per square foot with no cleaning agents and properly disposing of all debris collected as authorized under Regional Board Resolution No.98-08.

39. **"Site"** means the land or water area where any "facility or activity" is physically located or conducted, including adjacent land used in connection with the facility or activity.

40. **"Source Control BMP"** means any schedules of activities, prohibitions of practices, maintenance procedures, managerial practices or operational practices that aim to prevent storm water pollution by reducing the potential for contamination at the source of pollution.

41. **"SQUIMP"** shall mean the Ventura Countywide Stormwater Quality Urban Impact Mitigation Plan. The SQUIMP shall address conditions and requirements of new development.

42. **"State General Permit"** shall mean a permit issued by the State Water Resources Control Board or the Regional Board pursuant to 40 CFR §122 and 123 to regulate a category of point sources. The term State General Permit includes but is not limited to the General Permit for Stormwater Discharges Associated with Construction Activity and the General Industrial Activities Stormwater Permit and the terms and requirements of both. In the event the EPA revokes the in-lieu permitting authority of the State Water Resources Control Board, then the term State General Permit shall also refer to any EPA administered stormwater control program for industrial, construction and any other category of activities.

43. **"Storm Water"** shall mean "stormwater".

44. **"Storm Water Pollution Prevention Plan"** shall mean a plan, as required by a State General Permit, identifying potential pollutant sources and describing the design, placement and implementation of BMPs, to effectively prevent non-stormwater Discharges and reduce Pollutants in Stormwater Discharges during activities covered by the General Permit.

45. **"Stormwater"** shall mean any surface flow, runoff and/or drainage associated with rainstorm events and/or snowmelt.

46. **"Storm Water Pollution Control Plan (SWPCP)"** shall mean a plan identifying potential pollutant sources from a construction site and describing proposed design, placement and implementation of BMPs, to effectively prevent non-stormwater Discharges and reduce Pollutants in Stormwater Discharges to the Storm Drain System, to the maximum extent practicable, during construction activities.

47. **"Stormwater Quality Management Plan"** shall mean the Ventura Countywide Stormwater Quality Management Plan, which includes descriptions of programs, collectively developed by the Co-permittees in accordance with provisions of the NPDES Permit, to comply with applicable federal and state law, as the same is amended from time to time.

48. **"Structural BMP"** means any structural facility designed and constructed to mitigate the adverse impacts of storm water and urban runoff pollution (e.g., canopy, structural enclosure). The category may include both treatment control BMPs and source control BMPs.

49. **"Total Maximum Daily Load (TMDL)"** means the amount of pollutant, or property of a pollutant, from point, non-point and natural background sources, that may be discharged to a water quality-limited receiving water. Any pollutant loading above the TMDL results in a violation of applicable water quality standards.

50. **"Treatment"** means the application of engineered systems that use physical, chemical, or biological processes to remove pollutants. Such processes include, but are not limited to, filtration, gravity settling, media absorption, biodegradation, biological uptake, chemical oxidation and UV radiation.

51. **"Treatment Control BMP"** means any engineered system designed to remove pollutants by simple gravity settling of particulate pollutants, filtration, biological uptake, media absorption or any other physical, biological or chemical process.

52. "**Upset**" means an exceptional incident in which there is unintentional and temporary noncompliance with the permit limit because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance or careless or improper maintenance.

53. "**Water Quality Standards and Water Quality Objectives**" applicable to the Permittee include those contained in the Los Angeles Regional Water Quality Control Plan (Basin Plan), the California Ocean Plan, the National Toxics Rule, the California Toxics Rule, and other state or federally approved surface water quality plans. Such plans are used by the Regional Board to regulate all discharges, including storm water discharges.

54. "**Waters of the State**" means any surface water or groundwater, including saline waters, within boundaries of the state.

55. "**Waters of the United States or Waters of the U.S.**" means:
    a. All waters that are currently used, were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide
    b. All interstate waters, including interstate "wetlands"
    c. "All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, "wetlands", sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds the use, degradation, or destruction of which would affect or could affect interstate or foreign commerce including any such waters:
        - Which are or could be used by interstate or foreign travelers for recreational or other purposes
        - From which fish or shellfish are or could be taken and sold in interstate or foreign commerce
        - Which are used or could be used for industrial purposes by industries in interstate commerce
    d. All impoundments of waters otherwise defined as waters of the United States under this definition
    e. Tributaries of waters identified in paragraphs (a) through (d) of this definition
    f. The territorial sea
    g. "Wetlands" adjacent to waters (other than waters that are themselves wetlands) identified in paragraph (a) through (f) of this definition

    Waste treatment systems, including treatment ponds or lagoons designed to meet the requirements of CWA (other than cooling ponds as defined in 40 CFR 423.22(m), which also meet the criteria of this definition) are not waters of the United States. This exclusion applies only to man-made bodies of water, which neither were originally created in waters of the United States (such as disposal area in wetlands) nor resulted from the impoundment of waters of the United States. Waters of the United States do not include prior converted cropland. Notwithstanding the determination of an area's status as prior converted cropland by any other federal agency, for the purposes of the Clean Water Act, the final authority regarding Clean Water Act jurisdiction remains with USEPA.

56. "**Watercourse**" shall mean any natural or artificial channel for passage of water, including the VCWPD jurisdictional channels included in the List of Channels within the Comprehensive Plan of the VCWPD, as approved by the Board of Supervisors of the VCWPD on October 4, 1993 and any amendments thereto.

57. "**Wet Season**" means the calendar period beginning October 1 through April 15.

58. "**Whole Effluent Toxicity**" means the aggregate toxic effect of an effluent measured directly by a toxicity test.

59. "**Work in Progress**" shall mean work required during a construction project that requires removal of BMPs or operational changes that could otherwise violate the SWPPP when undertaken on a limited basis for the purpose of increasing the effectiveness or improvement of BMPs as the construction progresses.

file

California Regional Water Quality Control Board

Los Angeles Region

Recipient of the 2001 *Environmental Leadership Award* from Keep California Beautiful

Alan C. Lloyd, Ph.D.
Agency Secretary

320 W. 4th Street, Suite 200, Los Angeles, California 90013
Phone (213) 576-6600 FAX (213) 576-6640 - Internet Address: http://www.waterboards.ca.gov/losangeles

Arnold Schwa ger
Govern

February 25, 2005

Mr. Jeff Pratt
Director
Ventura County Watershed
Protection District
800 South Victoria Avenue
L#1600
Ventura, CA 93009

Certified Mail
Return Receipt Requested
Claim No. 7002 2030 0002 1673 0243

REPORT OF WASTE DISCHARGE (ROWD)– APPLICATION OF RENEWAL OF THE VENTURA MUNICIPAL NPDES PERMIT

Dear Mr. Pratt:

Thank you for your ROWD submittal that is dated January 26, 2005. The document lists your program achievements over the last few years, and contains a Draft Permit.

Federal regulations at 40 CFR 122.21(d) require that the ROWD be submitted at least 180 days prior to the MS4 permit expiration date, and that the permitting authority respond as to its completeness no later than 30 days from the date of submittal. The USEPA in addition has issued guidelines for review and consideration of MS4 permit re-applications (61 Fed. Reg.41697).

Based on our preliminary review, the ROWD appears to lack crucial details in proposed program areas of the Permit. For instance, the proposed industrial/commercial program lacks details on the level, frequency, type and enforcement of inspections. Similarly, the proposed land development program appears not to have taken into account the experience from the last four countywide program evaluations performed over the last few years. Issues pertaining to source control, SQUIMP database, matching BMPs with Pollutants of Concern, and the legal mechanisms for responsibility of BMP maintenance are some of the land development program key items not included or discussed in sufficient detail. Also, the proposed monitoring program emphasizing land use monitoring does not seem to be adequate to meet MS4 monitoring objectives and California model program recommendations.

We will notify you in the near future of a proposed schedule to start discussions on developing a Draft Permit. If you have any questions, please call me at (213) 620-2237.

Sincerely,

Ejigu Solomon, Unit Chief
Storm Water Compliance and Enforcement

Cc: Municipal Co-Permittees (via email)

Ventura Countywide
Stormwater Quality
Management Program

see staff email response date 3/16.

Participating Agencies

Camarillo

County of Ventura

Fillmore

Moorpark

Ojai

Oxnard

Port Hueneme

San Buenaventura

Santa Paula

Simi Valley

Thousand Oaks

Ventura County
Watershed Protection
District

March 4, 2005

Mr. Ejigu Solomon
California Regional Water Quality Control Board
Los Angeles Region
320 W. 4th Street
Los Angeles, CA 90013

Subject: **Report of Waste Discharge (ROWD)**
Application of Renewal of the Ventura Countywide Municipal NPDES Permit

Dear Mr. Solomon:

Thank you for your letter regarding the Report of Waste Discharge (ROWD) submitted on behalf of the Ventura Countywide Stormwater Quality Management Program. As indicated in your letter the ROWD was submitted in accordance with Title 23, California Code of Regulation, no later than 180 days in advance of permit expiration. Federal regulations 40 CFR 122.21(d) requires the permitting authority to respond within thirty days from the date of the ROWD submittal and indicate whether the ROWD application is complete and satisfactory.

Per your letter and our subsequent conversation the ROWD application is deemed satisfactory. Work now begins on drafting the next term permit.

Thank you for your prompt response to the ROWD application. We look forward to working with you and Xavier Swamikannu on the Countywide third term permit and implementing effective program elements to mitigate stormwater impacts and improve water quality in our local rivers and streams.

If you have any questions, feel free to contact me at (805) 654-2040.

Sincerely,

Jeff Pratt

Jeff Pratt
Director
Ventura County Watershed Protection District

Ventura Countywide Stormwater Quality Management Program

L #1600, 800 South Victoria Avenue, Ventura, CA 93009

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Mr. Ejigu Solomon
RWQCB
320 W. 4th Street
Los Angeles, CA 90013

90013+2342 31

A017917

From: Ejigu Solomon
To: Jeff Pratt
Date: 3/16/05 2:47PM
Subject: ROWD -Ventura

Thank you for your letter dated Mrach 4, 2005.

The purpose of this email is in response to that letter and to further clarify issues pertaining to the ROWD.

In our letter dated February 25, 2005, we stated at the beginning of the third paragraph that "based on our preliminary review, the ROWD appears to lack crucial details in proposed program areas of the Permit". The letter then goes onto pointing out examples of missing elements.

We would like to affirm that this is the case, and hence our plan to notify you in the near future of a proposed schedule to start discussions on developing a Draft Permit.

If you have any questions, please call me at 213-620-2237.

Ejigu Solomon, Unit Chief
Storm Water Compliance & Enforcement Unit
Los Angeles Regional Water Quality Control Board
(213) 620-2237
fax (213) 576-5777

Note new email address:esolomon@waterboards.ca.gov

***

CC: Xavier Swamikannu

STATE OF CALIFORNIA

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LOS ANGELES REGION

ORDER NO. 01-182
NPDES PERMIT NO. CAS004001
WASTE DISCHARGE REQUIREMENTS
FOR
MUNICIPAL STORM WATER AND URBAN RUNOFF DISCHARGES WITHIN THE COUNTY OF LOS ANGELES, AND THE INCORPORATED CITIES THEREIN, EXCEPT THE CITY OF LONG BEACH

December 13, 2001

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STATE OF CALIFORNIA

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LOS ANGELES REGION

ORDER NO. 01-182
NPDES PERMIT NO. CAS004001
WASTE DISCHARGE REQUIREMENTS
FOR
MUNICIPAL STORM WATER AND URBAN RUNOFF DISCHARGES WITHIN THE COUNTY OF LOS ANGELES, AND THE INCORPORATED CITIES THEREIN, EXCEPT THE CITY OF LONG BEACH

The California Regional Water Quality Control Board, Los Angeles Region (hereinafter referred to as the Regional Board) finds:

A. **Existing Permit**

The Los Angeles County Flood Control District, the County of Los Angeles, and 84 incorporated cities within the Los Angeles County Flood Control District (see Attachment A, List of Permittees), hereinafter referred to separately as Permittees and jointly as the Discharger, discharge or contribute to discharges of storm water and urban runoff from municipal separate storm sewer systems (MS4s), also called storm drain systems. The discharges flow to water courses within the Los Angeles County Flood Control District and into receiving waters of the Los Angeles Region. These discharges are covered under countywide waste discharge requirements contained in Order No. 96-054 adopted by this Regional Board on July 15, 1996, which replaced Order No. 90-079 adopted by this Regional Board on June 18, 1990. Order No. 96-054 also serves as a National Pollutant Discharge Elimination System (NPDES) permit for the discharge of municipal storm water.

B. **Nature of Discharges and Sources of Pollutant**

1. Storm water discharges consist of surface runoff generated from various land uses in all the hydrologic drainage basins that discharge into water bodies of the State. The quality of these discharges varies considerably and is affected by the hydrology, geology, land use, season, and sequence and duration of hydrologic events. The primary constituents of concern currently identified by the Los Angeles County Flood Control District Integrated Receiving Water Impacts Report (1994-2000) are cyanide, indicator bacteria, total dissolved solids, turbidity, total suspended solids, nutrients, total aluminum, dissolved cadmium, copper, lead, total mercury, nickel, zinc, bis(2-ethylhexyl)phthalate, polycyclic aromatic hydrocarbons (PAHs), diazinon, and chlorpyrifos.

2. Certain pollutants present in storm water and/or urban runoff may be derived from extraneous sources that Permittees have no or limited jurisdiction over. Examples of such pollutants and their respective sources are: PAHs which are products of internal combustion engine

operation, nitrates, bis (2-ethylhexyl) phthalate and mercury from atmospheric deposition, lead from fuels, copper from brake pad wear, zinc from tire wear, dioxins as products of combustion, and natural-occurring minerals from local geology. However, the implementation of the measures set forth in this Order is intended to reduce the entry of these pollutants into storm water and their discharge to receiving waters.

3. Water quality assessments conducted by the Regional Board identified impairment, or threatened impairment, of beneficial uses of water bodies in the Los Angeles Region. The causes of impairments include pollutants of concern identified in municipal storm water discharges by the County of Los Angeles in the Integrated Receiving Water Impacts Report (1994-2000). Pollutants in storm water can have damaging effects on both human health and aquatic ecosystems.

4. The Los Angeles County Grand Jury, September 2000, completed an investigation into the health risks of swimming near beaches in Los Angeles County and made several recommendations to reduce public health risks (Final Report, Grand Jury, Los Angeles County, 1999-2000). The Grand Jury recommended that the Regional Board consider among other actions, (i) a focus on setting contaminant limits rather than programmatic evaluations; (ii) audit of MS4 Permittee programs; and (iii) clarifying enforcement responsibilities between the State and local governments.

5. Studies and research conducted by other Regional agencies, academic institutions, and universities have also identified storm water and urban runoff as significant sources of pollutants to surface waters in Southern California. See, e.g., [*Surface Runoff to the Southern California Bight*, Southern California Coastal Water Research Project, (1992); *Impacts of Urban Runoff on Santa Monica Bay and Surrounding Ocean Waters* (Gersberg, R.M., 1995); *State of the Bay 1998*, Santa Monica Bay Restoration Project; *Storm Water Impact*, In, Southern California Environmental Report Card 1999, Institute of the Environment, University of California, Los Angeles (Stenstrom, M.S., 1999); *Distribution of Anthropogenic and Natural Debris on the Mainland Shelf of Southern California Bight*, Shelly L. Moore and M. James Allen (1999); *The Health Effects of Swimming in Ocean Water Contaminated by Storm Drain Runoff*, Haile, R.W. et al. (1999); *Huntington Beach Closure Investigation: Technical Review* (University of Southern California, 2000); *A Regional Survey of the Microbiological Water Quality Along the Shoreline of the Southern California Bight*, Rachel T. Noble *et al.* (2001); *Integrated Receiving Water Impacts Report (1994-2000)*, County of Los Angeles (2001)].

6. Development and urbanization increase pollutant load, volume, and discharge velocity. First, natural vegetated pervious ground cover is converted to impervious surfaces such as paved highways, streets, rooftops and parking lots. Natural vegetated soil can both absorb rainwater and remove pollutants providing an effective natural purification process. In contrast, pavement and concrete can neither absorb water nor remove pollutants, and thus the natural purification characteristics are

lost. Second, urban development creates new pollution sources as the increased density of human population brings proportionately higher levels of vehicle emissions, vehicle maintenance wastes, municipal sewage waste, pesticides, household hazardous wastes, pet wastes, trash, and other anthropogenic pollutants. Development and urbanization especially threaten environmentally sensitive areas. Such areas have a much lower capacity to withstand pollutant shocks than might be acceptable in the general circumstance. In essence, development that is ordinarily insignificant in its impact on the environment may in a particular sensitive environment become significant. These environmentally sensitive areas designated by the State and/or the County of Los Angeles include Areas of Special Biological Significance (ASBS), water bodies designated as supporting a RARE beneficial use, Significant Natural Areas (SNAs), and Significant Ecological Areas (SEAs).

7. The increased volume, increased velocity, and discharge duration of storm water runoff from developed areas has the potential to greatly accelerate downstream erosion and impair stream habitat in natural drainages. Studies have demonstrated a direct correlation between the degree of imperviousness of an area and the degradation of its receiving waters. Significant declines in the biological integrity and physical habitat of streams and other receiving waters have been found to occur with as little as 10 percent conversion from natural to impervious surfaces. Percentage impervious cover is a reliable indicator and predictor of potential water quality degradation expected from new development. (*Impervious Cover as An Urban Stream Indicator and a Watershed Management Tool*, Schueler, T. and R. Claytor, In, Effects of Water Development and Management on Aquatic Ecosystems (1995), ASCE, New York; Leopold, L. B., (1973), *River Channel Change with Time: An Example*, Geological Society of America Bulletin, v. 84, p. 1845-1860; Hammer, T. R., (1972), *Stream Channel Enlargement Due to Urbanization: Water Resources Research*, v. 8, p. 1530-1540; Booth, D. B., (1991), *Urbanization and the Natural Drainage System--Impacts, Solutions and Prognoses*: The Northwest Environmental Journal, v. 7, p. 93-118; Klein, R. D., (1979), *Urbanization and Stream Quality Impairment*: Water Resources Bulletin, v. 15, p. 948-963; May, C. W., Horner, R. R., Karr, J. R., Mar, B. W., and Welch, E. B., (1997), *Effects of Urbanization on Small Streams in the Puget Sound Lowland Ecoregion*: Watershed Protection Techniques, v. 2, p. 483-494; Morisawa, M. and LaFlure, E. *Hydraulic Geometry, Stream Equilibrium and Urbanization* In Rhodes, D. P. and Williams, G. P. *Adjustments to the Fluvial System* p.333-350. (1979); Dubuque, Iowa, Kendall/Hunt. Tenth Annual Geomorphology Symposia Series; and *The Importance of Imperviousness*: Watershed Protection Techniques, 1(3), Schueler, T. (1994).)

8. The County of Los Angeles has identified as the seven highest priority industrial and commercial critical source types, (i) wholesale trade (scrap recycling, auto dismantling); (ii) automotive repair/parking; (iii) fabricated metal products; (iv) motor freight; (v) chemical and allied products; (vi) automotive dealers/gas stations; (vii) primary metal products (*Critical*

Source Selection and Monitoring Report, Los Angeles County Department of Public Works -Sept 1996). Monitoring conducted by Los Angeles County and the Regional Board demonstrates that the priority industrial sectors and auto repair facilities (one of the commercial sectors) on the list, contribute significant concentrations of heavy metals to storm water (*Los Angeles County 1999-2000 Storm Water Monitoring Report*, Los Angeles County Department of Public Works -July 2000; *Compliance Assessment of the Auto Dismantling Industry; Evaluation of the California General Industrial Storm Water Permit*, H. Chang, (2001), 70 pp., California Regional Water Quality Control Board, Los Angeles Region).

9. The discharge of washwaters and contaminated storm water from industries and businesses specified in this Order for inspection by Permittees is an environmental threat and can also adversely impact public health and safety. For example, a review of industrial waste/ pretreatment records performed in 1995 in the County of Los Angeles on illicit discharges indicates that automotive service facilities and food service facilities sometimes discharge polluted washwaters to the MS4. The pollutants of concern in such washwaters include food waste, oil and grease, and toxic chemicals. Other storm water/industrial waste programs in California have reported similar observations. Illicit discharges from automotive service facilities and food service facilities have been identified elsewhere as a major cause of widespread contamination and water quality problems (Washtenaw County Statutory Drainage Board - 1987 Huron River Pollution Abatement Program).

10. Studies indicate that facilities with paved surfaces subject to frequent motor vehicular traffic (such as parking lots and fast food restaurants), or facilities that perform vehicle repair, maintenance, or fueling (automotive service facilities) are potential sources of pollutants of concern in storm water. [References: Pitt *et al.*, *Urban Storm Water Toxic Pollutants: Assessment, Sources, and Treatability*, Water Environment Res., 67, 260 (1995); *Results of Retail Gas Outlet and Commercial Parking Lot Storm Water Runoff Study*, Western States Petroleum Association and American Petroleum Institute, (1994); *Action Plan Demonstration Project, Demonstration of Gasoline Fueling Station Best Management Practices*, Final Report, County of Sacramento (1993); *Source Characterization*, R. Pitt, In Innovative Urban Wet-Weather Flow Management Systems (2000) Technomic Press, Field, R *et al.* editors; *Characteristics of Parking Lot Runoff Produced by Simulated Rainfall*, , L.L. Tiefenthaler *et al.* Technical Report 343, Southern California Coastal Water Research Project (2001).]

11. Retail Gasoline Outlets (RGOs) are points of convergence for vehicular traffic and are similar to parking lots and urban roads. Studies indicate that storm water discharges from RGOs have high concentrations of hydrocarbons and heavy metals. [*The Quality of Trapped Sediments and Poor Water within Oil Grit Separators in Suburban MD,* Schueler T. and Shepp D. (1992), and *Concentrations of Selected Constituents in Runoff from Impervious Surfaces in Four Urban Catchments of Different*

Landuse, Ranabal, F.I., and T.J. Gizzard (1995), In Proceedings of the Fourth Biennial Stormwater Research Conference, Florida, pp-42-52]. Pilot studies indicate that treatment control best management practices installed at retail gasoline stations are effective in removing pollutants, reasonable in capital cost, easy to operate, and do not present safety risks [*Rouge River National Wet Weather Demonstration Project, Task Product Memorandum – Evaluation of On-line Media Filters RPO-NPS-TPM59.00*, Wayne County, MI, March 1999]. The Regional Board and the San Diego Regional Board have jointly prepared a Technical Report on the applicability of new development BMP design criteria for retail gasoline outlets, (*Retail Gasoline Outlets: New Development Design Standards for Mitigation of Storm Water Impacts*, (June 2001)). Retail Gasoline Outlets in Western U.S. States (such as Washington and Oregon) are already subject to numerical BMP design criteria, as well in other U.S. States.

C. Permit Background

1. The essential components of the Storm Water Management Program, as established by federal regulations [40 CFR 122.26(d)] are: (i) Adequate Legal Authority, (ii) Fiscal Resources, (iii) Storm Water Quality Management Program (SQMP) - (Public Information and Participation Program, Industrial/Commercial Facilities Program, Development Planning Program, Development Construction Program, Public Agency Activities Program, Illicit Connection and Illicit Discharges Elimination Program), and (iv) Monitoring and Reporting Program.

2. The Permittees have filed a Report of Waste Discharge (ROWD), dated February 1, 2001, and applied for renewal of their waste discharge requirements that serves as an NPDES permit to discharge wastes to surface waters. The ROWD includes a proposed SQMP and a Monitoring Program. The proposed SQMP contains programs previously approved under Board Order No. 96-054 in the following areas:

   Public Information and Participation
   Development Planning
   Development Construction
   Public Agency Activities
   Illicit Connection/Illicit Discharge Elimination Program

   These programs are revised pursuant to the provisions of this Order after adoption.

3. The County of Los Angeles has previously conducted source identification and pollutant characterization consistent with 40 CFR 122.26(d)(1)(ii) and (iii) under its storm water Monitoring Program. The Monitoring Program submitted with the ROWD proposes to advance the assessment of receiving water impacts, identification of sources of pollution, evaluation of Best Management Practices (BMPs), and measurement of long term trends in mass emissions.

4. The Regional Board has reviewed the ROWD and has determined it to be complete under the reapplication policy of MS4s issued by the U.S. Environmental Protection Agency (USEPA) (61 *Fed. Reg.* 41697). The Regional Board finds that the Permittees' proposed SQMP, incorporating the additional and/or revised provisions contained in this Order would meet the minimum requirements of federal regulations.

5. The City of Los Angeles has conducted shoreline and nearshore water quality monitoring off the Santa Monica Bay since the 1950s under the monitoring program for the Hyperion Waste Water Treatment Plant (NPDES No. CA0109991). The monitoring results indicate that effluent from Hyperion's 5-Mile Outfall does not impinge the shoreline, and that elevated bacterial counts are associated with runoff from storm drains and discharges from piers. In 1994, the Regional Board approved the relocation of Hyperion's shoreline stations to implement a bay-wide, regional shoreline-monitoring program associated with storm drain outfalls in the Santa Monica Bay. The City of Los Angeles requested that the shoreline-monitoring requirement be incorporated in this Order. The shoreline pathogen monitoring requirements are outlined in the Monitoring Program for this Order.

D. Permit Coverage

1. The requirements in this Order cover all areas within the boundaries of the Permittee municipalities (see Attachment A) over which they have regulatory jurisdiction as well as unincorporated areas in Los Angeles County within the jurisdiction of the Regional Board. The Permittees serve a population of about 9.5 million [Reference: *2000 Census of Population and Housing*, Bureau of the Census, U.S. Department of Commerce (2001)] in an area of approximately 3,100 square miles.

2. Federal, state, regional or local entities within the Permittees' boundaries or in jurisdictions outside the Los Angeles County Flood Control District, and not currently named in this Order, may operate storm drain facilities and/or discharge storm water to storm drains and watercourses covered by this Order. The Permittees may lack legal jurisdiction over these entities under state and federal constitutions. The Regional Board will coordinate with these entities to implement programs that are consistent with the requirements of this Order. The Regional Board will consider such facilities for coverage in 2003 under its NPDES permitting scheme pursuant to USEPA Phase II storm water regulations.

3. Sources of discharges into receiving waters in the County of Los Angeles but in jurisdictions outside its boundary include the following:

   About 34 square miles of unincorporated area in Ventura County, which drain into Malibu Creek and then to Santa Monica Bay,

   About 9 square miles of the City of Thousand Oaks, which also drain into Malibu Creek and then to Santa Monica Bay, and

About 86 square miles of area in Orange County, which drain into Coyote Creek and then into the San Gabriel River.

The Regional Board will ensure that storm water management programs for the areas in Ventura County and the City of Thousand Oaks that drain into Santa Monica Bay are consistent with the requirements of this Order. The Regional Board will coordinate with the Santa Ana Regional Board so that storm water management programs for the areas in Orange County that drain into Coyote Creek are consistent with the requirements of this Order.

4. This permit is intended to develop, achieve, and implement a timely, comprehensive, cost-effective storm water pollution control program to reduce the discharge of pollutants in storm water to the Maximum Extent Practicable (MEP) from the permitted areas in the County of Los Angeles to the waters of the U.S. subject to the Permittees' jurisdiction.

5. Permittees have expressed their intention to work cooperatively to control the contribution of pollutants from one portion of the MS4 to another portion of the system. Permittees may control the contribution of pollutants to the MS4 from non-permittee dischargers such as Caltrans, the U.S. Department of Defense, and other state and federal facilities, through interagency agreements.

E. Federal, State, and Regional Regulations

1. The Water Quality Act of 1987 added Section 402(p) to the federal Clean Water Act (CWA) (33 U.S.C. § 1251-1387). This section requires the USEPA to establish regulations setting forth NPDES requirements for storm water discharges in two phases.

   - The USEPA Phase I storm water regulations were directed at MS4s serving a population of 100,000 or more, including interconnected systems and storm water discharges associated with industrial activities, including construction activities. The Phase I Final Rule was published on November 16, 1990 (55 *Fed. Reg.* 47990).

   - The USEPA Phase II storm water regulations are directed at storm water discharges not covered in Phase I, including small MS4s (serving a population of less than 100,000), small construction projects (one to five acres), municipal facilities with delayed coverage under the Intermodal Surface Transportation Efficiency Act of 1991, and other discharges for which the USEPA Administrator or the State determines that the storm water discharge contributes to a violation of a water quality standard, or is a significant contributor of pollutants to waters of the United States. The Phase II Final Rule was published on December 8, 1999 (64 *Fed. Reg.* 68722).

2. The USEPA published an 'Interim Permitting Approach for Water Quality-Based Effluent Limitations in Storm Water Permits' on August 26, 1996 (61 *Fed. Reg.* 43761). This policy discusses the appropriate kinds of

water quality-based effluent limitations to be included in NPDES storm water permits to provide for the attainment of water quality standards.

3. The USEPA published an 'Interpretative Policy Memorandum on Reapplication Requirements' for MS4 permits on August 9, 1996 (61 *Fed. Reg.* 41697). This policy requires that MS4 reapplication for reissuance for a subsequent five-year permit term contain certain basic information and information for proposed changes and improvements to the storm water management program and monitoring program.

4. The USEPA has entered into a Memorandum of Agreement (MOA) with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service for enhancing coordination regarding the protection of endangered and threatened species under Section 7 of the Endangered Species Act and the CWA's Water Quality Standards and NPDES programs. Among other actions, the MOA establishes a framework for coordination of actions by the USEPA, the Services, and CWA delegated States on CWA permit issuance under Section 402 of the CWA [66 *Fed. Reg.* 11202 – 11217].

5. USEPA regulations at 40 CFR 122.26(d)(2)(iv)(A) and 40 CFR 122.26(d)(2)(iv)(C) require that MS4 permittees implement a program to monitor and control pollutants in discharges to the municipal system from industrial and commercial facilities that contribute a substantial pollutant load to the MS4. The regulations require that permittees establish priorities and procedures for inspection of industrial facilities and priority commercial establishments. This permit, consistent with the USEPA policy, incorporates a cooperative partnership, including the specifications of minimum expectations, between the Regional Board and the Permittees for the inspection of industrial facilities and priority commercial establishments to control pollutants in storm water discharges (58 *Fed. Reg.* 61157).

6. Section 402 (p) of the CWA (33 U.S.C. § 1342(p) provides that MS4 permits must "require controls to reduce the discharge of pollutants to the maximum extent practicable, including management practices, control techniques and system, design engineering method and such other provisions as the [EPA] Administrator or the State determines appropriate for the control of such pollutants." The State Water Resources Control Board's (State Board) Office of Chief Counsel (OCC) has issued a memorandum interpreting the meaning of MEP to include technical feasibility, cost, and benefit derived with the burden being on the municipality to demonstrate compliance with MEP by showing that a BMP is not technically feasible in the locality or that BMPs costs would exceed any benefit to be derived (dated February 11, 1993).

7. The CWA authorizes the USEPA to permit a state to serve as the NPDES permitting authority in lieu of the USEPA. The State of California has in-lieu authority for an NPDES program. The Porter-Cologne Water Quality Control Act authorizes the State Board, through the Regional Boards, to regulate and control the discharge of pollutants into waters of the State. The State Board entered into a MOA with the USEPA, on

September 22, 1989, to administer the NPDES Program governing discharges to waters of the U.S.

8. Section 303(d) of the CWA requires that the State identify a list of impaired water-bodies and develop and implement Total Maximum Daily Loads (TMDLs) for these waterbodies (33 U.S.C. §1313(d)(1)). A TMDL specifies the maximum amount of a pollutant that a water-body can receive, still meet applicable water quality standards and protect beneficial uses. The USEPA entered into a consent decree with the Natural Resources Defense Council (NRDC), Heal the Bay, and the Santa Monica BayKeeper on March 22, 1999, under which the Regional Board must adopt all TMDLs for the Los Angeles Region within 13 years from that date. This permit incorporates a provision to implement and enforce approved load allocations for municipal storm water discharges and requires amending the SQMP after pollutants loads have been allocated and approved.

9. Section 6217(g) of the Coastal Zone Act Reauthorization Amendments of 1990 (CZARA) requires coastal states with approved coastal zone management programs to address non-point pollution impacting or threatening coastal water quality. CZARA (16 U.S.C. § 1451-1465) amends the Coastal Zone Management Act of 1972, to address five sources of non-point pollution: agriculture, silviculture, urban, marinas, and hydromodification. This NPDES permit addresses the management measures required for the urban category, with the exception of septic systems. The Regional Board addresses septic systems through the administration of other programs.

10. On May 18, 2000, the USEPA established numeric criteria for priority toxic pollutants for the State of California (California Toxics Rule (CTR)) 65 *Fed. Reg.* 31682 (40 CFR 131.38), for the protection of human health and aquatic life. These apply as ambient water quality criteria for inland surface waters, enclosed bays, and estuaries. The State Board adopted the *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (SIP) – 2000,* on March 2, 2000, for implementation of the CTR (State Board Resolution No. 2000-15 as amended by Board Resolution No. 2000-030). This policy requires that discharges comply with TMDL-derived load allocations as soon as possible but no later than 20 years from the effective date of the policy.

11. The State Board adopted a revised Water Quality Control Plan for Ocean Waters of California (Ocean Plan) on July 23, 1997. The Ocean Plan contains water quality objectives which apply to all discharges to the coastal waters of California.

12. The State Board in *In Re*: California Department of Transportation (State Board Order WQ 2001-08), determined that the discharge of storm water to ASBS is subject to the prohibition in the Ocean Plan against the discharge of wastes to an ASBS.

13. The Regional Board adopted an updated Water Quality Control Plan (Basin Plan) for the Los Angeles Region on June 13, 1994, '*Water Quality Control Plan, Los Angeles Region: Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties*, (1994).' The Basin Plan designates beneficial uses of receiving waters and specifies both narrative and numerical water quality objectives for the receiving waters in Los Angeles County.

14. The Regional Board on September 19, 2001, adopted amendments to the Basin Plan, to incorporate TMDLs for trash in the Los Angeles River (Resolution No. 01-013) and Ballona Creek (Resolution No. 01-014). After approval by the State Board, the Office of Administrative Law, and the USEPA, the TMDLs for trash will be effective and enforceable.

15. The Regional Board on April 13, 1998, approved BMPs for sidewalk rinsing to minimize the discharge of wash waters to the storm drain system (Resolution No. 98-08). By the same resolution, the Regional Board prohibited the discharge of municipal street wash waters to the storm drain system.

16. The Regional Board on April 13, 1998, approved recommended BMPs for industrial/commercial facilities (Resolution No. 98-08).

17. The Regional Board on April 22, 1999, approved a list of BMPs for use in development planning and development construction (Resolution No. 99-03)

18. The Regional Board adopted and approved requirements for new development and significant redevelopment projects in Los Angeles County to control the discharge of storm water pollutants in post-construction storm water, on January 26, 2000, in Board Resolution No. R-00-02. The Regional Board Executive Officer issued the approved Standard Urban Storm Water Mitigation Plans (SUSMPs) on March 8, 2000. The State Board in large part affirmed the Regional Board action and SUSMPs in State Board Order No. WQ 2000-11 issued on October 5, 2000.

    - The State Board's Chief Counsel has issued a statewide policy memorandum (dated December 26, 2000), which interprets the Order to provide broad discretion to Regional Boards and identifies potential future areas for inclusion in SUSMPs and the types of evidence and findings necessary. Such areas include ministerial projects, projects in environmentally sensitive areas, and water quality design criteria for RGOs.
    - The State Board's Chief Counsel interprets the Order to encourage regional solutions and endorses a mitigation fund or "bank" that may be funded by developers who obtain waivers from the numerical design standards for new development and significant redevelopment.

19. 40 CFR 131.10(a) prohibits states from designating waste transport or waste assimilation as a use for any water of the U.S. Authorizing the

construction of a storm water/ urban runoff treatment facility in a jurisdictional water body would be tantamount to accepting waste assimilation as an appropriate use for that water body. Furthermore, the construction and operation of a pollution control facility in a water body can impact the physical, chemical, and biological integrity as well as the beneficial uses of the water body. Therefore, storm water treatment and/or mitigation in accordance with SUSMPs and any other requirements of this Order must occur prior to the discharge of storm water into a water of the U.S.

20. The Regional Board supports a Watershed Management Approach to address water quality protection in the region. The objective of the Watershed Management Approach should be to provide a comprehensive and integrated strategy towards water resource protection, enhancement, and restoration while balancing economic and environmental impacts within a hydrologically defined drainage basin or watershed. It emphasizes cooperative relationships between regulatory agencies, the regulated community, environmental groups, and other stakeholders in the watershed to achieve the greatest environmental improvements with available resources.

21. To promote a watershed management approach, the County of Los Angeles is divided into six Watershed Management Areas (WMAs) as follows:

Malibu Creek and Rural Santa Monica Bay WMA
Ballona Creek and Urban Santa Monica Bay WMA
Los Angeles River WMA
San Gabriel River WMA
Dominguez Channel/Los Angeles Harbor WMA, and
Santa Clara River WMA

Attachment A shows the list of Permittees under each WMA and some Permittees have expressed an intent to form sub-watershed groups within the WMA to promote regional solutions for the mitigation of storm water discharge pollution.

22. To facilitate compliance with federal regulations, the State Board has issued two statewide general NPDES permits for storm water discharges: one for storm water from industrial sites [NPDES No. CAS000001, General Industrial Activity Storm Water Permit (GIASP)] and the other for storm water from construction sites [NPDES No. CAS000002, General Construction Activity Storm Water Permit (GCASP)]. The GCASP was reissued on August 19, 1999. The GIASP was reissued on April 17, 1997. Facilities discharging storm water associated with industrial activities and construction projects with a disturbed area of five acres or more are required to obtain individual NPDES permits for storm water discharges, or to be covered by a statewide general permit by completing and filing a Notice of Intent (NOI) with the State Board. The USEPA guidance anticipates coordination of the state-administered programs for

industrial and construction activities with the local agency program to reduce pollutants in storm water discharges to the MS4.

The Regional Board is the enforcement authority in the Los Angeles Region for the two statewide general permits regulating discharges from industrial facilities and construction sites, and all NPDES storm water and non-storm water permits issued by the Regional Board. These industrial and construction sites and discharges are also regulated under local laws and regulations.

23. The State Board, on October 28, 1968, adopted Resolution No. 68-16, which established an anti-degradation policy for the State and Regional Boards. This policy restricts the degradation of surface waters and protects waterbodies where existing water quality is higher than is necessary for the protection of beneficial uses.

24. The State Board, on June 17, 1999, adopted Order No. WQ 99-05, which, in a precedential decision, identifies acceptable receiving water limitations language to be included in municipal storm water permits issued by the State and Regional Boards. The receiving water limitations included herein are consistent with the State Board Order, USEPA Policy, and the U.S. Appellate court decision in, *Defenders of Wildlife v. Browner* (9^{th}. Cir, 1999). The State Board OCC has determined that the federal court decision did not conflict with State Board Order No. WQ 99-05 (memorandum dated October 14, 1999)

25. California Water Code (CWC) § 13263(a) requires that waste discharge requirements issued by the Regional Board shall implement any relevant water quality control plans that have been adopted; shall take into consideration the beneficial uses to be protected and the water quality objectives reasonably required for that purpose; other waste discharges; the need to prevent nuisance; and provisions of CWC § 13241. The Regional Board has considered the requirements of § 13263 and § 13241, and applicable plans, policies, rules, and regulations in developing these waste discharge requirements.

26. CWC § 13370 *et seq.* requires that waste discharge requirements issued by the Regional Boards be consistent with provisions of the federal CWA and its amendments.

27. On March 12, 2001, the U.S. Court of Appeals ruled that it is necessary to obtain a NPDES permit for application of aquatic pesticides to waterways. (*Headwaters, Inc. vs. Talent Irrigation District,* 243 F.3d. 526 (9^{th} Cir., 2001)) This decision is controlling in California for nonagricultural applications of pesticides to waterways. The State Board adopted a general NPDES permit (Order No. 2001-12-DWQ) on July 19, 2001, for public entities that discharge pollutants to waters of the U.S. associated with the application of aquatic pesticides for resource or pest management. Public entities that conduct such activities must seek coverage under the general permit.

F. Implementation

1. The California Environmental Quality Act (CEQA) (Cal. Pub. Resources Code § 21000 *et seq.*) requires that public agencies consider the environmental impacts of the projects they approve for development. CEQA applies to projects that are considered discretionary and does not apply to ministerial projects, which involve the use of established standards or objective measurements. A ministerial project may be made discretionary by adopting local ordinance provisions or imposing conditions to create decision-making discretion in approving the project. In the alternative, Permittees may establish standards and objective criteria administratively for storm water mitigation for ministerial projects. For water quality purposes, the Regional Board considers that all new development and significant redevelopment activity in specified categories, that receive approval or permits from a municipality, are subject to storm water mitigation requirements.

2. The objective of this Order is to protect the beneficial uses of receiving waters in Los Angeles County. To meet this objective, this Order requires that the SQMP specify BMPs that will be implemented to reduce the discharge of pollutants in storm water to the maximum extent practicable. Further, Permittees are to assure that storm water discharges from the MS4 shall neither cause nor contribute to the exceedance of water quality standards and objectives nor create conditions of nuisance in the receiving waters, and that the discharge of non-storm water to the MS4 has been effectively prohibited.

3. The SQMP required in this Order builds upon the programs established in Order Nos. 90-079, and 96-054, consists of the components recommended in the USEPA guidance manual, and was developed with the cooperation of representatives from the regulated community and environmental groups. The SQMP includes provisions that promote customized initiatives, both on a countywide and watershed basis, in developing and implementing cost-effective measures to minimize discharge of pollutants to the receiving water. The various components of the SQMP, taken as a whole rather than individually, are expected to reduce pollutants in storm water and urban runoff to the maximum extent practicable. Provisions of the SQMP are fully enforceable under provisions of this Order.

4. The emphasis of the SQMP is pollution prevention through education, public outreach, planning, and implementation as source control BMPs first and then Structural and Treatment Control BMPs next. Successful implementation of the provisions of the SQMP will require cooperation and coordination of all public agencies in each Permittee's organization, among Permittees, and with the regulated community.

5. The implementation of a Public Information and Participation Program is a critical component of a storm water management program. An informed and knowledgeable community is critical to the success of a storm water management program since it helps insure the following: (i) greater support for the program as the public gains a greater understanding of

the reasons why it is necessary and important, and (ii) greater compliance with the program as the public becomes aware of the personal responsibilities expected of them and others in the community, including the individual actions they can take to protect or improve the quality of area waters.

6. This Order includes a Monitoring Program that incorporates Minimum Levels (MLs) established under the SIP. The SIP's MLs represent the lowest quantifiable concentration for priority toxic pollutants that is measurable with the use of proper method-based analytical procedures and factoring out matrix interference. The SIP's MLs therefore represent the best available science for determining MLs and are appropriate for a storm water monitoring program. The use of MLs allows the detection of toxic priority pollutants at concentrations of concern using recent advances in chemical analytical methods.

7. This Order provides flexibility for Permittees to petition the Regional Board Executive Officer to substitute a BMP under the SQMP with an alternative BMP, if they can provide information and documentation on the effectiveness of the alternative, equal to or greater than the prescribed BMP in meeting the objectives of this Order.

8. This Order contemplates that the Permittees are responsible for considering potential storm water impacts when making planning decisions in order to fulfill the Permittees' CWA requirement to reduce the discharge of pollutants in municipal storm water to the MEP from new development and redevelopment activities. However, the Permittees retain authority to make the final land-use decisions and retain full statutory authority for deciding what land uses are appropriate at specific locations within each Permittee's jurisdiction. This Order and its requirements are not intended to restrict or control local land use decision-making authority.

9. This Order is not intended to prohibit the inspection for or abatement of vectors by the State Department of Health Services or local vector agencies in accordance with Cal. Health and Safety Code § 2270 *et seq.* and §116110 *et seq.* Certain Treatment Control BMPs if not properly designed, operated or maintained may create habitats for vectors (e.g. mosquito and rodents). This Order contemplates that the Permittees will closely cooperate and collaborate with local vector control agencies and the State Department of Health Services for the implementation, operation, and maintenance of Treatment Control BMPs in order to minimize the risk to public health from vector borne diseases.

G. Public Process

1. The Regional Board has notified the Permittees and interested agencies and persons of its intent to issue waste discharge requirements for this discharge, and has provided them with an opportunity to submit their written view and recommendations.

2. The Regional Board, in a public hearing, heard and considered all comments pertaining to the discharge and to the tentative requirements.

3. The Regional Board has conducted public workshops to discuss drafts of the permit. On April 24, 2001, Regional Board staff conducted a workshop outlining the reasoning behind the changes proposed for the new permit and received input from the Permittees and the public regarding those proposed changes. On July 26, 2001, a second public workshop was held at a special Regional Board meeting. The Permittees and the public had another opportunity to express their opinions regarding the proposed changes to the permit in front of the Regional Board members. A significant number of working meetings with the Permittees and other interested parties have occurred throughout the period from the submittal of the ROWD and completion of the tentative draft, in an attempt to incorporate and address all the comments presented.

4. The Los Angeles County Flood Control District, the County of Los Angeles and the other municipalities are co-permittees as defined in 40 CFR 122.26 (b)(1). Los Angeles County Flood Control District will coordinate with the other municipalities and facilitate program implementation. Each Permittee is responsible only for a discharge for which it is the operator.

5. This Order shall serve as a NPDES Permit, pursuant to CWA § 402, or amendments thereto, and shall take effect 50 days from Order adoption provided the Regional Administrator of the USEPA has no objections.

6. The action to adopt an NPDES permit is exempt from the provisions of Chapter 3 of CEQA (Cal. Pub. Resources Code § 21100 *et seq.*), in accordance with CWC § 13389.

7. Pursuant to CWC §13320, any aggrieved party may seek review of this Order by filing a petition with the State Board. A petition must be sent to: State Water Resources Control Board, P.O. Box 100, Sacramento, California, 95812, within 30 days of adoption of the Order by the Regional Board.

8. This Order may be modified or alternatively revoked or reissued prior to its expiration date, in accordance with the procedural requirements of the NPDES program, and the CWC for the issuance of waste discharge requirements.

IT IS HEREBY ORDERED that the Los Angeles County Flood Control District, Los Angeles County, and the Cities of Agoura Hills, Alhambra, Arcadia, Artesia, Azusa, Baldwin Park, Bell, Bellflower, Bell Gardens, Beverly Hills, Bradbury, Burbank, Calabasas, Carson, Cerritos, Claremont, Commerce, Compton, Covina, Cudahy, Culver City, Diamond Bar, Downey, Duarte, El Monte, El Segundo, Gardena, Glendale, Glendora, Hawaiian Gardens, Hawthorne, Hermosa Beach, Hidden Hills, Huntington Park, Industry, Inglewood, Irwindale, La Cañada Flintridge, La Habra Heights, Lakewood, La Mirada, La Puente, La Verne, Lawndale, Lomita, Los Angeles, Lynwood, Malibu, Manhattan Beach, Maywood, Monrovia, Montebello, Monterey Park, Norwalk, Palos Verdes Estates, Paramount, Pasadena, Pico Rivera, Pomona, Rancho Palos Verdes, Redondo Beach, Rolling Hills, Rolling Hills Estates, Rosemead, San Dimas, San Fernando, San Gabriel, San Marino, Santa Clarita, Santa Fe Springs, Santa Monica, Sierra Madre, Signal Hill, South El Monte, South Gate, South Pasadena, Temple City, Torrance, Vernon, Walnut, West Covina, West Hollywood, Westlake Village, and Whittier, in order to meet the provisions contained in Division 7 of the CWC and regulations adopted thereunder, and the provisions of the CWA, as amended, and regulations and guidelines adopted thereunder, shall comply with the following:

Part 1. DISCHARGE PROHIBITIONS

The Permittees shall effectively prohibit non-storm water discharges into the MS4 and watercourses, except where such discharges:

1. Are covered by a separate individual or general NPDES permit for non-storm water discharges; or

2. Fall within one of the categories below, and meet all conditions when specified by the Regional Board Executive Officer:

    a) Category A - Natural flow:

        (1) Natural springs and rising ground water;

        (2) Flows from riparian habitats or wetlands;

        (3) Stream diversions, permitted by the State Board; and

        (4) Uncontaminated ground water infiltration [as defined by 40 CFR 35.2005(20)].

    b) Category B - Flows from emergency fire fighting activity.

    c) Category C - Flows incidental to urban activities:

        (1) Reclaimed and potable landscape irrigation runoff;

        (2) Potable drinking water supply and distribution system releases (consistent with American Water Works Association guidelines for dechlorination and suspended solids reduction practices);

        (3) Drains for foundations, footings, and crawl spaces;

        (4) Air conditioning condensate;

        (5) Dechlorinated/debrominated swimming pool discharges;

        (6) Dewatering of lakes and decorative fountains;

        (7) Non-commercial car washing by residents or by non-profit organizations; and

        (8) Sidewalk rinsing.

    The Regional Board Executive Officer may add or remove categories of non-storm water discharges above. Furthermore, in the event that any of the above categories of non-storm water discharges are determined to be a source of pollutants by the Regional Board Executive Officer, the discharge will no longer be exempt from this prohibition unless the Permittee implements conditions approved by the Regional Board Executive Officer to ensure that the discharge is not a source of pollutants. Notwithstanding the above, the Regional Board Executive Officer may impose additional prohibitions of non-storm water discharges in consideration of anti-degradation policies and TMDLs.

Part 2. RECEIVING WATER LIMITATIONS

1. Discharges from the MS4 that cause or contribute to the violation of Water Quality Standards or water quality objectives are prohibited.

2. Discharges from the MS4 of storm water, or non-storm water, for which a Permittee is responsible for, shall not cause or contribute to a condition of nuisance.

3. The Permittees shall comply with Part 2.1. and 2.2. through timely implementation of control measures and other actions to reduce pollutants in the discharges in accordance with the SQMP and its components and other requirements of this Order including any modifications. The SQMP and its components shall be designed to achieve compliance with receiving water limitations. If exceedances of Water Quality Objectives or Water Quality Standards (collectively, Water Quality Standards) persist, notwithstanding implementation of the SQMP and its components and other requirements of this permit, the Permittee shall assure compliance with discharge prohibitions and receiving water limitations by complying with the following procedure:

   a) Upon a determination by either the Permittee or the Regional Board that discharges are causing or contributing to an exceedance of an applicable Water Quality Standard, the Permittee shall promptly notify and thereafter submit a Receiving Water Limitations (RWL) Compliance Report (as described in the Program Reporting Requirements, Section I of the Monitoring and Reporting Program) to the Regional Board that describes BMPs that are currently being implemented and additional BMPs that will be implemented to prevent or reduce any pollutants that are causing or contributing to the exceedances of Water Quality Standards. This RWL Compliance Report may be incorporated in the annual Storm Water Report and Assessment unless the Regional Board directs an earlier submittal. The RWL Compliance Report shall include an implementation schedule. The Regional Board may require modifications to the RWL Compliance Report.

   b) Submit any modifications to the RWL Compliance Report required by the Regional Board within 30 days of notification.

   c) Within 30 days following the approval of the RWL Compliance Report, the Permittee shall revise the SQMP and its components and monitoring program to incorporate the approved modified

BMPs that have been and will be implemented, an implementation schedule, and any additional monitoring required.

d) Implement the revised SQMP and its components and monitoring program according to the approved schedule.

4. So long as the Permittee has complied with the procedures set forth above and is implementing the revised SQMP and its components, the Permittee does not have to repeat the same procedure for continuing or recurring exceedances of the same receiving water limitations unless directed by the Regional Board to develop additional BMPs.

Part 3. STORM WATER QUALITY MANAGEMENT PROGRAM (SQMP) IMPLEMENTATION

A. General Requirements

1. Each Permittee shall, at a minimum, implement the SQMP. The SQMP is an enforceable element of this Order. The SQMP shall be implemented no later than February 1, 2002, unless a later date has been specified for a particular provision in this Order.

2. The SQMP shall, at a minimum, comply with the applicable storm water program requirements of 40 CFR 122.26(d)(2). The SQMP and its components shall be implemented so as to reduce the discharges of pollutants in storm water to the MEP.

3. Each Permittee shall implement additional controls, where necessary, to reduce the discharges of pollutants in storm water to the MEP.

4. Permittees that modify the countywide SQMP (i.e., implement additional controls, implement different controls than described in the countywide SQMP, or determine that certain BMPs in the countywide SQMP are not applicable in the area under its jurisdiction), shall develop a local SQMP, no later than August 1, 2002. The local SQMP shall be customized to reflect the conditions in the area under the Permittee's jurisdiction and shall specify activities being implemented under the appropriate elements described in the countywide SQMP.

B. Best Management Practice Implementation

The Permittees shall implement or require the implementation of the most effective combination of BMPs for storm water/urban runoff pollution control. When implemented, BMPs are intended to result in the reduction of pollutants in storm water to the MEP.

C. Revision of the Storm Water Quality Management Program

The Permittees shall revise the SQMP, at the direction of the Regional Board Executive Officer, to incorporate program implementation amendments so as to comply with regional, watershed specific requirements, and/or waste load allocations developed and approved pursuant to the process for the designation and implementation of Total Maximum Daily Loads (TMDLs) for impaired water bodies.

D. Designation and Responsibilities of the Principal Permittee

The Los Angeles County Flood Control District is hereby designated as the Principal Permittee. As such, the Principal Permittee shall:

1. Coordinate and facilitate activities necessary to comply with the requirements of this Order, but is not responsible for ensuring compliance of any individual Permittee;
2. Coordinate permit activities among Permittees and act as liaison between Permittees and the Regional Board on permitting issues;
3. Provide personnel and fiscal resources for the necessary updates of the SQMP and its components;
4. Provide technical and administrative support for committees that will be organized to implement the SQMP and its components;
5. Convene the Watershed Management Committees (WMCs) constituted pursuant to Part F, below, upon designation of representatives;
6. Implement the Countywide Monitoring Program required under this Order and evaluate, assess and synthesize the results of the monitoring program;
7. Provide personnel and fiscal resources for the collection, processing and submittal to the Regional Board of annual reports and summaries of other reports required under the SQMP; and
8. Comply with the "Responsibilities of the Permittees" in Part 3.E., below.

E. Responsibilities of the Permittees.

Each Permittee is required to comply with the requirements of this Order applicable to discharges within its boundaries (see Findings D.1, D.2. and D.3.) and not for the implementation of the provisions applicable to the Principal Permittee or other Permittees. Each Permittee shall, within its geographic jurisdiction:

1. Comply with the requirements of the SQMP and any modifications thereto;
2. Coordinate among its internal departments and agencies, as appropriate, to facilitate the implementation of the requirements of the SQMP applicable to such Permittee in an efficient and cost-effective manner;
3. Designate a technically knowledgeable representative to the appropriate WMC;

4. Participate in intra-agency coordination (e.g. Fire Department, Building and Safety, Code Enforcement, Public Health, etc.) necessary to successfully implement the provisions of this Order and the SQMP.

5. Prepare an annual Budget Summary of expenditures applied to the storm water management program. This summary shall identify the storm water budget for the following year, using estimated percentages and written explanations where necessary, for the specific categories noted below:

   a) Program management
      - Administrative costs

   b) Program Implementation
      Where information is available, provide an estimated percent breakdown of expenditures for the categories below:
      - Illicit connection/illicit discharge
      - Development planning
      - Development construction
      - Construction inspection activities
      - Industrial/Commercial inspection activities
      - Public Agency Activities
         - Maintenance of Structural BMPs and Treatment Control BMPs
         - Municipal Street Sweeping
         - Catch basin clean-up
         - Trash collection
         - Capital costs

   c) Public Information and Participation

   d) Monitoring Program

   e) Miscellaneous Expenditures

6. Each Permittee, in addition to the Budget Summary, shall report any supplemental dedicated budgets for the same categories.

F. Watershed Management Committees (WMCs)

1. Each WMC shall be comprised of a voting representative from each Permittee in the WMA.

2. The WMC's chair and secretary shall be chosen by the WMC upon Order adoption and on an annual basis, thereafter. In the absence of volunteer Permittee(s) for the positions, the Principal Permittee shall assume those roles until the WMC chooses members of the committee for the positions.

3. Each WMC shall:

   a) Facilitate cooperation and exchange of information among Permittees;

b) Establish additional goals and objectives and associated deadlines for the WMA, as the program implementation progresses;

c) Prioritize pollution control efforts based on beneficial use impairment(s), watershed characteristics and analysis of results from studies and the monitoring program;

d) Develop and/or update and monitor the adequate implementation, on an annual basis, of the tasks identified for the WMA;

e) Assess the effectiveness of, prepare revisions for, and recommend appropriate changes to the SQMP and its components;

f) Continue to prioritize the Industrial/Commercial critical sources for investigation, outreach and follow-up; and

g) Meet four times per year and, as necessary.

G. Legal Authority

1. Permittees shall possess the necessary legal authority to prohibit non-storm water discharges to the storm drain system, including, but not limited to:

a) Illicit discharges and illicit connections and require removal of illicit connections;

b) The discharge of wash waters to the MS4 from the cleaning of gas stations, auto repair garages, or other types of automotive service facilities;

c) The discharge of runoff to the MS4 from mobile auto washing, steam cleaning, mobile carpet cleaning, and other such mobile commercial and industrial operations;

d) The discharge of runoff to the MS4 from areas where repair of machinery and equipment which are visibly leaking oil, fluid or antifreeze, is undertaken;

e) The discharge of runoff to the MS4 from storage areas of materials containing grease, oil, or other hazardous substances, and uncovered receptacles containing hazardous materials;

f) The discharge of chlorinated/ brominated swimming pool water and filter backwash to the MS4;

g) The discharge of runoff from the washing of toxic materials from paved or unpaved areas to the MS4;

h) Washing impervious surfaces in industrial/commercial areas that results in a discharge of runoff to the MS4;

i) The discharge of concrete or cement laden wash water from concrete trucks, pumps, tools, and equipment to the MS4; and

j) Dumping or disposal of materials into the MS4 other than storm water, such as:

(1) Litter, landscape debris and construction debris;

(2) Any state or federally banned or unregistered pesticides;

(3) Food and food processing wastes; and

(4) Fuel and chemical wastes, animal wastes, garbage, batteries, and other materials that have potential adverse impacts on water quality.

2. The Permittees shall possess adequate legal authority to:

a) Require persons within their jurisdiction to comply with conditions in Permittees' ordinances, permits, contracts, model programs, or orders (i.e. hold dischargers to its MS4 accountable for their contributions of pollutants and flows);

b) Utilize enforcement mechanisms to require compliance with Permittees ordinances, permits, contracts, or orders;

c) Control pollutants, including potential contribution, in discharges of storm water runoff associated with industrial activities (including construction activities) to its MS4 and control the quality of storm water runoff from industrial sites (including construction sites). This requirement applies to Source Control, and Treatment Control BMPs;

d) Carry out all inspection, surveillance and monitoring procedures necessary to determine compliance and non-compliance with permit conditions, including the prohibition of illicit discharges to the MS4. Permittees must possess authority to enter, sample, inspect, review and copy records, and require regular reports from industrial facilities (including construction sites) discharging polluted or with the potential to discharge polluted storm water runoff into its MS4;

e) Require the use of BMPs to prevent or reduce the discharge of pollutants to MS4s to MEP; and

f) Require that Treatment Control BMPs be properly operated and maintained to prevent the breeding of vectors.

3. Each Permittee shall, no later than November 1, 2002, amend and adopt (if necessary), a Permittee-specific storm water and urban runoff ordinance to enforce all requirements of this permit.

4. Each Permittee shall submit no later than December 2, 2002, a new or updated statement by its legal counsel that the Permittee has obtained all

necessary legal authority to comply with this Order through adoption of ordinances and/or municipal code modifications.

Part 4. SPECIAL PROVISIONS

Maximum Extent Practicable Standard

This permit, and the provisions herein, are intended to develop, achieve, and implement a timely, comprehensive, cost-effective storm water pollution control program to reduce the discharge of pollutants in storm water to the MEP from the permitted areas in the County of Los Angeles to the waters of the State.

A. General Requirements

1. Best Management Practice Substitution

   The Regional Board Executive Officer may approve any site-specific BMP substitution upon petition by a Permittee(s), if the Permittee can document that:

   a) The proposed alternative BMP or program will meet or exceed the objective of the original BMP or program in the reduction of storm water pollutants; or

   b) The fiscal burden of the original BMP or program is substantially greater than the proposed alternative and does not achieve a substantially greater improvement in storm water quality; and,

   c) The proposed alternative BMP or program will be implemented within a similar period of time.

B. Public Information and Participation Program (PIPP)

The Principal Permittee shall implement a Public Information and Participation Program (PIPP) that includes, but is not limited to, the requirements listed in this section. The Principal Permittee shall be responsible for developing and implementing the Public Education Program, as described in the SQMP, and shall coordinate with Permittees to implement specific requirements.

The objectives of the PIPP are as follows:

- To measurably increase the knowledge of the target audiences regarding the MS4, the impacts of storm water pollution on receiving waters, and potential solutions to mitigate the problems caused;
- To measurably change the waste disposal and runoff pollution generation behavior of target audiences by encouraging implementation of appropriate solutions; and
- To involve and engage socio-economic groups and ethnic communities in Los Angeles County to participate in mitigating the impacts of storm water pollution.

The Principal Permittee shall convene an advisory committee to provide input and assistance in meeting the goals and objectives of the public education campaign. The advisory committee shall be consulted during the process of developing the PIPP campaign, and shall provide comments and advice during the process of preparing a Request For Proposals for a storm water public education contractor. The committee may participate as a part of a working group that evaluates contractor proposals and other tasks as appropriate. The committee shall be comprised of representatives of the environmental community, Permittee cities, Regional Board staff, and experts in the fields of public education and marketing. The Principal Permittee shall ensure that the committee meets at least once a year.

1. Residential Program

a) "No Dumping" Message

Each Permittee shall mark all storm drain inlets that they own with a legible "no dumping" message. In addition, signs with prohibitive language discouraging illegal dumping must be posted at designated public access points to creeks, other relevant water bodies, and channels no later than February 2, 2004. Signage and storm drain messages shall be legible and maintained as necessary during the term of the permit.

b) Countywide Hotline

The 888-CLEAN-LA hotline will serve as the general public reporting contact for reporting clogged catch basin inlets and illicit discharges/dumping, faded or lack of catch basin stencils, and general storm water management information. Each Permittee may establish its own hotline if preferred. Permittees shall include this information, updated when necessary, in public information, and the government pages of the telephone book, as they are developed or published. The Principal Permittee shall compile a list of the general public reporting contacts from all Permittees and make this information available on the web site (888CleanLA.com) and upon request. Permittees shall provide the Principal Permittee with their reporting contacts no later than March 1, 2002. Permittees are responsible for providing current, updated information to the Principal Permittee.

c) Outreach and Education

(1) The Principal Permittee shall continue to implement the following activities that were components of the first five-year PIPP:

(i) Advertising;

(ii) Media relations;

(iii) Public service announcements;

(iv) "How To" instructional material distributed in a targeted and activity-related manner;

(v) Corporate, community association, environmental organization and entertainment industry tie-ins; and

(vi) Events targeted to specific activities and population subgroups.

(2) The Principal Permittee shall develop a strategy to educate ethnic communities and businesses through culturally effective methods. Details of this strategy should be incorporated into the Public Education Program, and implemented, no later than February 3, 2003.

(3) The Principal Permittee shall enhance the existing outreach efforts to residents and businesses related to the proper disposal of cigarette butts.

(4) Each Permittee shall conduct educational activities within its jurisdiction and participate in countywide events.

(5) The Principal Permittee shall organize Public Outreach Strategy meetings for Permittees on a quarterly basis, beginning no later than May 1, 2002. The Principal Permittee shall provide guidance for Permittees to augment the countywide outreach and education program. Permittees shall coordinate regional and local outreach and education to reduce duplication of efforts. Permittees are encouraged to include other interested parties in the outreach strategy to strengthen and coordinate educational efforts.

(6) The Principal Permittee shall ensure that a minimum of 35 million impressions per year are made on the general public about storm water quality via print, local TV access, local radio, or other appropriate media.

(7) The Principal Permittee, in cooperation with the Permittees, shall provide schools within each School District in the County with materials, including, but not limited to, videos, live presentations, and other information necessary to educate a minimum of 50 percent of all school children (K-12) every 2 years on storm water pollution.

(8) Permittees shall provide the contact information for their appropriate staff responsible for storm water public education activities to the Principal Permittee no later than April 1, 2002, and changes to contact information no later than 30 days after a change occurs.

(9) The Principal Permittee shall develop a strategy to measure the effectiveness of in-school educational programs. The protocol shall include assessment of students' knowledge of storm water pollution problems and

solutions before and after educational efforts are conducted. The protocol shall be developed and submitted to the Regional Board Executive Officer for approval no later than May 1, 2002. It shall be implemented upon approval.

(10) In order to ensure that the PIPP is demonstrably effective in changing the behavior of the public, the Principal Permittee shall develop a behavioral change assessment strategy no later than May 1, 2002. The strategy shall be developed based on sociological data and studies (such as the County Segmentation Study). The Principal Permittee shall submit the assessment strategy to the Regional Board Executive Office for approval. It shall be implemented on approval.

d) Pollutant-Specific Outreach

The Principal Permittee, in cooperation with Permittees, shall coordinate to develop outreach programs that focus on the watershed-specific pollutants listed in Table 1 no later than February 3, 2003. Metals may be appropriately addressed through the Industrial/Commercial Facilities Program (e.g. distribute education materials on appropriate BMPs for metal waste management to facilities that have been identified as a potential source, such as metal fabricating facilities). Region-wide pollutants may be included in the Principal Permittee's mass media outreach efforts.

Table 1.

Watershed	***Target Pollutants for Outreach***
Ballona Creek	Trash, Indicator Bacteria, Metals, PAHs
Malibu Creek	Trash, Nutrients (Nitrogen), Indicator Bacteria, Sediments
Los Angeles River	Trash, Nutrients (Nitrogen), Indicator Bacteria, Metals, Pesticides, PAHs
San Gabriel River	Trash, Nutrients (Nitrogen), Indicator Bacteria, Metals
Santa Clara River	Nutrients (Nitrogen), Coliform
Dominguez Channel	Trash, Indicator Bacteria, PAHs

Each Permittee shall make outreach materials available to the general public and target audiences, such as schools, community groups, contractors and developers, and at appropriate public counters and events. Outreach material shall include information on pollutants, sources of concern, and source abatement measures.

2. Businesses Program

a) Corporate Outreach

The Principal Permittee shall develop and implement a Corporate Outreach program to educate and inform corporate managers about storm water regulations. The program shall target RGOs and restaurant chains. At a minimum, this program shall include:

(1) Conferring with corporate management to explain storm water regulations;

(2) Distribution and discussion of educational material regarding storm water pollution and BMPs, and provide managers with suggestions to facilitate employee compliance with storm water regulations.

Corporate Outreach for all RGOs and restaurant chain corporations shall be conducted not less than twice during the permit term, with the first outreach contact to begin no later than February 3, 2003.

b) Business Assistance Program

The Principal Permittee and Permittees may implement a Business Assistance Program to provide technical resource assistance to small businesses to advise them on BMPs implementation to reduce the discharge of pollutants in storm water runoff. Programs may include:

(1) On-site technical assistance or consultation via telephone to identify and implement storm water pollution prevention methods and best management practices; and

(2) Making available, distributing, and discussing of applicable BMP and educational materials.

C. Industrial/Commercial Facilities Control Program

Each Permittee shall require implementation of pollutant reduction and control measures at industrial and commercial facilities, with the objective of reducing pollutants in storm water runoff. Except as specified in other sections of this Order, pollutant reduction and control measures can be used alone or in combination, and can include Structural and Source Control BMPs, and operation and maintenance procedures, which can be applied before, during, and/or after pollution generating activities. At a minimum, the Industrial/Commercial Facilities Control Program shall include requirements to: (1) track, (2) inspect, and (3) ensure compliance at industrial and commercial facilities that are critical sources of pollutants in storm water.

1. **Track Critical Sources**

a) Each Permittee shall maintain a watershed-based inventory or database of all facilities within its jurisdiction that are critical sources of storm water pollution. Critical sources to be tracked are summarized below, and also specified in Attachment B:

(1) Commercial Facilities
- restaurants;
- automotive service facilities; and
- RGOs and automotive dealerships.

(2) USEPA Phase I Facilities (Tier 1 and 2)

(3) Other Federally-mandated Facilities [as specified in 40 CFR 122.26(d)(2)(iv)(C)]
- municipal landfills;
- hazardous waste treatment, disposal, and recovery facilities; and
- facilities subject to SARA Title III (also known as EPCRA).

b) Each Permittee shall include the following minimum fields of information for each industrial and commercial facility:
- name of facility and name of owner/operator;
- address;
- coverage under the GIASP or other individual or general NPDES permits; and
- a narrative description including SIC codes that best reflects the industrial activities at and principal products of each facility.

The Regional Board encourages Permittees to add other fields of information, such as material usage and/or industrial output, and discrepancies between SIC Code designations (as reported by facility operators) and the actual type of industrial activity has the potential to pollute storm water. In addition, the Regional Board recommends use of an automated database system, such as a Geographical Information System (GIS) or Internet-based system; however, this is not required.

c) Each Permittee shall update its inventory of critical sources at least annually. The update may be accomplished through collection of new information obtained through field activities or through other readily available intra-agency informational databases (e.g. business licenses, pretreatment permits, sanitary sewer hook-up permits).

2. **Inspect Critical Sources**

Each Permittee shall inspect all facilities in the categories and at a level and frequency as specified in the following subsections.

a) Commercial Facilities

(1) Restaurants

Frequency of Inspections: Twice during the 5-year term of the Order, provided that the first inspection occurs no later than August 1, 2004, and that there is a minimum interval of one year in between the first compliance inspection and the second compliance inspection.

Level of inspections: Each Permittee, in cooperation with its appropriate department (such as health or public works), shall inspect all restaurants within its jurisdiction to confirm that storm water BMPs are being effectively implemented in compliance with State law, County and municipal ordinances, Regional Board Resolution 98-08, and the SQMP. At each restaurant, inspectors shall verify that the restaurant operator:

- has received educational materials on storm water pollution prevention practices;
- does not pour oil and grease or oil and grease residue onto a parking lot, street or adjacent catch basin;
- keeps the trash bin area clean and trash bin lids closed, and does not fill trash bins with washout water or any other liquid;
- does not allow illicit discharges, such as discharge of washwater from floormats, floors, porches, parking lots, alleys, sidewalks and street areas (in the immediate vicinity of the establishment), filters or garbage/trash containers;
- removes food waste, rubbish or other materials from parking lot areas in a sanitary manner that does not create a nuisance or discharge to the storm drain.

(2) Automotive Service Facilities

Frequency of Inspections: Twice during the 5-year term of the Order, provided that the first inspection occurs no later than August 1, 2004, and that there is a minimum interval of one year in between the first compliance inspection and the second compliance inspection.

Level of inspections: Each Permittee shall inspect all automotive service facilities within its jurisdiction to confirm that storm water BMPs are effectively implemented in compliance with County and municipal ordinances, Regional Board Resolution 98-08, and the SQMP. At each automotive service facility, inspectors shall verify that each operator:

- maintains the facility area so that it is clean and dry and without evidence of excessive staining;
- implements housekeeping BMPs to prevent spills and leaks;
- properly discharges wastewaters to a sanitary sewer and/or contains wastewaters for transfer to a legal point of disposal;
- is aware of the prohibition on discharge of non-storm water to the storm drain;
- properly manages raw and waste materials including proper disposal of hazardous waste;
- protects outdoor work and storage areas to prevent contact of pollutants with rainfall and runoff;
- labels, inspects, and routinely cleans storm drain inlets that are located on the facility's property; and
- trains employees to implement storm water pollution prevention practices.

(3) Retail Gasoline Outlets and Automotive Dealerships

Frequency of Inspection: Twice during the 5-year term of the Order, provided that the first inspection occurs no later than August 1, 2004, and that there is a minimum interval of one year in between the first compliance inspection and the second compliance inspection.

Level of Inspection: Each Permittee shall confirm that BMPs are being effectively implemented at each RGO and automotive dealership within its jurisdiction, in compliance with the SQMP, Regional Board Resolution 98-08, and the Stormwater Quality Task Force Best Management Practice Guide for RGOs. At each RGO and automotive dealership, inspectors shall verify that each operator:

- routinely sweeps fuel-dispensing areas for removal of litter and debris, and keeps rags and absorbents ready for use in case of leaks and spills;
- is aware that washdown of facility area to the storm drain is prohibited;
- is aware of design flaws (such as grading that doesn't prevent run-on, or inadequate roof covers and berms), and that equivalent BMPs are implemented;
- inspects and cleans storm drain inlets and catch basins within each facility's boundaries no later than October 1st of each year;

- posts signs close to fuel dispensers, which warn vehicle owners/operators against "topping off" of vehicle fuel tanks and installation of automatic shutoff fuel dispensing nozzles;
- routinely checks outdoor waste receptacle and air/water supply areas, cleans leaks and drips, and ensures that only watertight waste receptacles are used and that lids are closed; and
- trains employees to properly manage hazardous materials and wastes as well as to implement other storm water pollution prevention practices.

b) Phase I Facilities

Permittees need not inspect facilities that have been inspected by the Regional Board within the past 24 months. For the remaining Phase I facilities that the Regional Board has not inspected, each Permittee shall conduct compliance inspections as specified below.

Frequency of Inspection

Facilities in Tier 1 Categories: Twice during the 5-year term of the Order, provided that the first inspection occurs no later than August 1, 2004, and that there is a minimum interval of one year in between the first compliance inspection and the second compliance inspection.

Facilities in Tier 2 Categories: Twice during the 5-year term of the permit, provided that the first inspection occurs no later than August 1, 2004. Permittees need not perform additional inspections at those facilities determined to have no risk of exposure of industrial activity to storm water. For those facilities that do have exposure of industrial activities to storm water, a Permittee may reduce the frequency of additional compliance inspections to once every 5 years, provided that the Permittee inspects at least 20% of the facilities in Tier 2 each year.

Level of Inspection: Each Permittee shall confirm that each operator:

- has a current Waste Discharge Identification (WDID) number for facilities discharging storm water associated with industrial activity, and that a Storm Water Pollution Prevention Plan is available on-site, and
- is effectively implementing BMPs in compliance with County and municipal ordinances, Regional Board Resolution 98-08, and the SQMP.

c) Other Federally-mandated Facilities

Frequency of Inspection: Twice during the 5-year term of the Order, provided that the first inspection occurs no later than August 1, 2004, and that there is a minimum interval of one year in between the first compliance inspection and the second compliance inspection.

Level of Inspection: Each Permittee shall confirm that each operator:

- has a current Waste Discharge Identification (WDID) number for facilities discharging storm water associated with industrial activity, and that a Storm Water Pollution Prevention Plan is available on-site, and
- is effectively implementing BMPs in compliance with County and municipal ordinances, Regional Board Resolution 98-08, and the SQMP.

3. Ensure Compliance of Critical Sources

a) **BMP Implementation:** In the event that a Permittee determines that a BMP specified by the SQMP or Regional Board Resolution 98-08 is infeasible at any site, that Permittee shall require implementation of other BMPs that will achieve the equivalent reduction of pollutants in the storm water discharges. Likewise, for those BMPs that are not adequate to achieve water quality objectives, Permittees may require additional site-specific controls, such as Treatment Control BMPs.

b) **Environmentally Sensitive Areas and Impaired Waters:** For critical sources that are in ESAs or that are tributary to CWA § 303(d) impaired water bodies, Permittees shall consider requiring operators to implement additional controls to reduce pollutants in storm water runoff that are causing or contributing to the exceedences of Water Quality Objectives.

c) **Progressive Enforcement:** Each Permittee shall implement a progressive enforcement policy to ensure that facilities are brought into compliance with all storm water requirements within a reasonable time period as specified below.

(1) In the event that a Permittee determines, based on an inspection conducted above, that an operator has failed to adequately implement all necessary BMPs, that Permittee shall take progressive enforcement action which, at a minimum, shall include a follow-up inspection within 4 weeks from the date of the initial inspection.

(2) In the event that a Permittee determines that an operator has failed to adequately implement BMPs after a follow-up inspection, that Permittee shall take further enforcement action as established through authority in its municipal code and ordinances or through the judicial system.

(3) Each Permittee shall maintain records, including inspection reports, warning letters, notices of violations, and other enforcement records, demonstrating a good faith effort to bring facilities into compliance.

d) Interagency Coordination

(1) **Referral of Violations of the SQMP, Regional Board Resolution 98-08, and Municipal Storm Water Ordinances:** A Permittee may refer a violation(s) to the Regional Board provided that that Permittee has made a good faith effort of progressive enforcement. At a minimum, a Permittee's good faith effort must include documentation of:

- Two follow-up inspections, and
- Two warning letters or notices of violation.

(2) **Referral of Violations of the GIASP, including Requirements to File a Notice of Intent:** For those facilities in violation of the GIASP, Permittees may escalate referral of such violations to the Regional Board after one inspection and one written notice to the operator regarding the violation. In making such referrals, Permittees shall include, at a minimum, the following documentation:

- Name of the facility;
- Operator of the facility;
- Owner of the facility;
- Industrial activity being conducted at the facility that is subject to the GIASP; and
- Records of communication with the facility operator regarding the violation, which shall include at least an inspection report and one written notice of the violation.

Permittees shall, at a minimum, make such referrals on a quarterly basis.

(3) **Investigation of Complaints Regarding Facilities – Transmitted by the Regional Board Staff:** Each Permittee shall initiate, within one business day, investigation of complaints (other than non-storm water discharges) regarding facilities within its jurisdiction. The initial investigation shall include, at a minimum, a limited

inspection of the facility to confirm the complaint to determine if the facility is effectively complying with the SQMP and municipal storm water/urban runoff ordinances, and to oversee corrective action.

(4) **Support of Regional Board Enforcement Actions:** As directed by the Regional Board Executive Officer, Permittees shall support Regional Board enforcement actions by: assisting in identification of current owners, operators, and lessees of facilities; providing staff, when available, for joint inspections with Regional Board inspectors; appearing as witnesses in Regional Board enforcement hearings; and providing copies of inspection reports and other progressive enforcement documentation.

(5) **Participation in a Task Force:** The Permittees, Regional Board, and other stakeholders may form a Storm Water Task Force, the purpose of which is to communicate concerns regarding special cases of storm water violations by industrial and commercial facilities and to develop a coordinated approach to enforcement action.

D. Development Planning Program

The Permittees shall implement a development-planning program that will require all Planning Priority development and Redevelopment projects to:

- Minimize impacts from storm water and urban runoff on the biological integrity of Natural Drainage Systems and water bodies in accordance with requirements under CEQA (Cal. Pub. Resources Code § 21100), CWC § 13369, CWA § 319, CWA § 402(p), CWA § 404, CZARA § 6217(g), ESA § 7, and local government ordinances ;
- Maximize the percentage of pervious surfaces to allow percolation of storm water into the ground;
- Minimize the quantity of storm water directed to impervious surfaces and the MS4;
- Minimize pollution emanating from parking lots through the use of appropriate Treatment Control BMPs and good housekeeping practices;
- Properly design and maintain Treatment Control BMPs in a manner that does not promote the breeding of vectors; and
- Provide for appropriate permanent measures to reduce storm water pollutant loads in storm water from the development site.

1. Peak Flow Control

The Permittees shall control post-development peak storm water runoff discharge rates, velocities, and duration (peak flow control) in Natural

Drainage Systems (i.e., mimic pre-development hydrology) to prevent accelerated stream erosion and to protect stream habitat. Natural Drainage Systems are located in the following areas:

a) Malibu Creek;

b) Topanga Canyon Creek;

c) Upper Los Angeles River;

d) Upper San Gabriel River;

e) Santa Clara River; and

f) Los Angeles County Coastal streams (see Basin Plan Table 2-1).

The Principal Permittee in consultation with Permittees shall develop numerical criteria for peak flow control, based on the results of the Peak Discharge Impact Study (see Monitoring Program Section II.I).

Each Permittee shall, no later than February 1, 2005, implement numerical criteria for peak flow control.

A Permittee or group of Permittees may substitute for the countywide peak flow control criteria with a Hydromodification Control Plan (HCP), on approval by the Regional Board, in the following circumstances:

(1) Stream or watershed-specific conditions indicate the need for a different peak flow control criteria, and the alternative numerical criteria is developed through the application of hydrologic modeling and supporting field observations; or

(2) A watershed-wide plan has been developed for implementation of control measures to reduce erosion and stabilize drainage systems on a watershed basis.

2. Standard Urban Storm Water Mitigation Plans (SUSMPs)

a) Each Permittee shall amend codes and ordinances not later than August 1, 2002 to give legal effect to SUSMP changes contained in this Order. Changes to SUSMP requirements shall take effect not later than September 2, 2002.

b) Each Permittee shall require that a single-family hillside home:

(1) Conserve natural areas;

(2) Protect slopes and channels;

(3) Provide storm drain system stenciling and signage;

(4) Divert roof runoff to vegetated areas before discharge unless the diversion would result in slope instability; and

(5) Direct surface flow to vegetated areas before discharge unless the diversion would result in slope instability.

c) Each Permittee shall require that a SUSMP as approved by the Regional Board in Board Resolution No. R 00-02 be implemented for the following categories of developments:

(1) Ten or more unit homes (includes single family homes, multifamily homes, condominiums, and apartments);

(2) A 100,000 or more square feet of impervious surface area industrial/ commercial development;

(3) Automotive service facilities (SIC 5013, 5014, 5541, 7532-7534, and 7536-7539);

(4) Retail gasoline outlets;

(5) Restaurants (SIC 5812);

(6) Parking lots 5,000 square feet or more of surface area or with 25 or more parking spaces; and

(7) Redevelopment projects in subject categories that meet Redevelopment thresholds.

d) Each Permittee shall submit an ESA Delineation Map for its jurisdictional boundary, based on the Regional Board's ESA Definition, no later than June 3, 2002, for approval by the Regional Board Executive Officer in consultation with the California Department of Fish and Game, and the California Coastal Commission.

e) Each Permittee shall require the implementation of SUSMP provisions no later than September 2, 2002, for all projects located in or directly adjacent to or discharging directly to an ESA, where the development will:

(1) Discharge storm water and urban runoff that is likely to impact a sensitive biological species or habitat; and

(2) Create 2,500 square feet or more of impervious surface area.

3. Numerical Design Criteria

The Permittees shall require that post-construction Treatment Control BMPs incorporate, at a minimum, either a volumetric or flow based treatment control design standard, or both, as identified below to mitigate (infiltrate, filter or treat) storm water runoff:

a) Volumetric Treatment Control BMP

(1) The 85th percentile 24-hour runoff event determined as the maximized capture storm water volume for the area, from

the formula recommended in *Urban Runoff Quality Management, WEF Manual of Practice No. 23/ ASCE Manual of Practice No. 87, (1998)*; or

(2) The volume of annual runoff based on unit basin storage water quality volume, to achieve 80 percent or more volume treatment by the method recommended in *California Stormwater Best Management Practices Handbook – Industrial/ Commercial,* (1993); or

(3) The volume of runoff produced from a 0.75 inch storm event, prior to its discharge to a storm water conveyance system; or

(4) The volume of runoff produced from a historical-record based reference 24-hour rainfall criterion for "treatment" (0.75 inch average for the Los Angeles County area) that achieves approximately the same reduction in pollutant loads achieved by the 85th percentile 24-hour runoff event.

b) Flow Based Treatment Control BMP

(1) The flow of runoff produced from a rain event equal to at least 0.2 inches per hour intensity; or

(2) The flow of runoff produced from a rain event equal to at least two times the 85th percentile hourly rainfall intensity for Los Angeles County; or

(3) The flow of runoff produced from a rain event that will result in treatment of the same portion of runoff as treated using volumetric standards above.

4. Applicability of Numerical Design Criteria

The Permittees shall require the following categories of Planning Priority Projects to design and implement post-construction treatment controls to mitigate storm water pollution:

a) Single-family hillside residential developments of one acre or more of surface area;

b) Housing developments (includes single family homes, multifamily homes, condominiums, and apartments) of ten units or more;

c) A 100,000 square feet or more impervious surface area industrial/ commercial development;

d) Automotive service facilities (SIC 5013, 5014, 5541, 7532-7534 and 7536-7539) [5,000 square feet or more of surface area];

e) Retail gasoline outlets [5,000 square feet or more of impervious surface area and with projected Average Daily Traffic (ADT) of 100 or more vehicles]. Subsurface Treatment Control BMPs which may endanger public safety (i.e., create an explosive environment) are considered not appropriate;

f) Restaurants (SIC 5812) [5,000 square feet or more of surface area];

g) Parking lots 5,000 square feet or more of surface area or with 25 or more parking spaces;

h) Projects located in, adjacent to or discharging directly to an ESA that meet threshold conditions identified above in 2.e; and

i) Redevelopment projects in subject categories that meet Redevelopment thresholds.

5. Not later than March 10, 2003, each Permittee shall require the implementation of SUSMP and post-construction control requirements for the industrial/commercial development category to projects that disturb one acre or more of surface area.

6. Site Specific Mitigation

Each Permittee shall, no later than September 2, 2002, require the implementation of a site-specific plan to mitigate post-development storm water for new development and redevelopment not requiring a SUSMP but which may potentially have adverse impacts on post-development storm water quality, where one or more of the following project characteristics exist:

a) Vehicle or equipment fueling areas;

b) Vehicle or equipment maintenance areas, including washing and repair;

c) Commercial or industrial waste handling or storage;

d) Outdoor handling or storage of hazardous materials;

e) Outdoor manufacturing areas;

f) Outdoor food handling or processing;

g) Outdoor animal care, confinement, or slaughter; or

h) Outdoor horticulture activities.

7. Redevelopment Projects

The Permittees shall apply the SUSMP, or site specific requirements including post-construction storm water mitigation to all Planning Priority Projects that undergo significant Redevelopment in their respective categories.

a) Significant Redevelopment means land-disturbing activity that results in the creation or addition or replacement of 5,000 square feet or more of impervious surface area on an already developed site.

Where Redevelopment results in an alteration to more than fifty percent of impervious surfaces of a previously existing development, and the existing development was not subject to post development storm water quality control requirements, the entire project must be mitigated. Where Redevelopment results in an alteration to less than fifty percent of impervious surfaces of a previously existing development, and the existing development was not subject to post development storm water quality control requirements, only the alteration must be mitigated, and not the entire development.

b) Redevelopment does not include routine maintenance activities that are conducted to maintain original line and grade, hydraulic capacity, original purpose of facility or emergency redevelopment activity required to protect public health and safety.

c) Existing single family structures are exempt from the Redevelopment requirements.

8. Maintenance Agreement and Transfer

Each Permittee shall require that all developments subject to SUSMP and site specific plan requirements provide verification of maintenance provisions for Structural and Treatment Control BMPs, including but not limited to legal agreements, covenants, CEQA mitigation requirements, and or conditional use permits. Verification at a minimum shall include:

a) The developer's signed statement accepting responsibility for maintenance until the responsibility is legally transferred; and either

b) A signed statement from the public entity assuming responsibility for Structural or Treatment Control BMP maintenance and that it meets all local agency design standards; or

c) Written conditions in the sales or lease agreement, which requires the recipient to assume responsibility for maintenance and conduct a maintenance inspection at least once a year; or

d) Written text in project conditions, covenants and restrictions (CCRs) for residential properties assigning maintenance responsibilities to the Home Owners Association for maintenance of the Structural and Treatment Control BMPs; or

e) Any other legally enforceable agreement that assigns responsibility for the maintenance of post-construction Structural or Treatment Control BMPs.

9. Regional Storm Water Mitigation Program

A Permittee or Permittee group may apply to the Regional Board for approval of a regional or sub-regional storm water mitigation program to substitute in part or wholly SUSMP requirements. Upon review and a determination by the Regional Board Executive Officer that the proposal is technically valid and appropriate, the Regional Board may consider for approval such a program if its implementation will:

a) Result in equivalent or improved storm water quality;

b) Protect stream habitat;

c) Promote cooperative problem solving by diverse interests;

d) Be fiscally sustainable and has secure funding; and

e) Be completed in five years including the construction and start-up of treatment facilities.

Nothing in this provision shall be construed as to delay the implementation of SUSMP requirements, as approved in this Order.

10. Mitigation Funding

The Permittees may propose a management framework, for endorsement by the Regional Board Executive Officer, to support regional or sub-regional solutions to storm water pollution, where any of the following situations occur:

a) A waiver for impracticability is granted;

b) Legislative funds become available;

c) Off-site mitigation is required because of loss of environmental habitat; or

d) An approved watershed management plan or a regional storm water mitigation plan exists that incorporates an equivalent or improved strategy for storm water mitigation.

11. California Environmental Quality Act (CEQA) Document Update

Each Permittee shall incorporate into its CEQA process, with immediate effect, procedures for considering potential storm water quality impacts and providing for appropriate mitigation when preparing and reviewing CEQA documents. The procedures shall require consideration of the following:

a) Potential impact of project construction on storm water runoff;

b) Potential impact of project post-construction activity on storm water runoff;

c) Potential for discharge of storm water from areas from material storage, vehicle or equipment fueling, vehicle or equipment maintenance (including washing), waste handling, hazardous materials handling or storage, delivery areas or loading docks, or other outdoor work areas;

d) Potential for discharge of storm water to impair the beneficial uses of the receiving waters or areas that provide water quality benefit;

e) Potential for the discharge of storm water to cause significant harm on the biological integrity of the waterways and water bodies;

f) Potential for significant changes in the flow velocity or volume of storm water runoff that can cause environmental harm; and

g) Potential for significant increases in erosion of the project site or surrounding areas.

12. General Plan Update

a) Each Permittee shall amend, revise or update its General Plan to include watershed and storm water quality and quantity management considerations and policies when any of the following General Plan elements are updated or amended: (i) Land Use, (ii) Housing, (iii) Conservation, and (iv) Open Space.

b) Each Permittee shall provide the Regional Board with the draft amendment or revision when a listed General Plan element or the General Plan is noticed for comment in accordance with Cal. Govt. Code § 65350 *et seq.*

13. Targeted Employee Training

Each Permittee shall train its employees in targeted positions (whose jobs or activities are engaged in development planning) regarding the development planning requirements on an annual basis beginning no later than August 1, 2002, and more frequently if necessary. For Permittees with a population of 250,000 or more (2000 U.S. Census), training shall be completed no later than February 3, 2003.

14. Developer Technical Guidance and Information

a) Each Permittee shall develop and make available to the developer community SUSMP (development planning) guidelines immediately.

b) The Principal Permittee in partnership with Permittees shall issue no later than February 2, 2004, a technical manual for the siting and design of BMPs for the development community in Los Angeles County. The technical manual may be adapted from the revised California Storm Water Quality Task Force Best Management Practices Handbooks scheduled for publication in September 2002. The technical manual shall at a minimum include:

(1) Treatment Control BMPs based on flow-based and volumetric water quality design criteria for the purposes of countywide consistency;

(2) Peak Flow Control criteria to control peak discharge rates, velocities and duration;

(3) Expected pollutant removal performance ranges obtained from national databases, technical reports and the scientific literature;

(4) Maintenance considerations; and

(5) Cost considerations.

E. **Development Construction Program**

1. Each Permittee shall implement a program to control runoff from construction activity at all construction sites within its jurisdiction. The program shall ensure the following minimum requirements are effectively implemented at all construction sites:

   a) Sediments generated on the project site shall be retained using adequate Treatment Control or Structural BMPs;

   b) Construction-related materials, wastes, spills, or residues shall be retained at the project site to avoid discharge to streets, drainage facilities, receiving waters, or adjacent properties by wind or runoff;

   c) Non-storm water runoff from equipment and vehicle washing and any other activity shall be contained at the project site; and

   d) Erosion from slopes and channels shall be controlled by implementing an effective combination of BMPs (as approved in Regional Board Resolution No. 99-03), such as the limiting of grading scheduled during the wet season; inspecting graded areas during rain events; planting and maintenance of vegetation on slopes; and covering erosion susceptible slopes.

2. For construction sites one acre and greater, each Permittee shall comply with all conditions in section E.1. above and shall:

   a) Require the preparation and submittal of a Local Storm Water Pollution Prevention Plan (Local SWPPP), for approval prior to issuance of a grading permit for construction projects.

      The Local SWPPP shall include appropriate construction site BMPs and maintenance schedules. (A Local SWPPP may substitute for the State SWPPP if the Local SWPPP is at least as inclusive in controls and BMPs as the State SWPPP). The Local SWPPP must include the rationale used for selecting or rejecting BMPs. The project architect, or engineer of record, or authorized qualified designee, must sign a statement on the Local SWPPP to the effect:

"As the architect/engineer of record, I have selected appropriate BMPs to effectively minimize the negative impacts of this project's construction activities on storm water quality. The project owner and contractor are aware that the selected BMPs must be installed, monitored, and maintained to ensure their effectiveness. The BMPs not selected for implementation are redundant or deemed not applicable to the proposed construction activity."

The landowner or the landowner's agent shall sign a statement to the effect:

"I certify that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, to the best of my knowledge and belief, the information submitted is true, accurate, and complete. I am aware that submitting false and/or inaccurate information, failing to update the Local SWPPP to reflect current conditions, or failing to properly and/or adequately implement the Local SWPPP may result in revocation of grading and/or other permits or other sanctions provided by law."

The Local SWPPP certification shall be signed by the landowner as follows, for a corporation: by a responsible corporate officer which means (a) a president, secretary, treasurer, or vice president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision-making functions for the corporation, or (b) the manager of the construction activity if authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures; for a partnership or sole proprietorship: by a general partner or the proprietor; or for a municipality or other public agency: by an elected official, a ranking management official (e.g., County Administrative Officer, City Manager, Director of Public Works, City Engineer, District Manager), or the manager of the construction activity if authority to sign Local SWPPPs has been assigned or delegated to the manager in accordance with established agency policy.

b) Inspect all construction sites for storm water quality requirements during routine inspections a minimum of once during the wet season. The Local SWPPP shall be reviewed for compliance with local codes, ordinances, and permits. For inspected sites that have not adequately implemented their Local SWPPP, a follow-up inspection to ensure compliance will take place within 2 weeks. If compliance has not been attained, the Permittee will take additional actions to achieve compliance (as specified in municipal codes). If compliance has not been achieved, and the site is also covered under a statewide general construction storm water permit, each Permittee shall enforce their local ordinance requirements, and if non-compliance continues the Regional Board shall be notified for further joint enforcement actions.

c) Require, no later than March 10, 2003, prior to issuing a grading permit for all projects less than five acres requiring coverage under a statewide general construction storm water permit, proof of a Waste Discharger Identification (WDID) Number for filing a Notice of Intent (NOI) for permit coverage and a certification that a SWPPP has been prepared by the project developer. A Local SWPPP may substitute for the State SWPPP if the Local SWPPP is at least as inclusive in controls and BMPs as the State SWPPP.

3. For sites five acres and greater, each Permittee shall comply with all conditions in Sections E.1. and E.2. and shall:

a) Require, prior to issuing a grading permit for all projects requiring coverage under the state general permit, proof of a Waste Discharger Identification (WDID) Number for filing a Notice of Intent (NOI) for coverage under the GCASP and a certification that a SWPPP has been prepared by the project developer. A Local SWPPP may substitute for the State SWPPP if the Local SWPPP is at least as inclusive in controls and BMPs as the State SWPPP.

b) Require proof of an NOI and a copy of the SWPPP at any time a transfer of ownership takes place for the entire development or portions of the common plan of development where construction activities are still on-going.

c) Use an effective system to track grading permits issued by each Permittee. To satisfy this requirement, the use of a database or GIS system is encouraged, but not required.

4. GCASP Violation Referrals

a) Referral of Violations of the SQMP, Regional Board Resolution 98-08, and municipal storm water ordinances:

A Permittee may refer a violation(s) to the Regional Board provided that the Permittee has made a good faith effort of progressive enforcement. At a minimum, a Permittee's good faith effort must include documentation of:

- Two follow-up inspections within 3 months, and
- Two warning letters or notices of violation.

b) Referral of Violations of GCASP Filing Requirements:

For those projects subject to the GCASP, Permittees shall refer non-filers (i.e., those projects which cannot demonstrate that they have a WDID number) to the Regional Board, within 15 days of making a determination. In making such referrals, Permittees shall include, at a minimum, the following documentation:

- Project location;
- Developer;
- Estimated project size; and
- Records of communication with the developer regarding filing requirements.

5. Each Permittee shall train employees in targeted positions (whose jobs or activities are engaged in construction activities including construction inspection staff) regarding the requirements of the storm water management program no later than August 1, 2002, and annually thereafter. For Permittees with a population of 250,000 or more (2000 U.S. Census), initial training shall be completed no later than February 3, 2003. Each Permittee shall maintain a list of trained employees.

F. Public Agency Activities Program

Each Permittee shall implement a Public Agency program to minimize storm water pollution impacts from public agency activities. Public Agency requirements consist of:

- Sewage Systems Maintenance, Overflow, and Spill Prevention
- Public Construction Activities Management
- Vehicle Maintenance/Material Storage Facilities/Corporation Yards Management
- Landscape and Recreational Facilities Management
- Storm Drain Operation and Management
- Streets and Roads Maintenance
- Parking Facilities Management
- Public Industrial Activities Management
- Emergency Procedures
- Treatment Feasibility Study

1. Sewage System Maintenance, Overflow, and Spill Prevention

a) Each Permittee shall implement a response plan for overflows of the sanitary sewer system within their respective jurisdiction, which shall consist at a minimum of the following:

(1) Investigation of any complaints received;

(2) Upon notification, immediate response to overflows for containment; and

(3) Notification to appropriate sewer and public health agencies when a sewer overflows to the MS4.

b) In addition to 1.a.1, 1.a.2, and 1.a.3 above, for those Permittees, which own and/or operate a sanitary sewer system, the Permittee shall also implement the following requirements:

(1) Procedures to prevent sewage spills or leaks from sewage facilities from entering the MS4; and

(2) Identify, repair, and remediate sanitary sewer blockages, exfiltration, overflow, and wet weather overflows from sanitary sewers to the MS4.

2. Public Construction Activities Management

a) Each Permittee shall implement the Development Planning Program requirements (Permit Part 4.D) at public construction projects.

b) Each Permittee shall implement the Development Construction Program requirements (Permit Part 4.E) at Permittee owned construction sites.

c) Each Permittee shall obtain coverage under the GCASP for public construction sites 5 acres or greater (or part of a larger area of development) except that a municipality under 100,000 in population (1990 U.S. Census) need not obtain coverage under a separate permit until March 10, 2003.

d)[1] Each Permittee, no later than March 10, 2003, shall obtain coverage under a statewide general construction storm water permit for public construction sites for projects between one and five acres.

3. Vehicle Maintenance/Material Storage Facilities/Corporation Yards Management

a) Each Permittee, consistent with the SQMP, shall implement SWPPPs for public vehicle maintenance facilities, material storage facilities, and corporation yards which have the potential to discharge pollutants into storm water.

b) Each Permittee shall implement BMPs to minimize pollutant discharges in storm water including but not be limited to:

(1) Good housekeeping practices;

(2) Material storage control;

(3) Vehicle leaks and spill control; and

(4) Illicit discharge control.

c) Each Permittee shall implement the following measures to prevent the discharge of pollutants to the MS4:

(1) For existing facilities, that are not already plumbed to the sanitary sewer, all vehicle and equipment wash areas (except for fire stations) shall either be:

(i) Self-contained;

(ii) Equipped with a clarifier;

(iii) Equipped with an alternative pre-treatment device; or

(iv) Plumbed to the sanitary sewer.

(2) For new facilities, or during redevelopment of existing facilities (including fire stations), all vehicle and equipment wash areas shall be plumbed to the sanitary sewer and be equipped with a pre-treatment device in accordance with requirements of the sewer agency.

4. Landscape and Recreational Facilities Management

Each Permittee shall implement the following requirements:

a) A standardized protocol for the routine and non-routine application of pesticides, herbicides (including pre-emergents), and fertilizers;

b) Consistency with State Board's guidelines and monitoring requirements for application of aquatic pesticides to surface waters (WQ Order No. 2001-12 DWQ);

c) Ensure no application of pesticides or fertilizers immediately before, during, or immediately after a rain event or when water is flowing off the area to be applied;

d) Ensure that no banned or unregistered pesticides are stored or applied;

e) Ensure that staff applying pesticides are certified by the California Department of Food and Agriculture, or are under the direct supervision of a certified pesticide applicator;

f) Implement procedures to encourage retention and planting of native vegetation and to reduce water, fertilizer, and pesticide needs;

g) Store fertilizers and pesticides indoors or under cover on paved surfaces or use secondary containment;

h) Reduce the use, storage, and handling of hazardous materials to reduce the potential for spills; and

i) Regularly inspect storage areas.

5. Storm Drain Operation and Management

a) Each Permittee shall designate catch basin inlets within its jurisdiction as one of the following:

Priority A:	Catch basins that are designated as consistently generating the highest volumes of trash and/or debris.
Priority B:	Catch basins that are designated as consistently generating moderate volumes of trash and/or debris.
Priority C:	Catch basins that are designated as generating low volumes of trash and/or debris.

b) Permittees subject to a trash TMDL (Los Angeles River and Ballona Creek WMAs) shall continue to implement the requirements listed below until trash TMDL implementation measures are adopted. Thereafter, the subject Permittees shall implement programs in conformance with the TMDL implementation schedule, which shall include an effective combination of measures such as street sweeping, catch basin cleaning, installation of treatment devices and trash receptacles, or other BMPs. Default requirements include:

(1) Inspection and cleaning of catch basins between May 1 and September 30 of each year;

(2) Additional cleaning of any catch basin that is at least 40% full of trash and/or debris;

(3) Record keeping of catch basins cleaned; and

(4) Recording of the overall quantity of catch basin waste collected.

If the implementation phase for the Los Angeles River and Ballona Creek Trash TMDLs has not begun by October 2003, subject Permittees shall implement the requirements described below in subsection 5(c), until such time programs in conformance with the subject Trash TMDLs are being implemented.

c) Permittees not subject to a trash TMDL shall:

(1) Clean catch basins according to the following schedule:

Priority A:	A minimum of three times during the wet season and once during the dry season every year.
Priority B:	A minimum of once during the wet season and once during the dry season every year.

Priority C: A minimum of once per year.

In addition to the schedule above, between February 1, 2002 and July 1, 2003, Permittees shall ensure that any catch basin that is at least 40% full of trash and/or debris shall be cleaned out. After July 1, 2003, Permittees shall ensure that any catch basin that is at least 25% full of trash and debris shall be cleaned out.

(2) For any special event that can be reasonably expected to generate substantial quantities of trash and litter, include provisions that require for the proper management of trash and litter generated, as a condition of the special use permit issued for that event. At a minimum, the municipality who issues the permit for the special event shall arrange for either temporary screens to be placed on catch basins or for catch basins in that area to be cleaned out subsequent to the event and prior to any rain event.

(3) Place trash receptacles at all transit stops within its jurisdiction that have shelters no later than August 1, 2002, and at all other transit stops within its jurisdiction no later than February 3, 2003. All trash receptacles shall be maintained as necessary.

d) Each Permittee shall inspect the legibility of the catch basin stencil or label nearest the inlet. Catch basins with illegible stencils shall be recorded and re-stenciled or re-labeled within 180 days of inspection.

e) Each Permittee shall implement BMPs for Storm Drain Maintenance that include:

(1) A program to visually monitor Permittee-owned open channels and other drainage structures for debris at least annually and identify and prioritize problem areas of illicit discharge for regular inspection;

(2) A review of current maintenance activities to assure that appropriate storm water BMPs are being utilized to protect water quality;

(3) Removal of trash and debris from open channel storm drains shall occur a minimum of once per year before the storm season;

(4) Minimize the discharge of contaminants during MS4 maintenance and clean outs; and

(5) Proper disposal of material removed.

6. Streets and Roads Maintenance

a) Each Permittee shall designate streets and/or street segments within its jurisdiction as one of the following:

Priority A: Streets and/or street segments that are designated as consistently generating the highest volumes of trash and/or debris.

Priority B: Streets and/or street segments that are designated as consistently generating moderate volumes of trash and/or debris.

Priority C: Streets and/or street segments that are designated as generating low volumes of trash and/or debris.

b) Each Permittee shall perform street sweeping of curbed streets according to the following schedule:

Priority A: These streets and/or street segments shall be swept at least two times per month.

Priority B: Each Permittee shall ensure that each street and/or street segments is swept at least once per month.

Priority C: These streets and/or street segments shall be swept as necessary but in no case less than once per year.

c) Each Permittee shall require that:

(1) Sawcutting wastes be recovered and disposed of properly and that in no case shall waste be left on a roadway or allowed to enter the storm drain;

(2) Concrete and other street and road maintenance materials and wastes shall be managed to prevent discharge to the MS4; and

(3) The washout of concrete trucks and chutes shall only occur in designated areas and never discharged to storm drains, open ditches, streets, or catch basins.

d) Each Permittee shall, no later than August 1, 2002, train their employees in targeted positions (whose interactions, jobs, and activities affect storm water quality) regarding the requirements of the storm water management program to:

(1) Promote a clear understanding of the potential for maintenance activities to pollute storm water; and

(2) Identify and select appropriate BMPs.

For Permittees with a population of 250,000 or more (2000 U.S. Census) training shall be completed no later than February 1, 2003.

7. Parking Facilities Management

Permittee-owned parking lots exposed to storm water shall be kept clear of debris and excessive oil buildup and cleaned no less than 2 times per month and/or inspected no less than 2 times per month to determine if cleaning is necessary. In no case shall a Permittee-owned parking lot be cleaned less than once a month.

8. Public Industrial Activities Management

Each Permittee shall, for any municipal activity considered a discharge of storm water associated with industrial activity, obtain separate coverage under the GIASP except that a municipality under 100,000 in population (1990 U.S. Census) need not file the Notice Of Intent to be covered by said permit until March 10, 2003 (with the exception of power plants, airports, and uncontrolled sanitary landfills).

9. Emergency Procedures

Each Permittee shall repair essential public services and infrastructure in a manner to minimize environmental damage in emergency situations such as: earthquakes; fires; floods; landslides; or windstorms. BMPs shall be implemented to the extent that measures do not compromise public health and safety. After initial emergency response or emergency repair activities have been completed, each Permittee shall implement BMPs and programs as required under this Order.

10. Treatment Feasibility Study

The Permittees in cooperation with the County Sanitation Districts of Los Angeles County shall conduct a study to investigate the possible diversion of dry weather discharges or the use of alternative Treatment Control BMPs to treat flows from their jurisdiction which may impact public health and safety and/or the environment. The Permittees shall collectively review their individual prioritized lists and create a watershed based priority list of drains for potential diversion or treatment and submit the priority listing to the Regional Board Executive Officer, no later than July 1, 2003.

G. Illicit Connections and Illicit Discharges Elimination Program

Permittees shall eliminate all illicit connections and illicit discharges to the storm drain system, and shall document, track, and report all such cases in accordance with the elements and performance measures specified in the following subsections.

1. General

a) Implementation: Each Permittee must develop an Implementation Program which specifies how each Permittee is implementing revisions to the IC/ID Program of the SQMP. This Implementation Program must be documented, and available for review and approval by the Regional Board Executive Officer, upon request.

b) Tracking: All Permittees shall, no later than February 3, 2003, develop and maintain a listing of all permitted connections to their storm drain system. All Permittees shall map at a scale and in a format specified by the Principal Permittee all illicit connections and discharges on their baseline maps, and shall transmit this information to the Principal Permittee. No later than February 3, 2003, the Principal Permittee shall use this information as well as results of baseline and priority screening for illicit connections (as set forth in subsection 2 below) to start an annual evaluation of patterns and trends of illicit connections and illicit discharges, with the objectives of identifying priority areas for elimination of illicit connections and illicit discharges.

c) Training: All Permittees shall train all targeted employees who are responsible for identification, investigation, termination, cleanup, and reporting of illicit connections and discharges. For Permittees with a population of less than 250,000 (2000 U.S. Census), training shall be completed no later than August 1, 2002. For Permittees with a population of 250,000 or more (2000 U.S. Census), training shall be completed no later than February 3, 2003. Furthermore, all Permittees shall conduct refresher training on an annual basis thereafter.

2. Illicit Connections

a) Screening for Illicit Connections

(1) Field Screening: All Permittees shall field Screen the storm drain system for illicit connections in accordance with the following schedule:

(i) Open channels: No later than February 3, 2003;

(ii) Underground pipes in priority areas: No later than February 1, 2005; and

(iii) Underground pipes with a diameter of 36 inches or greater: No later than December 12, 2006.

Permittees shall report, to the Principal Permittee, on the location and length of open channels or underground pipes that have been Screened *vis a vis* the entire storm drain network, and on the status of suspected, confirmed, and terminated illicit connections. Permittees shall maintain a list containing all permitted connections and the status of connections under investigation for possible illicit connection.

(2) Permit Screening: No later than December 12, 2006, Permittees shall complete a review of all permitted connections to the storm drain system, to confirm compliance with Part 1 (Discharge Prohibition).

b) Response to Illicit Connections

(1) Investigation: Upon discovery or upon receiving a report of a suspected illicit connection, Permittees shall initiate an investigation within 21 days, to determine the source of the connection, the nature and volume of discharge through the connection, and the responsible party for the connection.

(2) Termination: Upon confirmation of the illicit nature of a storm drain connection, Permittees shall ensure termination of the connection within 180 days, using enforcement authority as needed.

3. Illicit Discharges

a) Abatement and Cleanup: Permittees shall respond, within one business day of discovery or a report of a suspected illicit discharge, with activities to abate, contain, and clean up all illicit discharges, including hazardous substances.

b) Investigation: Permittees shall investigate illicit discharges as soon as practicable (during or immediately following containment and cleanup activities), and shall take enforcement action as appropriate.

Part 5. DEFINITIONS

The following are definitions for terms applicable to this Order:

"Adverse Impact" means a detrimental effect upon water quality or beneficial uses caused by a discharge or loading of a pollutant or pollutants.

"Anti-degradation policies" means the *Statement of Policy with Respect to Maintaining High Quality Water in California* (State Board Resolution No. 68-16) which protects surface and ground waters from degradation. In particular, this policy protects waterbodies where existing quality is higher than that necessary for the protection of beneficial uses including the protection of fish and wildlife propagation and recreation on and in the water.

"Applicable Standards and Limitations" means all State, interstate, and federal standards and limitations to which a "discharge" or a related activity is subject under the CWA, including "effluent limitations, "water quality standards, standards of performance, toxic effluent standards or prohibitions, "best management practices," and pretreatment standards under sections 301, 302, 303, 304, 306, 307, 308, 403 and 404 of CWA.

"Areas of Special Biological Significance (ASBS)" means all those areas of this state as ASBS, listed specifically within the California Ocean Plan or so designated by the State Board which, among other areas, includes the area from Mugu Lagoon to Latigo Point: Oceanwater within a line originating from Laguna Point at 34° 5' 40" north, 119° 6'30" west, thence southeasterly following the mean high tideline to a point at Latigo Point defined by the intersection of the meanhigh tide line and a line extending due south of Benchmark 24; thence due south to a distance of 1000 feet offshore or to the 100 foot isobath, whichever distance is greater; thence northwesterly following the 100 foot isobath or maintaining a 1,000-foot distance from shore, whichever maintains the greater distance from shore, to a point lying due south of Laguna Point, thence due north to Laguna Point.

"Authorized Discharge" means any discharge that is authorized pursuant to an NPDES permit or meets the conditions set forth in this Order.

"Automotive Service Facilities" means a facility that is categorized in any one of the following Standard Industrial Classification (SIC) codes: 5013, 5014, 5541, 5511, 7532-7534, or 7536-7539. For inspection purposes, Permittees need not inspect facilities with SIC codes 5013, 5014, 5541, 5511, provided that these facilities have no outside activities or materials that may be exposed to storm water.

"Basin Plan" means the Water Quality Control Plan, Los Angeles Region, Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties, adopted by the Regional Board on June 13, 1994 and subsequent amendments.

"Beneficial Uses" means the existing or potential uses of receiving waters in the permit area as designated by the Regional Board in the Basin Plan.

"Best Management Practices (BMPs)" means methods, measures, or practices designed and selected to reduce or eliminate the discharge of pollutants to surface waters from point and nonpoint source discharges including storm water. BMPs include structural and nonstructural controls, and operation and maintenance procedures, which can be applied before, during, and/or after pollution producing activities.

"Commercial Development" means any development on private land that is not heavy industrial or residential. The category includes, but is not limited to: hospitals, laboratories and other medical facilities, educational institutions, recreational facilities, plant nurseries, car wash facilities, mini-malls and other business complexes, shopping malls, hotels, office buildings, public warehouses and other light industrial complexes.

"Construction" means constructing, clearing, grading, or excavation that results in soil disturbance. Construction includes structure teardown. It does not include routine maintenance to maintain original line and grade, hydraulic capacity, or original purpose of facility; emergency construction activities required to immediately protect public health and safety; interior remodeling with no outside exposure of construction material or construction waste to storm water; mechanical permit work; or sign permit work.

"Control" means to minimize, reduce, eliminate, or prohibit by technological, legal, contractual or other means, the discharge of pollutants from an activity or activities.

"Dechlorinated/Debrominated Swimming Pool Discharge" means swimming pool discharges which have no measurable chlorine or bromine and do not contain any detergents, wastes, or additional chemicals not typically found in swimming pool water. The term does not include swimming pool filter backwash.

"Development" means any construction, rehabilitation, redevelopment or reconstruction of any public or private residential project (whether single-family, multi-unit or planned unit development); industrial, commercial, retail and other non-residential projects, including public agency projects; or mass grading for future construction. It does not include routine maintenance to maintain original line and grade, hydraulic capacity, or original purpose of facility, nor does it include emergency construction activities required to immediately protect public health and safety.

"Directly Adjacent" means situated within 200 feet of the contiguous zone required for the continued maintenance, function, and structural stability of the environmentally sensitive area.

"Director" means the Director of a municipality and Person(s) designated by and under the Director's instruction and supervision.

"Discharge" means when used without qualification the "discharge of a pollutant."

"Discharging Directly" means outflow from a drainage conveyance system that is composed entirely or predominantly of flows from the subject, property, development, subdivision, or industrial facility, and not commingled with the flows from adjacent lands.

"Discharge of a Pollutant" means: any addition of any "pollutant" or combination of pollutants to "waters of the United States" from any "point source" or, any addition of any pollutant or combination of pollutants to the waters of the "contiguous zone" or the ocean from any point source other than a vessel or other floating craft which is being used as a means of transportation. The term discharge includes additions of pollutants into waters of the United States from: surface runoff which is collected or channeled by man; discharges through pipes, sewers, or other conveyances owned by a State, municipality, or other person which do not lead to a treatment works; and discharges through pipes, sewers, or other conveyances, leading into privately owned treatment works.

"Disturbed Area" means an area that is altered as a result of clearing, grading, and/or excavation.

"Environmentally Sensitive Areas (ESAs)" means an area in which plant or animal life or their habitats are either rare or especially valuable because of their special nature or role in an ecosystem and which would be easily disturbed or degraded by human activities and developments (California Public Resources Code § 30107.5). Areas subject to storm water mitigation requirements are: areas designated as Significant Ecological Areas by the County of Los Angeles (*Los Angeles County Significant Areas Study, Los Angeles County Department of Regional Planning (1976)* and amendments); an area designated as a Significant Natural Area by the California Department of Fish and Game's Significant Natural Areas Program, provided that area has been field verified by the Department of Fish and Game; an area listed in the

Basin Plan as supporting the "Rare, Threatened, or Endangered Species (RARE)" beneficial use; and an area identified by a Permittee as environmentally sensitive.

"General Construction Activities Storm Water Permit (GCASP)" means the general NPDES permit adopted by the State Board which authorizes the discharge of storm water from construction activities under certain conditions.

"General Industrial Activities Storm Water Permit (GIASP)" means the general NPDES permit adopted by the State Board which authorizes the discharge of storm water from certain industrial activities under certain conditions.

"Hillside" means property located in an area with known erosive soil conditions, where the development contemplates grading on any natural slope that is 25% or greater and where grading contemplates cut or fill slopes.

"Illicit Connection" means any man-made conveyance that is connected to the storm drain system without a permit, excluding roof drains and other similar type connections. Examples include channels, pipelines, conduits, inlets, or outlets that are connected directly to the storm drain system.

"Illicit Discharge" means any discharge to the storm drain system that is prohibited under local, state, or federal statutes, ordinances, codes, or regulations. The term illicit discharge includes all non storm-water discharges except discharges pursuant to an NPDES permit, discharges that are identified in Part 1, "Discharge Prohibitions" of this order, and discharges authorized by the Regional Board Executive Officer.

"Illicit Disposal" means any disposal, either intentionally or unintentionally, of material(s) or waste(s) that can pollute storm water.

"Industrial/Commercial Facility" means any facility involved and/or used in the production, manufacture, storage, transportation, distribution, exchange or sale of goods and/or commodities, and any facility involved and/or used in providing professional and non-professional services. This category of facilities includes, but is not limited to, any facility defined by the Standard Industrial Classifications (SIC). Facility ownership (federal, state, municipal, private) and profit motive of the facility are not factors in this definition.

"Infiltration" means the downward entry of water into the surface of the soil.

"Inspection" means entry and the conduct of an on-site review of a facility and its operations, at reasonable times, to determine compliance with specific municipal or other legal requirements. The steps involved in performing an inspection, include, but are not limited to:

1. Pre-inspection documentation research.;
2. Request for entry;
3. Interview of facility personnel;
4. Facility walk-through.
5. Visual observation of the condition of facility premises;
6. Examination and copying of records as required;
7. Sample collection (if necessary or required);

8. Exit conference (to discuss preliminary evaluation); and,
9. Report preparation, and if appropriate, recommendations for coming into compliance.

In the case of restaurants, a Permittee may conduct an inspection from the curbside, provided that such "curbside" inspection provides the Permittee with adequate information to determine an operator's compliance with BMPs that must be implemented per requirements of this Order, Regional Board Resolution 98-08, County and municipal ordinances, and the SQMP.

"Large Municipal Separate Storm Sewer System (MS4)" means all MS4s that serve a population greater than 250,000 (1990 Census) as defined in 40 CFR 122.26 (b)(4). The Regional Board designated Los Angeles County as a large MS4 in 1990, based on: (i) the U.S. Census Bureau 1990 population count of 8.9 million, and (ii) the interconnectivity of the MS4s in the incorporated and unincorporated areas within the County.

"Local SWPPP" means the Storm Water Pollution Prevention Plan required by the local agency for a project that disturbs one or more acres of land.

"Maximum Extent Practicable (MEP)" means the standard for implementation of storm water management programs to reduce pollutants in storm water. CWA § 402(p)(3)(B)(iii) requires that municipal permits "shall require controls to reduce the discharge of pollutants to the maximum extent practicable, including management practices, control techniques and system, design and engineering methods, and such other provisions as the Administrator or the State determines appropriate for the control of such pollutants. See also State Board Order WQ 2000-11 at page 20.

"Method Detection Limit (MDL)" means the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero, as defined in 40 CFR 136, Appendix B.

"Minimum Level (ML)" means the concentration at which the entire analytical system must give a recognizable signal and acceptable calibration point. The ML is the concentration in a sample that is equivalent to the concentration of the lowest calibration standard analyzed by a specific analytical procedure, assuming that all the method specified sample weights, volumes, and processing steps have been followed.

"Municipal Separate Storm Sewer System (MS4)" means a conveyance or system of conveyances (including roads with drainage systems, municipal streets, alleys, catch basins, curbs, gutters, ditches, manmade channels, or storm drains) owned by a State, city, county, town or other public body, that is designed or used for collecting or conveying storm water, which is not a combined sewer, and which is not part of a publicly owned treatment works, and which discharges to Waters of the United States.

"National Pollutant Discharge Elimination System (NPDES)" means the national program for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcing permits, and imposing and enforcing pretreatment requirements, under CWA §307, 402, 318, and 405. The term includes an "approved program."

"Natural Drainage Systems" means unlined or unimproved (not engineered) creeks, streams, rivers or similar waterways.

"New Development" means land disturbing activities; structural development, including construction or installation of a building or structure, creation of impervious surfaces; and land subdivision.

"Non-Storm Water Discharge" means any discharge to a storm drain that is not composed entirely of storm water.

"Nuisance" means anything that meets all of the following requirements: (1) is injurious to health, or is indecent or offensive to the senses, or an obstruction to the free use of property, so as to interfere with the comfortable enjoyment of life or property; (2) affects at the same time an entire community or neighborhood, or any considerable number of persons, although the extent of the annoyance or damage inflicted upon individuals may be unequal.; (3) occurs during, or as a result of, the treatment or disposal of wastes.

"Parking Lot" means land area or facility for the parking or storage of motor vehicles used for businesses, commerce, industry, or personal use, with a lot size of 5,000 square feet or more of surface area, or with 25 or more parking spaces.

"Permittee(s)" means Co-Permittees and any agency named in this Order as being responsible for permit conditions within its jurisdiction. Permittees to this Order include the Los Angeles County Flood Control District, Los Angeles County, and the cities of Agoura Hills, Alhambra, Arcadia, Artesia, Azusa, Baldwin Park, Bellflower, Bell Gardens, Beverly Hills, Bradbury, Burbank, Calabasas, Carson, Cerritos, Claremont, Commerce, Compton, Covina, Cudahy, Culver City, Diamond Bar, Downey, Duarte, El Monte, El Segundo, Gardena, Glendale, Glendora, Hawaiian Gardens, Hawthorne, Hermosa Beach, Hidden Hills, Huntington Park, Industry, Inglewood, Irwindale, La Canada Flintridge, La Habra Heights, Lakewood, La Mirada, La Puente, La Verne, Lawndale, Lomita, Los Angeles, Lynwood, Malibu, Manhattan Beach, Maywood, Monrovia, Montebello, Monterey Park, Norwalk, Palos Verdes Estates, Paramount, Pasadena, Pico Rivera, Pomona, Rancho Palos Verdes, Redondo Beach, Rolling Hills, Rolling Hills Estates, Rosemead, San Dimas, San Fernando, San Gabriel, San Marino, Santa Clarita, Santa Fe Springs, Santa Monica, Sierra Madre, Signal Hill, South El Monte, South Gate, South Pasadena, Temple City, Torrance, Vernon, Walnut, West Covina, West Hollywood, Westlake Village, and Whittier.

"Planning Priority Projects" means those projects that are required to incorporate appropriate storm water mitigation measures into the design plan for their respective project. These types of projects include:

1. Ten or more unit homes (includes single family homes, multifamily homes, condominiums, and apartments)
2. A 100,000 or more square feet of impervious surface area industrial/ commercial development (1 ac starting March 2003)
3. Automotive service facilities (SIC 5013, 5014, 5541, 7532-7534, and 7536-7539)
4. Retail gasoline outlets
5. Restaurants (SIC 5812)
6. Parking lots 5,000 square feet or more of surface area or with 25 or more parking spaces

7. Redevelopment projects in subject categories that meet Redevelopment thresholds
8. Projects located in or directly adjacent to or discharging directly to an ESA, which meet thresholds; and
9. Those projects that require the implementation of a site-specific plan to mitigate post-development storm water for new development not requiring a SUSMP but which may potentially have adverse impacts on post-development storm water quality, where the following project characteristics exist:

   a) Vehicle or equipment fueling areas;
   b) Vehicle or equipment maintenance areas, including washing and repair;
   c) Commercial or industrial waste handling or storage;
   d) Outdoor handling or storage of hazardous materials;
   e) Outdoor manufacturing areas;
   f) Outdoor food handling or processing;
   g) Outdoor animal care, confinement, or slaughter; or
   h) Outdoor horticulture activities.

"Pollutants" means those "pollutants" defined in CWA §502(6) (33.U.S.C.§1362(6)), and incorporated by reference into California Water Code §13373.

"Potable Water Distribution Systems Releases" means sources of flows from drinking water storage, supply and distribution systems including flows from system failures, pressure releases, system maintenance, distribution line testing, fire hydrant flow testing; and flushing and dewatering of pipes, reservoirs, vaults, and minor non-invasive well maintenance activities not involving chemical addition(s). It does not include wastewater discharges from activities that occur at wellheads, such as well construction, well development (i.e., aquifer pumping tests, well purging, etc.), or major well maintenance.

"Project" means all development, redevelopment, and land disturbing activities. The term is not limited to "Project" as defined under CEQA (Pub. Resources Code §21065).

"Rain Event" means any rain event greater than 0.1 inch in 24 hours except where specifically stated otherwise.

"Rare, Threatened, or Endangered Species (RARE)" means a beneficial use for waterbodies in the Los Angeles Region, as designated in the Basin Plan (Table 2-1), that supports habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under state or federal law as rare, threatened, or endangered.

"Receiving Waters" means all surface water bodies in the Los Angeles Region that are identified in the Basin Plan.

"Redevelopment" means land-disturbing activity that results in the creation, addition, or replacement of 5,000 square feet or more of impervious surface area on an already developed site. Redevelopment includes, but is not limited to: the expansion of a building footprint;

addition or replacement of a structure; replacement of impervious surface area that is not part of a routine maintenance activity; and land disturbing activities related to structural or impervious surfaces. It does not include routine maintenance to maintain original line and grade, hydraulic capacity, or original purpose of facility, nor does it include emergency construction activities required to immediately protect public health and safety.

"Regional Administrator" means the Regional Administrator of the Regional Office of the USEPA or the authorized representative of the Regional Administrator.

"Restaurant" means a facility that sells prepared foods and drinks for consumption, including stationary lunch counters and refreshment stands selling prepared foods and drinks for immediate consumption (SIC Code 5812).

"Retail Gasoline Outlet" means any facility engaged in selling gasoline and lubricating oils.

"Runoff" means any runoff including storm water and dry weather flows from a drainage area that reaches a receiving water body or subsurface. During dry weather it is typically comprised of base flow either contaminated with pollutants or uncontaminated, and nuisance flows.

"Screening" means using proactive methods to identify illicit connections through a continuously narrowing process. The methods may include: performing baseline monitoring of open channels, conducting special investigations using a prioritization approach, analyzing maintenance records for catch basin and storm drain cleaning and operation, and verifying all permitted connections into the storm drains. Special investigation techniques may include: dye testing, visual inspection, smoke testing, flow monitoring, infrared, aerial and thermal photography, and remote control camera operation.

"Sidewalk Rinsing" means pressure washing of paved pedestrian walkways with average water usage of 0.006 gallons per square foot, with no cleaning agents, and properly disposing of all debris collected, as authorized under Regional Board Resolution No. 98-08.

"Significant Ecological Area (SEA)" means an area that is determined to possess an example of biotic resources that cumulatively represent biological diversity, for the purposes of protecting biotic diversity, as part of the Los Angeles County General Plan.[1]
Areas are designated as SEAs, if they possess one or more of the following criteria:

1. The habitat of rare, endangered, and threatened plant and animal species.
2. Biotic communities, vegetative associations, and habitat of plant and animal species that are either one of a kind, or are restricted in distribution on a regional basis.
3. Biotic communities, vegetative associations, and habitat of plant and animal species that are either one of a kind or are restricted in distribution in Los Angeles County.

[1] The 61 existing SEAs represent the findings of a study that was completed in 1976 by England and Nelson, Environmental Consultants, as amended through the adoption of a revised Los Angeles County General Plan in 1980. The results of an update study to evaluate existing SEAs within unincorporated Los Angeles County is currently being proposed to the Los Angeles County Planning Commission (*Los Angeles County Significant Ecological Area Update Study 2000, Background Report*, PCR Services Corporation). The *Update Study 2000*, which contains existing and proposed SEA boundaries, can be downloaded from the Los Angeles County Department of Planning website at http://planning.co.la.ca.us/drp_revw.html#SEA

4. Habitat that at some point in the life cycle of a species or group of species, serves as a concentrated breeding, feeding, resting, migrating grounds and is limited in availability either regionally or within Los Angeles County.
5. Biotic resources that are of scientific interest because they are either an extreme in physical/geographical limitations, or represent an unusual variation in a population or community.
6. Areas important as game species habitat or as fisheries.
7. Areas that would provide for the preservation of relatively undisturbed examples of natural biotic communities in Los Angeles County.
8. Special areas.[2]

"Significant Natural Area (SNA)" means an area defined by the California Department of Fish and Game (DFG), Significant Natural Areas Program, as an area that contains an important example of California's biological diversity. The most current SNA maps, reports, and descriptions can be downloaded from the DFG website at ftp://maphost.dfg.ca.gov/outgoing/whdab/sna/. These areas are identified using the following biological criteria only, irrespective of any administrative or jurisdictional considerations:

1. Areas supporting extremely rare species or habitats.
2. Areas supporting associations or concentrations of rare species or habitats.
3. Areas exhibiting the best examples of rare species and habitats in the state.

"Site" means the land or water area where any "facility or activity" is physically located or conducted, including adjacent land used in connection with the facility or activity.

"Source Control BMP" means any schedules of activities, prohibitions of practices, maintenance procedures, managerial practices or operational practices that aim to prevent storm water pollution by reducing the potential for contamination at the source of pollution.

"SQMP" means the Los Angeles Countywide Stormwater Quality Management Program.

"State Storm Water Pollution Prevention Plan (State SWPPP)" means a plan, as required by a State General Permit, identifying potential pollutant sources and describing the design, placement and implementation of BMPs, to effectively prevent non-stormwater Discharges and reduce Pollutants in Stormwater Discharges during activities covered by the General Permit.

"Storm Water" means storm water runoff, snow melt runoff, and surface runoff and drainage.

"Storm Water Discharge Associated with Industrial Activity" means industrial discharge as defined in 40 CFR 122.26(b)(14)

"Stormwater Quality Management Program" means the Los Angeles Countywide Stormwater Quality Management Program, which includes descriptions of programs, collectively developed by the Permittees in accordance with provisions of the NPDES Permit, to comply with applicable federal and state law, as the same is amended from time to time.

[2] These criteria from the 1976 study have been modified in the *Update Study 2000*.

"Structural BMP" means any structural facility designed and constructed to mitigate the adverse impacts of storm water and urban runoff pollution (e.g. canopy, structural enclosure). The category may include both Treatment Control BMPs and Source Control BMPs.

"SUSMP" means the Los Angeles Countywide Standard Urban Stormwater Mitigation Plan. The SUSMP shall address conditions and requirements of new development.

"Total Maximum Daily Load (TMDL)" means the sum of the individual waste load allocations for point sources and load allocations for nonpoint sources and natural background.

"Toxicity Identification Evaluation (TIE)" means a set of procedures to identify the specific chemical(s) responsible for toxicity. These procedures are performed in three phases (characterization, identification, and confirmation) using aquatic organism toxicity tests.

"Toxicity Reduction Evaluation (TRE)" means a study conducted in a step-wise process to identify the causative agents of effluent or ambient toxicity, isolate the sources of toxicity, evaluate the effectiveness of toxicity control options, and then confirm the reduction in toxicity.

"Treatment" means the application of engineered systems that use physical, chemical, or biological processes to remove pollutants. Such processes include, but are not limited to, filtration, gravity settling, media absorption, biodegradation, biological uptake, chemical oxidation and UV radiation.

"Treatment Control BMP" means any engineered system designed to remove pollutants by simple gravity settling of particulate pollutants, filtration, biological uptake, media absorption or any other physical, biological, or chemical process.

"USEPA Phase I Facilities" means facilities in specified industrial categories that are required to obtain an NPDES permit for storm water discharges, as required by 40 CFR 122.26(c). These categories include:

i. facilities subject to storm water effluent limitation guidelines, new source performance standards, or toxic pollutant effluent standards (40 CFR N)
ii. manufacturing facilities
iii. oil and gas/mining facilities
iv. hazardous waste treatment, storage, or disposal facilities
v. landfills, land application sites, and open dumps
vi. recycling facilities
vii. steam electric power generating facilities
viii. transportation facilities
ix. sewage of wastewater treatment works
x. light manufacturing facilities

"Vehicle Maintenance/Material Storage Facilities/Corporation Yards" means any Permittee owned or operated facility or portion thereof that:

i. Conducts industrial activity, operates equipment, handles materials, and provides services similar to Federal Phase I facilities;
ii. Performs fleet vehicle service/maintenance on ten or more vehicles per day including repair, maintenance, washing, and fueling;

iii. Performs maintenance and/or repair of heavy industrial machinery/equipment ; and
iv. Stores chemicals, raw materials, or waste materials in quantities that require a hazardous materials business plan or a Spill Prevention, Control , and Countermeasures (SPCC) plan.

"Water Quality Standards and Water Quality Objectives" means water quality criteria contained in the Basin Plan, the California Ocean Plan, the National Toxics Rule, the California Toxics Rule, and other state or federally approved surface water quality plans. Such plans are used by the Regional Board to regulate all discharges, including storm water discharges.

"Waters of the State" means any surface water or groundwater, including saline waters, within boundaries of the state.

"Waters of the United States" or "Waters of the U.S." means:

a. All waters that are currently used, were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide;
b. All interstate waters, including interstate "wetlands";
c. All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, "wetlands," sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds the use, degradation, or destruction of which would affect or could affect interstate or foreign commerce including any such waters:
    1. Which are or could be used by interstate or foreign travelers for recreational or other purposes;
    2. From which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or
    3. Which are used or could be used for industrial purposes by industries in interstate commerce;
d. All impoundments of waters otherwise defined as waters of the United States under this definition;
e. Tributaries of waters identified in paragraphs (a) through (d) of this definition;
f. The territorial sea; and
g. "Wetlands" adjacent to waters (other than waters that are themselves wetlands) identified in paragraph (a) through (f) of this definition.

Waste treatment systems, including treatment ponds or lagoons designed to meet the requirements of CWA (other than cooling ponds as defined in 40 CFR 423.22(m), which also meet the criteria of this definition) are not waters of the United States. This exclusion applies only to man-made bodies of water, which neither were originally created in waters of the United States (such as disposal area in wetlands) nor resulted from the impoundment of waters of the United States. Waters of the United States do not include prior converted cropland. Notwithstanding the determination of an area's status as prior converted cropland by any other federal agency, for the purposes of the CWA, the final authority regarding CWA jurisdiction remains with USEPA.

"Wet Season" means the calendar period beginning October 1 through April 15.

Part 6. STANDARD PROVISIONS

A. Standard Requirements

1. Each Permittee shall comply with all provisions and requirements of this permit.

2. Should a Permittee discover a failure to submit any relevant facts or that it submitted incorrect information in a report, it shall promptly submit the missing or correct information.

3. Each Permittee shall report all instances of non-compliance not otherwise reported at the time monitoring reports are submitted.

4. This Order includes the attached Monitoring and Reporting Program, and SUSMP(Regional Board Resolution No. R00-02), which are a part of the permit and must be complied with in the same manner as with the rest of the requirements in the permit.

B. Regional Board Review

Any formal determination or approval made by the Regional Board Executive Officer pursuant to the provisions of this Order may be reviewed by the Regional Board. A Permittee(s) or a member of the public may request such review upon petition within 30 days of the effective date of the notification of such decision to the Permittee(s) and interested parties on file at the Regional Board.

C. Public Review

1. All documents submitted to the Regional Board in compliance with the terms and conditions of this Order shall be made available to members of the public pursuant to the Freedom of Information Act (5 U.S.C. § 552 (as amended) and the Public Records Act (Cal. Government Code § 6250 *et seq.*).

2. All documents submitted to the Regional Board Executive Officer for approval shall be made available to the public for a 30-day period to allow for public comment.

D. Duty to Comply

1. Each Permittee must comply with all of the terms, requirements, and conditions of this Order. Any violation of this order constitutes a violation of the Clean Water Act, its regulations and the California Water Code, and is grounds for enforcement action, Order termination, Order revocation and reissuance, denial of an application for reissuance; or a combination thereof [40 CFR 122.41(a), CWC § 13261, 13263, 13265, 13268, 13300, 13301, 13304, 13340, 13350].

2. A copy of these waste discharge specifications shall be maintained by each Permittee so as to be available during normal business hours to Permittee employees and members of the public.

3. Any discharge of wastes at any point(s) other than specifically described in this Order is prohibited, and constitutes a violation of the Order.

E. Duty to Mitigate [40 CFR 122.41 (d)]

Each Permittee shall take all reasonable steps to minimize or prevent any discharge that has a reasonable likelihood of adversely affecting human health or the environment.

F. Inspection and Entry [40 CFR 122.41(i), CWC § 13267]

The Regional Board, USEPA, and other authorized representatives shall be allowed:

1. Entry upon premises where a regulated facility is located or conducted, or where records are kept under conditions of this Order;
2. Access to copy any records, at reasonable times, that are kept under the conditions of this Order;
3. To inspect at reasonable times any facility, equipment (including monitoring and control equipment), practices, or operations regulated or required under this Order; and,
4. To photograph, sample, and monitor at reasonable times for the purpose of assuring compliance with this Order, or as otherwise authorized by the CWA and the CWC.

G. Proper Operation and Maintenance [40 CFR 122.41 (e), CWC § 13263(f)]

The Permittees shall at all times properly operate and maintain all facilities and systems of treatment (and related appurtenances) that are installed or used by the Permittees to achieve compliance with this Order. Proper operation and maintenance includes adequate laboratory controls and appropriate quality assurance procedures. This provision requires the operation of backup or auxiliary facilities or similar system that are installed by a Permittee only when necessary to achieve compliance with the conditions of this Order.

H. Signatory Requirements [40 CFR 122.41(k) & 122.22]

Except as otherwise provided in this Order, all applications, reports, or information submitted to the Regional Board shall be signed by the Director of Public Works, City Engineer, or authorized designee and certified as set forth in 40 CFR 122.22.

I. Reopener and Modification [40 CFR 122.41(f) & 122.62]

1. This Order may only be modified, revoked, or reissued, prior to the expiration date, by the Regional Board, in accordance with the procedural requirements of the CWC and CCR Title 23 for the issuance of waste

discharge requirements, 40 CFR 122.62, and upon prior notice and hearing, to:

a) Address changed conditions identified in the required reports or other sources deemed significant by the Regional Board;

b) Incorporate applicable requirements or statewide water quality control plans adopted by the State Board or amendments to the Basin Plan;

c) Comply with any applicable requirements, guidelines, and/or regulations issued or approved pursuant to CWA Section 402(p); and/or,

d) Consider any other federal, or state laws or regulations that became effective after adoption of this Order.

2. After notice and opportunity for a hearing, this Order may be terminated or modified for cause, including, but not limited to:

a) Violation of any term or condition contained in this Order;

b) Obtaining this Order by misrepresentation, or failure to disclose all relevant facts; or,

c) A change in any condition that requires either a temporary or permanent reduction or elimination of the authorized discharge.

3. The filing of a request by the Principal Permittee or Permittees for a modification, revocation and re-issuance, or termination, or a notification of planned changes or anticipated noncompliance does not stay any condition of this Order.

4. This Order may be modified to make corrections or allowances for changes in the permitted activity listed in this section, following the procedures at 40 CFR 122.63, if processed as a minor modification. Minor modifications may only:

a) Correct typographical errors, or

b) Require more frequent monitoring or reporting by the Permittee.

J. Severability

The provisions of this permit are severable; and if any provision of this permit or the application of any provision of this permit to any circumstance is held invalid, the application of such provision to other circumstances and the remainder of this permit shall not be affected.

K. Duty to Provide Information [40 CFR 122.41(h)]

The Permittees shall furnish, within a reasonable time, any information the Regional Board or USEPA may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this Order. The Permittees shall also furnish to the Regional Board, upon request, copies of records required to be kept by this Order.

L. **Twenty-four Hour Reporting [40 CFR 122.41(l)(6)][3]**

1. The Permittees shall report to the Regional Board any noncompliance that may endanger health or the environment. Any information shall be provided orally within 24 hours from the time any Permittee becomes aware of the circumstances. A written submission shall also be provided within five days of the time the Permittee becomes aware of the circumstances. The written submission shall contain a description of the noncompliance and its cause; the period of noncompliance, including exact dates and times and, if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance.

2. The Regional Board may waive the required written report on a case-by-case basis.

M. **Bypass [40 CFR 122.41(m)][4]**

Bypass (the intentional diversion of waste streams from any portion of a treatment facility) is prohibited. The Regional Board may take enforcement action against Permittees for bypass unless:

1. Bypass was unavoidable to prevent loss of life, personal injury or severe property damage. (Severe property damage means substantial physical damage to property, damage to the treatment facilities that causes them to become inoperable, or substantial and permanent loss of natural resources that can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.);

2. There were no feasible alternatives to bypass, such as the use of auxiliary treatment facilities, retention of untreated waste, or maintenance during normal periods of equipment down time. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass that could occur during normal periods of equipment downtime or preventive maintenance;

3. The Permittee submitted a notice at least ten days in advance of the need for a bypass to the Regional Board; or,

4. Permittees may allow a bypass to occur that does not cause effluent limitations to be exceeded, but only if it is for essential maintenance to

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[3] This provision applies to incidents where effluent limitations (numerical or narrative) as provided in this Order or in the Los Angeles County SQMP are exceeded, and which endanger public health or the environment.

[4] This provision applies to the operation and maintenance of storm water controls and BMPs as provided in this Order or in the SQMP.

assure efficient operation. In such a case, the above bypass conditions are not applicable. The Permittee shall submit notice of an unanticipated bypass as required.

N. Upset [40 CFR 122.41(n)][5]

Upset means an exceptional incident in which there is unintentional and temporary noncompliance with technology based permit effluent limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

1. A Permittee that wishes to establish the affirmative defense of an upset in an action brought for non compliance shall demonstrate, through properly signed, contemporaneous operating logs, or other relevant evidence that:

    a) An upset occurred and that the Permittee can identify the cause(s) of the upset;

    b) The permitted facility was being properly operated by the time of the upset;

    c) The Permittee submitted notice of the upset as required; and,

    d) The Permittee complied with any remedial measures required.

2. No determination made before an action for noncompliance, such as during administrative review of claims that non-compliance was caused by an upset, is final administrative action subject to judicial review.

3. In any enforcement proceeding, the Permittee seeking to establish the occurrence of an upset has the burden of proof.

O. Property Rights [40 CFR 122.41(g)]

This Order does not convey any property rights of any sort, or any exclusive privilege.

P. Enforcement

1. Violation of any of the provisions of the NPDES permit or any of the provisions of this Order may subject the violator to any of the penalties described herein, or any combination thereof, at the discretion of the prosecuting authority; except that only one kind of penalties may be applied for each kind of violation. The CWA provides the following:

    a) Criminal Penalties for:

[5] *Supra*. See footnote number 3.

(1) Negligent Violations:

The CWA provides that any person who negligently violates permit conditions implementing § 301, 302, 306, 307, 308, 318, or 405 is subject to a fine of not less than $2,500 nor more than $25,000 per day for each violation, or by imprisonment for not more than 1 year, or both.

(2) Knowing Violations:

The CWA provides that any person who knowingly violates permit conditions implementing § 301, 302, 306, 307, 308, 318, or 405 is subject to a fine of not less than $5,000 nor more than $50,000 per day of violation, or by imprisonment for not more than 3 years, or both.

(3) Knowing Endangerment:

The CWA provides that any person who knowingly violates permit conditions implementing § 301, 302, 307, 308, 318, or 405 and who knows at that time that he is placing another person in imminent danger of death or serious bodily injury is subject to a fine of not more than $250,000, or by imprisonment for not more than 15 years, or both.

(4) False Statement:

The CWA provides that any person who knowingly makes any false material statement, representation, or certification in any application, record, report, plan, or other document filed or required to be maintained under the Act or who knowingly falsifies, tampers with, or renders inaccurate, any monitoring device or method required to be maintained under the Act, shall upon conviction, be punished by a fine of not more than $10,000 or by imprisonment for not more than two years, or by both. If a conviction is for a violation committed after a first conviction of such person under this paragraph, punishment shall be by a fine of not more than $20,000 per day of violation, or by imprisonment of not more than four years, or by both. (See CWA § 309(c)(4))

b) Civil Penalties

The CWA provides that any person who violates a permit condition implementing § 301, 302, 306, 307, 308, 318, or 405 is subject to a civil penalty not to exceed $27,500 per day for each violation.

2. The CWC provides that any person who violates a waste discharge requirement provision of the CWC is subject to civil penalties of up to $5,000 per day, $10,000 per day, or $25,000 per day of violation; or when the violation involves the discharge of pollutants, is subject to civil penalties of up to $10 per gallon per day or $25 per gallon per day of violation; or some combination thereof, depending on the violation or combination of violations.

Q. Need to Halt or Reduce Activity not a Defense [40 CFR 122.41(c)]

It shall not be a defense for a Permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this Order.

R. Rescission

Regional Board Order No. 96-054 is hereby rescinded.

S. Expiration

This Order expires on December 12, 2006. The Permittees must submit a Report of Waste Discharges and a proposed Storm Water Quality Management Program in accordance with CCR Title 23 as application for reissuance of waste discharge requirements no later than June 12, 2006.

I, Dennis A. Dickerson, Regional Board Executive Officer, do hereby certify that the foregoing is a full, true, and correct copy of an order adopted by the California Regional Water Quality Control Board, Los Angeles Region, on December 13, 2001.

Dennis A. Dickerson
Executive Officer

State of California
CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LOS ANGELES REGION
MONITORING AND REPORTING PROGRAM - CI 6948
FOR
ORDER No. 01-182
NPDES No. CAS004001
MUNICIPAL STORM WATER AND URBAN RUNOFF DISCHARGES WITHIN THE COUNTY OF LOS ANGELES, AND THE INCORPORATED CITIES, EXCEPT THE CITY OF LONG BEACH

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I. Program Reporting Requirements

The Principal Permittee shall submit, no later than October 15 of each year beginning in the year 2002, a Unified Annual Storm Water Report (Unified Annual Report) documenting the progress of Permittees' implementation of the SQMP and the requirements of this Order. The Unified Annual Report shall contain a section covering common activities conducted collectively by the Permittees, and an integrated summary of the Monitoring Program results. Each Permittee shall submit an Individual Annual Report to the Principal Permittee, by the date determined by the Principal Permittee, to be included in the Unified Annual Report. The Unified Annual Reports shall cover each fiscal year from July 1 through June 30. The first Unified Annual Report, to be submitted on October 15, 2002, shall report for the period from July 1, 2001 through June 30, 2002. Specific requirements that must be addressed in the Annual Reports are listed below.

A. Unified Annual Report

The Principal Permittee shall include the following in the Unified Annual Report:

1. A compilation of Permittee Individual Annual Reports.

2. Proposed changes to the SQMP, as recommended by the WMCs.

3. An assessment of the effectiveness of SQMP requirements to reduce storm water pollution. This assessment shall be comprised of a compilation of watershed-wide assessments conducted by each WMC. Assessments shall be based upon the specific record-keeping information requirement in each section of the permit, monitoring data, summaries of program effectiveness from each Permittee, and any other information related to program effectiveness. The program assessment shall include summaries of the following:

   a) Summary of common activities conducted by all Permittees;

   b) WMA BMP implementation;

   c) Identification of management measures proven to be effective and/or ineffective at reducing urban runoff pollutants and flow;

   d) Permittee level of effort, as indicated in their Individual Annual Report self evaluations (Attachment U-4, section VI); and

   e) Integrated summary of Monitoring Program results, including the identification of water quality improvements or degradation, and recommendations for improvements to the SQMP (including proposed BMPs) based on the results from the Monitoring Program.

4. Pursuant to Part 2 of this Order, after a determination by either a Permittee or the Regional Board that discharges are causing or contributing to an exceedance of an applicable Water Quality Standard, a Receiving Water Limitations (RWL) Compliance Report shall be attached to the subsequent Unified Annual Report. A status RWL Compliance Report shall be submitted every alternate year following the submittal of the first Report. The RWL Compliance Report shall include the following:

   a) A plan to comply with the RWL (Part 2 of this Order);

   b) Changes to the SQMP to eliminate water quality exceedances;

   c) Enhanced monitoring to demonstrate compliance; and

   d) Results of implementation.

   After all water quality exceedances have been abated, a RWL Compliance Report is not required.

B. Individual Annual Reports

Each Individual Annual Report shall document and describe all activities conducted by a Permittee to meet all requirements of this Order, during the completed annual reporting period. Individual Annual Reports shall use the attached form (Attachment U-4), or create another reporting format that includes all items on the attached form. Each Permittee shall complete the form in its entirety, except for those requirements applicable only to the Principal Permittee, as indicated on the form. Status of compliance with permit requirements including implementation dates for all time-specific deadlines should be included for each program area. If permit deadlines are not met, Permittees shall report the reasons why the requirement was not met and how the requirements will be met in the future, including projected implementation dates. A comparison of program implementation results to performance standards established in this Order and in the SQMP shall be included for each program area.

C. Monitoring Program Management

The Principal Permittee shall submit a Storm Water Monitoring Report (Monitoring Report) on August 15, 2002, and annually on August 15, thereafter. The Monitoring Report to be submitted on August 15, 2002 shall include the results of monitoring from July 1, 2001 through June 30, 2002. Each Monitoring Report shall include:

1. Status of implementation of the Monitoring Program.

2. Data, results, methods of evaluating the data, graphical summaries of the data, and an explanation/discussion of the data for each component of the monitoring program, including any specific reporting requirements included in Section II. Monitoring Program.

3. An analysis of the findings of each Monitoring Program component. The analysis shall identify and prioritize water quality problems. Based on the identification and prioritization of water quality problems, the analysis shall identify potential sources of the problems, and recommend future

monitoring and BMP implementation measures for identifying and addressing the sources. The analysis shall also include an evaluation of the effectiveness of existing control measures.

4. Identification and analysis of any long-term trends in storm water or receiving water quality.

5. An estimation of total pollutant loads due to storm water/urban runoff for each mass emission station.

6. A comparison to the applicable Water Quality Standards for each component of the Monitoring Program. The lowest applicable standard from the Basin Plan, the Ocean Plan, or the CTR shall be used for comparison. Constituents that exceed applicable Water Quality Standards shall be highlighted. When data indicate that discharges are causing or contributing to exceedances of applicable Water Quality Standards, a discussion of possible pollutant sources shall be included in the Monitoring Report and a RWL Compliance Report (Section I.A.4) shall be submitted with the subsequent Unified Annual Report.

7. For each monitoring component, maps of all monitoring station locations and descriptions of each location.

8. All Monitoring Reports shall be submitted in both electronic and paper formats.

D. Integrated Receiving Water Impacts Report

The Principal Permittee shall, not later than August 15, 2005, prepare and submit an Integrated Receiving Water Impacts Report, which may also serve as the fourth-year Monitoring Report. The Report shall include, but not be limited to, a comprehensive analysis of the results of the data from each component of the Monitoring Program, and other pertinent studies available, and feasible environmental indicators. It should also include a budget summary for each monitoring requirement and recommendations on future monitoring requirements. This report will be an integral part of the next ROWD.

E. Certification

All applications, reports, or information submitted to the Regional Board shall be signed and certified pursuant to US EPA regulations at 40 CFR 122.41 (k). Each report shall contain the following completed declaration:

> "I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted.
>
> Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for

submitting false information, including the possibility, of a fine and imprisonment for knowing violations.

Executed on the ___ day of _________, 20_,

at _________________________.

(Signature)_______________ (Title)_______________";

Permittee submittals to the Principal Permittee shall also be signed and certified pursuant to USEPA regulations 40 CFR 122.41 (k).

The Principal Permittee shall submit the original of each Unified Annual Report to:

INFORMATION TECHNOLOGY
CALIFORNIA REGIONAL WATER QUALITY
CONTROL BOARD - LOS ANGELES REGION
320 W. 4TH STREET, SUITE 200
LOS ANGELES, CA 90013

A copy of the Unified Annual Report shall also be mailed to:

REGIONAL ADMINISTRATOR
ENVIRONMENTAL PROTECTION AGENCY
REGION 9
75 Hawthorne Street
San Francisco, CA 94105

II. Monitoring Program

The primary objectives of the Monitoring Program include, but are not limited to:

- Assessing compliance with this Order;
- Measuring and improving the effectiveness of the SQMPs;
- Assessing the chemical, physical, and biological impacts of receiving waters resulting from urban runoff;
- Characterization of storm water discharges;
- Identifying sources of pollutants; and
- Assessing the overall health and evaluating long-term trends in receiving water quality.

Ultimately, the results of the monitoring requirements outlined below should be used to refine the SQMP for the reduction of pollutant loadings and the protection and enhancement of the beneficial uses of the receiving waters in Los Angeles County.

The Principal Permittee and Permittees shall implement the Monitoring Program as follows:

CORE MONITORING

A. Mass Emissions

The Principal Permittee shall monitor mass emissions to accomplish the following objectives:

- Estimate the mass emissions from the MS4;
- Assess trends in the mass emissions over time; and
- Determine if the MS4 is contributing to exceedances of Water Quality Standards by comparing results to applicable standards in the Basin Plan, the Ocean Plan, or the CTR, and with emissions from other dischargers.

1. The Principal Permittee shall monitor mass emissions from the following seven mass emission stations: Ballona Creek, Malibu Creek, Los Angeles River, San Gabriel River, Coyote Creek, Dominguez Channel, and the Santa Clara River. The Principal Permittee shall monitor the first storm event and a minimum of 2 additional storm events for each season. A minimum of two dry weather samples per year at each mass emission station shall also be analyzed. Sampling at all stations shall begin no later than February 1, 2002, except for sampling in the Santa Clara River, which will begin no later than October 15, 2002.

2. All storms events, in addition to those required above, that result in at least 0.25 inches of rainfall shall be sampled and analyzed for TSS. Results shall be used to assess the variability of storm water constituents and provide a more accurate estimate of mass emissions (pollutant correlation with TSS). This requirement does not apply to manual sampling stations.

3. Samples for mass emission monitoring may be taken with the same type of automatic sampler used under Order 96-054. Grab samples shall be taken for pathogen indicators and oil and grease. The samplers shall be set to monitor storms that produce 0.25 inches or greater of rainfall.

Samples taken at mass emission stations during the first storm event of the wet season shall be analyzed for all constituents listed in Attachment U-1.

4. Manual samples shall be collected from mass emission stations where it is not feasible to install an automatic sampler (Santa Clara River). Manual samples shall be flow-weighted composites, collected during the first 3 hours, or for the duration of the storm if it is less than 3 hours. A minimum of 3 sample aliquots, separated by a minimum of 15 minutes, shall be taken within each hour of discharge[1], unless the Regional Board Executive Officer approves an alternate protocol.

5. Samples from mass emission stations shall be analyzed for all constituents listed in Attachment U-1. If a constituent is not detected at the method detection limit for its respective test method listed in Attachment U-1 in more than 75 percent of the first 48 sampling events, it need not be further analyzed unless the observed occurrences show concentrations greater than state water quality standards. The Principal Permittee will also conduct annual confirmation sampling for non-detected constituents during the first storm of the wet season every year at each station.

6. The Principal Permittee shall perform an annual analysis, to be included in the Monitoring Report, of the correlation between pollutants of concern (including but not limited to metals and PAHs) and TSS loadings for the sampling events that are analyzed for the complete list of constituents.

B. Water Column Toxicity Monitoring

The Principal Permittee shall analyze mass emission samples for toxicity to evaluate the extent and causes of toxicity in receiving waters and to modify and utilize the SQMP to implement practices that eliminate or reduce sources of toxicity in storm water.

1. The Principal Permittee shall analyze samples from two storm events (including the first storm of each year) and two dry weather events from each mass emission station for toxicity every year. A minimum of one freshwater and one marine species shall be used for toxicity testing for each station event. Specifically, *Ceriodaphnia dubia* (water flea) 7-day survival/reproduction and *Strongylocentrotus purpuratus* (sea urchin) fertilization tests shall be used. These tests should include a dilution series (0.5x steps) that ranges from the undiluted sample (or the highest concentration that can be tested within the limitations of the test methods or sample type) to less than or equal to 6% sample.

2. Toxicity Identification Evaluations (TIE)

The Principal Permittee shall begin a Phase I TIE immediately on all samples that are substantially toxic (greater than or equal to 1 Toxic Unit)

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[1] Required in 40 CFR 122.21(g)(7)(ii), and described in NPDES Storm Water Sampling Guidance Document EPA 833-B-92-001. Time-weighted samples may be appropriate if flow is measured during sampling.

to either test species.[2] If a sample is substantially toxic to both species, a TIE shall be performed for both species. The Phase I TIE shall include the following treatments and corresponding blanks:

a) Baseline toxicity;

b) Particle removal by centrifugation;

c) Solid phase extraction of the centrifuged sample using C18 media;

d) Complexation of metals using ethylenediaminetetraacetic acid (EDTA) addition to the raw sample;

e) Neutralization of oxidants/metals using sodium thiosulfate addition to the raw sample; and

f) Inhibition of organo-phosphate (OP) pesticide activation using piperonyl butoxide addition to the raw sample (crustacean toxicity tests only).

3. Toxicity Reduction Evaluations (TRE)

a) When the same pollutant or class of pollutants is identified through the TIE process as causing at least 50% of the toxic responses in at least 3 samples at a sampling location, a TRE shall be performed for that identified toxic pollutant. TRE development shall be performed by a neutral third party (retained by the Principal Permittee), with input from Permittees and Regional Board staff. The TRE shall include all reasonable steps to identify the source(s) of toxicity and discuss appropriate BMPs to eliminate the causes of toxicity. Once the source of toxicity and appropriate BMPs are identified, the Principal Permittee shall submit the TRE to the Regional Board Executive Officer for approval. At a minimum, it shall include a discussion of the following items:

(1) The potential sources of pollutant(s) causing toxicity;

(2) A list of municipalities that may have jurisdiction over sources of pollutant(s) causing toxicity;

(3) Recommended BMPs to reduce the pollutant(s) causing toxicity;

(4) Proposed changes to the SQMP to reduce the pollutant(s) causing toxicity; and

(5) Suggested follow-up monitoring to demonstrate that toxicity has been removed.

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[2] Substantial toxicity means the amount of toxicity necessary to successfully conduct a Phase I TIE. Toxic Units are calculated by dividing 100 by the calculated median test response value (e.g., LC50 or EC50). For example, a LC50 of 50% sample equals 2 Toxic Units. Ceriodaphnia TIEs require at least 50% mortality in undiluted sample (1 Toxic Unit) at any time during the 7-day duration of the initial chronic bioassay (SCCWRP).

b) Since the Phase I TIEs may only identify a broad category of toxicants (e.g., nonpolar organics), additional TIE analyses may be required in order to identify or confirm the identity of the pollutants causing toxicity before the TRE can be completed.

c) If TRE implementation for a specific pollutant coincides with TMDL implementation for that pollutant, the efforts may be coordinated.

d) Upon approval by the Regional Board Executive Officer, the Permittee(s) having jurisdiction over sources causing or contributing to toxicity shall implement the recommended BMPs and take all reasonable steps necessary to eliminate toxicity.

e) The Principal Permittee shall be responsible for the development of a maximum of two TREs per year. If applicable, the Principal Permittee may use the same TRE for the same toxic pollutant or pollutant class in different watersheds. The TRE process shall be coordinated with TMDL development and implementation (ie. If a TMDL for zinc is being implemented when a TRE for zinc is required, the efforts shall be coordinated to avoid overlap).

f) The Principal Permittee shall report on the development, implementation, and results for each TRE in the annual Monitoring Report, beginning the year following the identification of each pollutant or pollutant class causing toxicity.

C. Tributary Monitoring

The Principal Permittee shall monitor tributaries to identify sub-watersheds where storm water discharges are causing or contributing to exceedances of Water Quality Standards, and to prioritize drainage and sub-drainage areas that need management actions.

1. The Principal Permittee shall develop and implement a watershed-based tributary monitoring program, in which a minimum of six tributaries per year will be monitored, based on the schedule described below:

   a) Monitoring station locations will be rotated so that a minimum total of six tributaries will be monitored per year. Each tributary shall be monitored for a minimum period of one year. If no exceedances of applicable water quality standards occur during one year of monitoring at a single tributary station, the Principal Permittee may move that monitoring station to another tributary, subject to the approval of the Regional Board Executive Officer. When an applicable water quality standard is exceeded in three out of four sampling events in a given monitoring year, the Permittees shall initiate a focused effort to identify sources of pollutants within that subwatershed.

   b) Tributary monitoring shall begin in the Los Angeles River WMA, and shall be rotated to locations in other watersheds as monitoring at each station is complete, as approved by the Regional Board Executive Officer. The Principal Permittee shall include a description and explanation of each proposed station location and a summary of the prior year's results of the tributary monitoring program in the annual Monitoring Report.

c) Monitoring shall begin at the following tributaries:

(1) Aliso Creek;
(2) Bull Creek;
(3) Arroyo Seco Channel;
(4) Rio Hondo Channel;
(5) Burbank West; and
(6) Verdugo Wash.

2. Tributary monitoring shall begin October 15, 2002.

3. The Principal Permittee shall monitor the first storm event and at least 3 additional storm events during each storm season. At least one dry weather flow per year will also be sampled at each station.

4. Samples shall be flow-weighted composites, collected during the first 3 hours or for the duration of the storm if it is less than 3 hours. Samples may be collected manually or automatically. A minimum of 3 sample aliquots, separated by a minimum of 15 minutes, shall be taken within each hour of discharge[3], unless the Regional Board Executive Officer approves an alternate protocol. Samples shall be taken just upstream of the tributary's confluence with the mainstem. Constituents to be analyzed for each location shall include the following:

a) pH, dissolved oxygen, temperature, conductivity, and total suspended solids;

b) Indicator bacteria;

c) All priority pollutants (Attachment U-1) for the first storm of the year;

d) All constituents for which the water body is impaired downstream of the monitoring station;[4]

e) All constituents that caused toxicity or exceeded any applicable water quality criteria at the associated mass emission station the previous year (these constituents shall be listed in each Monitoring Report); and

f) Flow (flow may be estimated using EPA methods[5] at sites where flow measurement devices are not in place).

[3] Required in 40 CFR 122.21(g)(7)(ii), and described in NPDES Storm Water Sampling Guidance Document EPA 833-B-92-001. Time-weighted samples may be appropriate if flow is measured during sampling.

[4] The 1998 California 303(d) List and TMDL Priority Schedule lists pollutants for which each water body is impaired, www.swrcb.ca.gov/tmdl/docs/303d98.pdf#reg4

[5] NPDES Storm Water Sampling Guidance Document, EPA 833-B-92-001, July 1992

D. Shoreline Monitoring

The City of Los Angeles shall monitor shoreline stations to evaluate the impacts to coastal receiving waters and the loss of recreational beneficial uses resulting from storm water/urban runoff. This component shall be integrated and coordinated with similar monitoring programs in the region.

1. The City of Los Angeles shall monitor eighteen water quality sampling stations along the shoreline of the Pacific Ocean within the Santa Monica Bay to determine compliance with the California's bathing water standards for public beaches and ocean water-contact sport areas[6], and the related impacts of discharges from storm drains and piers. The shoreline monitoring program shall be implemented as follows:

   a) The eighteen established shoreline water quality stations listed in Attachment U-2 shall be monitored. Station locations may be modified based on recommendations from the Santa Monica Bay Restoration Project (SMBRP) and approval from the Regional Board Executive Officer;

   b) Three indicator groups shall be tested for using either membrane filtration, multiple tube fermentation, or chromogenic substrate test kits. Monitoring shall include the following types and frequencies of sampling:

Parameter	Units	Sample Frequency
Total coliforms	CFU or MPN/100 ml	6/week (Mon-Sat)[7]
Fecal coliform[8]	CFU or MPN/100 ml	6/week (Mon-Sat)[5]
Enterococcus	CFU or MPN/100 ml	6/week (Mon-Sat)[5]

   c) Shoreline monitoring shall occur during daylight hours. Samples may be omitted in the event of hazardous weather;

   d) Shoreline monitoring frequencies at certain stations may be modified based on the use of the adjacent beaches and their proximity to storm drains, as recommended by the SMBRP's Technical Advisory Committee and the Los Angeles County Department of Health Services (LA County DHS).

   e) Data collected shall be transmitted daily to the LA County DHS. The City of Los Angeles will annually assess the data and submit it to the Principal Permittee for inclusion in the Monitoring Report;

   f) When exceedances of public health standards for bacteria occur, the LA County DHS shall take the appropriate action, as described in the Regulations for Public Beaches and Ocean Water-Contact Sports Areas.[9]

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[6] California Department of Health Services, Health and Safety Code §115880 (Assembly Bill 411, Statutes of 1997, Chapter 765

[7] Samples will be collected on Sundays preceding Monday holidays

[8] *Escherichia Coli (E. Coli)* may be substituted for Fecal Coliform if chromogenic substrate test kits are used

[9] Regulations for Public Beaches and Ocean Water-Contact Sports Areas, Title 17 CCR Group 10, developed in response to Health and Safety Code §115880

g) The City of Los Angeles will continue to conduct all monitoring, testing, and data transferring actions as part of the SMBRP regional program for the Santa Monica Bay.

E. Trash Monitoring

To assess the quantities of trash in receiving waters after storm events and to identify areas impaired for trash, the Principal Permittee shall conduct visual observations of trash and take a minimum of one photograph at each mass emission station after the first storm event and 3 additional storm events per year.

1. The Principal Permittee and Permittees in the Los Angeles River and Ballona Creek WMAs (listed in Permit Attachment A) shall develop and implement a trash monitoring program for the Los Angeles River and Ballona Creek watersheds no later than October 15, 2002. The monitoring program and schedule shall be consistent with and pursuant to CWC §13267 "Request for Trash Monitoring", issued by the Regional Board on December 21, 2001. For the first two years of monitoring, either of the following formats for monitoring plans may be used:

   a) For each watershed, the group of Permittees in that watershed will capture and quantify trash from an area no less than 10% of the total land area over which they have jurisdiction. The monitoring areas shall represent 10% of every land use the group of Permittees has jurisdiction over. If storm drain configuration versus land use make the representation of 10% of a land use infeasible, the Permittees can choose areas that represent their land uses as accurately as possible, as long as the extent of the surface being monitored represents 10%. This monitoring shall use full capture devices. During wet weather, all sampling devices will be emptied within 72 hours of every rain event of 0.25 inch or greater. During dry weather, sampling devices will be emptied and analyzed every three months in the absence of precipitation.

   b) For each watershed, the group of Permittees in that watershed will sample a minimum of ten representative sites for each land use monitored. For each sampling site, a minimum of five catch basins will be fitted with inserts, for a total of not less than 50 catch basin inserts per land use monitored. The existing litter removal practices that the cities implement will remain in place, so that monitoring will evaluate how much trash is washed into the system under current practices. A structural full capture device shall be installed downstream of at least one sampling site for each land use monitored. For this sampling site, all of the catch basins that are upstream of the full capture-monitoring device must be fitted with inserts. This configuration will provide information on the relative effectiveness of the catch basin inserts as opposed to the full capture systems in varying land uses and under varying weather conditions. During wet weather, all sampling devices will be emptied within 72 hours of every rain event of 0.25 inch or greater. During dry weather, sampling devices will be emptied and analyzed every three months in the absence of precipitation.

2. Permittees shall report data in a single unit of measure that is reproducible and measures the amount of trash, irrespective of water content (e.g. compacted volume based on a standardized compaction rate, or dry weight). Permittees may select the unit, but all Permittees must use the same unit of measure.

3. Following the first two years of data collection, Permittees shall conduct compliance monitoring, which involves calculating trash loading as a running three-year average (estimated total load discharged from 2003-2006, divided by three).

4. All trash collected shall be disposed of in compliance with all applicable State, federal, and local regulations.

REGIONAL MONITORING

The Principal Permittee shall participate on regional monitoring committees to help establish on-going regional programs that address public health concerns, monitor trends in natural resources and nearshore habitats, and assess regional impacts from all pollutant sources. Regional Monitoring participation shall include, but not necessarily be limited to, the efforts described below.

F. Estuary Sampling

The Southern California Coastal Waters Research Project (SCCWRP), in conjunction with the USEPA, the State Board, three Regional Boards, and participating dischargers, has organized an effort to implement a regional monitoring program for the southern California bight. Previous studies (in 1994 and 1998) included microbiology, water quality, sediment chemistry, sediment toxicity testing, benthic infauna, demersal fish, and bioaccumulation. A similar bight-wide monitoring effort is planned to be conducted in 2003. The Principal Permittee shall participate on the Steering Committee for this bight-wide monitoring project, and complete the estuary sampling requirement described below in parallel with this effort.

In addition to participation in the Bight-wide study, the goal of this requirement is to sample estuaries for sediment chemistry, sediment toxicity, and benthic macroinvertibrate community to determine the spatial extent of sediment fate from storm water, and the magnitude of its effects. A map of each estuary which depicts the impacted areas shall be produced. The maps shall provide the information necessary to conduct effective sediment monitoring to determine trends and accumulation, as a future permit requirement.

1. The Principal Permittee shall sample a maximum of 25 sites in each estuary/mouth (Ballona Creek, Malibu Creek, Los Angeles River, San Gabriel River, and Dominguez Channel) once during the permit term. Sediment samples shall be taken at each station by means of a $0.1 m^2$ ($1.1 ft^2$) modified Van Veen sediment grab sampler.

2. The Principal Permittee shall also sample a total of 25 sites outside of the direct outfalls to assess cumulative effects.

3. All samples shall be analyzed for the following:
   a) Sediment Chemistry (priority pollutants)
   b) Total Organic Carbon (TOC)
   c) Grain size
   d) Sediment Toxicity

      (1) Amphipod survival bioassays shall be conducted on each sediment sample. Toxicity shall be indicated by an amphipod survival rate of 70% or less in a single test.

      (2) Phase I TIEs of interstitial water, using the amphipod test species, shall be conducted for samples from stations identified to be toxic in a single amphipod survival bioassay.

   e) Benthic Macroinvertibrates

      (1) All sediment samples shall be passed through a 1.0mm (0.039 in) screen to retrieve the benthic organisms. Benthic epifauna and infauna shall be analyzed to determine the structure of the benthic community.

      (2) The Principal Permittee shall identify all organisms to lowest possible taxon.

      (3) The Principal Permittee shall determine the Total Biomass of:

         (i) Mollusks;
         (ii) Echinoderms;
         (iii) Annelids/polychaetes
         (iv) Crustaceans; and
         (v) All other macroinvertebrates.

      (4) The Principal Permittee shall determine the community structure analysis, including wet weight of each taxonomic group (listed above), number of species, number of individuals per species, total numerical abundance, species abundance per grab, species richness, species diversity, species evenness and dominance, similarity analysis, cluster analyses, or other appropriate multivariate statistical techniques approved by the Regional Board Executive Officer, and the Infaunal Index[10].

4. The Principal Permittee shall create a map of each estuary depicting degraded areas and the spatial distribution of sediment from storm water. In the Integrated Monitoring Report, the Principal Permittee shall suggest appropriate locations for regular sediment monitoring, based on the results of this study.

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[10] Benthic Response Index for Assessing Infaunal Communities on the Mainland Shelf of Southern California, the SCCWRP

G. Bioassessment

The Principal Permittee shall continue participation in the Stormwater Monitoring Coalition (SMC), as well as coordinate with the Surface Water Ambient Monitoring Program (SWAMP) being developed by the State Board to complete the bioassessment requirement. The Regional Board anticipates that the SMC will organize an effort to evaluate the biological index approach for southern California and to design a research project for developing an Index of Biological Integrity (IBI) for this region. The SWAMP has begun work on a statewide effort to determine how to identify reference sites with the goal of IBI development.

The purpose of the bioassessment requirement is to detect biological trends in receiving waters and to collect data for the development of an IBI for southern California. The ultimate goals of bioassessment are to assess the biological integrity of receiving waters, to detect biological responses to pollution, and to identify probable causes of impairment not detected by chemical and physical water quality analysis.

1. The Principal Permittee shall coordinate with the SMC and SWAMP to identify the most appropriate locations for bioassessment stations within Los Angeles County.

2. Station selection shall be complete within one year from the date this Order is adopted, and sampling shall begin no later than October of 2003.

3. The Principal Permittee shall monitor a minimum of 20 bioassessment stations in October of each year, beginning in 2003. A minimum of three replicate samples shall be collected at each station during each sampling event.

4. A professional environmental laboratory shall perform all laboratory, quality assurance, and analytical procedures. The Principal Permittee may collect samples when properly trained in CSBP methods. The Principal Permittee shall develop Standard Operation Procedures (SOPs) for the Bioassessment Monitoring Program that describes all procedures and responsible parties. The SOPs must contain step-by-step field, laboratory and data entry procedures, as well as, related QA/QC procedures. There must also be specific information about the bioassessment program including: assessment program description, its organization and the responsibilities of all its personnel; assessment project description and objectives; qualifications of all personnel; and the type of training each member has received. A copy of the SOPs shall be available to the Regional Board Executive Officer upon request.

5. Field sampling must conform to the SOP established for the California Stream Bioassessment Procedure (CSBP) when appropriate. For sampling of aquatic environments where the CSBP is not appropriate (i.e., an estuary or unwadable stream), California Department of Fish and Game and the Regional Board Executive Officer shall be consulted in order to determine the most appropriate protocol to be implemented. Field crews shall be trained on aspects of the protocol and appropriate safety issues. All field data and sample Chain of Custody (COC) forms must be examined for completion and gross errors by the field crews, the

receiving laboratory, and the Principal Permittee. These forms shall be available to California Department of Fish and Game or the Regional Board Executive Officer upon request. Field inspections should be planned with random visits and should be performed by the Principal Permittee, if properly trained in CSBP methods, or an independent auditor. These visits should report on all aspects of the field procedure with corrective action occurring immediately.

6. Taxonomic identification laboratories process the biological samples that usually consist of subsampling organisms, enumerating and identifying taxonomic groups and entering the information into an electronic format. There should be intra-laboratory QA/QC results for subsampling, taxonomic validation and corrective actions. Biological laboratories should also maintain reference collections, vouchered specimens (the Principal Permittee can request return of their sample voucher collections) and remnant collections. Biological laboratories shall participate in an inter-laboratory (external) taxonomic validation program at a recommended level of 20% for the first two years of the program. If there are no substantial QA/QC problems, the level of external validation may be decreased to 10% in year three upon approval from the Regional Board. External QA/QC should be arranged through the California Department of Fish and Game's Aquatic Bioassessment Laboratory in Rancho Cordova.

7. Sampling, laboratory, quality assurance, and analysis procedures shall follow the standardized "Non-point Source Bioassessment Sampling Procedures" for professional bioassessment as set forth in the California Department of Fish and Game California Stream Bioassessment Procedure (CSBP)[11]. The following results and information shall be included in the annual Monitoring Report:

   a) All physical, chemical and biological data collected in the assessment;

   b) Photographs and GPS locations of all stations;

   c) Documentation of quality assurance and control procedures;

   d) Analysis that shall include calculation of the metrics used in the CSBP;

   e) Comparison of mean biological and habitat assessment metric values between stations and year-to-year trends;

   f) Electronic data formatted to the California Department of Fish and Game Aquatic Bioassessment Laboratory for inclusion in the Statewide Access Bioassessment Database; and

   g) Copies of all QA/AC documents from laboratories.

[11] California Stream Bioassessment Procedure (Protocol Brief for Biological and Physical/Habitat Assessment in Wadeable Streams), California Department of Fish and Game - Aquatic Bioassessment Laboratory, May 1999. Located at www.dfg.ca.gov/cabw/protocols.html.

SPECIAL STUDIES

H. New Development Impacts Study in the Santa Clara Watershed

The Principal Permittee, with support from the City of Santa Clarita, shall monitor tributaries in the Santa Clara watershed to determine impacts from new development and to compare storm water quality between subwatersheds with and without SUSMPs.

1. The Principal Permittee, in cooperation with the City of Santa Clarita, shall select one station that is representative of a subwatershed in which the majority of development has occurred without SUSMP implementation, and one station (SUSMP station) in a subwatershed in which the majority of the development has/will include SUSMP implementation. Other inputs to runoff, such as septic systems, in the two subwatersheds should be similar.

2. The Principal Permittee shall coordinate with the City of Santa Clarita and the Regional Board to develop a proposed study design, including a description of the drainage areas to be monitored and sampling locations, no later than August 1, 2002. If appropriate, this study may be conducted in conjunction with the Peak Discharge Impact Study, described below.

3. The Principal Permittee shall monitor the first storm event and at least 2 additional storm events during each storm season. At least one dry weather event per year will also be sampled at each station.

4. Samples shall be flow-weighted composites, collected during the first 3 hours, or for the duration of the storm if it is less than 3 hours. Samples may be collected manually or automatically. A minimum of 3 sample aliquots, separated by a minimum of 15 minutes, shall be taken within each hour of discharge[12], unless the Regional Board Executive Officer approves alternate protocol. Constituents to be analyzed for each location shall include the following:

    a) pH, dissolved oxygen, temperature, conductivity, chloride, nitrogen, and TSS;

    b) Metals: aluminum, arsenic, beryllium, cadmium, chromium, copper, iron, lead, mercury, nickel, selenium, silver, and zinc;

    c) Pathogen Indicators (Coliform);

    d) PAHs; and

    e) Flow (flow may be estimated using EPA methods at sites where flow measurement devices are not in place).

5. The Principal Permittee shall submit an analysis of the data, including a description of each subwatershed, year-to-year changes compared to the amount of development that occurred in each, comparisons between

[12] Required in 40 CFR 122.21(g)(7)(ii), and described in NPDES Storm Water Sampling Guidance Document EPA 833-B-92-001. Time-weighted samples may be appropriate if flow is measured during sampling.

stations, and an analysis of SUSMP effectiveness, with the fourth year Monitoring Report.

I. Peak Discharge Impact Study

The Principal Permittee shall conduct a study to evaluate peak flow control and to determine numeric criteria to prevent or minimize erosion of natural stream channels and banks caused by urbanization.[13] The Principal Permittee may partner with the Ventura County Flood Control District to expand the stream erosion study to the Santa Clara River watershed. The study shall begin no later than August 1, 2002.

J. BMP Effectiveness Study

The Principal Permittee shall conduct or participate in studies to evaluate the effectiveness of structural and treatment control BMPs. The objective of this study shall include the following:

- Monitor the reduction of pollutants of concern in storm water (including, but not limited to: trash, suspended sediment, pathogen indicators, nutrients, heavy metals, and oil and grease) from five or more different types of BMPs that have been properly installed within the year preceding monitoring. Monitoring shall be continued until the effectiveness of the BMP can be determined.
- Evaluate the requirements, feasibility and cost of maintenance for each BMP.
- Develop recommendations for appropriate BMPs for the reduction of pollutants of concern in storm water in Los Angeles County.

The Principal Permittee may participate in the SMBRP's, "Performance Evaluation of Structural BMPs for Storm Water Pollution Control in the Santa Monica Bay Watershed" study to meet this requirement. Participation includes collaboration and fund contribution to cover the scope of the proposed study.

K. Standard Monitoring Provisions

All monitoring activities shall meet the following requirements:

1. Monitoring and Records [40 CFR 122.41(j)(1)]
   Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity.
2. Monitoring and Records [40 CFR 122.41(j)(2)] [CWC §13383(a)]
   The Principal Permittee and Permittees shall retain records of all monitoring information, including all calibration and maintenance of monitoring instrumentation, copies of all reports required by this Order, and records of all data used to complete the Report of Waste Discharge and application for this Order, for a period of at least five (5) years from

[13] Permit, Part 4.D.2 (Development Planning Program) requires the development of numerical criteria for peak flow control in natural drainage systems.

the date of the sample, measurement, report, or application. This period may be extended by request of the Regional Board or USEPA at any time and shall be extended during the course of any unresolved litigation regarding this discharge.

3. Monitoring and Records [40 CFR 122.21(j)(3)]

   Records of monitoring information shall include:

   a) The date, exact place, and time of sampling or measurements;

   b) The individual(s) who performed the sampling or measurements;

   c) The date(s) analyses were performed;

   d) The individual(s) who performed the analyses;

   e) The analytical techniques or methods used; and,

   f) The results of such analyses.

4. Monitoring and Records [40 CFR 122.21(j)(4)]

   All sampling, sample preservation, and analyses must be conducted according to test procedures under 40 CFR Part 136, unless other test procedures have been specified in this Order.

5. Monitoring and Records [40 CFR 122.21(j)(5)]

   The CWA provides that any person who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required to be maintained under this Order shall, upon conviction, be punished by a fine of not more than $10,000, or by imprisonment for not more than two years, or both. If a conviction of a person is for a violation committed after a first conviction of such person under this paragraph, punishment is a fine of not more than $20,000 per day of violation, or by imprisonment of not more than four years, or both.

6. All chemical, bacteriological, and toxicity analyses shall be conducted at a laboratory certified for such analyses by an appropriate governmental regulatory agency.

7. For priority toxic pollutants that are identified in the CTR (65 *Fed. Reg.* 31682), the MLs published in Appendix 4 of the SIP shall be used for all analyses, unless otherwise specified. The MLs from the SIP are incorporated into the Constituent List (Attachment U-1).

8. The Monitoring Report shall specify the analytical method used, the MDL and the ML for each pollutant. For the purpose of reporting compliance with numerical limitations, performance goals, and receiving water limitations, analytical data shall be reported with one of the following methods, as appropriate:

a) An actual numerical value for sample results greater than or equal to the ML;

b) "Not-detected (ND)" for sample results less than the laboratory's MDL with the MDL indicated for the analytical method used; or

c) "Detected, but Not Quantified (DNQ)" if results are greater than or equal to the laboratory's MDL but less than the ML. The estimated chemical concentration of the sample shall also be reported. This is the concentration that results from the confirmed detection of the substance by the analytical method below the ML value.

9. For priority toxic pollutants, if the Principal Permittee or Permittee can demonstrate that a particular ML is not attainable, in accordance with procedures set forth in 40 CFR 136, the lowest quantifiable concentration of the lowest calibration standard analyzed by a specific analytical procedure (assuming that all the method specified sample weights, volumes, and processing steps have been followed) may be used instead of the ML listed in Appendix 4 of the SIP. The Principal Permittee must submit documentation from the laboratory to the Regional Board Executive Officer for approval prior to raising the ML for any constituent.

10. Monitoring Reports [40 CFR 122.41(I)(4)(ii)]

If the Principal Permittee monitors any pollutant more frequently than required by the permit using test procedures approved under 40 CFR part 136, unless otherwise specified in the Order, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the annual Monitoring Reports.

11. Monitoring Reports [40 CFR 122.41(I)(4)(iii)]

Calculations for all limitations which require averaging of measurements shall utilize an arithmetic mean unless otherwise specified in this Order.

12. If no flow occurred during the reporting period, the Monitoring Report shall so state.

13. The Regional Board Executive Officer or the Regional Board, consistent with 40 CFR 122.41, may approve changes to the Monitoring Program, after providing the opportunity for public comment, either:

a) By petition of the Principal Permittee or by petition of interested parties after the submittal of the annual Monitoring Report. Such petition shall be filed not later than 60 days after the Monitoring Report submittal date, or

b) As deemed necessary by the Regional Board Executive Officer following notice to the Principal Permittee.

Ordered by:

Dennis A. Dickerson
Executive Officer
Date: December 13, 2001

ATTACHMENT A
LIST OF PERMITTEES BY WATERSHED MANAGEMENT AREAS

Santa Monica Bay

Malibu Creek and Other Rural

Agoura Hills
*Calabasas
Los Angeles County Flood Control
Los Angeles County
Malibu
Westlake Village

Ballona Creek and Other Urban

Beverly Hills
Culver City
El Segundo
Hermosa Beach
Los Angeles (City of)
Los Angeles County Flood Control
Los Angeles (County of)
Manhattan Beach
Palos Verdes Estates
Rancho Palos Verdes
Redondo Beach
Rolling Hills
Rolling Hills Estates

*Santa Monica
West Hollywood

Dominguez Channel/ Los Angeles Harbor Drainage

Carson
Gardena
Hawthorne
Inglewood
Lawndale
Lomita
Los Angeles (City of)
Los Angeles County Flood Control

Los Angeles (County of)
*Torrance

Los Angeles River

Alhambra
Arcadia
Bell
Bell Gardens
Burbank
Commerce
Compton
Cudahy
El Monte
*Glendale
Hidden Hills
Huntington Park
La Canada Flintridge
Los Angeles (City of)
Los Angeles County Flood Control
Los Angeles (County of)
Lynwood
Maywood
Monrovia
Montebello
Monterey Park
Paramount

Pasadena
Rosemead
San Fernando
San Gabriel
San Marino
Sierra Madre
Signal Hill
South El Monte
South Gate
South Pasadena
Temple City
Vernon

San Gabriel River

Artesia
Azusa
Baldwin Park
Bellflower
Bradbury
Cerritos
Claremont
Covina
Diamond Bar
Downey
Duarte
Glendora
Hawaiian Gardens
Industry
Irwindale
La Habra Heights
La Mirada
La Puente
La Verne
Lakewood
*Long Beach[1]
Los Angeles County Flood Control
Los Angeles (County of)
Norwalk
Pomona
Pico Rivera
San Dimas
Santa Fe Springs
Walnut
West Covina
Whittier

Santa Clara River

*Santa Clarita
Los Angeles County Flood Control
Los Angeles (County of)

*Italicized agencies are present in more than one Watershed Management Area. *Indicates City with the largest watershed population other than County of Los Angeles and the City of Los Angeles.*

[1] *The City of Long Beach is covered under order No. 99-060*

ATTACHMENT B
Critical Sources Categories[1]

Tier 1 Categories

Municipal Landfills (SIC 4953)

Hazardous Waste Treatment, Disposal and Recovery Facilities[2]

Facilities Subject to SARA Title III (also known as EPCRA)[2]

Restaurants[3]

Wholesale trade (scrap, auto dismantling) (SIC 50)

Automotive service facilities[3]

Fabricated metal products (SIC 34)

Motor freight (SIC 42)

Chemical/allied products (SIC 28)

Automotive Dealers/Gas Stations (SIC 55)

Primary Metals Products (SIC 33)

Tier 2 Categories

Electric/Gas/Sanitary (SIC 49)

Air Transportation (SIC 45)

Rubbers/Miscellaneous Plastics (SIC 30)

Local/Suburban Transit (SIC 41)

Railroad Transportation (SIC 40)

Oil & Gas Extraction (SIC 13)

Lumber/Wood Products (SIC 24)

Machinery Manufacturing (SIC 35)

Transportation Equipment (SIC 37)

Stone, Clay, Glass, Concrete (SIC 32)

Leather/Leather Products (SIC 31)

Miscellaneous Manufacturing (SIC 39)

Food and kindred Products (SIC 20)

Mining of Nonmetallic Minerals (SIC 14)

Printing and Publishing (SIC 27)

Electric/Electronic (SIC 36)

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[1] Italicized categories belong to Phase 1 facilities
[2] Various categories subject to these requirements
[3] See Definition in Part 5. of the permit

Paper and Allied Products (SIC 26)

Furniture and Fixtures (SIC 25)

Laundries *(SIC 72)*

Instruments (SIC 38)

Textile Mills Products (SIC 22)

Apparel (SIC 23)

ATTACHMENT U-1
LIST OF CONSTITUENTS FOR THE STORM WATER MONITORING PROGRAM AND ASSOCIATED MINIMUM LEVELS (MLs)[1]

CONSTITUENTS	MLs
CONVENTIONAL POLLUTANTS	**mg/L**
Oil and Grease	5
Total Phenols	0.1
Cyanide	0.005
pH	0 - 14
Temperature	None
Dissolved Oxygen	Sensitivity to 5 mg/L
BACTERIA	
Total coliform	<20mpn/100ml
Fecal coliform	<20mpn/100ml
Enterococcus (marine waters)	<20mpn/100ml
E. coli (fresh waters)	
GENERAL	**mg/L**
Dissolved Phosphorus	0.05
Total Phosphorus	0.05
Turbidity	0.1NTU
Total Suspended Solids	2
Total Dissolved Solids	2
Volatile Suspended Solids	2
Total Organic Carbon	1
Total Petroleum Hydrocarbon	5
Biochemical Oxygen Demand	2
Chemical Oxygen Demand	20-900
Total Ammonia-Nitrogen	0.1
Total Kjeldahl Nitrogen	0.1
Nitrate-Nitrite	0.1
Alkalinity	2
Specific Conductance	1umho/cm
Total Hardness	2
MBAS	0.5
Chloride	2
Fluoride	0.1
Methyl tertiary butyl ether (MTBE)	1

[1] For Priority Pollutants, the MLs represent the lowest value listed in Appendix 4 of SIP. MDLs must be lower than or equal to the ML value. If a particular ML is not attainable in accordance with procedures set forth in 40 CFR 136, the lowest quantifiable concentration of the lowest calibration standard analyzed by a specific analytical procedure may be used instead.

METALS	µg/L
Aluminum	100
Antimony	0.5
Arsenic	1
Beryllium	0.5
Cadmium	0.25
Chromium (total)	0.5
Copper	0.5
Hex. Chromium	5
Iron	100
Lead	0.5
Mercury	0.5
Nickel	1
Selenium	1
Silver	0.25
Thallium	1
Zinc	1
SEMIVOLATILE ORGANIC COMPOUNDS	**µg/L**
Acids	
2-Chlorophenol	2
2, 4-Dichlorophenol	1
2,4-Dimethylphenol	2
2, 4-Dinitrophenol	5
2-Nitrophenol	10
4-Nitrophenol	5
4-Chloro-3-methylphenol	1
Pentachlorophenol	2
Phenol	1
2,4,6-Trichlorophenol	10
BASE/NEUTRAL	**µg/L**
Acenaphthene	1
Acenaphthylene	2
Anthracene	2
Benzidine	5
1,2 Benzanthracene	5
Benzo(a)pyrene	2
Benzo(g,h,i)perylene	5
3,4 Benzoflouranthene	10
Benzo(k)flouranthene	2
Bis(2-Chloroethoxy) methane	5
Bis(2-Chloroisopropyl) ether	2
Bis(2-Chloroethyl) ether	1
Bis(2-Ethylhexl) phthalate	5
4-Bromophenyl phenyl ether	5

Butyl benzyl phthalate	10
2-Chloroethyl vinyl ether	1
2-Chloronaphthalene	10
4-Chlorophenyl phenyl ether	5
Chrysene	5
Dibenzo(a,h)anthracene	0.1
1,3-Dichlorobenzene	1
1,4-Dichlorobenzene	1
1,2-Dichlorobenzene	1
3,3-Dichlorobenzidine	5
Diethyl phthalate	2
Dimethyl phthalate	2
di-n-Butyl phthalate	10
2,4-Dinitrotoluene	5
2,6-Dinitrotoluene	5
4,6 Dinitro-2-methylphenol	5
1,2-Diphenylhydrazine	1
di-n-Octyl phthalate	10
Fluoranthene	0.05
Fluorene	0.1
Hexachlorobenzene	1
Hexachlorobutadiene	1
Hexachloro-cyclopentadiene	5
Hexachloroethane	1
Indeno(1,2,3-cd)pyrene	0.05
Isophorone	1
Naphthalene	0.2
Nitrobenzene	1
N-Nitroso-dimethyl amine	5
N-Nitroso-diphenyl amine	1
N-Nitroso-di-n-propyl amine	5
Phenanthrene	0.05
Pyrene	0.05
1,2,4-Trichlorobenzene	1
CHLORINATED PESTICIDES	**µg/L**
Aldrin	0.005
alpha-BHC	0.01
beta-BHC	0.005
delta-BHC	0.005
gamma-BHC (lindane)	0.02
alpha-chlordane	0.1
gamma-chlordane	0.1
4,4'-DDD	0.05
4,4'-DDE	0.05
4,4'-DDT	0.01
Dieldrin	0.01
alpha-Endosulfan	0.02

beta-Endosulfan	0.01
Endosulfan sulfate	0.05
Endrin	0.01
Endrin aldehyde	0.01
Heptachlor	0.01
Heptachlor Epoxide	0.01
Toxaphene	0.5
Polychlorinated Biphenyls	**µg/L**
Aroclor-1016	0.5
Aroclor-1221	0.5
Aroclor-1232	0.5
Aroclor-1242	0.5
Aroclor-1248	0.5
Aroclor-1254	0.5
Aroclor-1260	0.5
ORGANOPHOSPHATE PESTICIDES	**µg/L**
Chlorpyrifos	0.05
Diazinon	0.01
Prometryn	2
Atrazine	2
Simazine	2
Cyanazine	2
Malathion	1
HERBICIDES	**µg/L**
Glyphosate	5
2,4-D	0.02
2,4,5-TP-SILVEX	0.2

ATTACHMENT U-2
SHORELINE MONITORING STATIONS

Station	Location[1]	Latitude	Longitude
S1	Surfrider Beach, Malibu, 50 yds E. of breech	34.03500	118.67833
S2	Topanga Point, Malibu, seaward of lifeguard station	34.03833	118.58083
S3	Pulga storm drain, Pacific Palisades, 50 yds E. of drain	34.03361	118.53417
S4	Santa Monica Canyon storm drain, Pacific Palisades, 50 yds E. of drain	34.02639	118.51861
S5	Santa Monica Pier, Santa Monica, 50 yds S. of pier	34.00833	118.49667
S6	Pico-Kenter storm drain, Santa Monica, 50 yds S. of drain	34.00583	118.49250
S7	Ashland storm drain, Santa Monica, 50 yds S. of drain	33.99639	118.48472
S8	Windward storm drain, Los Angeles, 50 yds S. of drain	33.98778	118.47750
S9	Marina Del Rey Beach, Marina Del Rey, at lifeguard tower.	33.98139	118.45833
S10	Ballona Creek, Playa Del Rey, 50 yds S. of south jetty	33.96083	118.45611
S11	Culver Blvd., extended, Playa Del Rey, N side of Culver storm drain	33.95639	118.45167
S12	Imperial Hwy. Storm drain, Playa Del Rey, 50 yds S. of drain	33.93028	118.43722
S13	El Porto, Manhattan Beach, 40th St. extended	33.90389	118.42250
S14	Manhattan Beach Pier, Manhattan Beach, 50 yds S. of pier	33.88360	118.41278
S15	Hermosa Beach Pier, Hermosa Beach, 50 yds S. of pier	33.86111	118.40278
S16	Redondo Pier, Redondo Beach, 50 yds S. of pier	33.83833	118.39111
S17	Ave. I storm drain, Redondo Beach, Ave. I extended, 50 yds S. of drain	33.81889	118.39111
S18	Malaga Cove, Palos Verdes Estates, Arroyo Circle extended	33.80500	118.39467

[1] Station locations from *Ocean Water Regulatory & Monitoring Protocol*, County of Los Angeles, Department of Health Services, May 5, 1999.

Attachment U-3
Total Maximum Daily Loads Scheduled for Implementation in Los Angeles County within 10 Years

Watershed	*TMDL*
Malibu	Coliform, Nutrients
Malibu Creek Lakes and Tributaries	Metals
Ballona Creek	Trash, Coliform, Historic Pesticides, Metals, TBT
Dominguez Channel/LA Harbor	Coliform, PAHs, Historic Pesticides, PCBs, DDT, Metals, Nutrients, Trash
Los Angeles River	Trash, Nutrients, Coliform, Chlorpyrifos, Metals
San Gabriel River	Nutrients, Coliform, Metals, Trash
San Gabriel Lakes	Coliform
Santa Monica Bay Beaches	Coliform, Metals, Chlordane, Historic PCBs and Pesticides
Santa Clara River	Historic Pesticides, Chloride, Coliform, Nitrogen, Eutrophication, Trash
Los Cerritos Channel	Metals, Ammonia, Coliform

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This form summarizes the requirements in Order No. 01-182. Each Permittee must complete this form in its entirety, except for those requirements applicable only to the Principal Permittee. Only report activities that were performed during the previous fiscal year. Upon completion, this form shall be submitted to the Principal Permittee, by the date specified by the Principal Permittee, for inclusion in the unified Annual Storm Water Program Report. Attachments should be included where necessary to provide sufficient information on program implementation.

The goals of this Report are to: 1) concisely document implementation of the Storm Water Quality Management Program (SQMP) during the past fiscal year; 2) evaluate program results for continuous improvement; 3) to determine compliance with Order 01-182; and 4) to share this information with other Permittees, municipal decision makers, and the public.

!	YOU MUST FILL OUT ALL THE INFORMATION REQUESTED *Do not leave any of the sections blank.*
N/A	If the question does not apply to your municipality, please indicate N/A in the space provided and provide a brief explanation
U	If the information requested is currently unavailable, please indicate U in the space provided and give a brief explanation.

This Report Form consists of the following sections:

SECTION	PAGE
I. Program Management	2-4
II. Receiving Water Limitations	5
III. SQMP Implementation	5-7
IV. Special Provisions	8
IV.A. Public Information and Participation Program	8-14
IV.B. Industrial/Commercial Facilities Program	15-17
IV.C. Development Planning Program	18-21
IV.D. Development Construction Program	22-23
IV.E. Public Agency Activities Program	24-33
IV.F. IC/ID Elimination Program	34-37
V. Monitoring	38
VI. Assessment of Program Effectiveness	38
VII. Certification	39

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Reporting Year 200__- 200__

I. Program Management

A. Permittee Name: ______________________________

B. Permittee Program Supervisor: ______________________
Title:
Address:
City: Zip Code:
Phone: Fax:

C. In the space below, briefly describe how the storm water program is coordinated within your agency's departments and divisions. Include a description of any problems with coordination between departments. To facilitate this, complete the Table 1.

TABLE 1 - Program Management

Storm Water Management Activity	Division/Department	# of Individuals Responsible for Implementing
1. Outreach & Education		
2. Industrial/Commercial Inspections		
3. Construction Permits/Inspections		
4. IC/ID Inspections		
5. Street sweeping		
6. Catch Basin Cleaning		
7. Spill Response		
8. Development Planning (project/SUSMP review and approval)		
9. Trash Collection		

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D. Staff and Training

Attach a summary of staff training over the last fiscal year. This shall include the staff name, department, type of training, and date of training.

E. Budget Summary

1. Does your municipality have a storm water utility? Yes ☐ No ☐

If no, describe the funding source(s) used to implement the requirements of Order No. 01-182.

2. Are the existing financial resources sufficient to accomplish all required activities? Yes ☐ No ☐
3. Complete Table 2 to the extent that accurate information is available (indicate U in the spaces where the information is unavailable), and report any supplemental dedicated budgets for the same categories on the lines below the table.
4. List any additional state/federally funded projects related to storm water.

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TABLE 2

Program Element	Expenditures in Previous Fiscal Year	Estimated Amount Needed to implement Order 01-182
1. Program management a. Administrative costs b. Capital costs		
2. Public Information and Participation a. Public Outreach/Education b. Employee Training c. Corporate Outreach d. Business Assistance		
3. Industrial/Commercial inspection/ site visit activities		
4. Development Planning		
5. Development Construction a. Construction inspections		
6. Public Agency Activities a. Maintenance of structural and treatment control BMPs b. Municipal street sweeping c. Catch basin cleaning d. Trash collection/recycling e. Capital costs f. Other		
7. IC/ID Program a. Operations and Maintenance b. Capitol Costs		
8. Monitoring		
9. Other		
10. TOTAL		

List any supplemental dedicated budgets for the above categories:

List any activities that have been contracted out to consultants/other agencies:

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II. Receiving Water Limitations (Part 2)

A. Are you aware, or have you been notified, of any discharges from your MS4 that cause or contribute to a condition of nuisance or to the violation of any applicable water quality standards? Yes ☐ No ☐

B. Has the Regional Board notified you that discharges from your MS4 are causing or contributing to an exceedance of water quality standards? Yes ☐ No ☐

C. If you answered Yes to either of the above questions, you must attach a Receiving Water Limitations (RWL) Compliance Report. The Report must include the following:

1. A description of the pollutants that are in exceedance and an analysis of possible sources;
2. A plan to comply with the RWL (Permit, Part 2);
3. Changes to the SQMP to eliminate water quality exceedances;
4. Enhanced monitoring to demonstrate compliance; and
5. Results of implementation.

III. SQMP Implementation (Part 3)

A. Has your agency implemented the SQMP and any additional controls necessary to reduce the discharges of pollutants in storm water to the maximum extent practicable? Yes ☐ No ☐

B. If your agency has implemented additional or different controls than described in the countywide SQMP, has your agency developed a local SQMP that reflects the conditions in its jurisdiction and specifies activities being implemented under the appropriate elements described in the countywide SQMP? Yes ☐ No ☐

C. Describe the status of developing a local SQMP in the box below.

D. If applicable, describe an additional BMP, in addition to those in the countywide SQMP, that your city has implemented to reduce pollutants in storm water to the maximum extent practicable.

E. Watershed Management Committees (WMCs)

1. Which WMC are you in?
2. Who is your designated representative to the WMC?
3. How many WMC meetings did you participate in last year?
4. Describe specific improvements to your storm water management program as a result of WMC meetings.

5. Attach any comments or suggestions regarding your WMC.

F. Storm Water Ordinance

1. Have you adopted a storm water and urban runoff ordinance to enforce all requirements of Order 01-182? Yes ☐ No ☐

If not, describe the status of adopting such an ordinance.

2. If yes, have you already submitted a copy of the ordinance to the Regional Board? Yes ☐ No ☐

If not, please attach a copy to this Report.

3. Were any amendments made to your storm water ordinance during the last fiscal year? Yes ☐ No ☐

   If yes, attach a copy of amendments to this Report.

G. Discharge Prohibitions

1. List any non-storm water discharges you feel should be further regulated:

2. List any non-storm water discharges you feel should be exempt, and provide an explanation for each:

IV. Special Provisions (Part 4)

A. Public Information and Participation (Part 4.B)

In addition to answering the following questions, attach a summary of all storm water education activities that your agency conducted or participated in last year.

1. No Dumping Message

a) How many storm drain inlets does your agency own?

b) How many storm drain inlets were marked with a no dumping message in the last fiscal year?

c) What is the total number of storm drain inlets that are legibly marked with a no dumping message?

If this number is less than the number in question 1.b, describe why all inlets have not been marked, the process used to implement this requirement, and the expected completion date.

d) How many public access points to creeks, channels, and other water bodies within your jurisdiction have been posted with no dumping signage in the past year?

Describe your agency's status of implementing this requirement by the date required in Order No. 01-182.

2. Reporting Hotline

a) Has your agency established its own hotline for reporting and for general storm water management information? Yes ☐ No ☐

b) If so, what is the number?

c) Is this information listed in the government pages of the telephone book? Yes ☐ No ☐

d) If no, is your agency coordinated with the countywide hotline? Yes ☐ No ☐

e) Do you keep record of the number of calls received and how they were responded to? Yes ☐ No ☐

f) How many calls were received in the last fiscal year?

g) Describe the process used to respond to hotline calls.

h) Have you provided the Principal Permittee with your current reporting contact information? Yes ☐ No ☐

i) Have you compiled a list of the general public reporting contacts for all Permittees and posted it on the www.888CleanLA.com web site *(Principal Permittee only)*? Yes ☐ No ☐

If not, when is this scheduled to occur?

3. Outreach and Education

a) Describe the strategy developed to provide outreach and bilingual materials to target ethnic communities. Include an explanation of why each community was chosen as a target, how program effectiveness will be determined, and status of implementation. *(Principal Permittee only)*

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b) Did the Principal Permittee organize quarterly Public Outreach Strategy meetings that you were aware of? Yes ☐ No ☐

How many Public Outreach Strategy meetings did your agency participate in last year?

Explain why your agency did not attend any or all of the organized meetings.

Identify specific improvements to your storm water education program as a result of these meetings:

List suggestions to increase the usefulness of quarterly meetings:

If quarterly Public Outreach Strategy meetings were not organized, explain why not and when this requirement will be implemented *(Principal Permittee only).*

c) Approximately how many impressions were made last year on the general public about storm water quality via print, local TV, local radio, or other media?

d) Describe efforts your agency made to educate local schools on storm water pollution.

e) Did you provide all schools within each school district in Los Angeles County with materials necessary to educate a minimum of 50 percent of all school children (K-12) every 2 years on storm water pollution *(Principal Permittee only)*? Yes ☐ No ☐

If not, explain why.

f) Describe the strategy developed to measure the effectiveness of in-school educational programs, including assessing students' knowledge of storm water pollution problems and solutions before and after educational efforts *(Principal Permittee only)*.

For Permit Years 2-5, attach an assessment of the effectiveness of in-school storm water education programs.

g) What is the behavioral change target that was developed based on sociological data and other studies *(Principal Permittee only)*?

If no target has been developed, explain why and describe the status of developing a target.

What is the status of meeting the target by the end of Year 5?

4. Pollutant-Specific Outreach

a) Attach a description of each watershed-specific outreach program that your agency developed *(Principal Permittee only).* All pollutants listed in Table 1 (Section B.1.d.) must be included.

b) Did your agency cooperate with the Principal Permittee to develop specific outreach programs to target pollutants in your area? Yes ☐ No ☐

c) Did your agency help distribute pollutant-specific materials in your city? Yes ☐ No ☐

d) Describe how your agency has made outreach material available to the general public, schools, community groups, contractors and developers, etc...

5. Businesses Program

a) Briefly describe the Corporate Outreach Program that has been developed to target gas stations and restaurant chains *(Principal Permittee only).*

b) How many corporate managers did your agency *(Principal Permittee only)* reach last year?

c) What is the total number of corporations to be reached through this program *(Principal Permittee only)*?

d) Is your agency meeting the requirement of reaching all gas station and restaurant corporations once every two years *(Principal Permittee only)*? Yes ☐ No ☐

If not, describe measures that will be taken to fully implement this requirement.

e) Has your agency developed and/or implemented a Business Assistance Program? Yes ☐ No ☐

If so, briefly describe your agency's program, including the number of businesses assisted, the type of assistance, and an assessment of the program's effectiveness.

6. Did you encourage local radio stations and newspapers to use public service announcements? Yes ☐ No ☐

How many media outlets were contacted?

Which newspapers or radio stations ran them?

Who was the audience?

7. Did you supplement the County's media purchase by funding additional media buys? Yes ☐ No ☐

Estimated dollar value/in-kind contribution:

Type of media purchased:

Frequency of the buys:

Did another agency help with the purchase? Yes ☐ No ☐

8. Did you work with local business, the County, or other Permittees to place non-traditional advertising? Yes ☐ No ☐

If so, describe the type of advertising.

9. Did you establish local community partnerships to distribute educational storm water pollution prevention material? Yes ☐ No ☐

Describe the materials that were distributed:

Who were the key partners?

Who was the audience (businesses, schools, etc.)?

10. Did you participate in or publicize workshops or community events to discuss storm water pollution? Yes ☐ No ☐

How many events did you attend?

11. Does your agency have a website that provides storm water pollution prevention information? Yes ☐ No ☐

If so, what is the address?

12. Has awareness increased in your community regarding storm water pollution? Yes ☐ No ☐

Do you feel that behaviors have changed? Yes ☐ No ☐

Explain the basis for your answers. Include a description of any evaluation methods that are used to determine the effectiveness of your agency's outreach.

13. How would you modify the storm water public education program to improve it on the City or County level?

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B. Industrial/Commercial Facilities Program

1. Critical Source Inventory Database

Did you (individually or jointly) update the Database for Critical Sources Inventory? Yes ☐ No ☐

Comments/Explanation/Conclusion:

2. Inspection Program

Provide the reporting data as suggested in the following tables.

Category	Initial Number of Facilities at the start of cycle proposed for inspection by categories (after the initial year, the updated number based on the new data)	Number of facilities inspected in the current reporting year	% Completed at the time of this report for present cycle (from the initial value, and from the updated value after first cycle)	Total number since permit adoption
Landfills				
TSDF				
...				

Comments/Explanation/Conclusion:

3. BMPs Implementation

Provide the reporting data as suggested in the following table.

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Category	Number of facilities inspected by category in this reporting year	Number of facilities identified as adequately implementing BMPs as specified in this reporting year	% adequately implementing out of total in this reporting year	Number of facilities required to implement or upgrade in this reporting year	Number of facilities inspected by category in this reporting cycle	Number of facilities identified as adequately implementing BMPs as specified in this reporting cycle	% adequately implementing out of total in this reporting cycle	Number of facilities required to implement or upgrade in this reporting cycle	Total Number during this permit adequately implementing	Total Number during this permit required to implement or upgrade
Landfills										
…										

Comments/Explanation/Conclusion:

4. Enforcement Activities

Provide the reporting data as suggested in the following tables.

Enforcement Actions by categories (e.g. Warning letter, NOV, referral to D.A., etc.)	Number of facilities issued enforcement actions in the current reporting year	Number of facilities issued enforcement actions in the current reporting cycle	Number of facilities (re)inspected due to enforcement actions in current reporting year	Number of facilities (re)inspected due to enforcement actions in current reporting cycle	Number of facilities brought into compliance in the current reporting year	Number of facilities brought into compliance in current reporting cycle	Total number of enforcement actions since permit adoption (by category)

Facilities by category	Number of Warning letters	Number of NOVs	Number of Referral	Number of Other

Comments/Explanation/Conclusion:

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5. Program Implementation Effectiveness Assessment

Please give a brief assessment of the implementation of the program in removing pollutants from the storm water discharges. Please provide an explanation. Suggested improvements or adjustments based on the knowledge gained through this reporting period activities must be reflected in a change in the SQMP, if warranted.

Highly Effective ☐ Somewhat Effective ☐ Non-effective ☐

Comments/Explanation/Conclusion:

6. You must also submit a quarterly electronic submittal of your Industrial/Commercial Facilities Program activities.

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C. Development Planning Program (Part 4.D)

1. Does your agency have a process to minimize impacts from storm water and urban runoff on the biological integrity of natural drainage systems and water bodies in accordance with requirements under CEQA, Section 404 of the CWA, local ordinances, and other legal authorities? Yes ☐ No ☐

   Attach examples showing how storm water quality impacts were addressed in environmental documents for projects over the past year.

2. Does your agency have procedures to include the following requirements in all priority development and redevelopment projects:

   a) Maximize the percentage of permeable surfaces to allow more percolation of storm water into the ground? Yes ☐ No ☐

   b) Minimize the quantity of storm water directed to impermeable surfaces and the MS4? Yes ☐ No ☐

   c) Minimize pollution emanating from parking lots through the use of appropriate treatment control BMPs and good housekeeping practices? Yes ☐ No ☐

   d) Provide for appropriate permanent measures to reduce storm water pollutant loads from the development site? Yes ☐ No ☐

3. List the types and numbers of BMPs that your agency required for priority projects to meet the requirements described above.

4. Describe the status of the development or implementation of peak flow controls in Natural Drainage Systems.

5. Has your agency amended codes and/or ordinances to give legal effect to the SUSMP changes required in the Permit? Yes ☐ No ☐

6. Describe the process your agency uses to include SUSMP design standards in new development and redevelopment project approvals.

7. How many of each of the following projects did your agency review and condition to meet SUSMP requirements last year?

   a) Residential

   b) Commercial

   c) Industrial

   d) Automotive Service Facilities

   e) Retail Gasoline Outlets

   f) Restaurants

   g) Parking Lots

   h) Projects located in or directly adjacent to or discharging directly to an environmentally sensitive area

   i) Total number of permits issued to priority projects

8. What is the percentage of total development projects that were conditioned to meet SUSMP requirements? %

9. How has your agency prepared to reduce the SUSMP threshold for industrial/commercial facilities to 1 acre from 100,000 square feet in 2003?

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10. After 2003, how many additional projects per year will require/did require implementation of SUSMP requirements as a result of the lower threshold?

11. Does your agency participate in an approved regional or sub-regional storm water mitigation program to substitute in part or wholly SUSMP requirements for new development? Yes ☐ No ☐

12. Has your agency modified its planning procedures for preparing and reviewing CEQA documents to consider potential storm water quality impacts and provide for appropriate mitigation? Yes ☐ No ☐

If no, provide an explanation and an expected date of completion.

13. Did your agency update any of the following General Plan elements in the past year?

a) Land Use Yes ☐ No ☐

b) Housing Yes ☐ No ☐

c) Conservation Yes ☐ No ☐

d) Open Space Yes ☐ No ☐

If yes, please describe how watershed and storm water quality and quantity management considerations were included.

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14. How many targeted staff were trained last year?

15. How many targeted staff are trained annually?

16. What percentage of total staff are trained annually? %

17. Has your agency developed and made available development planning guidelines? Yes ☐ No ☐

18. If no, what is the expected date that guidelines will be developed and available to developers?

19. What is the status of completion of the technical manual for siting and design of BMPs for the development community?

D. Development Construction Program

1. Describe your agency's program to control runoff from construction activity at all construction sites within its jurisdiction.

2. Does your agency require the preparation, submittal, and implementation of a Local Storm Water Pollution Prevention Plan (Local SWPPP) prior to the issuance of a grading permit for all sites that meet one or all of the following criteria?

   a) Will result in soil disturbance of one acre or greater — Yes ☐ No ☐

   b) Is within, directly adjacent to, or is discharging directly to an environmentally sensitive area — Yes ☐ No ☐

   c) Is located in a hillside area — Yes ☐ No ☐

3. Attach one example of a local SWPPP

4. Describe the process your agency uses to require proof of filing a Notice of Intent for coverage under the State General Construction Activity Storm Water permit and a certification that a SWPPP has been prepared prior to issuing a grading permit?

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5. How many building/grading permits were issued to sites requiring Local SWPPPs last year?

6. How many building/grading permits were issued to sites requiring coverage under the General Construction Activities Storm Water Permit last year?

7. How many building/grading permits were issued to construction site less than one acre in size last year?

8. How many construction sites were inspected during the last wet season?

9. Complete the table below.

Type of Violation	# of Violations	% of Total Inspections	# of Follow-up Inspections	# of Enforcement Actions
Off-site discharge of sediment				
Off-site discharge of other pollutants				
No or inadequate SWPPP				
Inadequate BMP/SWPPP implementation				

10. Describe the process for taking enforcement actions against construction site violations, including the types of actions that are taken.

11. Describe the system that your agency uses to track the issuance of grading permits.

E. Public Agency Activities (Part 4.F)

1. Sewage System Maintenance, Overflow, and Spill Prevention (only applicable to agencies that own and/or operate a sanitary sewer system)

a) Has your agency developed and implemented a response plan for sanitary sewer overflows that includes the requirements in Order 01-182? Yes ☐ No ☐

b) How many sanitary sewer overflows occurred within your jurisdiction?

c) How many did your agency respond to?

d) Did your agency investigate all complaints received? Yes ☐ No ☐

e) How many complaints were received?

f) Upon notification, did your agency immediately respond to overflows by containment? Yes ☐ No ☐

g) Did your agency notify appropriate sewer and public health agencies when a sewer overflowed to the MS4? Yes ☐ No ☐

h) Did your agency implement a program to prevent sewage spills or leaks from sewage facilities from entering the MS4? Yes ☐ No ☐

If so, describe the program:

i) Did your agency implement a program to identify, repair, and remediate sanitary sewer blockages, exfiltration, overflow, and wet weather overflows from sanitary sewers to the MS4? Yes ☐ No ☐

If so, describe the program:

2. Public Construction Activities Management

a) What percentage of public construction sites 5 acres or greater in size did your agency obtain coverage under the State of California General Construction Activities Storm Water Discharge Permit ? ☐ %

b) Give an explanation for any sites greater than 5 acres that were not covered:

c) What is the total number of active public construction sites?

How many were 5 acres or greater in size?

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d) (After March, 2003) Did your agency obtain coverage under the State of California General Construction Activities Storm Water Discharge Permit coverage for public construction sites for sites one acre or greater? Yes ☐ No ☐

3. Vehicle Maintenance/Material Storage Facilities/Corporation Yards Management

a) Did your agency implement pollution prevention plans for each public vehicle maintenance facility, material storage facility, and corporation yard? Yes ☐ No ☐

b) Briefly describe how your agency implements the following, and any additional, BMPs to minimize pollutant discharges in storm water:

(1) Good housekeeping practices

(2) Material storage control

(3) Vehicle leaks and spill control

(4) Illicit discharge control

c) Are all Permittee owned and/or operated vehicle/equipment wash areas self-contained, covered, equipped with a clarifier, and properly connected to the sanitary sewer? Yes ☐ No ☐

If not, what is the status of implementing this requirement?

d) How many Permittee owned and/or operated vehicle/equipment wash areas are scheduled to be redeveloped to include the BMPs listed above?

4. Landscape and Recreational Facilities Management

a) Has your agency developed a standardized protocol for the routine and non-routine application of pesticides, herbicides (including pre-emergents), and fertilizers? Yes ☐ No ☐

Briefly describe this protocol:

b) How does your agency ensure that there is no application of pesticides or fertilizers immediately before, during, or immediately after a rain event or when water is flowing off the area to be applied?

c) Are any banned pesticides, herbicides, fungicides, or rodenticides stored or applied in your agency's jurisdiction that you know of? Yes ☐ No ☐

If so, list them:

d) What percentage of your agency's staff that apply pesticides are certified by the California Department of Food and Agriculture, or are under the direct supervision of a certified pesticide applicator?

e) Describe procedures your agency has implemented to encourage retention and planting of native vegetation and to reduce water, fertilizer, and pesticide needs:

5. Storm Drain Operation and Management

a) Did your agency designate catch basin inlets within its jurisdiction as Priority A; Priority B; and Priority C? Yes ☐ No ☐

b) How many of each designation exist in your jurisdiction?

Priority A:

Priority B:

Priority C:

c) Is your city subject to a trash TMDL? Yes ☐ No ☐

d) If yes, describe the activities and/or implementation measures that your agency conducted pursuant to the TMDL and any other trash reduction efforts that occurred.

e) How many times were all Priority A basins cleaned last year?

f) How many times were all Priority B basins cleaned last year?

g) How many times were all Priority C basins cleaned last year?

h) How much total waste was collected in tons from catch basin clean-outs last year?

i) Attach a record of all catch basins in your jurisdiction. This shall identify each basin as City or County owned, and Priority A, B, or C. For all basins that are owned and operated by your agency, include dates that each was cleaned out over the past year.

j) Did your agency place and maintain trash receptacles at all transit stops within its jurisdiction. Yes ☐ No ☐

k) How many new trash receptacles were installed last year?

l) Did your agency place special conditions for events that generated substantial quantities of trash and litter including provisions that:

(1) Provide for the proper management of trash and litter generated from the event? Yes ☐ No ☐

(2) Arrange for temporary screens to be placed on catch basins? Yes ☐ No ☐

(3) Or for catch basins in that area to be cleaned out subsequent to the event and prior to any rain? Yes ☐ No ☐

m) Did your agency inspect the legibility of the catch basin stencil or labels? Yes ☐ No ☐

What percentage of stencils were legible?

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n) Were illegible stencils recorded and re-stenciled or re-labeled within 180 days of inspection? Yes ☐ No ☐

o) Did your agency visually monitor Permittee-owned open channel storm drains and other drainage structures for debris at least annually and identify and prioritize problem areas of illicit discharge for regular inspection? Yes ☐ No ☐

Is the prioritization attached? Yes ☐ No ☐

p) Did your agency review its maintenance activities to assure that appropriate storm water BMPs are being utilized to protect water quality? Yes ☐ No ☐

What changes have been made?

q) Did your agency remove trash and debris from open channel storm drains a minimum of once per year before the storm season? Yes ☐ No ☐

r) How did your agency minimize the discharge of contaminants during MS4 maintenance and clean outs?

s) Where is removed material disposed of?

6. Streets and Roads Maintenance

a) Did your agency designate streets and/or street segments within its jurisdiction as one of the following:

(1) Priority A – streets and/or street segments that are designated as consistently generating the highest volumes of trash and/or litter? Yes ☐ No ☐

(2) Priority B - streets and/or street segments that are designated as consistently generating moderate volumes of trash and/or litter? Yes ☐ No ☐

(3) Priority C – streets and/or street segments that are designated as generating low volumes of trash and/or litter? Yes ☐ No ☐

b) Did your agency perform all street sweeping in compliance with the permit and according to the following schedule:

(1) Priority A – These streets and/or street segments shall be swept at least two times per month? Yes ☐ No ☐

(2) Priority B - Each Permittee shall ensure that each streets and/or street segments is cleaned at least once per month? Yes ☐ No ☐

(3) Priority C – These streets and/or street segments shall be cleaned as necessary but in no case less than once per year? Yes ☐ No ☐

c) Did your agency require that saw cutting wastes be recovered and disposed of properly and that in no case shall waste be left on a roadway or allowed to enter the storm drain? Yes ☐ No ☐

d) Did your agency require that concrete and other street and road maintenance materials and wastes be managed to prevent pollutant discharges? Yes ☐ No ☐

e) Did your agency require that the washout of concrete trucks and chutes only occur in designated areas and never into storm drains, open ditches, streets, or catch basins leading to the storm drain system? Yes ☐ No ☐

f) Did your agency train its employees in targeted positions (whose interactions, jobs, and activities affect storm water quality) regarding the requirements of the storm water management program to:

(1). Promote a clear understanding of the potential for maintenance activities to pollute storm water? and Yes ☐ No ☐

(2) Identify and select appropriate BMPs? Yes ☐ No ☐

7. Parking Facilities Management

a) Did your agency ensure that Permittee-owned parking lots be kept clear of debris and excessive oil buildup and cleaned no less than 2 times per month and/or inspected no less than 2 times per month to determine if cleaning is necessary. Yes ☐ No ☐

b) Were any Permittee-owned parking lots cleaned less than once a month? Yes ☐ No ☐

How many?

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8. Public Industrial Activities Management

a) Did your agency, for all municipal activity considered an industrial activity under USEPA Phase I storm water regulations, obtain separate coverage under the State of California General Industrial Activities Storm Water Discharge Permit no later than December 31, 2001? Yes ☐ No ☐

b) Does your agency serve a population of less than 100,000 people? Yes ☐ No ☐

9. Emergency Procedures

a) In case of real emergencies, did your agency repair essential public services and infrastructure in a manner to minimize environmental damage? Yes ☐ No ☐

b) Were BMPs implemented to the extent that measures did not compromise public health and safety? Yes ☐ No ☐

10. Feasibility Study

a) Did your agency cooperate with the County Sanitation Districts of Los Angeles County to prepare a study which investigates the possible diversion of dry weather flows or the use of alternative treatment control BMPs? Yes ☐ No ☐

b) Did your agency review its individual prioritized list and create a watershed based priority list of drains for potential diversion and submit a listing of priority diversions to the Regional Board Executive Officer? Yes ☐ No ☐

Los Angeles County Municipal Storm Water Permit (Order 01-182)
Individual Annual Report Form
Attachment U-4

F. Illicit Connections and Illicit Discharges (IC/ID) Elimination Program (Part 4.G)

1. Attach a copy of your agency's IC/ID Elimination Implementation Program (Part 4.G.1.a.).

2. Attach a map of your storm drain system showing all permitted connections (if available), and the locations of all illicit connections and discharges that occurred last year (Part 4.G.1.b). If your agency has not completed this requirement, describe the status of the development of a baseline map, including an expected completion date.

3. Describe your enforcement procedures for eliminating illicit discharges and terminating illicit connections.

4. Describe your record keeping system to document all illicit connections and discharges.

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5. What is the total length of open channel that your agency owns and operates?

6. What length was screened last year for illicit connections?

7. What is the total length of closed storm drain that your agency owns and operates?

8. What length was screened last year for illicit connections?

9. Describe the method used to screen your storm drains.

10. Provide the reporting data for illicit connections as suggested in the following table (you may submit a spreadsheet from your database that contains the information).

Year	Total # reported/ identified	Total # investigated	# that conveyed exempt discharges or NPDES permitted	# that conveyed illicit discharges that were terminated	# that were removed	# that resulted in enforcement action	# that resulted in *other* actions
01/02							
02/03							
03/04							
04/05							
05/06							

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11. Explain any *other* actions that occurred in the last year.

12. What is the average time it takes your agency to initiate an illicit connection investigation after it is reported?

a) Were all identified connections terminated within 180 days? Yes ☐ No ☐

b) If not, explain why.

13. Provide the reporting data for illicit discharges as suggested in the following table (you may submit a spreadsheet from you database that contains this information).

Year	Total # reported	Total # that were discontinued/ cleaned up voluntarily through enforcement and the source was identified	# that were cleaned up but the source could not be identified	# that resulted in no evidence of discharge	# that were determined to be conditionally exempt	# that were exempt or in compliance and the source identified	# that resulted in enforcement action
01/02							
02/03							
03/04							
04/05							
05/06							

14. What is the average response time after an illicit discharge is reported?

    a) Did any response times exceed 72 hours? Yes ☐ No ☐

    b) If yes, explain why.

15. Describe the your agency's spill response procedures.

16. What would you do differently to improve your agency's IC/ID Elimination Program?

17. Attach a list of all permitted connections to your storm sewer system.

V. Monitoring

Briefly describe any storm water monitoring activities that are not required by Order No. 01-182 that your municipality conducted, participated in, or received funding to conduct in the past fiscal year. These activities should correspond with the dollar amount you listed in Table 2.

VI. Assessment of Program Effectiveness

A. Attach a summary of the effectiveness of your storm water management program. This summary should include, at a minimum, the following:

1. An assessment of your agency's compliance with permit requirements, based on your responses to the questions in this form;
2. Descriptions of any evaluation methods that your agency uses to determine the effectiveness of your storm water management program;
3. A summary of the strengths and weaknesses of your agency's storm water management program;
4. A list of specific program highlights and accomplishments;
5. A description of water quality improvements or degradation in your watershed over the past fiscal year;
6. Interagency coordination between cities to improve the storm water management program;
7. Future plans to improve your agency's storm water management program; and
8. Suggestions to improve the effectiveness of your program or the County model programs.

B. On a scale of 1 to 10 (10 being full implementation of requirements by their deadlines), rate your municipality's level of compliance with Order No. 01-182.

C. List any suggestions your agency has for improving program reporting and assessment.

VII. Certification Statement

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted.

Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility, of a fine and imprisonment for knowing violations.

Executed on the ___ day of ________, 20_,

at ________________________.

Printed Name ________________________ Title ________________

(Signature) ____

Signature by duly authorized representative

A018058

SARASOTA COUNTY PERMITTEES
NPDES PERMIT FOR
MUNICIPAL SEPARATE STORM SEWER SYSTEMS

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SARASOTA COUNTY PERMITTEES
NPDES PERMIT FOR
MUNICIPAL SEPARATE STORM SEWER SYSTEMS

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PART I.

DISCHARGES AUTHORIZED UNDER THIS PERMIT

A. **<u>Permit Area.</u>** This permit covers all areas located within the political boundary of Sarasota County and the portion of the Town of Longboat Key within Manatee County served by municipal separate storm sewer systems owned or operated by the permittees identified in Part I.C.

B. **<u>Authorized Discharges.</u>** Except for discharges prohibited under Part I.D., this permit authorizes all existing or new storm water point source discharges to waters of the United States from those portions of the Municipal Separate Storm Sewer System (MS4) owned or operated by the permittees.

C. **<u>Permittees.</u>**

The following entities are permittees subject to the conditions of this permit:

- **Sarasota County**
- **Town of Longboat Key***
- **City of North Port**
- **City of Sarasota**
- **City of Venice**
- **Florida Department of Transportation, District One**

* ***Permit coverage includes the entire Town of Longboat Key which is located in both Sarasota and Manatee Counties***

References to "permittee" in this permit includes each of the entities above.

1. Each permittee is individually responsible for:

   a. Compliance with permit conditions relating to discharges from portions of the MS4 where they are the operator;

   b. Storm water management program implementation on portions of the MS4 where they are the operator;

   c. Where permit conditions are established for specific portions of the MS4, the permittee need only comply with the permit conditions relating to those portions of the MS4 for which they are the operator; and

   d. A plan of action to assume responsibility for implementation of storm water management and monitoring programs on their portions of the MS4 should inter-jurisdictional agreements allocating responsibility between permittees be dissolved or in default. (See Part II.G.3., page _20_ of this permit also.)

2. Each permittee is jointly responsible for:

   a. Submission of annual reporting requirements as specified in Part V.C. (ANNUAL REPORT), page _49_;

   b. Collection of monitoring data as required by Part V.B., page _47_, according to such agreements as may be established between permittees;

   c. Insuring implementation of system-wide management program elements, including any system-wide public education efforts.

3. Specific permittees are jointly liable for permit compliance on portions of the MS4:

   a. Where operational or storm water management program implementation authority over portions of the MS4 has been transferred from one permittee to another in accordance with legally binding interagency or inter-jurisdictional agreements, both the owner and operator are jointly responsible for permit compliance on those portions of the MS4, unless specific responsibility provisions have been otherwise outlined in said agreements.

D. **Limitations on Coverage.** Section 402(p)(3)(B)(ii) of the Clean Water Act specifically requires EPA to include within this permit an effective prohibition on non-storm water entering the MS4. The following discharges are not authorized by this permit:

1. *Non-storm Water:* discharges of non-storm water, except where such discharges are:

   a. in compliance with a separate NPDES permit (or the discharger has applied for such permit); or

   b. identified by and in compliance with Part II.A.7.a., page _9_ of this permit.

2. *Spills*: discharges of material resulting from a spill, except where such discharges are:

   a. the result of an Act of God where reasonable and prudent measures have been taken to minimize the impact of the discharge; or

   b. an emergency discharge required to prevent imminent threat to human health or prevent severe property damage, provided reasonable and prudent measures have been taken to minimize the impact of the discharge.

PART II.

STORM WATER POLLUTION PREVENTION & MANAGEMENT PROGRAMS

Each permittee covered by this permit shall contribute to the development, revision, and implementation of a comprehensive Storm Water Management Program (SWMP) including pollution prevention measures, treatment or removal techniques, storm water monitoring, use of legal authority, and other appropriate means to control the quality of storm water discharged from the Municipal Separate Storm Sewer System (MS4). The SWMP shall be implemented in accordance with Section 402(p)(3)(B) of the Clean Water Act and 40 CFR Part 122.26.

Controls and activities in the SWMP shall identify areas of permittee jurisdiction, applicability, or specific area basis. The SWMP shall include controls necessary to effectively prohibit the discharge of non-storm water into municipal separate storm sewers and reduce the discharge of pollutants from the MS4 to the MEP and shall not cause or contribute to violations of State water quality standards of the receiving stream. Compliance with this SWMP shall be reported annually in the ANNUAL REPORT discussed in Part V.C. on page 49 of this permit.

The SWMP shall cover the term of the permit and shall be updated as necessary, or as required by the Director, to ensure compliance with this statutory requirement of Clean Water Act Section 402(p)(3)(B). Modifications to the SWMP shall be made in accordance with Part II.G. of this permit. Compliance with the SWMP and the compliance schedules in Part III shall be deemed in compliance with Parts II.A. and II.B. of the permit. **The Storm Water Management Program submitted by the permittees in the July 23, 1993, Part 2 Application, and all approved updates, are hereby incorporated into this permit by reference and thus are conditions of this permit. FDOT's *Statewide Storm Water Management Program for Part 2 EPA NPDES-MS4 Permit Application* dated June 1993 and all approved updates, are hereby incorporated into this permit by reference and thus are conditions of this permit.** Specific components from these Storm Water Management Programs are identified in Parts II and III to serve as measurable enforcement permit conditions. Compliance dates specified in Part III of the permit shall take precedence over compliance dates which may have been proposed in Part 1 or Part 2 of the municipal applications from the permittees.

Implementation of the SWMP may be achieved through participation with other permittees, public agencies, or private entities in cooperative efforts to satisfy the requirements of Part II and Part III of the permit in lieu of creating duplicate program elements for each individual permittee. The SWMP, taken as a whole, shall achieve the "effective prohibition" and "MEP" standards from Section 402(p)(3)(B) of the Clean Water Act, and shall not cause or contribute to violations of State water quality standards of the receiving stream pursuant to the Florida Administrative Code (FAC)§62-40.420(1)-(4).

A. **Storm Water Management Program (SWMP) Requirements.**

1. *Structural Controls and Storm Water Collection System Operation:* The MS4 and any storm water structural control shall be operated in a manner to reduce the discharge of pollutants to the MEP and shall not cause or contribute to violations of State water quality standards of the receiving stream.

   a. The permittees listed in Table II.A.1.a. on pages 4 and 5 own and/or operate the structural controls identified. The maintenance activities identified for the structural controls in Table II.A.1.b. on page 6 of this permit represent suggested maintenance practices that can be implemented on an as needed basis. In addition, each shall maintain an internal record keeping system to track inspections and maintenance activities performed during the permit term. If these activities are performed by others under a contractual agreement, then the permittee shall retain copies of the contractual agreement which specifies the maintenance activities to be performed and the schedule of frequency. Inspection and maintenance records shall be retained by the permittees in accordance with Part V.G. on page 58 of this permit. Annual evaluations shall be made to assess the appropriateness of the inspection and maintenance schedule and to ensure the optimization of equipment use. A summary of the annual evaluation shall be included within each ANNUAL REPORT required under Part V.C. on page 49 of this permit.

TABLE II.A.1.a.

PERMITTEE / LABOR SOURCE(S)	STRUCTURAL CONTROL	TOTAL NO. MAINTAINED
SARASOTA COUNTY / Prison Labor and Contract Staff	Wet Retention Areas (Maintained Lakes)	85
	Storm Water Treatment Ponds	62
	Channel Control Structures	51
	Channels	500 miles
CITY OF SARASOTA / Interlocal agreement with Sarasota County	Wet Retention Areas (Maintained Lakes)	4
	Storm Water Treatment Ponds	11
	Channels	30 miles

TABLE II.A.1.a.		
PERMITTEE / LABOR SOURCE(S)	STRUCTURAL CONTROL	TOTAL NO. MAINTAINED
CITY OF VENICE / City of Venice Parks Dept. and Maintenance Dept.	Storm Water Treatment Ponds	7
	Channels	5 miles
CITY OF NORTH PORT / Maintenance Dept.	Wet Retention Areas (Maintained Lakes)	1
	Storm Water Treatment Ponds	190
	Channel Control Structures	10
	Channels	76 miles
FDOT / Maintenance Management System	Storm Water Treatment Ponds	2

TABLE II.A.1.b.
MAINTENANCE SCHEDULE FOR STRUCTURAL CONTROLS

STRUCTURAL CONTROL	FREQUENCY OF INSPECTION	FREQUENCY OF MAINTENANCE	MAINTENANCE ACTIVITY
Dry Retention Areas	Semi-Annually	As Needed	NMowing and invasive plant species removal NSediment and grass clippings removal, including proper sediment disposal NAeration of bottom (dry/infiltration-type ponds) NStabilization of eroded bank areas NLitter and debris removal NBack flush underdrains (where applicable)
Wet Retention Areas (Mantained Lakes)	Semi-Annually	As Needed	NMowing and invasive plant species removal NStabilization of eroded bank areas NLitter and debris removal
		As necessary to ensure that the depth of sediments does not exceed 1/3 of the design storage volume	NSediment and grass clippings removal, including proper sediment disposal NMonitor sediment accumulations and remove when 1/3 of the storage volume is filled
	Every 18 Months	As Needed	NBack flush underdrains (where applicable)
Channel Control Structures	Quarterly	As Needed	NLitter and debris removal NSediment removal with proper sediment disposal
Channels	Annually - to determine priority	As Needed	NLitter and debris removal NMowing and invasive plant species removal NStabilization of eroded bank areas
		5 Year Revolving Schedule	NSediment removal with proper sediment disposal provided the original cross-section is not exceeded

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1. *Structural Controls and Storm Water Collection System Operation:* (continued)

   b. Additionally, to satisfy the requirements of this section, the permittees shall develop and implement the Storm Water Management Programs identified in Part III.A.1. on pages 21 and 22 of this permit.

2. *Areas of New Development and Significant Redevelopment:* A comprehensive master planning process (or equivalent) shall be implemented to reduce, to the MEP, the discharge of pollutants from MS4s, which receive discharges from areas of new development and significant redevelopment, after construction is completed. The master planning process shall limit the increases in the discharge of pollutants in storm water as a result of new development, and shall reduce the discharge of pollutants in storm water from redeveloped areas, and shall not cause or contribute to violations of State water quality standards of the receiving stream.

   a. To satisfy the requirements of this section, the permittees shall implement the Storm Water Management Programs identified in Part III.A.2. on page 23 of this permit.

3. *Roadways:* Public streets, roads, and highways shall be operated and maintained in a manner to reduce to the MEP the discharge of pollutants and shall not cause or contribute to violations of State water quality standards of the receiving stream.

   a. As per the schedule identified in Part III.A.3. on page 24 of this permit, the permittees shall develop and implement standard road repair practices to reduce the pollutants in storm water runoff from areas associated with road repair and maintenance. The program developed shall include practices such as limiting the amount of soil disturbance to the immediate area under repair and scheduling potential pollutant-causing routine repair work during dry seasons, when possible. The program shall establish procedures that address spill prevention, material management practices, and good housekeeping measures at all municipal equipment yards & maintenance shops that support road maintenance activities.

   b. Additionally, to satisfy the requirements of this section, the permittees shall implement the Storm Water Management Programs identified in Part III.A.3. on pages 24 and 25 of this permit.

4. *Flood Control Projects:* Water quality impacts on receiving water shall be assessed for all flood management projects identified in the basin master planning process (or comparable planning process). The feasibility of retrofitting existing structural flood control devices to provide additional pollutant removal from storm water shall be evaluated.

   a. To satisfy the requirements of this section, the permittees shall implement the Storm Water Management Programs identified in Part III.A.4. on page 26 of this permit.

5. *Municipal waste treatment, storage, or disposal facilities not covered by an NPDES storm water permit:* The permittees shall implement a program to identify measures to monitor and reduce pollutants in storm water discharges from facilities that handle municipal waste, including sewage sludge.

   a. To satisfy the requirements of this section, the permittees shall develop and implement a program to reduce pollutants in the storm water discharges from municipally-operated solid waste transfer stations, maintenance and storage yards for waste transportation fleets and equipment, publicly owned treatment works (POTWs), and sludge application and/or disposal sites which are not covered by NPDES storm water permits. This program shall be developed and implemented in accordance with the schedule identified in Part III.A.5. on page 27 of this permit. The initial phase of the program developed shall contain procedures to evaluate, inspect, and monitor these sites. Based upon the evaluations, inspections and monitoring performed, priorities and procedures for implementing control measures for pollutant reduction at these sites shall be developed. Monitoring methodology used during the initial investigative period may be relaxed from standard protocol and may be based on experience gained during actual field activities. The goal of this investigative portion is to actively identify areas within these sites with poorer quality discharges during storm events, so that those areas will be given priority when implementing control measures.

6. *Pesticide, Herbicide, and Fertilizer Application:* Each permittee shall implement controls to reduce, to the MEP and shall not cause or contribute to violations of State water quality standards of the receiving stream, the discharge of pollutants related to the storage and application of pesticides, herbicides, and fertilizers applied, by employees or contractors, to public right of ways, parks, and other municipal property. Permittees with jurisdiction over lands shall implement programs to encourage the reduction of the discharge of pollutants related to application and distribution of pesticides, herbicides, and fertilizers.

   a. To satisfy the requirements of this section, the permittees shall implement the Storm Water Management Programs identified in Part III.A.6. on pages 28 and 29 of this permit.

7. *Illicit Discharges and Improper Disposal:* The permittees shall implement an ongoing program to detect and eliminate (or require the discharger to the MS4 to eliminate) illicit discharges and improper disposal into the storm sewer system.

a. *Inspection, Ordinances, and Enforcement Measures:* Non-storm water discharges to the MS4 shall be effectively prohibited by the permittees through the use of inspections, ordinances, and enforcement. The permittees, however, may allow the following non-storm water discharges to the MS4 where they are not identified as a source of pollutants to waters of the United States:

- water line flushing;
- landscape irrigation;
- diverted stream flows;
- rising ground waters;
- uncontaminated ground water infiltration (as defined at 40 CFR 35.2005(20)) to separate storm sewers;
- uncontaminated pumped ground water;
- discharges from potable water sources;
- foundation drains;
- air conditioning condensate;
- irrigation water;
- springs;
- water from crawl space pumps;
- footing drains;
- lawn watering;
- individual residential car washing;
- flows from riparian habitats and wetlands;
- dechlorinated swimming pool discharges;
- street wash waters; and
- discharges or flows from emergency fire fighting activities.

To satisfy the requirements of this section, the permittee(s) identified in Part III.A.7.a. on pages 30 and 31 of the permit shall:

(1) Identify those of the non-storm water discharges listed under Part II.A.7.a. (above), as well as any other non-storm water discharges, which will be allowed to be discharged to the MS4. Describe any conditions to be placed on these allowable discharges.

(2) Enforce ordinances which prohibit illicit connections and illegal dumping into the MS4. As per the schedule in Part III.A.7.a. on page 30 of this permit (page 31 for FDOT), the permittees shall develop a random inspection program to uncover illicit connections. The program shall include a schedule for inspections and an allocation of staff and resources. A description of the enforcement procedures shall be detailed within the program developed. Because the potential for illicit discharges and improper disposal is generally higher for areas of older development, areas with many automobile-related industries, and areas with significant numbers of heavy industrial facilities, the permittees shall consider the specific land use and age of development when determining inspection priorities and inspection schedules for this program component. Facility inspections may be carried out in conjunction with other municipal programs (e.g. pretreatment inspections of industrial users, health inspections, fire inspections, etc.). The permittees shall maintain an internal log documenting the inspections performed.

(3) Provide in the first ANNUAL REPORT, a photocopy of the signed adopted ordinance(s) identified in Table II.A.7.a.(3) below.

Table II.A.7.a.(3)

PERMITTEE	ORDINANCE
Sarasota County	93-038
Town of Longboat Key	Chapters 33, 52, and 158.102 of the Ordinances of the Town of Longboat Key
City of Sarasota	93-3699 and Section 2-314 of the City of Sarasota Code

(4) As per the schedule in Part III.A.7.a. on page 31 of this permit, the permittees in Table II.A.7.a.(4) shall amend the identified ordinances to change the citation for the definition of *"industrial activity,"* contained within these ordinances, to 40 CFR 122.26**(b)**(14) from the incorrect citation of 40 CFR 122.26**(a)**(14).

Table II.A.7.a.(4)	
PERMITTEE	ORDINANCE
City of Sarasota	93-3699
City of North Port	93-15, Section 180-21
City of Venice	93-14, Section 9-74

b. *Dry Weather Field Screening Program:* The permittees shall continue ongoing efforts to detect the presence of illicit connections and improper discharges to the MS4.

(1) To satisfy the requirements of this section, the permittees shall implement a dry weather field screening program to locate and eliminate illicit discharges and improper disposal into the MS4 in accordance with the schedule provided in Part III.A.7.b. on page 32 of this permit. This program shall include the dry weather screening activities identified in Table II.A.7.b. The minimum level of effort for the field screening program shall be based upon a 0.50-mile grid system, with each grid area containing at least one field screening location. In industrial and heavy commercial areas, the minimum level of effort shall be based upon a 0.25-mile grid system, with each grid area containing at least one field screening location. Under this program, all grid areas of the MS4 must be screened once during the permit term. Some grid areas may require more than one field screening location or a more frequent inspection schedule. In lieu of the grid system, the permittees may choose to field screen at all outfalls. Follow-up activities to eliminate illicit discharges and improper disposal may be prioritized on the basis of magnitude and nature of the suspected discharge; sensitivity of the receiving water; and/or other relevant factors. Screening methodology may be modified based on experience gained during actual field screening activities. While performing field screening activities, the permittees shall collect information on outfalls and portions of the MS4 which are not mapped, and this updated information shall be entered into the database system on an ongoing basis. An internal log documenting the results of all field screening performed shall be maintained.

Table II.A.7.b.	
GRID MAP COVERING AREA SERVED BY MS4 or ALL OUTFALLS	FREQUENCY OF FIELD SCREENING
Industrial Land Use	0.25-mile Grid or All Outfalls Once / 3 years
Heavy Commercial Land Use	0.25-mile Grid or All Outfalls Once / 3 years
All Other Land Uses	0.50-mile Grid or All Outfalls Once / 5 years
Entire MS4 System	a of the Outfalls or a of the Grid Areas Screened During Permit Years Three, Four, & Five with the Entire MS4 Screened Once / 5 years

c. *Investigation of Suspected Illicits and/or Improper Disposal:* The permittees shall develop and implement standard procedures to be followed to investigate portions of the MS4 that, based on the results of the field screen or other appropriate information, indicate a reasonable potential of containing illicit discharges or other sources of non-storm water. Notification to EPA of any illicit connection shall be an element of the investigative standard procedures.

(1) To satisfy the requirements of this section, the permittees identified in Part III.A.7.c. on page 32 shall develop and implement standard investigative procedures to identify and terminate the source of the illicit connection or discharge in accordance with the schedule provided. The procedures developed shall require proper training for the field personnel involved in identifying conditions that may indicate the presence of illicit discharges. Upon the verification of responsible parties, the standard procedures developed shall require the immediate cessation of improper disposal practices and the elimination of the illicit connection as expeditiously as possible. Where the elimination of an illicit connection or the submittal of an NPDES application to EPA is not possible within a specified time frame determined by the permittee, the standard procedures developed shall require that the responsible parties submit for approval a written compliance schedule for the removal of the discharge. In the interim, the permittees shall require the operator of the illicit discharge to take all reasonable and prudent measures to minimize the discharge of pollutants to the MS4.

(2) To satisfy the requirements of this section, FDOT shall develop and implement standard investigative procedures to identify the source of the illicit connection or discharge to the FDOT MS4, in accordance with the schedule provided in Part III.A.7.c. on page 33 of this permit. Upon the identification of responsible parties, the standard procedures developed shall require the timely reporting of water quality violations to Florida Department of Environmental Protection (FDEP) and EPA. Until such time that the illicit connection has been eliminated or the responsible parties have submitted an NPDES application for the discharge to EPA, FDOT shall require the operator of the illicit discharge to take all reasonable and prudent measures to minimize the discharge of pollutants to the MS4. Where measures to minimize the discharge are not taken, the developed procedures shall consider the termination of the connecting entity's FDOT drainage connection permit.

d. *Spill Prevention and Response:* The permittees shall implement procedures to prevent, contain, and respond to spills that may discharge into the MS4.

(1) To satisfy the requirements of this section, the permittees shall adopt Sarasota County's *Hazardous Materials Emergency Plan*, FDOT's *Emergency Operations Procedures*, or a comparable plan and procedures which effectively mitigate potential pollutant discharges to surface waters. These documents shall be adopted in accordance with the schedule provided in Part III.A.7.d. on page 33 of this permit.

e. *Public Notification:* The permittees shall develop and implement a program to promote, publicize, and facilitate public reporting of illicit discharges of water quality impacts associated with discharges from the MS4.

(1) To satisfy the requirements of this section, the permittees shall develop and implement programs to facilitate public reporting of illicit discharges and improper disposal of materials into the MS4 in accordance with the schedule provided in Part III.A.7.e. on page 34 of this permit. The program shall inform the public about what to look for and how to report incidents. The program shall also enhance public awareness of the problems associated with illicit discharges and may include programs such as educating school students, using inserts in utility bills, and public service announcements in newspaper, on television, or on radio.

f. *Oils, Toxics, and Household Hazardous Waste Control:* The permittees shall effectively prohibit the discharge or disposal of used motor vehicle fluids, household hazardous wastes, grass clippings, leaf litter, and animal wastes into the MS4.

(1) To satisfy the requirements of this section, the permittees shall implement the Storm Water Management Programs identified in Part III.A.7.f. on page 35 of this permit.

g. *Limitation of Sanitary Sewer Seepage:* The permittees shall prevent (or require the operator of the sanitary sewer to eliminate) unpermitted discharges of dry and wet weather overflows from sanitary sewers into the MS4. Each permittee shall eliminate the infiltration of seepage from sanitary sewers into the MS4.

(1) To satisfy the requirements of this section, the permittees shall implement the Storm Water Management Programs identified in Part

III.A.7.g. on page 36 of this permit.

8. *Industrial and High Risk Runoff:* The permittees shall develop and implement a program to identify and control pollutants, to the MEP and shall not cause or contribute to violations of State water quality standards of the receiving stream, in storm water discharges to the MS4 from the municipal landfill(s); hazardous waste treatment, storage, disposal and recovery facilities; facilities that are subject to EPCRA Title III, Section 313; and any other industrial or commercial discharge in which the permittees determine is contributing a substantial pollutant loading to the MS4.

To satisfy the two (2) requirements of this section, the permittees shall:

a. *Identify priorities and procedures for inspections:* Identify all targeted facilities and determine priority sites in accordance with the schedule provided in Part III.A.8.a. on pages 37 and 38 of this permit. Inspection schedules and procedures for the identified facilities shall be developed and implemented. Also, the permittees shall provide a listing in each ANNUAL REPORT of additionally identified industrial facilities which discharge storm water into the MS4 which have not been previously reported. The industrial storm water discharges that must be included in this inventory fall into the eleven (11) classes of industrial activities as defined in the November 1990 regulations under 40 CFR 122.26(b)(14).

b. *Monitoring for High Risk Industries:* Develop and implement a monitoring (or self monitoring) program for facilities identified under this section in accordance with the schedule provided in Part III.A.8.b. on page 38 of this permit. The monitoring program shall include the collection of quantitative data on the following constituents:

- any pollutants limited in an existing NPDES permit for an identified facility;
- oil and grease;
- chemical oxygen demand (COD);
- pH;
- biochemical oxygen demand, five-day (BOD_5);
- total suspended solids (TSS);
- total phosphorous;
- total Kjeldahl nitrogen (TKN);
- nitrate plus nitrite nitrogen; and
- any information on discharges required under 40 CFR 122.21(g)(7)(iii) and (iv).

Data collected by the industrial facility to satisfy the monitoring requirements of an NPDES or State discharge permit may be used to satisfy this requirement.

Permittees may require the industrial facility to conduct self-monitoring to satisfy this requirement.

9. *Construction Site Runoff:* The permittees shall develop and implement a program to reduce the discharge of pollutants from construction sites to the MEP, and to shall not cause or contribute to violations of State water quality standards of the receiving stream.

a. *Site Planning and Non-structural & Structural Best Management Practices:* The permittees shall require the use and maintenance of appropriate structural and non-structural best management practices to reduce pollutants discharged to the MS4 during the time of construction.

(1) To satisfy the requirements of this section, the permittees shall implement the Storm Water Management Programs identified in Part III.A.9.a. on page 39 of this permit.

b. *Inspection and Enforcement:* The permittees shall develop and implement a program for inspecting construction sites and for enforcing the requirement for control measures.

(1) To satisfy the requirements of this section, the permittees shall implement the Storm Water Management Programs identified in Part III.A.9.b. on pages 40 and 41 of this permit.

c. *Site Operator Training:* The permittees shall conduct appropriate education and training measures for construction site operators and those associated with the implementation of proper sediment & erosion control measures at construction sites.

(1) To satisfy the requirements of this section, the permittees shall implement the Storm Water Management Program(s) identified in Part III.A.9.c. on pages 41 and 42 of this permit.

B. Area-specific Storm Water Management Program Requirements.

Reserved pending additional requirements which may be included as a result of State Certification of the permit. (See Section 401 of the CWA.)

C. **<u>Deadlines for Program Compliance.</u>** Except as provided in Part III, compliance with the storm water management program shall be required 90 days from the effective date of the permit.

D. **<u>Roles and Responsibilities of Permittees.</u>** The Storm Water Management Program, together with any attached interagency agreements or interagency agreements developed subsequent to the effective date of the permit, shall clearly identify the roles and responsibilities of each permittee. Following the effective date of the permit, interagency agreements developed and implemented must be included in the ANNUAL REPORT covering the permit year in which the agreement became effective.

E. **<u>Legal Authority.</u>** To the extent allowed by law, each permittee shall ensure legal authority to control discharges to and from those portions the MS4 over which it has jurisdiction. This legal authority may be a combination of statute, ordinance, permit, contract, order or inter-jurisdictional agreements between permittees with adequate existing legal authority to accomplish Items 1 - 6 below. This legal authority for FDOT may be a combination of State statutes administered and enforced by sister agencies within the State of Florida government system which have adequate existing legal authority to accomplish Items 1 - 6 below.

1. Control the contribution of pollutants to the MS4 by Storm Water Discharges Associated with Industrial Activity and the quality of storm water discharged from sites of industrial activity;

2. Prohibit illicit discharges to the MS4;

3. Control the discharge of spills and the dumping or disposal of materials other than storm water (e.g. industrial and commercial wastes, trash, used motor vehicle fluids, leaf litter, grass clippings, animal wastes, etc.) into the MS4;

4. Control through interagency or inter-jurisdictional agreements among permittees the contribution of pollutants from one portion of the MS4 to another;

5. Require compliance with conditions in ordinances, permits, contracts or orders; and

6. Carry out all inspection, surveillance and monitoring procedures necessary to determine compliance with permit conditions.

F. **<u>Storm Water Management Program Resources.</u>** Each permittee shall provide adequate finances to implement their activities under the Storm Water Management Program. Each permittee shall also have a source of funding for implementing all other requirements included within this NPDES storm water permit.

G. Storm Water Management Program Review and Modification.

1. *Program Review:* Each permittee shall participate in an annual review of the current Storm Water Management Program (SWMP) in conjunction with preparation of the ANNUAL REPORT required under Part V.C. of the permit.

2. *Program Modification:* The permittee(s) may modify the SWMP during the life of the permit in accordance with the following procedures:

   a. Modifications adding (but not subtracting nor replacing) components, controls, or requirements to the approved SWMP may be made by the permittee(s) at any time. A description of the modification shall be included within the subsequent ANNUAL REPORT.

   b. Modifications replacing an ineffective or unfeasible BMP specifically identified in the SWMP with an alternate BMP may be made by the permittee(s) at any time. A description of the replacement BMP shall be included in the subsequent ANNUAL REPORT along with the following information:

      (1) an analysis of why the former BMP was ineffective or infeasible (including cost prohibitive);

      (2) expectations on the effectiveness of the replacement BMP; and

      (3) an analysis of why the replacement BMP is expected to achieve the goals of the BMP which was replaced.

   c. Modifications to adjust the schedule for maintenance activities or the frequency of inspections or monitoring identified in the SWMP may be made by the permittee(s) on an annual basis. The permittees must include in the subsequent ANNUAL REPORT a description of the schedule adjustment along with the following information:

      (1) an analysis of why the former schedule was ineffective or infeasible;

      (2) expectations on the effectiveness of the replacement schedule; and

      (3) an analysis, if applicable, of why the replacement schedule will ensure the optimization of equipment use.

d. Modifications subtracting components, controls, or requirements of the SWMP may not be made by the permittee(s) UNLESS it can be clearly demonstrated that with the elimination of this component, the SWMP will continue to achieve a reduction in pollutants to the MEP and shall not cause or contribute to violations of State water quality standards of the receiving stream. In the case where this type of modification is appropriate, the permittee(s) may make the required modification and shall include in the subsequent ANNUAL REPORT a description of the component which has been eliminated along with the following information:

(1) an analysis of why the component was ineffective or infeasible, and

(2) a detailed explanation of why, with the elimination of this component, the SWMP will continue to achieve a reduction in pollutants to the MEP and shall not cause or contribute to violations of State water quality standards of the receiving stream.

e. Modifications included within the ANNUAL REPORT shall be signed in accordance with Part VI.H. by all directly affected permittees, and shall include a certification that all affected permittees were given an opportunity to comment on proposed changes.

3. *Transfer of Ownership, Operational Authority, or Responsibility for Storm Water Management Program Implementation:* The permittee(s) shall implement the SWMP on all new areas added to their portion of the municipal separate storm sewer system (or for which they become responsible for implementation of storm water quality controls) as expeditiously as practicable. Implementation of the program in any new area shall consider the plans in the SWMP of the previous MS4 ownership.

Prior to land annexation, the permittee shall include a schedule for extending the SWMP to the annexed areas. At least 30 days prior to transfer of operational authority or responsibility for SWMP implementation, all parties shall prepare a schedule for transfer of responsibility for SWMP implementation on the affected portions of the MS4. This schedule shall be included in the ANNUAL REPORT.

PART III. SCHEDULES FOR IMPLEMENTATION AND COMPLIANCE

The permittee(s) shall comply with the following schedules for Storm Water Management Program implementation and augmentation, and for permit compliance.

A. IMPLEMENTATION AND AUGMENTATION OF STORM WATER MANAGEMENT PROGRAMS

STORM WATER MANAGEMENT PROGRAM	PERMITTEE(S)	ACTIVITY	DATE DUE / FREQUENCY
1. *Operation and Maintenance of Structural Controls and Storm Water Collection System*	Sarasota County City of Sarasota City of Venice City of North Port FDOT	Perform inspections and maintenance of structural controls. Maintain an internal record keeping system to track inspections and maintenance activities performed during the permit. Conduct an annual assessment of the effectiveness of inspection & maintenance schedule and provide a summary of the assessment in each ANNUAL REPORT.	Annual Requirement
	ALL	Identify and inventory each privately-owned and maintained storm water management facility which discharges into the MS4.	Within 12 Months of the Effective Date of the Permit
		Develop a revolving inspection program for privately-owned and maintained storm water treatment systems which discharge into the MS4 to determine compliance with local permit conditions and/or local ordinances. Program developed shall include a description of the enforcement provisions for non-compliance. Following development, include a summary of the inspection program & schedule in the subsequent ANNUAL REPORT for incorporation into the permit.	Within 12 Months of the Effective Date of the Permit

STORM WATER MANAGEMENT PROGRAM	PERMITTEE(S)	ACTIVITY	DATE DUE / FREQUENCY
		Implement revolving inspection program for privately-owned and maintained storm water treatment systems which discharge into the MS4.	Within 24 Months of the Effective Date of the Permit.
1. *Operation and Maintenance of Structural Controls and Storm Water Collection System* (continued)	Sarasota County	Complete Florida Water & Pollution Control Operators Association (FW&PCOA) course or equivalent.	5 employees / year
	ALL OTHERS **except for** FDOT		1 employee / permit

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STORM WATER MANAGEMENT PROGRAM	PERMITTEE(S)	ACTIVITY	DATE DUE / FREQUENCY
2. *Control of Discharges from Areas of New Development and Significant Redevelopment*	ALL **except for** City of North Port and FDOT	Adopt as local ordinances storm water quality treatment criteria consistent, but not necessarily similar to the State of Florida Storm Water Treatment Regulations (F.A.C. 40D-4, 40D-40, 62-25).	Prior to the end of the Permit Term
	FDOT	Employ new FDOT Drainage Connection Permit requirements which include a "certification of water quality" to be provided by the connecting entity.	Effective Date of Permit
	ALL **except for** FDOT	Continue on the current schedule to perform master basin studies on the major watersheds identified in Table 1 on page 4A-34 of Appendix A. Develop a course of action for each as they are completed. Include in each ANNUAL REPORT a brief summary of each basin study completed during the permit year and the resulting course of action.	Effective Date of the Permit
	ALL **except for** City of North Port and FDOT	Evaluate land development practices to reduce the amount of impervious surfaces in future development. After completing the evaluation, include a summary of the resulting course of action in the subsequent ANNUAL REPORT for incorporation into the permit.	Within 36 Months of the Effective Date of Permit
		Implement appropriate land development practices & incentives for the reduction of impervious surfaces.	As Determined by the Evaluation - Prior to the end of the Permit Term

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STORM WATER MANAGEMENT PROGRAM	PERMITTEE(S)	ACTIVITY	DATE DUE / FREQUENCY
3. *Operation and Maintenance of Public Streets, Roads, and Highways*	Sarasota County City of Sarasota City of Venice	Provide a description of the municipally-operated Litter Control Program(s) for highways and streets within jurisdictional area for incorporation into the permit.	Provide in First ANNUAL REPORT
	ALL **except for** City of North Port and FDOT	Implement Litter Control Program(s) for highways and streets within jurisdictional area and properly dispose of collected material.	Effective Date of the Permit
	FDOT	Implement Litter Control Program for highways and streets within jurisdictional area and properly dispose of collected material. Report in each ANNUAL REPORT the approximate frequency of litter collection services performed under contractual agreements during the permit year.	Effective Date of the Permit
	ALL **except for** North Port WCD City of North Port & FDOT	Implement street sweeping program within jurisdictional area and properly dispose of collected material.	Effective Date of the Permit
	FDOT	Implement street sweeping program within jurisdictional area and properly dispose of collected material. Report in each ANNUAL REPORT the approximate frequency of street sweeping services performed under contractual agreements during the permit year.	
	Sarasota County	Provide the maintenance schedule for storm water structures (i.e., catch basins) and roadside ditches.	Provide in First ANNUAL REPORT

STORM WATER MANAGEMENT PROGRAM	PERMITTEE(S)	ACTIVITY	DATE DUE / FREQUENCY
3. *Operation and Maintenance of Public Streets, Roads, and Highways* (continued)	ALL	Perform scheduled maintenance on catch basins, grates, and other storm water structures and roadside ditches and properly dispose of accumulated sediments. Maintain an internal log documenting maintenance activities.	Effective Date of the Permit
	ALL **except for** City of North Port	As described in Part II.3.a. on page _7_ of the permit, develop practices to reduce to the MEP and shall not cause or contribute to violations of State water quality standards of the receiving stream regarding the pollutants from road repair and from all municipal equipment yards & maintenance shops. After development, include a summary of the practices in the subsequent ANNUAL REPORT for incorporation into the permit.	Within 12 months of the Effective Date of the Permit
		Implement developed practices to reduce to the MEP pollutants from road repair and municipal yards.	Within 24 months of the Effective Date of the Permit
	FDOT	Coordinate the "Adopt A Highway" program for local organizations to be identified with specific highway cleanup and beautification projects.	Within 24 months of the Effective Date of the Permit
		Conduct annual routine inspections of each FDOT maintenance facility to ensure that BMPs are operational. The FDOT NPDES Coordinator or his/her representative shall perform this activity.	

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STORM WATER MANAGEMENT PROGRAM	PERMITTEE(S)	ACTIVITY	DATE DUE / FREQUENCY
4. *Ensure Flood Control Projects Comply With State Storm Water Quality Requirements*	ALL **except for** FDOT	Develop a priority list and construction schedule for the retrofit projects recommended by the master basin studies completed to date.	Within 12 Months of the Effective Date of the Permit
		Include a copy of the prioritized project list and construction schedule in the ANNUAL REPORT for incorporation into the permit. Provide updates to this list in future ANNUAL REPORTS as additional master basin studies are completed.	
	FDOT	Present a retrofitting program to the local Metropolitan Planning Organizations (MPO) for consideration which focuses on water quality improvement.	Within 12 Months of the Effective Date of the Permit
		Submit within the ANNUAL REPORT the list of approved retrofit projects in the MPO's work program for District One. Also provide the construction schedule for these approved projects. Provide updates to this list in future ANNUAL REPORTS as additional projects are approved.	Within 24 Months of the Effective Date of the Permit
		Begin retrofit priority projects as per the construction schedule in the approved work program for District One.	

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STORM WATER MANAGEMENT PROGRAM	PERMITTEE(S)	ACTIVITY	DATE DUE / FREQUENCY
5. *Identification, Monitoring, and Control of Discharges from Municipal Waste Treatment, Storage, or Disposal Facilities not covered by an NPDES Storm Water Permit*	Sarasota County City of Sarasota City of North Port	Develop program to evaluate, through inspections and monitoring, the municipally-operated solid waste transfer station(s), maintenance and storage yards for waste transportation fleets, POTWs, and sludge application and/or disposal sites. The goals of the evaluation program shall be to identify these facilities, determine the necessary control measures & procedures to be employed at each, and administer an appropriate implementation schedule. After developing the evaluation program, submit a program summary in the subsequent ANNUAL REPORT for incorporation into the permit.	Within 30 Months of the Effective Date of the Permit
		Implement developed program to reduce pollutants in storm water discharges to the MEP and shall not cause or contribute to violations of State water quality standards of the receiving stream from these facilities.	Within 36 Months of the Effective Date of the Permit

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STORM WATER MANAGEMENT PROGRAM	PERMITTEE(S)	ACTIVITY	DATE DUE / FREQUENCY
6. *Control of Pollutants Related to Application of Pesticides, Herbicides, and Fertilizers*	ALL	Provide the details, for incorporation into the permit, of the specific public education program(s) designed to encourage the public to reduce their use of pesticides, herbicides and fertilizers.	Provide in First ANNUAL REPORT
		Implement public education program(s).	Effective Date of the Permit
	ALL **except for** FDOT	Evaluate current training requirements & certification procedures for employees who handle pesticides, herbicides and fertilizers. After completing the evaluation, include a summary of the results in the subsequent ANNUAL REPORT for incorporation into the permit.	Within 24 Months of the Effective Date of the Permit
		Implement any revised procedures for the training & certification of these employees.	As Necessary - Within 36 Months of the Effective Date of the Permit
	ALL	Require evidence of proper certification and licensing for all applicators contracted to apply pesticides, herbicides, and fertilizers on municipal and FDOT property.	Effective Date of the Permit

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STORM WATER MANAGEMENT PROGRAM	PERMITTEE(S)	ACTIVITY	DATE DUE / FREQUENCY
6. *Control of Pollutants Related to Application of Pesticides, Herbicides, and Fertilizers* (continued)	ALL **except for** FDOT	Develop a program with procedures to minimize the use of pesticides, herbicides, and fertilizers and to properly store and mix these products. The program developed should also consider including components such as providing xeriscape planning assistance and promoting voluntary use of native Florida plantings and slow-release fertilizers. After development, include a summary of the procedures in the subsequent ANNUAL REPORT for incorporation into the permit.	Within 24 Months of the Effective Date of the Permit
	ALL **except for** FDOT	Employ program procedures to minimize the use of pesticides, herbicides, and fertilizers and to properly store and mix these products.	Within 36 Months of the Effective Date of the Permit
	FDOT		Effective Date of the Permit

STORM WATER MANAGEMENT PROGRAM	PERMITTEE(S)	ACTIVITY	DATE DUE / FREQUENCY
7. *Illicit Discharges and Improper Disposal*			
a.) *Inspections, ordinances, and enforcement measures*	ALL **except for** City of North Port and FDOT	Complete the assessment of non-storm water discharges allowed to be discharged to the MS4 as detailed on page 9 of the permit. After completing the assessment, include a summary of the results in the subsequent ANNUAL REPORT for incorporation into the permit.	Within 18 Months of the Effective Date of the Permit
	ALL **except for** City of North Port and FDOT	Develop an inspection program to enforce ordinances which prohibit illicit connections and illegal dumping into the MS4. After development, include a summary of the inspection program in the subsequent ANNUAL REPORT for incorporation into the permit.	Within 30 Months of the Effective Date of the Permit
	Sarasota County	Implement inspection program to enforce ordinances which prohibit illicit connections and illegal dumping into the MS4. Maintain an internal log documenting inspections and enforcement actions performed and provide a summary of these reports in each ANNUAL REPORT.	Within 36 Months of the Effective Date of the Permit
	ALL OTHERS **except for** City of North Port and FDOT		Within 36 Months of the Effective Date of the Permit

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STORM WATER MANAGEMENT PROGRAM	PERMITTEE(S)	ACTIVITY	DATE DUE / FREQUENCY
7. *Illicit Discharges and Improper Disposal*			
a.) Inspections, ordinances, and enforcement measures (continued)	FDOT	Develop a program to inspect drainage connections after project completion to ensure continued compliance with drainage connection permit requirements and to ensure that no illicit or non-permitted connections have been made. In cases where another regulatory agency requires a periodic certification of compliance, the program developed may allow FDOT to accept this certification of compliance in lieu of further inspections by FDOT. After development, include a summary of the inspection program in the subsequent ANNUAL REPORT for incorporation into the permit.	Within 21 Months of the Effective Date of the Permit
		Implement developed program to inspect drainage connections after project completion. Maintain an internal log documenting inspections and enforcement actions performed and provide a summary of these records in each ANNUAL REPORT.	Within 30 Months of the Effective Date of the Permit
	Sarasota County Longboat Key City of Sarasota	Provide photocopies of signed adopted storm water ordinances as identified in Table II.A.7.a.(3) on page 10 of the permit.	Provide in First ANNUAL REPORT
	City of North Port City of Sarasota City of Venice	Amend ordinances as identified in Table II.A.7.a.(4) on page 11 of the permit to reflect correct citation for *"industrial activity"* {40 CFR 122.26(b)(14)} Include a copy of the amended ordinances in the subsequent ANNUAL REPORT for incorporation into the permit.	Within 12 Months of the Effective Date of the Permit

STORM WATER MANAGEMENT PROGRAM	PERMITTEE(S)	ACTIVITY	DATE DUE / FREQUENCY
7. *Illicit Discharges and Improper Disposal* (continued)			
b.) *Field Screening*	ALL	Conduct field screening of the MS4 for illicit discharges and improper disposal as shown in Table II.A.7.b. on page 12 of this permit. Collect inventory information on outfalls and on portions of MS4 not mapped and update database system on an ongoing basis. Maintain an internal log documenting the results of all field screening performed.	At least a of Grid Areas Screened in Permit Years Three, Four and Five with Entire MS4 Screened Once / 5 years
c.) *Investigation of Suspected Illicits and/or Improper Disposal*	ALL **except for** FDOT	Develop standard investigative procedures to identify and terminate the source(s) of illicit connections or discharges to the MS4. After development, include a summary of the investigative procedures in the subsequent ANNUAL REPORT for incorporation into the permit.	Within 24 Months of the Effective Date of the Permit
		Implement standard investigative procedures to identify and terminate the source(s) of illicit connections or discharges to the MS4.	Within 30 Months of the Effective Date of the Permit

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STORM WATER MANAGEMENT PROGRAM	PERMITTEE(S)	ACTIVITY	DATE DUE / FREQUENCY
7. *Illicit Discharges and Improper Disposal* (continued)			
c.) *Investigation of Suspected Illicits and/or Improper Disposal* (continued)	FDOT	Develop standard investigative procedures to identify and report the source(s) of illicit connections or discharges. These procedures shall include notification to FDEP and EPA of illicit connections. After development, include a summary of the investigative procedures in the subsequent ANNUAL REPORT for incorporation into the permit.	Within 24 Months of the Effective Date of the Permit
		Implement standard investigative procedures to identify the sources(s) of illicit connections or discharges to the MS4.	Within 30 Months of the Effective Date of the Permit
d.) *Spill Prevention and Response*	Sarasota County FDOT	Provide a copy of the applicable portions of Sarasota County's *Hazardous Materials Emergency Plan* and FDOT's *Emergency Operations Procedures* which effectively mitigate potential pollutant discharges to surface waters.	Provide in First Annual Report
	ALL **except for** Sarasota County and FDOT	Adopt Sarasota County's *Hazardous Materials Emergency Plan*, FDOT's *Emergency Operations Procedures*, or a comparable plan and procedures which effectively mitigate potential pollutant discharges to surface waters.	Within 12 Months of the Effective Date of the Permit

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STORM WATER MANAGEMENT PROGRAM	PERMITTEE(S)	ACTIVITY	DATE DUE / FREQUENCY
7. *Illicit Discharges and Improper Disposal* (continued)			
e.) Public Notification	ALL	Develop a program to promote, publicize, and facilitate public reporting of the presence of illicit discharges and improper disposal of materials into the MS4. After development, include a summary of the public program in the subsequent ANNUAL REPORT for incorporation into the permit.	Within 30 Months of the Effective Date of the Permit
		Implement public reporting program.	Within 36 Months of the Effective Date of the Permit
		Maintain a citizen complaint log documenting all reports of illicit discharges and what actions were taken to investigate and resolve the problem. Include a summary of this log in each ANNUAL REPORT.	Within 36 Months of the Effective Date of the Permit
	FDOT	Establish a direct dial local telephone number at the District Office to be used for the reporting of illicit connections, accidental spills, illegal dumping, or other water quality violations and action as needed. This requirement may be satisfied through cooperative efforts with other permittees.	Within 36 Months of the Effective Date of the Permit

STORM WATER MANAGEMENT PROGRAM	PERMITTEE(S)	ACTIVITY	DATE DUE / FREQUENCY
7. *Illicit Discharges and Improper Disposal* (continued)			
f.) *Oils, Toxics, and Household Hazardous Waste Control*	ALL **except for** FDOT	Support and promote on a regular basis the six (6) oil recycling site locations within Sarasota County and the two (2) permanent collection centers for household hazardous waste materials. Continue Amnesty Days program. Document the total annual amount of household hazardous waste materials collected.	Effective date of Permit
		Actively promote and support a voluntary stenciling program for all storm sewer inlets which discharge directly or indirectly into surface waters.	Within 12 Months of the Effective Date of the Permit
	FDOT	With each FDOT Drainage Connection Permit, include information on used oil recycling, proper hazardous waste disposal, storm water regulations, and spill reporting.	Within 12 Months of the Effective Date of the Permit

STORM WATER MANAGEMENT PROGRAM	PERMITTEE(S)	ACTIVITY	DATE DUE / FREQUENCY
7. *Illicit Discharges and Improper Disposal* (continued)			
g.) *Limitation of Sanitary Sewer Seepage*	ALL **except for** City of North Port and FDOT	Develop procedures to limit the infiltration of sanitary seepage into the MS4, in areas where wastewater infiltration is suspected. After development, include a summary of the procedures in the subsequent ANNUAL REPORT for incorporation into the permit.	Within 30 Months of the Effective Date of the Permit
		Implement developed procedures to limit the infiltration of sanitary seepage into the MS4.	Within 36 Months of the Effective Date of the Permit
	ALL	Advise appropriate utility owner of violation if constituents common to wastewater contamination are discovered in the MS4 during dry weather field screening.	Effective Date of the Permit
		Identify areas served by septic tanks. Advise appropriate State Agency of violation if constituents common to wastewater contamination due to malfunctioning septic tank systems are discovered in the MS4 during dry weather field screening.	Within 12 Months of the Effective Date of the Permit

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STORM WATER MANAGEMENT PROGRAM	PERMITTEE(S)	ACTIVITY	DATE DUE / FREQUENCY
8. *Industrial and High Risk Runoff*			
a.) Identification of Priorities and Procedures for Inspections	ALL	Develop an inventory of all existing high risk facilities discharging into the MS4. This inventory shall identify the outfall and surface waterbody into which each high risk facility drains.	Within 24 Months of the Effective Date of the Permit
		Based upon historical information and available monitoring & screening data, prioritize the identified high risk facilities.	Within 24 Months of the Effective Date of the Permit
	ALL **except for** FDOT	Develop procedures for inspecting high risk facilities and establish an inspection schedule. After development, include a summary of the procedures & inspection schedule in the subsequent ANNUAL REPORT for incorporation into the permit.	Within 24 Months of the Effective Date of the Permit
	FDOT	Develop procedures for the inspection of high risk facilities which hold FDOT drainage connection permits to ensure compliance with permit requirements. In cases where another regulatory agency requires a periodic certification of compliance, the program developed may allow FDOT to accept this certification of compliance in lieu of further inspections by FDOT. After development, include a summary of the procedures & inspection schedule in the subsequent ANNUAL REPORT for incorporation into the permit.	Within 24 Months of the Effective Date of the Permit
	ALL	Begin inspections of identified high risk facilities. Maintain an internal log documenting the results of the inspections performed.	Within 36 Months of the Effective Date of the Permit

STORM WATER MANAGEMENT PROGRAM	PERMITTEE(S)	ACTIVITY	DATE DUE / FREQUENCY
8. *Industrial and High Risk Runoff* (continued)			
a.) *Identification of Priorities and Procedures for Inspections* (continued)	ALL	Maintain a list of all industrial storm water sources discharging to MS4 & update in ANNUAL REPORTS.	Effective Date of the Permit
b.) *Monitoring for High Risk Industries*	ALL **except for** FDOT	Develop a monitoring (or self monitoring) program for high risk industrial facilities. Include a description of the specific enforcement steps to be taken to require compliance with local storm water ordinances if violations are identified. After development, include a summary of the monitoring program in the subsequent ANNUAL REPORT for incorporation into the permit.	Within 24 Months of the Effective Date of the Permit
	FDOT	Develop a monitoring (or self monitoring) program for high risk industrial facilities which hold FDOT drainage connection permits. Include a description of the specific enforcement steps to be taken to require compliance with permit conditions if violations are identified. After development, include a summary of the monitoring program in the subsequent ANNUAL REPORT for incorporation into the permit.	Within 24 Months of the Effective Date of the Permit

STORM WATER MANAGEMENT PROGRAM	PERMITTEE(S)	ACTIVITY	DATE DUE / FREQUENCY
	ALL	Implement the monitoring program for high risk industrial facilities.	Within 36 Months of the Effective Date of the Permit

STORM WATER MANAGEMENT PROGRAM	PERMITTEE(S)	ACTIVITY	DATE DUE / FREQUENCY
9. *Construction Site Runoff*			
a.) *Site Planning & Structural and Non-structural Controls*	ALL **except for** City of North Port and FDOT	Review erosion and sediment control requirements to determine modifications necessary to correlate with SWFWMD's requirements and EPA's NPDES Construction Activity General Permit. Summarize the necessary modifications in the subsequent ANNUAL REPORT for incorporation into the permit.	Within 12 Months of the Effective Date of the Permit
		Incorporate necessary modifications to the erosion and sediment control requirements.	Within 36 Months of the Effective Date of the Permit
		In land development regulations, incorporate guidelines and recommendations for reducing the amount of sediment leaving construction sites.	Within 36 Months of the Effective Date of the Permit
		Track construction projects required to install erosion and sediment controls. Document the installation, maintenance, and effectiveness of the controls. Integrate these records with the education program for training the site contractors.	Within 18 Months of the Effective Date of the Permit

STORM WATER MANAGEMENT PROGRAM	PERMITTEE(S)	ACTIVITY	DATE DUE / FREQUENCY
	FDOT	Employ new FDOT Drainage Connection Permit requirements which direct connecting entities subject to the NPDES storm water regulations to submit a copy of their NPDES Storm Water Pollution Prevention Plan to FDOT.	Effective Date of the Permit

STORM WATER MANAGEMENT PROGRAM	PERMITTEE(S)	ACTIVITY	DATE DUE / FREQUENCY
9. *Construction Site Runoff* (continued)			
b.) *Inspection and Enforcement*	ALL **except for** City of North Port and FDOT	Review existing inspection policies and code enforcement programs to first identify all agencies conducting site inspections and then to determine which agency is responsible for issuing enforcement actions for which code violations. Summarize results and include in the subsequent ANNUAL REPORT for incorporation into the permit.	Within 24 Months of the Effective Date of the Permit
		Train inspectors (regardless of specialty) who are likely to be on-site during earth moving activities in erosion control techniques.	1 Inspector / Year
		Implement the use of an erosion & sediment control checklist for all inspectors. Include verification that construction sites subject to the NPDES Storm Water Regulations have NPDES permit coverage and a Storm Water Pollution Prevention Plan on site. Include developed checklist in the subsequent ANNUAL REPORT for incorporation into the permit.	Within 24 Months of the Effective Date of the Permit
	ALL **except for** City of North Port	Develop a program to inspect construction projects for compliance with local storm water ordinances and/or local permits.	Within 24 Months of the Effective Date of the Permit
	ALL **except for** City of North Port and FDOT	Implement program developed to inspect construction projects for compliance with local storm water ordinances and/or local permits.	Within 36 Months of the Effective Date of the Permit

STORM WATER MANAGEMENT PROGRAM	PERMITTEE(S)	ACTIVITY	DATE DUE / FREQUENCY
9. *Construction Site Runoff* (continued)			
b.) *Inspection and Enforcement* (continued)	FDOT	Implement program developed to inspect construction projects that propose to directly discharge storm water to the FDOT MS4 and have been granted an FDOT drainage connection permit for compliance with FDOT permit conditions. Require connection entities, who are found or suspected of discharging storm water of unacceptable quality during or following construction, to sample and test the discharge to prove compliance with FDOT permit conditions.	Within 36 Months of the Effective Date of the Permit
c.) *Site Operator Training*	ALL **except for** City of North Port and FDOT	Implement an annual NPDES workshop for design professionals, land developers, inspectors and contractors, including earth moving contractors. Topics to include are measures to reduce pollutants from sites, awareness of the NPDES program requirements for construction activities, and solutions to erosion and sediment problems commonly found by the inspectors during construction.	Within 24 Months of the Effective Date of the Permit
		Evaluate the feasibility of an erosion & sediment control certification program for construction site operators (contractors and developers), plan reviewers, and inspectors that work on sites that discharge to the MS4. Upon conclusion of the evaluation, include a summary of the findings in the subsequent ANNUAL REPORT for incorporation into the permit.	Within 30 Months of the Effective Date of the Permit
		If certification program is deemed feasible, implement program for construction site operators, plan reviewers, and inspectors.	If Deemed Feasible - Within 36 Months of the Effective Date of the Permit

STORM WATER MANAGEMENT PROGRAM	PERMITTEE(S)	ACTIVITY	DATE DUE / FREQUENCY
c.) *Site Operator Training* (continued)	ALL **except for** City of North Port and FDOT	Develop a procedure to notify building permit applicants in developments which, because of the amount of land area disturbed, are subject to the NPDES storm water regulations of their application responsibilities under the NPDES permitting program for construction site runoff. After development, include a summary of procedures in the subsequent ANNUAL REPORT for incorporation into the permit.	Within 24 Months of the Effective Date of the Permit
		Implement developed procedures to notify building permit applicants in developments which, because of amount of land area disturbed, are subject to the NPDES storm water regulations of their application responsibilities under the NPDES permitting program for construction site runoff.	Within 30 Months of the Effective Date of the Permit
		Conduct presentations to local professional organizations which are associated with the construction industry to discuss proper construction site management for water quality.	Ongoing

B. COMPLIANCE WITH EFFLUENT LIMITATIONS.

NONE

PART IV. NUMERIC EFFLUENT LIMITATIONS

NONE

PART V. MONITORING AND REPORTING REQUIREMENTS

A. Seasonal Loadings and Event Mean Concentrations.

1. As per 40 CFR 122.26(d)(2)(iii)(C), the permittees shall provide estimates of the seasonal pollutant load and of the event mean concentration of a representative storm for the parameters listed in Table V.A.1. for each "major outfall" within the MS4. These constituents were detected in the sampling data reported in the Part 2 application. The location of all known major outfalls shall be inventoried in the ANNUAL REPORT for Year One of the permit, with updates describing any additionally identified major outfalls in each sequent ANNUAL REPORT. The seasonal pollutant load and event mean concentration for each major outfall may be estimated from the representative monitoring locations, from regional NURP or State data, or from pooling results from other nearby Florida MS4 monitoring activities and shall take into consideration land uses and drainage areas for the outfall. The estimates of seasonal loadings and event mean concentrations shall be included in the ANNUAL REPORT for Year Four of the permit. For the purposes of this permit, a "major outfall"is defined as follows:

   - a pipe (or closed conveyance) system with a cross-sectional area equal to or greater than 7.07 square feet (e.g., if a single circular pipe system, an inside diameter of 36 inches or greater);
   - a single conveyance other than a pipe, such as an open channel ditch, which is associated with a drainage area of more than 50 acres;
   - a pipe (or closed conveyance) system, draining *"industrial land use,"* with a cross-sectional area equal to or greater than 0.79 square feet (e.g., if a single circular pipe system, an inside diameter of 12 inches or greater); or
   - a single conveyance other than a pipe, such as an open channel ditch, which is associated with an *"industrial land use"* drainage area of more than 2 acres;

TABLE V.A.1.	
PARAMETERS	
Biochemical Oxygen Demand (BOD_5) (mg/l)	Oil & Grease (mg/l)
Chemical Oxygen Demand (COD) (mg/l)	Total Recoverable Cadmium (mg/l)
Total Suspended Solids (TSS) (mg/l)	Total Recoverable Chromium (mg/l)
Total Dissolved Solids (TDS) (mg/l)	Total Recoverable Copper (mg/l)
Total Kjeldahl Nitrogen (as N) (mg/l)	Total Recoverable Lead (mg/l)
Nitrate plus Nitrite (as N) (mg/l)	Total Recoverable Zinc (mg/l)
Total Phosphorus (mg/l)	Dissolved Phosphorus (mg/l)

2. The permittees listed in Table V.A.2. below shall conduct an investigation of the identified drainage basins to determine the sources of the following organic pollutants detected in the Part 2 application sampling data. A report summarizing the conclusions of this investigation shall be included in the ANNUAL REPORT for Year Three of the permit.

TABLE V.A.2.		
PARAMETERS	BASIN	PERMITTEE(S)
Benezo(a)anthracene	Indian Ave. - Site #5	City of Venice
Benezo(k)fluoranthene	Indian Ave. - Site #5	City of Venice
3,4-Benzofluoranthene	East Ave. - Site #2	City of Sarasota
	Indian Ave. - Site #5	City of Venice
Bis(2-ethylhexyl)phthalate	Longboat Key - Site #1	Longboat Key
	East Ave. - Site #2	City of Sarasota
	Indian Ave. - Site #5	City of Venice
	Richardson Rd. - Site #3	Sarasota County
Chrysene	East Ave. - Site #2	City of Sarasota
	Indian Ave. - Site #5	City of Venice
4,4'-DDE	East Ave. - Site #2	City of Sarasota
	Indian Ave. - Site #5	City of Venice

B. **<u>Monitoring Data Collection.</u>** According to the agreements established between permittees, the following monitoring program shall be developed and implemented:

1. *Monitoring:* Establish local monitoring stations in conjunction with the State of Florida's *Surface Water Ambient Monitoring Program*. (See definition of the *Surface Water Ambient Monitoring Program* in Part VIII for description of program goals and monitoring strategies.) The selection of the monitoring stations shall be the result of a cooperative effort between the permittees, EPA, and the Bureau of Surface Water Management, Florida Department of Environmental Protection (FDEP). Acceptance of the monitoring program components proposed by the permittees in the July 23, 1993, Part 2 application submittal shall be explored before any alternative monitoring programs are introduced. The number of monitoring stations as well as the type of sampling performed shall be established in accordance with the following:

    a.) The costs associated with the monitoring program developed shall not exceed the projected costs for the monitoring program proposed by the permittees in the July 23, 1993, Part 2 application submittal.

    b.) The monitoring program developed shall assist in determining the impact of storm water discharges on receiving waters located in the geographical area covered by this permit.

    c.) The monitoring program developed shall assist in determining the effectiveness of the storm water management programs being implemented under this permit and shall assist in identifying and prioritizing portions of the MS4 requiring additional controls.

    d.) The monitoring program developed shall be designed to help identify local sources and impacts of specific pollutants considered a problem in the geographic area covered by this permit. Once the source and the impacts are identified, these pollutants may be more effectively reduced or eliminated.

    e.) The selection of the monitoring stations and sampling program schedule shall be agreed upon by the permittees and the Bureau of Surface Water Management, FDEP and EPA. The monitoring program developed shall be implemented by the permittees within 24 months of the effective date of this permit or within 12 months of the date of program development, whichever is later. The details of the monitoring program shall be submitted to EPA in the subsequent ANNUAL REPORT; status reports shall be given in any Annual Reports prior to this one.

It is the intent of EPA to use the monitoring information collected to evaluate any trends in the reduction in pollutant loads discharged to waters of the U.S during the term of the permit. The pollutant loading trends will be used to evaluate the effectiveness of the permittees' Storm Water Management Program to reduce the discharge of pollutants to the MEP and to shall not cause or contribute to violations of State water quality standards of the receiving stream.

2. *Monitoring Data:* For Part V.B.1., records shall be maintained of all analytical results. Additionally, for the monitoring program developed under Part V.B.1. which involves storm event sampling, the records maintained shall include: the date and duration (in hours) of the storm event(s) sampled; rainfall measurements or estimates (in inches or centimeters) of the storm event which generated the sampled runoff; the duration (in hours) between the storm event sampled and the end of the previous measurable (greater than 0.1 inch or 0.25 centimeter rainfall) storm event; and an estimate of the total volume (in gallons or liters) of the discharge sampled.

3. *Sample Analysis:* All samples collected for Part V.B.1. shall be analyzed in accordance with the methods specified at 40 CFR Part 136.

4. *Sampling Waiver.* When a discharger is unable to collect samples required by Part V.B.1. due to adverse climatic conditions, the discharger must submit in lieu of sampling data, a description of why samples could not be collected, including available documentation of the event. Adverse climatic conditions which may prohibit the collection of samples include weather conditions that create dangerous conditions for personnel (such as local flooding, high winds, hurricane, tornadoes, electrical storms, etc.) or otherwise make the collection of a sample impracticable (drought, etc.).

C. **<u>Annual Report.</u>** Each permittee shall contribute to the preparation of an annual system-wide report to be submitted by no later than six months following the period covered by the report. The ANNUAL REPORT shall cover the 12 month period beginning on the effective date of this permit and annually thereafter.

The preparation and submittal of a system-wide ANNUAL REPORT shall be coordinated by a *"committee."* The *"committee"* shall include a member or designated representative from each municipal entity covered by this permit. Each permittee shall be individually responsible for providing information on the portions of the MS4 for which they are the operator and for providing information for the system-wide report in a timely manner. Joint responsibility for the ANNUAL REPORT submission shall be limited to the following: (1) participation in preparation of the overview for the entire system; and (2) inclusion of the identity of any permittee who failed to provide input to the report. Each permittee shall sign and certify the ANNUAL REPORT in accordance with Part VI.H. & VI.I. of this permit, and shall include a statement or resolution that the permittee's governing body or agency (or delegated representative) has reviewed or has been appraised of the content of the ANNUAL REPORT.

The ANNUAL REPORT shall include the following sections:

- Contacts List
- SWMP Evaluation
- Summary Table
- Narrative Report
- Monitoring Section
- Summary of SWMP and Monitoring Modifications
- Fiscal Analysis
- FDOT District Report
- Appendices

The following items describe in more detail the specific requirements for the ANNUAL REPORT.

1. Provide a list of contacts and responsible parties (e.g.: agency, name, phone number) who had input to and are responsible for the preparation of the ANNUAL REPORT.

2. Provide an overall evaluation of the Storm Water Management Program including: Objective of Program; Major Findings (e.g.: water quality improvements or degradation); Major Accomplishments; Overall Program Strengths / Weaknesses; and Future Direction of Program.

3. Provide a Summary Table of Storm Water Management Program Elements.

   a. A Summary Table of appropriate SWMP annual activities for each permittee shall be provided. The purpose of the Summary Table is to document in a concise form the program activities and permittees' compliance status with quantifiable permit requirements. Program elements that are administrative (e.g.: planning procedures, program development and pilot studies) are inappropriate for the summary table and shall be discussed in the narrative section of the ANNUAL REPORT. The following are <u>examples</u> of SWMP activities to be included in the Summary Table:

      (1) <u>Structural Controls</u> - maintenance and/or inspection activities of existing structural controls

      (2) <u>Roadway Maintenance</u> - street sweeping, litter control activities, and maintenance on storm water structures & roadside ditches

      (3) <u>Municipal Waste TSD Facilities</u> - inspections, monitoring, and implementation of control measures

(4) Pesticide, Herbicide, and Fertilizer Application - certification training and public education

(5) Illicits - facility inspections, investigations, enforcement actions, illicit (dry weather) screening, illicit public reporting, oil/household hazardous waste collection, and storm sewer inlet stencilling

(6) High Risk Industrial Facilities - inspection activities and monitoring

(7) Construction - training of inspectors, certification of construction site operators, inspections, and enforcement actions

(8) Storm Water Treatment Projects - description of municipal storm water treatment projects that have been completed, including a brief description of the affected drainage basin

b. The Summary Table shall indicate each permittee's SWMP activities and accomplishments. The format for this information shall adhere to the example shown in Table V.C.1. on page 55. Items to be reported include:

(1) Activity description;

(2) Number of activities (with frequency) that were scheduled for implementation and/or accomplishment in program element discussion (i.e., once/6 months, 100%/5 years, 6 sites monitored once/year, all sites inspected/permit term). Enter "Not Applicable" (N/A) if no specific schedule was specified;

(3) Status of schedule for year ("yes" for schedule was adhered to, or "no" for schedule was not adhered to);

(4) Number of activities which were accomplished; and

(5) The availability of documentation (i.e., inspection reports) for those activities which were accomplished and comments describing the reason(s) for any non-compliance.

4. The ANNUAL REPORT shall contain a Narrative Report to succinctly discuss the SWMP Elements which were not included within the SWMP Summary Table. Those SWMP Elements required to be developed under Parts II and III of the permit shall be discussed within this section of the ANNUAL REPORT following development.

a. The permittees shall include a brief discussion of the following applicable SWMP Elements:

(1) Structural Controls Maintenance
(2) Development Planning Procedures
(3) Roadway Maintenance
(4) Flood Management
(5) Municipal Facilities
(6) Pesticides, Herbicides, and Fertilizers
(7) Illicits Inspection/Investigation/Enforcement
(8) Field Screening
(9) Spill Response
(10) Public Reporting of Illicit Discharges
(11) Oil and Household Hazardous Waste
(12) Sanitary Sewer Seepage
(13) High Risk Industrial Facility Inspection
(14) Construction Planing Procedures
(15) Construction Inspections
(14) Education Activities
(15) Monitoring Activities
(16) Any additional elements of Storm Water Management Program

b. The format for the Narrative Report section of the ANNUAL REPORT shall be a brief discussion of the SWMP Element. The aspects of each permittee's activities concerning a SWMP Element shall be succinctly discussed in the section of the Narrative Report dedicated to that Element. The discussion shall include the following:

(1) Objective of SWMP Element,

(2) SWMP Element activities completed and those in progress,

(3) General discussion of Element. Explanation of all Element activity deficiencies (e.g.: activities described in the program that have not been fully implemented or completed). Results of activities shall be summarized and discussed (e.g.: maintenance caused by inspection, pollutants detected by monitoring, investigations as a result of dry and wet weather screening, number and nature of enforcement items, education activities participation),

(4) Status of SWMP Element with compliance, implementation, and augmentation schedules in Part III of the permit,

(5) SWMP Element strengths and weaknesses,

(6) Assessment of controls, and

(7) Discussion of Element revisions that are summarized elsewhere in the ANNUAL REPORT.

5. The ANNUAL REPORT shall contain a Monitoring Section which discusses the progress and results of the monitoring programs required under Part V of the permit.

a. The Monitoring Section of the ANNUAL REPORT shall include a summary of the monitoring program developed and implemented under Part V.B.1. of the permit. The details to be discussed include:

(1) Brief summary statement of the objective of each monitoring project included under the program,

(2) Summary chart of the data from the monitoring completed,

(3) Discussion of any results or conclusions derived from the monitoring completed,

(4) Status of monitoring with respect to the compliance schedule in Part V.B.1. of the permit, and

(5) Discussion of monitoring program revisions that are summarized elsewhere in the ANNUAL REPORT.

b. The Monitoring Section of the ANNUAL REPORT shall include the following information as required in Part V.A. of the permit:

(1) The ANNUAL REPORT for Year One of the permit shall contain an inventory of all known major outfalls, with updates describing additionally identified major outfall in each sequent ANNUAL REPORT.

(2) The ANNUAL REPORT for Year Three of the permit shall include the investigation of the sources of the organic pollutants detected in the Part 2 application sampling data as required in Part V.A.2. of the permit.

(3) The ANNUAL REPORT for Year Four of the permit shall include estimates of seasonal pollutant loadings and event mean concentrations (EMC) for each major outfall required by Part V.A.1.

6. Provide a summary of SWMP and Monitoring Modifications made during the permit year.

7. Provide a complete fiscal analysis for each permittee's program implementation, both for the past calendar year and the next. The analysis shall indicate budgets and funding sources.

8. FDOT shall report on the status of the FDOT statewide Storm Water Management Program elements as shown in Table V.C.8.a. on page _56_ and shall indicate whether the resulting program modifications have been implemented at the District Office. In addition, FDOT shall also indicate the number of District employees included in the training courses described in Table V.C.8.b. on page _57_.

9. The following information shall be included as Appendices within the ANNUAL REPORT for Year Five of the permit:

   a. Analytical data collected from the monitoring program.

   b. Results of illicit connections screening or dry weather screening.

   c. Any other data specifically requested by EPA to substantiate statements and conclusions reached in the ANNUAL REPORTS.

Table **V.C.1.** - EXAMPLE Summary Table for Storm Water Management Program Element Status/Compliance (EXAMPLE ONLY)

PROGRAM ELEMENT	PERMITTEE	REQUIREMENT	ACTIVITY SCHEDULE			COMMENTS
			Activities Required by SWMP	Complied with	Activities Accomplished during calendar year	
Structural Controls	Permittee 1	Major Channels Inspected	15 Channels, once/6 mos.	YES	15 Channels, once/6 mos	Copies of Inspection Report Forms - Available Upon Request
		Major Channels Maintained	As needed	N/A	7 Channels maintained	
		Grate Inlets Inspected	1500 Inlets, once/year	NO	1000 Inlets	Ambitious projection. Reducing to 1000 next year due to resources.
	Permittee 2	Detention Ponds Maintained	1 Pond, once/month	YES	1 Pond once/month	Sediment removed after spring rains.
		Storm Drain Inlets Inspected	35 Inlets, once/6 mos.	YES	35 Inlets once/6 mos.	Copies of Inspection Report Forms - Available Upon Request
Monitoring	Permittee 1	Municipal - Landfills	2 Facilities, once/6 mos.	YES	2 Facilities once/6 mos.	Copies of Monitoring Data - Available Upon Request
		POTW	3 Facilities, once/year	NO	2 Facilities	Copies of Monitoring Data - Available Upon Request
		Industrial - Hazardous	5 Facilities, once/6 mos.	YES	5 Facilities, once/6 mos.	Copies of Monitoring Data - Available Upon Request
		Title III	3 Facilities, once/6 mos.	YES	3 Facilities, once/6 mos.	Copies of Monitoring Data - Available Upon Request
		Others	2 Facilities, once/year	YES	2 Facilities	Copies of Monitoring Data - Available Upon Request
		Dry Weather Screening	100% system, once/5 yrs.	YES	20% system	Copies of Screening Field Reports - Appendix B.
		Floatable Assessment	100 sections surveyed/yr.	YES	140 sections surveyed	Copies of Field Survey - Available Upon Request

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Table **V.C.8.a.** - Table for FDOT Statewide Storm Water Management Program Element Status

FDOT STATEWIDE STORM WATER MANAGEMENT PROGRAM ELEMENT (To Be Conducted at State Office)	**ACTIVITY ACCOMPLISHED DURING THE PERMIT YEAR?**	**DESCRIPTION OF RESULTING PROGRAM MODIFICATIONS**	**PROGRAM POLICY INCORPORATED AT DISTRICT OFFICE?**
Evaluate the feasibility of the FDOT drainage connection permit becoming an operating permit requiring long-term storm water facility management by the connecting entity.	YES / NO (If no, list anticipated completion date)		YES / NO (If no, list reason and/or anticipated implementation date.)
Add information specific to storm water runoff protection and reduction of chemical usage to the FDOT's *Turf Management Manual* and *Chemical Weed and Grass Control Manual.*	YES / NO (If no, list anticipated completion date)		YES / NO (If no, list reason and/or anticipated implementation date.)
Evaluate, on an ongoing basis, innovative structural and non-structural BMPs and new technologies as they evolve to determine their efficiency and cost effectiveness in the field. Comment on those which are found suitable & adopted for use in FDOT projects in the District.	ONGOING ACTIVITY		Describe new BMPs adopted for use in the District.
Identify those of the non-storm water discharges listed under Part II.A.7.a. on page 9 of the permit, as well as any other non-storm water discharges, which will be allowed to be discharged into the FDOT MS4.	YES / NO (If no, list anticipated completion date)		YES / NO (If no, list reason and/or anticipated implementation date.)

Table **V.C.8.b.** - Table for FDOT Statewide Storm Water Management Program Training Status

FDOT STATEWIDE STORM WATER MANAGEMENT PROGRAM TRAINING (Conducted through State Office)	**TRAINING CONDUCTED DURING THE PERMIT YEAR?**	**DESCRIPTION OF TRAINING COURSE**	**NO. OF DISTRICT EMPLOYEES COMPLETING TRAINING COURSE?**
Conduct training for FDOT maintenance and construction inspectors in the identification and detection of potential storm water related problems, signs of illegal dumping and illicit connections, proper containment methods, and reporting procedures.	YES / NO (If no, give anticipated schedule.)		
Conduct training for the FDOT Emergency Coordinator assigned to each FDOT maintenance facility. Training shall not only educate the FDOT Emergency Coordinator in the proper containment of spills and spill reporting procedures, but shall include storm water remediation activities, storm water regulations, and storm water retrofitting necessary to eliminate polluted storm water discharges from FDOT maintenance facilities.	YES / NO (If no, give anticipated schedule.)		
Conduct training for all FDOT personnel involved in the chemical weed and grass control program to ensure a safe and effective program. Incorporate into the training of these applicators an emphasis on storm water implications of the use of pesticides, herbicides, and fertilizers.	YES / NO (If no, give anticipated schedule.)		
Conduct training for all FDOT personnel involved in hazardous waste handling. Incorporate into the training a segment on the identification, detection, and reporting of illicit storm water connections and potential storm water related problems such as visible water quality degradation and signs of illegal dumping.	YES / NO (If no, give anticipated schedule.)		

D. Certification and Signature of Reports.

All reports required by the permit and other information requested by the Director shall be signed and certified in accordance with Parts VI.H. & VI.I. of the permit.

E. Reporting: Where and When to Submit.

1. As required by Part V.C., monitoring results obtained during the reporting period running from the 12 month term beginning on the effective date of this permit and annually thereafter shall be submitted on Discharge Monitoring Report Form(s) in the ANNUAL REPORT for Year Five of the permit. A separate Discharge Monitoring Report Form is required for each event monitored.

2. Signed copies of the ANNUAL REPORT required by Part V.C. and all other reports required herein, shall be submitted to:

U.S. EPA, Region IV
Water Management Division
Water Permits and Enforcement Branch (WPEB-7)
345 Courtland Street, N.E.
Atlanta, Georgia 30365

F. Additional Notification.

In addition, the permittees shall provide a copy of each ANNUAL REPORT to:

Florida Department of Environmental Protection
Bureau of Surface Water Management
Storm Water Section
Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

G. Retention of Records.

The permittees shall retain the latest version of the Storm Water Management Program developed in accordance with Part II of this permit for at least three years after the expiration date of this permit. The permittees shall retain all records of all monitoring information, copies of all reports required by this permit, and records of all other data required by or used to demonstrate compliance with this permit, until at least three years after the expiration date of this permit. This period may be explicitly modified by alternative provisions of this permit or extended by request of the Director at any time.

PART VI. STANDARD PERMIT CONDITIONS

A. **Duty to Comply.** The permittees must comply with all conditions of this permit insofar as those conditions are applicable to each permittee, either individually or jointly. Any permit noncompliance by a permittee constitutes a violation of the CWA and is grounds for enforcement action, for permit termination, revocation and reissuance, or modification, or for denial of a permit renewal application for the non-complying permittee.

B. **Penalties for Violations of Permit Conditions.**

1. Criminal

   a. Negligent Violations The CWA provides that any person who negligently violates permit conditions implementing Sections 301, 302, 306, 307, 308, 318, or 405 of the Act is subject to a fine of not less than $2,500 nor more than $25,000 per day of violation, or by imprisonment for not more than 1 year, or both.

   b. Knowing Violations The CWA provides that any person who knowingly violates permit conditions implementing Sections 301, 302, 306, 307, 308, 318, or 405 of the Act is subject to a fine of not less than $5,000 nor more than $50,000 per day of violation, or by imprisonment for not more than 3 years, or both.

   c. Knowing Endangerment The CWA provides that any person who knowingly violates permit conditions implementing Sections 301, 302, 306, 307, 308, 318, or 405 of the Act and who knows at that time that he is placing another person in imminent danger of death or serious bodily injury is subject to a fine of not more than $250,000, or by imprisonment for not more than 15 year, or both.

   d. False Statement The CWA provides that any person who knowingly makes any false material statement, representation, or certification in any application, record, report, plan, or other document filed or required to be maintained under the Act or who knowingly falsifies, tampers with, or renders inaccurate, any monitoring device or method required to be maintained under the Act, shall upon conviction, be punished by a fine of not more than $10,000 or by imprisonment for not more than 2 years, or by both. If a conviction is for a violation committed after a first conviction of such person under this paragraph, punishment shall be by a fine of not more than $20,000 per day of violation, or by imprisonment of not more than 4 years, or by both. (See Section 309(c)(4) of the Clean Water Act).

2. Civil Penalties - The CWA provides that any person who violates a permit condition implementing Sections 301, 302, 306, 307, 308, 318, or 405 of the Act is subject to a civil penalty not to exceed $25,000 per day for each violation.

3. Administrative Penalties - The CWA provides that any person who violates a permit condition implementing Sections 301, 302, 306, 307, 308, 318, or 405 of the Act is subject to an administrative penalty, as follows:

   a. Class I penalty Not to exceed $10,000 per violation nor shall the maximum amount exceed $25,000.

   b. Class II penalty Not to exceed $10,000 per day for each day during which the violation continues nor shall the maximum amount exceed $125,000.

C. **Duty to Reapply.** If a permittee(s) wishes to continue an activity regulated by this permit after the permit expiration date, the permittee(s) must apply for and obtain a new permit. The application shall be submitted at least 180 days prior to expiration of this permit. The Director may grant permission to submit an application less than 180 days in advance but no later than the permit expiration date. Continuation of expiring permits shall be governed by regulations promulgated at 40 CFR 122.6 and any subsequent amendments.

D. **Need to Halt or Reduce Activity Not a Defense.** It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

E. **Duty to Mitigate.** Each permittee shall take all reasonable steps to minimize or prevent any discharge in violation of this permit which has a reasonable likelihood of adversely affecting human health or the environment.

F. **Duty to Provide Information.** Each permittee shall furnish to the Director, within a time specified by the Director, any information which the Director may request to determine compliance with this permit. The permittees shall also furnish to the Director upon request copies of records required to be kept by this permit.

G. **Other Information.** When a permittee becomes aware that he or she failed to submit any relevant facts or submitted incorrect information in any report to the Director, he or she shall promptly submit such facts or information.

H. **Signatory Requirements.** All Discharge Monitoring Reports, storm water management programs, reports, certifications or information either submitted to the Director or that this permit requires be maintained by the permittees, shall be signed by:

1. Either a principal executive officer or ranking elected official; or

2. A duly authorized representative of that person. A person is a duly authorized representative only if:

    a. The authorization is made in writing by a person described above and submitted to the Director, and

    b. The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity, such as the position of manager, operator, superintendent, or position of equivalent responsibility or an individual or position having overall responsibility for environmental matters for the company. (A duly authorized representative may thus be either a named individual or any individual occupying a named position.)

    If an authorization is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new written authorization satisfying the requirements of this paragraph must be submitted to the Director prior to or together with any reports, information, or applications to be signed by an authorized representative.

I. **Certification.** Any person signing documents under this section shall make the following certification:

> "I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

J. **Penalties for Falsification of Reports.** Section 309(c)(4) of the Clean Water Act provides that any person who knowingly makes any false material statement, representation, or certification in any record or other document submitted or required to be maintained under this permit, including reports of compliance or noncompliance shall, upon conviction, be punished by a fine of not more than $10,000, or by imprisonment for not more than 2 years, or by both.

K. **Penalties for Falsification of Monitoring Systems.** The CWA provides that any person who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required to be maintained under this permit shall, upon conviction, be punished by fines and imprisonment described in Section 309 of the CWA.

L. **Oil and Hazardous Substance Liability.** Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittees from any responsibilities, liabilities, or penalties to which the permittee is or may be subject under section 311 of the CWA or section 106 of CERCLA.

M. **Property Rights.** The issuance of this permit does not convey any property rights of any sort, nor any exclusive privileges, nor does it authorize any injury to private property nor any invasion of personal rights, nor any infringement of Federal, State or local laws or regulations.

N. **Severability.** The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit shall not be affected thereby.

O. **Requiring an Individual Permit.**

1. The Director may require any permittee authorized by this permit to obtain an individual NPDES permit. Any interested person may petition the Director to take action under this paragraph. The Director may require any owner or operator authorized to discharge under this permit to apply for an individual NPDES permit only if the owner or operator has been notified in writing that a permit application is required. This notice shall include a brief statement of the reasons for this decision, an application form (as necessary), a statement setting a deadline for the owner or operator to file the application, and a statement that on the effective date of the individual NPDES permit, coverage under this permit shall automatically terminate. Individual permit applications shall be submitted to the address of the appropriate Regional Office shown in Part V.E.2. of this permit. The Director may grant additional time to submit the application upon request of the applicant. If an owner or operator fails to submit in a timely manner an individual NPDES permit application as required by the Director, then the applicability of this permit to the individual NPDES permittee is automatically terminated at the end of the day specified for application submittal.

2. Any owner or operator authorized by this permit may request to be excluded from the coverage of this permit by applying for an individual permit. The owner or operator shall submit an individual application as specified by 40 CFR 122.26(d) with reasons supporting the request to the Director. Individual permit applications shall be submitted to the address of the appropriate Regional Office shown in Part V.E.2. of this permit. The request may be granted by the issuance of a individual permit if the reasons cited by the owner or operator are adequate to support the request.

P. **State/Environmental Laws.**

1. Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable State law or regulation under authority preserved by Section 510 of the Act.

2. No condition of this permit shall release the permittee from any responsibility or requirements under other environmental statutes or regulations.

Q. **Proper Operation and Maintenance**. Each permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to achieve compliance with the conditions of this permit and with the requirements of storm water management programs. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. Proper operation and maintenance requires the operation of backup or auxiliary facilities or similar systems, installed by a permittee only when necessary to achieve compliance with the conditions of the permit.

R. **Monitoring and Records.**

1. Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity.

2. The permittees shall retain records of all monitoring information including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of the reports required by this permit, and records of all data used to complete the application for this permit, for a period of at least 3 years from the date of the sample, measurement, report or application. This period may be extended by request of the Director at any time.

3. Records of monitoring information shall include:

   a. The date, exact place, and time of sampling or measurements;

   b. The initials or name(s) of the individual(s) who performed the sampling or measurements;

   c. The date(s) analyses were performed;

   d. The time(s) analyses were initiated;

   e. The initials or name(s) of the individual(s) who performed the analyses;

   f. References and written procedures, when available, for the analytical techniques or methods used; and

g. The results of such analyses, including the bench sheets, instrument readouts, computer disks or tapes, etc., used to determine these results.

S. **Monitoring Methods**. Monitoring must be conducted according to test procedures approved under 40 CFR Part 136, unless other test procedures have been specified in this permit.

T. **Inspection and Entry.** The permittee shall allow the Director or an authorized representative of EPA, or the State, upon the presentation of credentials and other documents as may be required by law, to:

1. Enter the permittee's premises where a regulated facility or activity is located or conducted or where records must be kept under the conditions of this permit;

2. Have access to and copy at reasonable times, any records that must be kept under the conditions of this permit; and

3. Inspect at reasonable times any facilities or equipment (including monitoring and control equipment).

U. **Permit Actions.** This permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by the permittee for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not stay any permit condition.

V. **Additional Monitoring by the Permittee(s).** If the permittees monitor more frequently than required by this permit, using test procedures approved under 40 CFR Part 136 or as specified in this permit, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the Discharge Monitoring Report (DMR). Such increased monitoring frequency shall also be indicated on the DMR.

PART VII. PERMIT MODIFICATION

A. **Modification of the Permit:** The permit may be reopened and modified during the life of the permit to:

1. Incorporate into the permit the finalized pollutant load reduction goals agreed to by the permittees and the National Estuary Program (NEP) in the National Estuary Program Comprehensive Conservation and Management Plan for the geographical area covered by this NPDES permit;

2. Address impacts on receiving water quality caused, or contributed to, by discharges from the MS4;

3. Address changes in State or Federal statutory or regulatory requirements;

4 Include the addition of a new permittee who is the owner or operator of a portion of the Municipal Separate Storm Sewer System; or

5. Include other modifications deemed necessary by the Director to comply with the goals and requirements of the Clean Water Act.

All modification to the permit will be made in accordance with 40 CFR 122.62, 122.63, and 124.5.

B. **Termination of Coverage for a Single Permittee**

Permit coverage may be terminated, in accordance with the provisions of 40 CFR 122.64 and 124.5, for a single permittee without terminating coverage for other permittees.

C. **Modification of Storm Water Management Program(s)**

Only those portions of the Storm Water Management Programs specifically required as permit conditions shall be subject to the modification requirements of 40 CFR 124.5. Replacement of an ineffective or infeasible BMP implementing a required component of the Storm Water Management Program with an alternate BMP expected to achieve the goals of the ineffective or infeasible BMP shall be considered minor modifications to the Storm Water Management Program and not modifications to the permit. (See also Part II.G.)

D. Changes in Monitored Outfalls

This permit is issued on a system-wide basis in accordance with CWA §402(p)(3)(i) and authorizes discharges from all portions of the Municipal Separate Storm Sewer System. Since all outfalls are authorized, changes in monitoring outfalls, other than those with specific numeric effluent limitations, if any, shall be considered minor modifications to the monitoring program and not modifications to the permit. (See also Part V.B.1. and V.C.6.) Changes in monitoring outfalls with specific numeric effluent limitations shall be considered modifications to the permit and will be made in accordance with the procedures at 40 CFR 122.62.

PART VIII. DEFINITIONS

All definitions contained in Section 502 of the CWA shall apply to this permit and are incorporated herein by reference. Unless otherwise specified in this permit, additional definitions of words or phrases used in this permit are as follows:

A. "Best Management Practices" ("BMPs") means schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the United States. BMPs also include treatment requirements, operating procedures, and practices to control facility site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

B. "Bypass" means the intentional diversion of waste streams from any portion of a treatment facility, which is not a designed or established operating mode for the facility.

C. "CWA" means Clean Water Act, also referred to as "the Act" (formerly referred to as the Federal Water Pollution Control Act or Federal Water Pollution Control Act Amendments of 1972) Pub.L. 92-500, as amended Pub. L. 95-217, Pub. L. 95-576, Pub. L. 6-483 and Pub. L. 97-117, 33 U.S.C. 1251 et.seq., as amended by the WQA of 1987, P.L. 100-4, the "Act."

D. "Director" means the EPA Regional Administrator or an authorized representative.

E. "Discharge" for the purpose of this permit, unless indicated otherwise, refers to discharges from the Municipal Separate Storm Sewer System (MS4).

F. "Flow-weighted composite sample" means a composite sample consisting of a mixture of aliquots collected at a constant time interval, where the volume of each aliquot is proportional to the flow rate of the discharge at the time of sampling.

G. "Illicit connection" means any man-made conveyance connecting a non-storm water discharge directly to a municipal separate storm sewer system.

H. "Illicit discharge" means any discharge to a municipal separate storm sewer that is not composed entirely of storm water except discharges pursuant to a NPDES permit (other than the NPDES permit for discharges from the municipal separate storm sewer) and other discharges listed in Part II. A.7.a. of this permit.

I. "Industrial Land Use" means land utilized in connection with manufacturing, processing, or raw materials storage at facilities identified under 40 CFR 122.26(b)(14).

J. "Landfill" means an area of land or an excavation in which wastes are placed for permanent disposal, and which is not a land application unit, surface impoundment, injection well, or waste pile.

K. "Large Municipal Separate Storm Sewer System" means all municipal separate storm sewers that are either:

(i) located in an incorporated place (city) with a population of 250,000 or more as determined by the latest Decennial Census by the Bureau of Census (these cities are listed in Appendices F and G of 40 CFR Part 122); or

(ii) located in the counties with unincorporated urbanized populations of 250,000 or more, except municipal separate storm sewers that are located in the incorporated places, townships or towns within such counties (these counties are listed in Appendices H and I of 40 CFR Part 122); or

(iii) owned or operated by a municipality other than those described in paragraph (i) or (ii) and that are designated by the Director as part of the large municipal separate storm sewer system.

L. "Medium Municipal Separate Storm Sewer System" means all municipal separate storm sewers that are either:

(i) located in an incorporated place (city) with a population of 100,000 or more as determined by the latest Decennial Census by the Bureau of Census (these cities are listed in Appendices F and G of 40 CFR Part 122); or

(ii) located in the counties with unincorporated urbanized populations of 100,000 or more, except municipal separate storm sewers that are located in the incorporated places, townships or towns within such counties (these counties are listed in Appendices H and I of 40 CFR Part 122); or

(iii) owned or operated by a municipality other than those described in paragraph (i) or (ii) and that are designated by the Director as part of the medium municipal separate storm sewer system.

M. "MEP" is an acronym for "Maximum Extent Practicable," the technology-based discharge standard for Municipal Separate Storm Sewer Systems established by CWA §402(p).

N. "MS4" is an acronym for "municipal separate storm sewer system" and is used to refer to either a Large or Medium Municipal Separate Storm Sewer System (e.g. "the Atlanta MS4").

O. "Municipal Separate Storm Sewer" means a conveyance, or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, and storm drains):

(i) owned or operated by a State, city, town, borough, county, parish, district, association, or other public body (created by or pursuant to State Law) having jurisdiction over disposal of sewage, industrial wastes, storm water, or other wastes, including special districts under State Law such as a sewer district, flood control district or drainage district, or similar entity, or an Indian Tribe or an authorized Indian tribal organization, or a designated and approved management agency under section 208 of the CWA that discharges to waters of the United States;

(ii) designed or used for collecting or conveying storm water;

(iii) which is not a combined sewer; and

(iv) which is not part of a Publicly Owned Treatment Works (POTW) as defined at 40 CFR 122.2.

P. "Permittee" means each individual co-applicant for an NPDES permit who is only responsible for permit conditions relating to the discharge that they own or operate. (Also, See 40 CFR 122.2)

Q. "Point Source" means any discernible, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel or other floating craft from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture or agricultural storm water runoff.

R. "Severe property damage" means substantial physical damage to property, damage to the treatment facility which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

S. "State Storm Water Quality Standards", is defined at Section 403.0891 of the Florida Statutes, and State Water Policy, Chapter 62-40, Florida Administrative Code.

T. "Storm Sewer", unless otherwise indicated, refers to a municipal separate storm sewer.

U. "Storm Water" means storm water runoff, snow melt runoff, surface runoff and drainage.

V. "Storm Water Discharge Associated with Industrial Activity" is defined at 40 CFR 122.26(b)(14). (Also, See Fact Sheet for this Permit.)

W. "Storm Water Management Program" refers to a comprehensive program to manage the quality of storm water discharged from the municipal separate storm sewer system. For the purposes of this permit, the Storm Water Management Program is considered a single document, but may actually consist of separate programs (e.g. "chapters") for each permittee.

X. "Surface Water Ambient Monitoring Program" refers to a comprehensive program implemented by the Florida Department of Environmental Protection, Bureau of Surface Water Management, which is designed to accomplish the following goals:

1. Identify and document the existing condition of the surface waters of the State,

2. Document potential problem areas,

3. Establish stream ecoregion reference sites for comparison purposes,

4. Collect biological data at ecoregion reference sites to establish preliminary biological integrity measurements techniques, and

5. Establish a Statewide ambient monitoring network which will eliminate duplication, share data, increase efficiency, and improve assessment and management capabilities.

To date, the monitoring strategies included within the State of Florida's Surface Water Ambient Monitoring Program have been based on:

- Ecoregion Subregionalization and the associated stream Community Bioassessment Protocols (CBA) developed for the nonpoint source program,
- Chemistry Trend Network to fulfill the need to evaluate the State's water quality over time,
- Chemistry Status Network with emphasis on water bodies with fair or poor water quality or areas which have not been recently sampled, and
- Lake Ecoregion and Community Bioassessment Projects.

Y. "SWMP" is an acronym for "Storm Water Management Program."

Z. "Time-weighted composite" means a composite sample consisting of a mixture of equal volume aliquots collected at a constant time interval.

AA. "Waters of the United States" is defined at 40 CFR 122.2.

AUTHORIZATION TO DISCHARGE

OKLAHOMA POLLUTANT DISCHARGE ELIMINATION SYSTEM

Permit Number OKS000201

In compliance with the Oklahoma Pollutant Discharge Elimination System Act (OPDES Act), Title 27A O.S. Supp.1999, § 2-6-201 *et seq.*, and the rules of the State of Oklahoma Department of Environmental Quality (DEQ) adopted hereunder {See OAC 252:605}; the Federal Clean Water Act, Public Law 95-217 (33 U.S.C. 1251 *et seq.*), Section 402; and NPDES Regulations (40 CFR Parts 122, 124, 136 and 403),

City of Tulsa 4818 S. Elwood Tulsa, OK 74107	Oklahoma Transportation Authority P.O. Box 11357 Oklahoma City, OK 73136	Oklahoma Department of Transportation 200 N.E. 21st Street Oklahoma City, OK 73105

co-permittees are hereby authorized to discharge storm water from the Municipal Separate Storm Sewer System to receiving waters:

Arkansas River Basin

Blackboy Creek, Cherry-Red Fork Creek, Vensel Creek, Crow Creek, Downtown Creek, Upper Joe Creek, Elm Creek, Fred Creek, Swan Creek, Fry Ditch No. 2, Garden City, S. Fork, Little Joe Creek, Hager Creek, Haikey Creek, S. Tulsa Drainage Area, Harlow Creek, Lower Basin, Perry Ditch, Lower Basin, Mooser Creek, Parkview Creek, Nickel Creek, N. Fork Little Joe, and Oak Creek.

Verdigris River Basin

Adams Creek, Center-Rolling Hills Creek, Bird Creek, Coal Creek, Cooley Creek, Dirty Butter Creek, Flat Rock Creek, Lower Middle Mingo Creek, Mingo Creek, Lower Mingo Creek, Reservoir Creek, Spunky - Pond Creeks, Upper Mingo Creek, and Upper Middle Mingo Creek and Knudson Creek.

Also included are tributaries thereto, in accordance with effluent limitations, monitoring requirements and other conditions set forth in Parts I, II, III, IV, V, VI, VII, and VIII hereof.

This permit shall become effective on January 13, 2003 It will replace and/or supersede the permit issued on April 1, 1997.

This permit and the authorization to discharge shall expire at midnight January 12, 2008.

For The Oklahoma Department of Environmental Quality:

/signed/
Mark Derichsweiler, P.E.
Engineering Manager

/signed/
Jon L. Craig, Director
Water Quality Division

A018130

TULSA MUNICIPAL SEPARATE STORM SEWER SYSTEM

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PART I. DISCHARGES AUTHORIZED UNDER THIS PERMIT

A. Permit Area

This permit covers all areas located within the corporate boundary of the City of Tulsa that are served by municipal separate storm sewers owned or operated by the permittee(s).

B. Authorized Discharges

1. Except for discharges prohibited under Part I.B.2, this permit authorizes all existing or new storm water point source discharges to waters of the State from those portions of the Municipal Separate Storm Sewer System owned or operated by the permittee(s).
2. This permit does not authorize the following discharges, whether discharged separately or commingled with municipal storm water:
   a. *Non-storm Water and Industrial Storm Water:* discharges of non-storm water, any Storm Water Discharge Associated with Industrial Activity, or other storm water discharges required by the Director to obtain an OPDES permit, except where such discharges are identified by and in compliance with Part II. A. 6. a. This permit does not transfer liability for discharging without (or in violation of) an OPDES permit from the operator of the discharge to the permittee(s).
   b. *Spills*: discharges of material resulting from a spill. This permit does not transfer liability for a spill itself from the party(s) responsible for the spill to the permittee(s) nor relieve the party(s) responsible for a spill from the reporting requirements of 40 CFR Part 117 and 40 CFR Part 302.

C. Permittee Responsibilities

1. Each permittee is responsible for:
   a. Compliance with permit conditions relating to discharges from portions of the Municipal Separate Storm Sewer System where the permittee is the operator;
   b. Storm Water Management Program implementation on portions of the Municipal Separate Storm Sewer System where the permittee is the operator;
   c. Compliance with annual reporting requirements as specified in Part V. C.;
   d. Collection of representative wet weather monitoring data required by Part V. A., according to such agreements as may be established between permittees; and
   e. A plan of action to assume responsibility for implementation of storm water management and monitoring programs on their portions of the Municipal Separate Storm Sewer System should interjurisdictional agreements allocating responsibility between permittees be dissolved or in default.
2. Permittees are jointly responsible for permit compliance on portions of the Municipal Separate Storm Sewer System where operational or Storm Water Management Program implementation authority over portions of the Municipal

Separate Storm Sewer System is shared or has been transferred from one permittee to another in accordance with legally binding agreements.

D. Discharge Goals

The following goals are established for discharges from the Municipal Separate Storm Sewer System:

1. No discharge of toxic pollutants in toxic amounts;
2. No discharge of pollutants in quantities that would cause a violation of Oklahoma's Water Quality Standards;
3. No discharge of floatable debris, oils, scum, foam, or grease in other than trace amounts.
4. No discharge of non-storm water from the municipal separate storm sewer system (except as provided in Part I. B. 2.);
5. No impairment or loss of State-designated beneficial uses of receiving waters as a result of storm water discharges from the municipal separate storm sewer. No degradation of receiving waters as a result of storm water discharges from the MS4 except as authorized by the State in accordance with the State's Antidegradation Policy [Title 82 O.S. § 1085.30 (C)(1) and OAC 785:45-5-25].

PART II. STORM WATER POLLUTION PREVENTION & MANAGEMENT PROGRAM

Each permittee shall contribute to the development, revision and implementation of a comprehensive Storm Water Management Program including pollution prevention measures, treatment or removal techniques, storm water monitoring, use of legal authority, and other appropriate means to control the quality of storm water discharged from the Municipal Separate Storm Sewer System. The Storm Water Management Program shall be implemented in accordance with Section 402(p)(3)(B) of the Act, and the Storm Water Regulations (40 CFR Part 122.26).

Controls and activities in the Storm Water Management Program shall identify areas of permittee responsibility on a jurisdiction, applicability, or specific area basis. The Storm Water Management Program shall include controls necessary to effectively prohibit the discharge of non-storm water into municipal separate storm sewers and reduce the discharge of pollutants from the Municipal Separate Storm Sewer System to the Maximum Extent Practicable (MEP).

The Storm Water Management Program shall cover the term of this permit and shall be updated as necessary, or as required by the Director, to ensure compliance with the statutory requirements of Section 402(p)(3)(B) of the Act. Modifications to the Storm Water Management Program shall be made in accordance with Part II.G of the permit. Compliance with the Storm Water management Program shall be deemed compliant with Part II. A. and II. B. The Storm Water Management Program, and all updates made in accordance with Part II. G are hereby incorporated by reference.

Implementation of the Storm Water Management Program may be achieved through participation with other permittees, public agencies, or private entities in cooperative efforts to satisfy the requirements of Part II in lieu of creating duplicate program elements for each individual permittee. The Storm Water Management Program, taken as a whole, shall achieve the "effective prohibition on the discharge of non-storm water" and "MEP" standards from Section 402(p)(3)(B) of the Act.

A. Storm Water Management Program Requirements

1. *Structural Controls and Storm Water Collection System Operation:* The Municipal Separate Storm Sewer System and any storm water structural controls shall be operated in manner to reduce the discharge of pollutants to the Maximum Extent Practicable.
2. *Areas of New Development and Significant Redevelopment:* A comprehensive master planning process (or equivalent) to develop, implement, and enforce controls to minimize the discharge of silt, scrap, trash, and other pollutants from areas of new development and significant re-development after construction is completed shall be implemented. The goals of such controls shall be:
   a. *New development:* limiting increases in the discharge of pollutants in storm water as a result of development;
   b. *Re-development:* reducing the discharge of pollutants in storm water; and
   c. *Post Construction Runoff Controls*: minimize increases in the quantity of storm

water and the discharge of pollutants in storm water discharges from post construction runoff.

3. *Roadways:* Public streets, roads, and highways shall be operated and maintained in a manner to minimize discharge of pollutants, including those pollutants related to deicing or sanding activities. Road maintenance and deicing contractors shall be familiar with MS4 regulations and requirements to prevent contamination of the Waters of the State. Contracts shall include appropriate provisions to ensure compliance with the SWMP and this permit.

4. *Flood Control Projects:* Impacts on receiving water quality shall be assessed for all flood management projects. The feasibility of retrofitting existing structural flood control devices to provide additional pollutant removal from storm water shall be evaluated.

5. *Pesticide, Herbicide, and Fertilizer Application:* Each permittee shall implement controls to reduce the discharge of pollutants related to the permittee's storage and application of pesticides, herbicides, and fertilizers. Permittees with jurisdiction over lands not directly owned by that entity (e.g. incorporated city with authority over activities occurring anywhere within their city limits) shall also implement programs to reduce the discharge of pollutants related to commercial application and distribution of pesticides, herbicides, and fertilizers.

6. *Illicit Discharges and Improper Disposal*: Non-storm water discharges to the Municipal Separate Storm Sewer System shall be effectively prohibited. For the purpose of this permit, the following discharges need not be addressed as illicit discharges by the permittee(s) nor prohibited from entering the Municipal Separate Storm Sewer System: discharges regulated by a separate OPDES or NPDES permit; and non-storm water discharges identified by the permittee as specified in item (a) below.

   a. Permittee(s) shall identify in the Storm Water Management Program any categories of non-storm water that are not prohibited from being discharged into the Municipal Separate Storm Sewer System, in accordance with conditions described in items (1) and (2) below.

      (1) Categories of non-storm water discharges that the permittee(s) may exempt from the prohibition on non-storm water entering the Municipal Separate Storm Sewer System include those either:

         (a) listed in 40 CFR 122.26(d)(2)(iv)(B)(1); or

         (b) other similar occasional incidental non-storm water discharges (e.g. non-commercial or charity car washes, etc.).

      (2) Categories of non-storm water discharges exempted from the prohibition on non-storm water must not be reasonably expected [based on information available to the permittee(s)] to be significant sources of pollutants to the waters of the State, because of either:

(a) the nature of the discharges; or

(b) conditions placed on the discharges by the permittee(s).

The Storm Water Management Program shall describe any local controls or conditions placed on discharges exempted from the prohibition on non-storm water. Permittee(s) shall prohibit any individual non-storm water discharge otherwise exempted under this paragraph from the prohibition on non-storm water that is determined to be contributing significant amounts of pollutants to the Municipal Separate Storm Sewer System.

b. Each permittee shall prevent (or require the operator of the sanitary sewer to eliminate) unpermitted discharges of dry and wet weather overflows from sanitary sewers into the Municipal Separate Storm Sewer System. Each permittee shall limit the infiltration or seepage from sanitary sewers into the Municipal Separate Storm Sewer System.

c. The permittee(s) shall ensure the implementation of a program to reduce the discharge of floatables (e.g. litter and other human-generated solid refuse). The floatables control program shall include source controls and, where necessary, structural controls.

d. The discharge or disposal of used motor vehicle fluids and household hazardous wastes and the intentional disposal of collected quantities of grass clippings, leaf litter, and animal wastes into storm sewers shall be prohibited. The permittee(s) shall ensure the implementation of programs to collect used motor vehicle fluids (at a minimum, oil and antifreeze) for recycle, reuse, or proper disposal and to collect household hazardous waste materials (including paint, solvents, pesticides, herbicides, and other hazardous materials) for recycle, reuse, or proper disposal. Such programs shall be readily available to all private residents and shall be publicized and promoted on a regular basis.

e. A program to locate and eliminate illicit discharges and improper disposal into the MS4 shall be revised, updated as needed and implemented. This program shall include dry weather screening activities to locate portions of the Municipal Separate Storm Sewer System with suspected illicit discharges and improper disposal. Follow-up activities to eliminate illicit discharges and improper disposal may be prioritized on the basis of magnitude and nature of the suspected discharge; sensitivity of the receiving water; and/or other relevant factors. This program shall establish priorities and schedules for screening the entire Municipal Separate Storm Sewer System at least once per five years. The permittee(s) shall utilize a consistent method (e.g. by land area, by outfall, etc.) for determining the percentage of the municipal separate storm sewer system that has been screened. Facility inspections may be carried out in conjunction with other municipal programs (e.g. pretreatment inspections of industrial users, health inspections, fire inspections, etc.), but must include random inspections for facilities not normally visited by the municipality.

f. Each permittee shall require the elimination of illicit discharges and improper disposal practices as expeditiously as reasonably possible. Where elimination of an illicit discharge within thirty (30) days is not possible, the permittee shall require an expeditious schedule for removal of the discharge. In the interim, the permittee shall require the operator of the illicit discharge to take all reasonable and prudent measures to minimize the discharge of pollutants to the Municipal Separate Storm Sewer System.

g. The permittee(s) shall maintain, and update as necessary, a list of discharges to municipal separate storm sewers that have been issued an OPDES permit or authorization. The list shall include the name, location and OPDES permit authorization number of the discharger.

7. *Spill Prevention and Response:* A program to prevent, contain, and respond to spills that may discharge into the MS4 shall be implemented. Where discharge of material resulting from a spill is necessary to prevent loss of life, personal injury, or severe property damage, the permittees shall take, or insure the responsible party for the spill takes, all reasonable steps to minimize or prevent any adverse effects on human health or the environment. The spill response program shall be made a part of the SWMP and include a combination of spill response actions by the permittee(s) (and/or another public or private entity), and legal requirements for private entities within the permittee's jurisdiction.

8. *Industrial & High Risk Runoff:* A program to identify and control pollutants in storm water discharges to the Municipal Separate Storm Sewer System from municipal landfills; other treatment, storage, or disposal facilities for municipal waste (e.g. transfer stations, incinerators, etc.); hazardous waste treatment, storage, disposal and recovery facilities; facilities that are subject to EPCRA Title III, Section 313; and any other industrial or commercial discharge the permittee(s) determines are contributing a substantial pollutant loading to the Municipal Separate Storm Sewer System shall be implemented. The program shall include:

a. priorities and procedures for inspections, monitoring (see also II. A. 12. c), and establishing and implementing control measures for such discharges; and

b. a list of industrial storm water sources discharging to the Municipal Separate Storm Sewer System that shall be maintained and updated as necessary.

9. *Construction Site Runoff:* A program to reduce the discharge of pollutants from construction sites shall be implemented. This program shall include:

a. requirements for the use and maintenance of appropriate structural and nonstructural best management practices to reduce pollutants discharged to the Municipal Separate Storm Sewer System during the time construction is underway;

b. inspection of construction sites and enforcement of control measures (in accordance with priorities and procedures established in the Storm Water Management Program);

c. appropriate education and training measures for construction site operators; and

d. notification of appropriate building permit applicants of their potential responsibilities under the NPDES permitting program for construction site runoff.

10. *Public Education:* A public education program with the following elements shall be revised and updated as needed:

    a. a program to promote, publicize, and facilitate public reporting of the presence of illicit discharges or improper disposal of materials, including floatables, into the Municipal Separate Storm Sewer System;

    b. a program to promote, publicize, and facilitate the proper management and disposal of used motor vehicle fluids and household hazardous wastes;

    c. a program to promote, publicize, and facilitate the proper use, application, and disposal of pesticides, herbicides, and fertilizers by the public and commercial and private applicators and distributors.

11. *Employee Education:* Permittees shall revise and update as needed a program to educate appropriate employees on internal policies and procedures, including education for engineers, specialists, and inspectors on the rules and regulations for permit compliance and municipal ordinances. A program to educate contractors responsible for herbicide, pesticide and fertilizer application, landscape specialists and other lawn care providers specifically on the proper use of chemicals, disposal thereof and spill prevention procedures shall be implemented.

12. *Monitoring Programs:* The following monitoring programs shall be implemented in addition to the monitoring required by Part V.

    a. *Dry Weather Screening Program:* Permittees shall continue ongoing efforts to detect the presence of illicit connections and improper discharges to the Municipal Separate Storm Sewer System. All areas of the Municipal Separate Storm Sewer System must be screened at least once during the permit term. Screening methodology may be modified based on experience gained during actual field screening activities and need not conform to the protocol at 40 CFR 122.26(d)(1)(iv)(D). Sample collection and analysis need not conform to the requirements of 40 CFR Part 136. However, samples taken to confirm (e.g. in support of possible legal action) a particular illicit connection or improper disposal practice should conform to the requirements of 40 CFR Part 136.

    b. *Wet Weather Screening Program:* The permittee(s) shall identify, investigate, and address areas within their jurisdiction that may be contributing excessive levels of pollutants to the Municipal Separate Storm Sewer System. The wet weather screening program:

(1) shall screen the Municipal Separate Storm Sewer System, in accordance with the procedures specified in the Storm Water Management Program.

(2) shall specify the sampling and non-sampling techniques to be used for initial screening and follow-up purposes. Sample collection and analysis need not conform to the requirements of 40 CFR Part 136. However, samples taken to confirm (e.g. in support of possible legal action) a particular discharger is a source of significant quantities of pollutants should conform to the requirements of 40 CFR Part 136.

c. *Industrial and High Risk Runoff Monitoring Program:* The program shall include monitoring for pollutants in storm water discharges to the Municipal Separate Storm Sewer System from municipal landfills; other treatment, storage, or disposal facilities for municipal waste (e.g. transfer stations, incinerators, etc.); hazardous waste treatment, storage, disposal and recovery facilities; facilities that are subject to EPCRA Title III, Section 313; and any other industrial or commercial discharge the permittee(s) determines are contributing a substantial pollutant loading to the Municipal Separate Storm Sewer System.

(1) Except as provided in (2) below, the monitoring program shall include the collection of quantitative data on the following constituents:

(a) any pollutants limited in an existing OPDES permit for a subject facility;

(b) oil and grease;

(c) chemical oxygen demand (COD);

(d) pH;

(e) biochemical oxygen demand, five-day (BOD_5);

(f) total suspended solids (TSS);

(g) total phosphorous;

(h) total Kjeldahl nitrogen (TKN);

(i) nitrate plus nitrite nitrogen; and

(j) any information on discharges required under 40 CFR 122.21(g)(7)(iii) and (iv).

Data collected by the industrial facility to satisfy the monitoring requirements of an NPDES or State discharge permit may be used to satisfy this requirement. Permittee(s) may require the industrial facility to conduct self-monitoring to satisfy this requirement.

(2) Alternative Certification: In lieu of monitoring, the permittee may accept a certification from a facility that raw and waste materials, final and intermediate products, by-products, material handling equipment or activities, industrial machinery or operations, or significant materials from past industrial activity are not presently exposed to storm water and are not expected to be exposed to storm water for the certification period. Where the permittee(s) accept a "no exposure" certification, the permittee(s) shall conduct at least one site inspection of the facility every five years to verify the "no exposure" certification.

B. Area-specific Storm Water Management Program Requirements (Reserved)

C. Deadlines for Program Implementation

Full implementation of the Storm Water Management Program shall begin on the effective date of the permit.

D. Roles and Responsibilities of Permittee(s)

The Storm Water Management Program, together with any attached interagency agreements, shall clearly identify the roles and responsibilities of each permittee.

E. Legal Authority

Each permittee shall ensure legal authority to control discharges to and from those portions the Municipal Separate Storm Sewer System over which it has jurisdiction. This legal authority may be a combination of statute, ordinance, permit, contract, order or inter-jurisdictional agreements with permittees with existing legal authority to:

1. Control the contribution of pollutants to the Municipal Separate Storm Sewer System by Storm Water Discharges Associated with Industrial Activity and the quality of storm water discharged from sites of industrial activity;
2. Prohibit illicit discharges to the Municipal Separate Storm Sewer System;
3. Control the discharge of spills and the dumping or disposal of materials other than storm water (e.g. industrial and commercial wastes, trash, used motor vehicle fluids, leaf litter, grass clippings, animal wastes, etc.) into the Municipal Separate Storm Sewer System;
4. Control through interagency or interjurisdictional agreements among permittees the contribution of pollutants from one portion of the Municipal Separate Storm Sewer System to another;
5. Require compliance with conditions in ordinances, permits, contracts or orders; and
6. Carry out all inspections, surveillance and monitoring procedures necessary to determine compliance with permit conditions.

F. Storm Water Management Program Resources

Each permittee shall provide adequate finances, staff, equipment, and support capabilities to implement their activities under the Storm Water Management Program.

G. Storm Water Management Program Review and Update

1. *Storm Water Management Program Review:* Each permittee shall participate in an annual review of the current Storm Water Management Program in conjunction with preparation of the annual report required under V. C.

2. *Storm Water Management Program Update:* The permittee(s) may change the Storm Water Management Program during the life of the permit in accordance with the following procedures:

   a. The approved Storm Water Management Program shall not be changed by the permittee(s) without the approval of the Director, unless in accordance with Parts II.G.2.b, or c.

   b. Changes adding (but not subtracting or replacing) components, controls, or requirements to the Storm Water Management Program may be made by the permittee(s) at any time upon written notification to the Director.

   c. Changes replacing an ineffective or unfeasible BMP specifically identified in the Storm Water Management Program with an alternate BMP may be requested at any time. Unless denied by the Director, changes proposed in accordance with the criteria below shall be deemed approved and may be implemented by the permittee(s) 60 days from submittal of the request. If request is denied, the Director will send the permittees a written response giving a reason for the decision. Such requests shall include the following:

      (1) an analysis of why the BMP to be replaced is ineffective or infeasible (including cost prohibitive),

      (2) expectations on the effectiveness and feasibility of the replacement BMP, and

      (3) an analysis of why the replacement BMP is expected to achieve the goals of the BMP to be replaced.

   d. Change requests and/or notifications shall be made in writing, signed in accordance with Part VI. H. by all directly affected permittees, and include a certification that all permittees were given an opportunity to comment on proposed changes.

3. *Updates Required by the Permitting Authority:* The permitting authority may require changes to the Storm Water Management Program as needed to:

   a. address impacts on receiving water quality caused, or contributed to, by discharges from the Municipal Separate Storm Sewer System;

   b. include more stringent requirements necessary to comply with new State or

Federal statutory or regulatory requirements;

c. include such other conditions deemed necessary by the Director to comply with the goals and requirements of the Act, and

d. update and implement changes required by any approved TMDL that addresses storm water pollutants.

Changes requested by the Director shall be made in writing, set forth the time schedule for the permittee(s) to develop the changes, and offer the permittee(s) the opportunity to propose alternative program changes to meet the objective of the requested modification. All changes required by the Director shall be made in accordance with 40 CFR 124.5, 40 CFR 122.62, or as appropriate 40 CFR 122.63.

4. *Transfer of Ownership, Operational Authority, or Responsibility for Storm Water Management Program Implementation:* The permittee(s) shall implement the Storm Water Management Program on all new areas added to their portion of the municipal separate storm sewer system (or for which they become responsible for implementation of storm water quality controls) as expeditiously as practicable, but not later than three years from addition of the new areas. Implementation may be accomplished in a phased manner to allow additional time for controls that cannot be implemented immediately.

   Within 90 days of a transfer of ownership, operational authority, or responsibility for storm water management program implementation, the permittee(s) shall have a plan for implementation the Storm Water Management Program on all affected areas. The plan may include schedules for implementation. Information on all new annexed areas and any resulting updates required to the Storm Water Management Program shall be submitted in the annual report.

H. Retention of Storm Water Management Program Records.

The permittee shall retain the Storm Water Management Program developed in accordance with Part II for at least 3 years after coverage under this permit terminates.

PART III. SCHEDULES FOR IMPLEMENTATION AND COMPLIANCE

A. Implementation and Augmentation of SWMP

A schedule for implementation and compliance for the creation of a SWMP is neither necessary nor required because a complete SWMP is already in effect. If changes are necessary, they will be made and a revised SWMP submitted with the annual report as required by Part II. G.

B. Compliance With Effluent Limitations (Reserved)

C. Updating SWMP

The permittee(s) shall update the SWMP as appropriate in response to changes required. Updates shall be made in accordance with Part II. G.

PART IV. DISCHARGE LIMITATIONS (RESERVED)

PART V. MONITORING AND REPORTING REQUIREMENTS

A. Storm Event Discharges

1. *Representative Monitoring:* Monitoring shall be conducted on representative outfalls, internal sampling stations, and/or in-stream monitoring locations to characterize the quality of storm water discharges from the Municipal Separate Storm Sewer System.

   a. Monitoring Requirements: Refer to Table(s) V.A.1.a.

   b. Outfall Descriptions: Refer to Table V. A. 1. b.

   c. Alternate representative monitoring: locations may be substituted for just cause during the term of the permit. Requests for approval of alternate monitoring locations shall be made to the Director in writing and include the rationale for the requested monitoring station relocation. Unless disapproved by the Director, use of an alternate monitoring location (except for outfalls with numeric effluent limitations) may commence 30 days from the date of the request. For outfalls where numeric effluent limitations have been established, the permit must be modified prior to substitution of alternate monitoring locations. Six samples shall be collected during the first year of monitoring at substitute outfalls.

Table V.A.1.a. - Representative Monitoring Requirements: Outfalls 001, 002, 003, 003, 004, & 005

PARAMETERS and STORET Code	REPORT FOR EACH MONITORING PERIOD (each sample type)			SAMPLE TYPE(S)		MONITORING FREQUENCY[1]
	Min.	Ave.	Max.	Grab	Composite	
Biochemical Oxygen Demand (BOD_5) (mg/l) – 00310		Yes	Yes		Yes	1/season[2]
Chemical Oxygen Demand (COD) (mg/l) – 00340		Yes	Yes		Yes	1/season
Oil and Grease (mg/l) - 00556		Yes	Yes	Yes		1/season
Total Suspended Solids (TSS) (mg/l) – 00530		Yes	Yes		Yes	1/season
Total Dissolved Solids (TDS) (mg/l) - 70300		Yes	Yes		Yes	1/season
Total Nitrate-Nitrate Nitrogen (mg/l) – 00630		Yes	Yes		Yes	1/season
Total Kjeldahl Nitrogen (TKN) (mg/l) – 00625		Yes	Yes		Yes	1/season
Total Phosphorus (mg/l) - 00665		Yes	Yes		Yes	1/season
Dissolved Phosphorus (mg/l) - 00666		Yes	Yes		Yes	1/season
Total Cadmium (ug/l) - 01027		Yes	Yes		Yes	1/season
Total Copper (ug/l) - 01042		Yes	Yes		Yes	1/season
Total Lead (ug/l) - 01051		Yes	Yes		Yes	1/season
Total Zinc (ug/l) - 01092		Yes	Yes		Yes	1/season
Fecal Coliform (colonies/100 ml) - 74055		Yes	Yes	Yes		1/season
pH (S.U.) - 00400	Yes		Yes	Yes		1/season
Hardness (as $CaCO_3$) (mg/l) - 00900	Yes	Yes	Yes	Yes		1/season
Temperature (°C) - 00010	Yes	Yes	Yes	Yes		1/season
Diazinon (ug/l) - 39570		Yes	Yes		Yes	1/season

1. Monitoring frequency for each year.
2. Seasonal monitoring periods are: July - October, November - February, and March - June.

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Table V.A.1.b - Representative Monitoring Outfall Descriptions

OUTFALL	LOCATION	DESCRIPTION	RESPONSIBLE PERMITTEE
001	2400 26th Street East, 200 feet west of Lewis Avenue and 5 ft south of 26th Street	100% old residential, drains 39.3 acres	City of Tulsa
002	11th Street (Southwest Blvd.), on the east bank of the Arkansas River, 50 ft north of the old 11th St. Bridge	Old commercial area, drains approximately 14.7 acres	City of Tulsa
003	71st Street East @ Joe Creek, 50 ft. south of 71st Street on the west bank of Joe Creek	100% New Commercial, drains 15.1 acres	City of Tulsa
004	54th Street East @ Mingo Creek, on the west bank of Mingo Creek at the end of 54th Street	100% Industrial, drains 25.0 acres	City of Tulsa
005	9717 58th Street East, directly north of 9717 E. 58th Street on the south bank of Mingo Creek	100% Industrial, drains 23.0 acres	City of Tulsa

2. *Storm Event Data:* For Part V. A. 1. and any additional sampling conducted, quantitative data shall be collected to estimate pollutant loadings and event mean concentrations for each parameter sampled. Records shall be maintained of all analytical results, the date and duration (in hours) of the storm event(s) sampled; rainfall measurements or estimates (in inches) of the storm event which generated the sampled runoff; the duration (in hours) between the storm event sampled and the end of the previous measurable (greater than 0.1 inch rainfall) storm event; and an estimate of the total volume (in gallons) of the discharge sampled.

3. *Sample Type, Collection, and Analysis:* The following requirements apply only to samples collected for Part V. A. 1 and any additional sampling conducted for Part V. A. 2.

   a. For discharges from holding ponds or other impoundments with a retention period greater than 24 hours, (estimated by dividing the volume of the detention pond by the estimated volume of water discharged during the 24 hours previous to the time that the sample is collected) a minimum of one grab sample may be taken.

   b. Grab samples taken within the first two hours of discharge shall be used for the analysis (if required) of pH, temperature, cyanide, oil & grease, fecal coliform, fecal streptococcus, total phenols, residual chlorine, and (at the permittee's option) volatile organics. For all other parameters, data shall be reported for flow weighted composite samples of the entire event or, at a minimum, the first three hours of discharge.

   c. Samples shall be collected from the discharge resulting from a representative storm event that is greater than 0.1 inches in magnitude and that occurs at least 72 hours from the previously measurable (greater than 0.1 inch rainfall) storm event. Composite samples may be taken with a continuous sampler or as a combination of a minimum of three sample aliquots taken in each hour of discharge for the entire discharge or for the first three hours of the discharge, with each aliquot being separated by a minimum period of fifteen minutes.

      The required 72 hour storm event interval is waived where the preceding measurable storm event did not result in a measurable discharge. The required 72 hour storm event interval may also be waived where the permittee(s) documents that less than a 72 hour interval is representative for local storm events during the season when sampling is being conducted.

   d. Analysis and collection of samples shall be done in accordance the methods specified at 40 CFR Part 136. Where an approved Part 136 method does not exist, any available method may be used unless a particular method or criteria for method selection (such as sensitivity) has been specified in the permit.

4. *Seasonal Loadings and Event Mean Concentrations:* All necessary sampling data shall be collected to provide estimates for each major outfall of seasonal pollutant loadings and event mean concentrations for a representative storm event for the

parameters listed in Table V.A.1.a - Representative Monitoring Requirements. This information may be estimated from the representative monitoring locations and shall take into consideration land uses and drainage areas for the outfall. The estimates of seasonal loadings and event mean concentrations shall be included in the Annual Report for year four of the permit.

B. Floatables Monitoring

The permittees shall establish two monitoring locations for removal of floatable material in discharges to or from the Municipal Separate Storm Sewer System. Floatable material shall be collected at the frequency necessary for maintenance of the removal devices, but not less that twice per year. The amount of material collected shall be estimated in cubic yards.

C. Annual Report.

Each permittee shall contribute to the preparation of an annual system-wide report to be submitted by no later than October 15, 2003 and annually thereafter in accordance with this permit. The report shall cover the previous year from July 1st to June 30th and include the following separate sections, with an overview for the entire Municipal Separate Storm Sewer System and subsections for each permittee:

1. The status of implementing the SWMP and status of compliance with any schedules established under this permit shall be included in this section);
2. Proposed changes to the SWMP;
3. Revisions, if necessary, to the assessment of controls and the fiscal analysis reported in the permit application under 40 CFR 122.26(d)(2)(iv) and (d)(2)(v);
4. A summary of the data, including monitoring data, which is accumulated throughout the reporting year;
5. Annual expenditures for the reporting period, with a breakdown for the major elements of the storm water management program, and the budget for the year following each annual report;
6. A summary describing the number and nature of enforcement actions, inspections, and public education programs; and
7. Identification of water quality improvements or degradation.

Preparation and submittal of a system-wide annual report shall be coordinated by the City of Tulsa. The report shall indicate which, if any, permittees have failed to provide required information on the portions of the Municipal Separate Storm Sewer System for which they are responsible to the core municipality, City of Tulsa, 45 days prior to the report due date. Joint responsibility for report submission shall be limited to participation in preparation of the overview for the entire system and inclusion of the identity of any permittee who failed to provide input to the annual report. Each individual permittee shall be individually responsible for content of the report relating to the portions of the Municipal

Separate Storm Sewer System for which they are responsible and for failure to provide information for the system-wide annual report in a timely manner. Each permittee shall sign and certify the annual report in accordance with Part VI. H and include a statement or resolution that the permittee's governing body or agency (or delegated representative) has reviewed or been appraised of the content of the Annual Report.

D. Certification and Signature of Reports

All reports required by the permit and other information requested by the Director shall be signed and certified in accordance with Part VI. H.

E. Reporting: Where and When to Submit

1. Representative monitoring results (Part V. A. 1) obtained during the reporting period running from July 1 to June 30 shall be submitted on Discharge Monitoring Report Form(s) no later that the due date for the annual report required by Part V. C. The Discharge Monitoring Reports should be submitted along with the Annual Report. A separate Discharge Monitoring Report Form is required for each monitoring period (e.g. season) specified in Part V. A. 1.
2. Signed copies of discharge monitoring reports required under Part V., the Annual Report required by Part V.C., and all other reports and notifications required herein, shall be submitted to.

Oklahoma Department of Environmental Quality
Water Quality Division
P.O. Box 1677
Oklahoma City, Oklahoma 73101-1677

PART VI. STANDARD PERMIT CONDITIONS

A. Duty to Comply

The permittee(s) must comply with all conditions of this permit insofar as those conditions are applicable to each permittee, either individually or jointly. Any permit noncompliance constitutes a violation of the Act and is grounds for enforcement action; for permit termination, revocation and reissue, or modification; or for denial of a permit renewal application.

B. Penalties for Violations of Permit Conditions

Permit violations are subject to the fines and penalties in 27A O.S. § 2-6-206.

1. Administrative penalties may be assessed up to $10,000 per day per violation with a $125,000 per violation maximum.
2. Civil penalties may be assessed up to $10,000 per day per violation.
3. Criminal penalties may range from the minimum of $2,500 to the maximum $2,000,000 with a maximum jail time of 30 years in the state penitentiary.
4. Penalties for permit fraud are subject to a maximum if $20,000 and a maximum of 4 years in prison.

C. Duty to Reapply

If the permittee wishes to continue an activity regulated by this permit after the permit expiration date, the permittee must apply for and obtain a new permit. The application shall be submitted at least 180 days prior to expiration of this permit. The Director may grant permission to submit an application less than 180 days in advance but no later than the permit expiration date. Continuation of expiring permits shall be governed by regulations promulgated at 40 CFR 122.6 and any subsequent amendments.

D. Need to Halt or Reduce Activity Not a Defense

It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

E. Duty to Mitigate

The permittee(s) shall take all reasonable steps to minimize or prevent any discharge in violation of this permit that has a reasonable likelihood of adversely affecting human health or the environment.

F. Duty to Provide Information

The permittee(s) shall furnish to the Director, within a time specified by the Director, any information that the Director may request to determine compliance with this permit. The permittee(s) shall also furnish to the Director upon request copies of records required to be kept by this permit.

G. Other Information

When the permittee becomes aware that he or she failed to submit any relevant facts or submitted incorrect information in any report to the Director, he or she shall promptly submit such facts or information.

H. Signatory Requirements

All Discharge Monitoring Reports, storm water management programs, reports, certifications or information either submitted to the Director or that this permit requires be maintained by the permittee(s), shall be signed by:

1. a principal executive officer or ranking elected official of a municipality, state, other public agency, or by either a principal executive officer; or
2. a duly authorized representative of that person. A person is a duly authorized representative only if:
   a. The authorization is made in writing by a person described above and submitted to the Director;
   b. The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity, such as the position of manager, operator, superintendent, or position of equivalent responsibility or an individual or position having overall responsibility for environmental matters. A duly authorized representative may thus be either a named individual or any individual occupying a named position;
   c. If an authorization is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new written authorization satisfying the requirements of this paragraph must be submitted to the Director prior to or together with any reports, information, or applications to be signed by an authorized representative.
3. Certification: Any person signing documents under this section shall make the following certification: "I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

I. Penalties for Falsification of Monitoring Systems

For permit violations, you are subject to the fines and penalties in 27A O.S. § 2-6-206.

1. Administrative penalties may be assessed up to $10,000 per day per violation with a $125,000 per violation maximum.

2. Civil penalties may be assessed up to $10,000 per day per violation.
3. Criminal penalties may range from the minimum of $2,500 to the maximum $2,000,000 with a maximum jail time of 30 years in the state penitentiary.
4. Penalties for permit fraud are subject to a maximum if $20,000 and a maximum of 4 years in prison.

J. Oil and Hazardous Substance Liability

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to the Act or section 106 of CERCLA.

K. Property Rights

The issuance of this permit does not convey any property rights of any sort, nor any exclusive privileges, nor does it authorize any injury to private property nor any invasion of personal rights, nor any infringement of Federal, State or local laws or regulations.

L. Severability

The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit shall not be affected thereby.

M. Requiring a Separate Permit

1. The Director may require any co-permittee authorized by this permit to obtain a separate NPDES permit. Any interested person may petition the Director to take action under this paragraph. The Director may require any co-permittee authorized to discharge under this permit to apply for a separate OPDES permit only if the co-permittee has been notified in writing that a permit application is required. This notice shall include a brief statement of the reasons for this decision, an application form (as necessary), a statement setting a deadline for the co-permittee to file the application, and a statement that on the effective date of the separate NPDES permit, coverage under this permit shall automatically terminate. Separate permit applications shall be submitted to the address shown in Part V. E. The Director may grant additional time to submit the application upon request of the applicant. If an owner or operator fails to submit in a timely manner a separate NPDES permit application as required by the Director, then the applicability of this permit to the co-permittee is automatically terminated at the end of the day specified for application submittal.
2. Any co-permittee authorized by this permit may request to be excluded from the coverage of this permit by applying for a separate permit. The co-permittee shall submit a separate application as specified by 40 CFR 122.26(d) with reasons supporting the request to the Director. Separate permit applications shall be

submitted to the address shown in Part V. E. 2. The request may be granted by the issuance of a separate permit if the reasons cited by the co-permittee are adequate to support the request.

N. State Environmental Laws

1. Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable State law or regulation under authority preserved by section 510 of the Act.
2. No condition of this permit shall release the permittee from any responsibility or requirements under other environmental statutes or regulations.

O. Proper Operation and Maintenance

The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to achieve compliance with the conditions of this permit and with the requirements of the Storm Water Management Program. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. Proper operation and maintenance requires the operation of backup or auxiliary facilities or similar systems, installed by a permittee only when necessary to achieve compliance with the conditions of the permit.

P. Monitoring and Records

1. Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity.
2. The permittee shall retain records of all monitoring information including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of the reports required by this permit, and records of all data used to complete the application for this permit, for a period of at least 3 years from the date of the sample, measurement, report or application. This period may be extended by request of the Director at any time.
3. Records of monitoring information shall include:
   a. The date, exact place, and time of sampling or measurements;
   b. The initials or name(s) of the individual(s) who performed the sampling or measurements;
   c. The date(s) analyses were performed;
   d. The time(s) analyses were initiated;
   e. The initials or name(s) of the individual(s) who performed the analyses;
   f. References and written procedures, when available, for the analytical techniques or methods used; and

g. The results of such analyses, including the bench sheets, instrument readouts, computer disks or tapes, etc., used to determine these results.

Q. Monitoring Methods

Monitoring must be conducted according to test procedures approved under 40 CFR Part 136, unless other test procedures have been specified in this permit.

R. Inspection and Entry

The permittee shall allow the Director or an authorized representative of EPA, or the State, upon the presentation of credentials and other documents as may be required by law, to:

1. Enter the permittee's premises where a regulated facility or activity is located or conducted or where records must be kept under the conditions of this permit;
2. Have access to and copy at reasonable times, any records that must be kept under the conditions of this permit;
3. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this permit; and
4. Sample or monitor at reasonable times, for the purposes of assuring permit compliance or as otherwise authorized by the Act, any substance or parameters at any location.

S. Permit Actions

This permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by the permittee for a permit modification, revocation and re issuance, or termination, or a notification of planned changes or anticipated noncompliance does not stay any permit condition.

T. Additional Monitoring by the Permittee

If the permittee monitor more frequently than required by this permit, using test procedures approved under 40 CFR Part 136 or as specified in this permit, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the Discharge Monitoring Report (DMR). Such increased monitoring frequency shall also be indicated on the DMR.

U. Archeological and Historical Sites (Reserved)

PART VII. Permit Modification

A. Modification of the Permit

The permit may be reopened and modified during the life of the permit to address:

1. changes in the State's Water Quality Management Plan, including Water Quality Standards;
2. changes in the State or Federal statutes or regulations;
3. addition of a new permittee who is the owner or operator of a portion of the Municipal Separate Storm Sewer System;
4. changes in portions of the Storm Water Management Program that are considered permit conditions;
5. other modifications deemed necessary by the Director to meet the requirements of the Clean Water Act; or
6. any additional provisions necessary to comply with requirements of an approved TMDL;

All modifications to the permit will be made in accordance with OAC 252:605-1-5(b)(3)(Z), (AA) and (4)(D) incorporating by reference 40 CFR 122.26, as amended 40 CFR 122.62, 122.63, and 124.5.

B. Termination of Coverage for a Single Permittee

Permit coverage may be terminated, in accordance with OAC 252.605-1-5(b)(3)(BB), incorporating by reference 40 CFR 122.64 and OAC 252.605-1-5(b)(4)(D) adopted and incorporated by reference 40 CFR 122.5, for a single permittee without terminating coverage for other permittees.

C. Modification of the SWMP

Only those portions of the SWMP specifically required as permit conditions shall be subject to the modification requirements of OAC 252:605-1-5(b)(3)(Z), (AA) and (4)(D) incorporating by reference 40 CFR 124.5. Addition of components, controls, or requirements by the permittee(s); replacement of an ineffective or infeasible BMP implementing a required component of the Storm Water Management Program with an alternate BMP expected to achieve the goals of the original BMP; and changes required as a result of new requirements issued by DEQ shall be considered minor changes to the Storm Water Management Program and not modifications to the permit. (See also Part II. G.)

D. Changes in Monitoring Outfalls

Changes in monitoring outfalls, other than those with specific numeric effluent limitations (as described in Part V. A. 1. c.), shall be considered minor modifications to the permit and will be made in accordance with the procedures at OAC 252:605-1-5(b)(3)(AA) incorporating by reference 40 CFR 122.63.

Part VIII. Definitions

A. **Best Management Practices" ("BMPs")** means schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of Waters of the State. BMPs also include treatment requirements, operating procedures, and practices to control facility site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

B. **"CWA" or "The Act"** means Clean Water Act (formerly referred to as the Federal Water Pollution Control Act or Federal Water Pollution Control Act Amendments of 1972) Pub. L. 92-500, as amended Pub. L. 95-217, Pub. L. 95-576, Pub. L. 96-483 and Pub. L. 97-117, 33 U.S.C. 1251 et. seq.

C. **"Co-permittee"** is defined at OAC 252.605-1-5(b)(3)(L) adopted and incorporated by reference 40 CFR 122.26 (b)(1).

D. **"Director"** means the Executive Director of the Oklahoma Department of Environmental Quality or an authorized representative.

E. **"Discharge"** for the purpose of this permit, unless indicated otherwise, refers to discharges from the Municipal Separate Storm Sewer System.

F. **"Illicit connection"** means any man-made conveyance connecting an illicit discharge directly to a Municipal Separate Storm Sewer System.

G. **"Illicit discharge"** is defined at OAC 252:605-1-5(b)(3)(L) incorporating by reference incorporating by reference 40 CFR 122.26(b)(2).

H. **"Individual Residence"** refers, for the purposes of this permit, to single or multi-family residences. (e.g. single family homes and duplexes, townhomes, apartments, etc.).

I. **"Landfill"** means an area of land or an excavation in which wastes are placed for permanent disposal, and which is not a land application unit, surface impoundment, injection well, or waste pile.

J. **"Land application unit"** means an area where wastes are applied onto or incorporated into the soil surface (excluding manure spreading operations) for treatment or disposal.

K. **"Large or medium Municipal Separate Storm Sewer System"** is defined at OAC 252.605-1-5-(b)(3)(L) adopted and incorporated by reference 40 CFR 122.26(b)(4) & (7).

L. **"MEP"** is an acronym for "Maximum Extent Practicable," the technology-based discharge standard for Municipal Separate Storm Sewer Systems established by CWA §402(p).

M. **"MS4"** is an acronym for "Municipal Separate Storm Sewer System" and is used to refer to either a Large or Medium Municipal Separate Storm Sewer System (e.g. "the

City of Tulsa MS4"). And is also defined at OAC 252.605-1-5(b)(3)(L) adopted and incorporated by reference 40 CFR 122.26(b)(8).

N. **"Municipal Separate Storm Sewer System** is defined at OAC 252.605-1-5(b)(3)(L) adopted and incorporated by reference 40 CFR 122.26(b)(8)

O. **"Permittee"** refers to any "person," as defined at OAC 252.605-1-5(b)(3)(B) adopted and incorporated by reference 40 CFR 122.2, authorized by this OPDES permit to discharge to Waters of the State.

P. **"Point Source"** means any discernible, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel or other floating craft from which pollutants are or may be discharges. This term does not include return flows from irrigated agriculture or agricultural storm water runoff.

Q. **"Storm Sewer",** unless otherwise indicated, refers to a municipal separate storm sewer.

R. **"Storm Water"** means storm water runoff, snow melt runoff, and surface runoff and drainage.

S. **"Storm Water Discharge Associated with Industrial Activity"** is defined at OAC 252.605-1-5(b)(3)(L) adopted by reference 40 CFR 122.26(b)(14).

T. **"Storm Water Management Program"** refers to a comprehensive program to manage the quality of storm water discharged from the municipal separate storm sewer system. For the purposes of this permit, the Storm Water Management Program is considered a single document, but may actually consist of separate programs (e.g. "chapters") for each permittee.

U. **"SWMP"** is an acronym for "Storm Water Management Program."

X. **"Waters of the State"** is defined as all streams, lakes, ponds, marshes, watercourses, waterways, wells, springs, irrigation systems, drainage systems, storm sewers, and all other bodies or accumulations of water, surface and underground, natural or artificial, public or private, which are contained within, flow through or border upon this state or any portion thereof, and shall include under all circumstances the water of the United States which are contained within the boundaries of, flow through or border upon this state or any portion thereof.

AUTHORIZATION TO DISCHARGE
OKLAHOMA POLLUTANT DISCHARGE ELIMINATION SYSTEM
Permit Number OKS000101

In compliance with the Oklahoma Pollutant Discharge Elimination System Act (OPDES Act), Title 27A O.S. Supp.1999, § 2-6-201 *et seq.*, and the rules of the State of Oklahoma Department of Environmental Quality (DEQ) adopted hereunder {See OAC 252:605}; the Federal Clean Water Act, Public Law 95-217 (33 U.S.C. 1251 *et seq.*), Section 402; and NPDES Regulations (40 CFR Parts 122, 124, 136 and 403),

City of Oklahoma City 420 West Main Oklahoma City, OK 73102	Oklahoma Turnpike Authority P.O. Box 11357 Oklahoma City, OK 73136	Oklahoma Department of Transportation 200 N.E. 21st Street Oklahoma City, OK 73105

Co-permittees are hereby authorized to discharge storm water from the Municipal Separate Storm Sewer System to receiving waters:

Canadian River, Coon Creek, Deep Fork of the Canadian River, Deer Creek, Hefner Lake, Hog Creek, North Canadian River, Overholser Lake, Pecan Creek, Stanley Draper Lake,

In accordance with effluent limitations, monitoring requirements and other conditions set forth in Parts I, II, III, IV, V, VI, VII, and VIII hereof.

This permit shall become effective on August 9, 2001. It will replace and/or supersede the permit issued on September 1, 1995.

This permit and the authorization to discharge shall expire at midnight August 8, 2006.

For Oklahoma Department of Environmental Quality.

/signed by/
Quang Pham, P.E.
Manager, Wastewater Discharge Permit Section

/signed by/
Jon L. Craig, Director
Water Quality Division

OKLAHOMA CITY MUNICIPAL SEPARATE STORM SEWER SYSTEM
OPDES DRAFT PERMIT NO. OKS000101
August 1, 2001

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OKLAHOMA CITY MUNICIPAL SEPARATE STORM SEWER SYSTEM
OPDES DRAFT PERMIT NO. OKS000101
August 1, 2001

PART I. DISCHARGES AUTHORIZED UNDER THIS PERMIT

A. Permit Area

This permit covers all areas located within the corporate boundary of the City of Oklahoma City that are served by municipal separate storm sewers owned or operated by the permittee(s).

B. Authorized Discharges

Except as specified in Part I.B.2, this permit authorizes all existing or new storm water point source discharges to waters of the United States from those portions of the Municipal Separate Storm Sewer System (MS4) owned or operated by the permittee(s).

1. The following discharges, whether discharged separately or commingled with municipal storm water, are not authorized by this permit:

   a. Non-storm Water and Industrial Storm Water:

      Storm Water Discharges Associated with Industrial Activity; other storm water discharges required by the Director to obtain an OPDES permit; and discharges of non-storm water, except where such discharges are identified by and in compliance with Part II.A.6.a.

   b. Discharges Of Material Resulting From Spills.

      Where discharge of material resulting from a spill is necessary to prevent loss of life, personal injury, or severe property damage, the permittee(s) shall take, or ensure the party responsible for the spill takes all reasonable steps to minimize or prevent any adverse effects to human health or the environment (See also Part II.A.7 and Part VI.E.). This permit does not transfer liability for a spill itself from the party(ies) responsible for the spill to the permittee(s) nor relieve the party(ies) responsible for a spill from the reporting requirements OAC 252:605-1-5(b)(2) adopted and incorporated by reference 40 CFR Part 117 and OAC 252:605-1-5(b)(10) adopted and incorporated by reference 40 CFR Part 302.

C. Permittee Responsibilities (also refer to Part III A.)

1. Each permittee is responsible for:

   a. Compliance with permit conditions relating to discharges from portions of the Municipal Separate Storm Sewer System where the permittee is the operator;

   b. Storm Water Management Program (SWMP) update revisions on portions of the Municipal Separate Storm Sewer System where the permittee is the operator;

   c. Compliance with annual reporting requirements as specified in Part V.D.

   d. Collection of representative wet weather monitoring data required by Part V.A according to such agreements as may be established between permittees; and

   e. A plan of action to assume responsibility for updating revisions of storm water management and monitoring programs on their portions of the Municipal Separate

Storm Sewer System should inter-jurisdictional agreements allocating responsibility between permittees be dissolved or in default.

2. Permittees are jointly responsible for permit compliance on portions of the Municipal Separate Storm Sewer System where operational or SWMP implementation authority over portions of the Municipal Separate Storm Sewer System is shared or has been transferred from one permittee to another in accordance with legally binding agreements.

D. Discharge Goals

The following goals are established for discharges from the Municipal Separate Storm Sewer System:

1. No discharge of toxics in toxic amounts.
2. No discharge of pollutants in quantities that would cause a violation of Oklahoma Water Quality Standards.
3. No discharge of floatable debris, oils, scum, foam, or grease in other than trace amounts.
4. No discharge of non-storm water from Municipal Separate Storm Sewer System, (except as provided in Part I.B.2.).
5. No degradation or loss of State-designated beneficial uses of receiving waters as a result of storm water discharges from the Municipal Separate Storm Sewer (unless authorized by the State in accordance with the State's Antidegradation Policy.

PART II. STORM WATER POLLUTION PREVENTION & MANAGEMENT PROGRAM

Each permittee shall contribute to the development, and revision updates of a comprehensive SWMP including pollution prevention measures, treatment or removal techniques, storm water monitoring, use of legal authority, and other appropriate means to control the quality of storm water discharged from the MS4. The SWMP shall be implemented in accordance with Section 402(p)(3)(B) of the Act and the Storm Water Regulations OAC 252.605-1-5(b)(3)(L) adopted and incorporated by reference 40 CFR Part 122.26.

Controls and activities in the SWMP shall identify areas of permittee responsibility on a jurisdiction, applicability, or specific area basis. The SWMP shall include controls necessary to effectively prohibit the discharge of non-storm water into municipal separate storm sewers and reduce the discharge of pollutants from the MS4 to the Maximum Extent Practicable (MEP).

The SWMP shall cover the term of the permit and shall be updated as necessary, or as required by the Director, to ensure compliance with the statutory requirements of Section 402(p)(3)(B) of the Act. Modifications to the SWMP shall be made in accordance with Parts II.G, and III of the permit. Compliance with the SWMP and any schedules in Part III shall be deemed compliant with Parts II.A and II.B. The SWMP, and all updates made in accordance with Part II.G are hereby incorporated by reference.

Implementation of the revised and updated SWMP may be achieved through participation with other permittees, public agencies, or private entities in cooperative efforts to satisfy the requirements of Part II in lieu of creating duplicate program elements for each individual permittee. The SWMP, taken as a whole, shall achieve the "effective prohibition on the discharge of non-storm water" and "MEP" standards from Section 402(p)(3)(B) of the Act.

A. SWMP Requirements

1. Structural Controls and Storm Water Collection System Operation: The MS4 and any storm water structural controls shall be operated in a manner to reduce the discharge of pollutants to the Maximum Extent Practicable.
2. Areas of New Development and Significant Redevelopment: A comprehensive master planning process (or equivalent) to develop, implement, and enforce controls to minimize the discharge of pollutants from areas of new development and significant re-development after construction is completed shall be implemented. The goals of such controls shall be:
   a. New development - limiting increases in the discharge of pollutants in storm water as a result of development, and;
   b. Re-development - reducing the discharge of pollutants in storm water.
3. Roadways: Public streets, roads, and highways shall be operated and maintained in a manner to minimize discharge of pollutants, including those pollutants related to deicing or sanding activities.
4. Flood Control Projects: Impacts on receiving water quality shall be assessed for all flood management projects. The feasibility of retrofitting existing structural flood control devices to provide additional pollutant removal from storm water shall be evaluated.
5. Pesticide, Herbicide, and Fertilizer Application: Each permittee shall update controls to reduce the discharge of pollutants related to the storage and application of pesticides, herbicides, and fertilizers applied, by the permittee's employees or contractors, to public rights of way, parks, and other municipal property. Permittee(s) with jurisdiction over lands not directly owned by that entity (e.g. incorporated city)

shall update and revise programs to reduce the discharge of pollutants related to commercial application and distribution of pesticides, herbicides, and fertilizers.

6. Illicit Discharges and Improper Disposal: Non-storm water discharges to the MS4 shall be effectively prohibited. For the purpose of this permit, the following discharges need not be addressed as illicit discharges by the permittee(s) nor prohibited from entering the MS4: discharges regulated by a separate OPDES permit; and non-storm water discharges identified by the permittee as specified in item (a) below.

   a. Permittee(s) shall identify in the SWMP any categories of non-storm water that are not prohibited from being discharged into the MS4, in accordance with conditions described in items (1) and (2) below.

      (1) Categories of non-storm water discharges that the permittee(s) may exempt from the prohibition on non-storm water entering the MS4 include those either:
      (a) listed in OAC 252:605-1-5(b)(3)(L) adopted and incorporated by reference 40 CFR 122.26(d)(2)(iv)(B)(1) or
      (b) other similar, occasional, incidental non-storm water discharges.

      (2) Categories of non-storm water discharges exempted from the prohibition on non-storm water must not be reasonably expected (based on information available to the permittee[s]) to be significant sources of pollutants to the waters of the United States, because of either:
      (a) the nature of the discharges; or
      (b) conditions placed on the discharges by the permittee(s).

   The SWMP shall describe any local controls or conditions placed on discharges exempted from the prohibition on non-storm water. Permittee(s) shall prohibit any individual non-storm water discharge otherwise exempted under this paragraph from the prohibition on non-storm water that is determined to be contributing significant amounts of pollutants to the MS4.

   b. Each permittee shall prevent (or require the operator of the sanitary sewer system to eliminate) unpermitted discharges of dry and wet weather overflows from sanitary sewers into the MS4. Each permittee shall limit the infiltration or seepage from sanitary sewers into the MS4.

   c. The permittee(s) shall ensure the update and revise the program to reduce the discharge of floatables (e.g. litter and other human-generated solid refuse). The floatables control program shall include source controls and, where necessary, structural controls.

   d. The discharge or disposal of used motor vehicle fluids, household hazardous wastes, grass clippings, leaf litter, and animal wastes into separate storm sewers shall be prohibited. The permittee(s) shall ensure the implementation of revised and updated programs to collect used motor vehicle fluids (at a minimum, oil and antifreeze) for recycle, reuse, or proper disposal and to collect household hazardous waste materials (including paint, solvents, pesticides, herbicides, and other hazardous materials) for recycle, reuse, or proper disposal. Such programs shall be readily available to all private residents and shall be publicized and promoted on a regular basis.

e. A program to locate and eliminate illicit discharges and improper disposal into the MS4 shall be revised, updated, then implemented. This program shall include dry weather screening activities to locate portions of the MS4 with suspected illicit discharges and improper disposal (described in Part II.A.11.a.). Follow-up activities to eliminate illicit discharges and improper disposal may be prioritized on the basis of magnitude and nature of the suspected discharge; sensitivity of the receiving water; and/or other relevant factors. This program shall establish priorities and schedules for screening the entire MS4 at least once per five years. Facility inspections may be carried out in conjunction with other municipal programs (e.g. pretreatment inspections of industrial users, health inspections, fire inspections, etc.), but must include random inspections for facilities not normally visited by the municipality.

f. Each permittee shall require the elimination of illicit discharges and improper disposal practices as expeditiously as reasonably possible. Where elimination of an illicit discharge within thirty (30) days is not possible, the permittee shall require an expeditious schedule for removal of the discharge. In the interim, the permittee(s) shall require the operator of the illicit discharge to take all reasonable and prudent measures to minimize the discharge of pollutants to the MS4.

g. The permittee(s) shall maintain, and update as necessary, a list of discharges to municipal separate storm sewers that have been issued an OPDES permit. The list shall include the name, location and OPDES permit number of the discharger.

7. Spill Prevention and Response: A program to prevent, contain, and respond to spills that may discharge into the MS4 shall be revised and updated. The spill response program may include a combination of spill response actions by the permittee(s) (and/or another public or private entities), and legal requirements for private entities within the permittee's municipal jurisdiction.

8. Industrial and High Risk Runoff: A program to identify and control pollutants in storm water discharges to the MS4 from municipal landfills; other treatment, storage, or disposal facilities for municipal waste (e.g. transfer stations, incinerators, etc.); hazardous waste treatment, storage, disposal and recovery facilities; facilities that are subject to EPCRA Title III, Section 313; and any other industrial or commercial discharge the permittee(s) determines are contributing a substantial pollutant loading to the MS4 shall be implemented. The program shall include:

   a. priorities and procedures for inspections and establishing and implementing control measures for such discharges;

   b. b. a monitoring program (Part II.A.11.c.); and

   c. a list of industrial storm water sources discharging to the MS4 which shall be maintained and updated as necessary.

9. Construction Site Runoff: The program to reduce the discharge of pollutants from construction sites shall be revised and updated. This program shall include:

   a. requirements for the use and maintenance of appropriate structural and nonstructural best management practices to reduce pollutants discharged to the MS4 during the time construction is underway;

   b. inspection of construction sites and enforcement of control measures (in accordance with priorities and procedures established in the SWMP);

c. appropriate education and training measures for construction site operators; and

d. notification of appropriate building permit applicants of their potential responsibilities under the OPDES permitting program for construction site runoff.

10. Public Education: A public education program with the following elements that has been successful in the past shall be revised and updated:

a. a program to promote, publicize, and facilitate public reporting of the presence of illicit discharges or improper disposal of materials, including floatables, into the MS4;

b. program to promote, publicize, and facilitate the proper management and disposal of used motor vehicle fluids and household hazardous wastes; and

c. program to promote, publicize, and facilitate the proper use, application, and disposal of pesticides, herbicides, and fertilizers by the public and commercial and private applicators and distributors.

11. Monitoring Programs: The following monitoring programs shall be revised and updated to implement the monitoring required by Part V:

a. The Dry Weather Screening Program shall continue ongoing efforts to detect the presence of illicit connections and improper discharges to the MS4. All areas of the MS4 must be screened at least once during the permit term. Screening methodology may be modified based on experience gained during actual field screening activities and need not conform to the protocol at OAC 252:605-1-5(b)(3)(L) adopted and incorporated by reference 40 CFR 122.26(d)(1)(iv)(D). Sample collection and analysis need not conform to the requirements of OAC 252:605-1-5(b)(7) adopted and incorporated by reference 40 CFR Part 136. However, samples taken to confirm (e.g. in support of possible legal action) a particular illicit connection or improper disposal practice should conform to the requirements of OAC 252:605-1-5(b)(7).

b. Wet Weather Screening Program: The permittee(s) shall identify, investigate, and address areas within their jurisdiction that may be contributing excessive levels of pollutants to the MS4. The wet weather screening program:

(1) shall screen the MS4, in accordance with the procedures specified in the SWMP;

(2) shall specify the sampling and non-sampling techniques to be used for initial screening and follow-up purposes. Sample collection and analysis need not conform to the requirements of OAC 252:605-1-5(b)(7) adopted and incorporated by reference 40 CFR Part 136. However, samples taken to confirm (e.g. in support of possible legal action) a particular illicit connection or improper disposal practice should conform to the requirements of OAC 252:605-1-5(b)(7). The Industrial and High Risk Runoff Monitoring Program shall include monitoring for pollutants in storm water discharges to the MS4 from municipal landfills; other treatment, storage, or disposal facilities for municipal waste (e.g. transfer stations, incinerators, etc.); hazardous waste treatment, storage, disposal and recovery facilities; facilities that are subject to EPCRA Title III, Section 313; and any other industrial or commercial discharge the permittee(s) determines are contributing a substantial pollutant loading to the MS4.

(3) Except as provided in (2) below, the monitoring program shall include the collection of quantitative data on the following constituents:

(a) any pollutants limited in an existing OPDES permit for a subject facility;
(b) oil and grease;
(c) chemical oxygen demand (COD);
(d) pH;
(e) biochemical oxygen demand, five-day (BOD_5);
(f) total suspended solids (TSS);
(g) total phosphorous;
(h) total Kjeldahl nitrogen (TKN);
(i) nitrate plus nitrite nitrogen; and
(j) any information on discharges required under OAC 252.605-1-5(b)(3)(H), adopted and incorporated by reference 40 CFR 122.21(g)(7)(iii) and (iv).

Data collected by the industrial facility to satisfy the monitoring requirements of an OPDES or NPDES permit may be used to satisfy this requirement. Permittee(s) may require the industrial facility to conduct self-monitoring to satisfy this requirement.

(4) Alternative Certification: In lieu of monitoring, the permittee(s) may accept a certification from a facility that raw and waste materials, final and intermediate products, by-products, material handling equipment or activities, industrial machinery or operations, or significant materials from past industrial activity are not presently exposed to storm water and are not expected to be exposed to storm water for the certification period. Where the permittee(s) accept a "no exposure" certification, the permittee(s) shall conduct at least one site inspection of the facility every five years to verify facility's "no exposure" exemption.

B. Area-specific SWMP Requirements (Reserved)

C. Deadlines for Program Implementation

Except as provided in Part III, full implementation of the revised and updated SWMP shall begin on the effective date of the permit.

D. Roles and Responsibilities of Permittee(s)

The SWMP, together with any attached interagency agreements, shall clearly identify the roles and responsibilities of each permittee.

E. Legal Authority

Each permittee shall ensure legal authority to control discharges to and from those portions the MS4 over which it has jurisdiction. This legal authority may be a combination of statute, ordinance, permit, contract, order or inter-jurisdictional agreements with permittees with existing legal authority to:

1. Control the contribution of pollutants to the MS4 by Storm Water Discharges Associated with Industrial Activity and the quality of storm water discharged from sites of industrial activity,
2. Prohibit illicit discharges to the MS4,

3. Control the discharge of spills and the dumping or disposal of materials other than storm water (e.g. industrial and commercial wastes, trash, used motor vehicle fluids, leaf litter, grass clippings, animal wastes, etc.) into the MS4,
4. Control through interagency or interjurisdictional agreements among permittees the contribution of pollutants from one portion of the MS4 to another,
5. Require compliance with conditions in ordinances, permits, contracts or orders; and,
6. Carry out all inspection, surveillance, enforcement and monitoring procedures necessary to determine compliance with permit conditions.

F. Storm Water Management Program Resources

Each permittee shall provide adequate finances, staff, equipment, and support capabilities to implement their activities under the SWMP.

G. SWMP Review and Update

1. SWMP Review: Each permittee shall participate in an annual review of the current SWMP in conjunction with preparation of the annual report required under Part V.D.
2. SWMP Update: The permittee(s) may change the SWMP during the life of the permit in accordance with the following procedures:
   a. The approved SWMP shall not be changed by the permittee(s) without the approval of the Director, unless in accordance with Parts II G.2.b., c., or d.
   b. Changes adding (but not subtracting or replacing) components, controls, or requirements to the SWMP may be made by the permittee(s) at any time upon written notification to the Director.
   c. Changes replacing an ineffective or unfeasible BMP specifically identified in the SWMP with an alternate BMP may be requested at any time. Unless denied by the Director, changes proposed in accordance with the criteria below shall be deemed approved and may be implemented immediately upon issuance of the permit. Such requests shall include the following:
      (1) an analysis of why the BMP is ineffective or infeasible (including cost prohibitive);
      (2) expectations on the effectiveness of the replacement BMP; and
      (3) an analysis of why the replacement BMP is expected to achieve the goals of the BMP to be replaced.

      Changes resulting from schedules contained in Part III may be requested following completion of an interim task or final deadline. Unless denied by the Director, proposed changes meeting the criteria contained in the applicable Part III schedule shall be deemed approved and may be implemented by the permittee(s) within 60 days from the submittal date.
   d. Change requests or notifications shall be made in writing, signed in accordance with Part VI.H. by all directly effected permittees, and include a certification that all permittees were given an opportunity to comment on proposed changes prior to submittal to the Director.
3. SWMP Updates Required by the Director: The Director may require changes to the SWMP as needed to:

a. address impacts on receiving water quality caused, or contributed to, by discharges from the MS4;

b. include more stringent requirements necessary to comply with new State or Federal statutory or regulatory requirements; or

c. include such other conditions deemed necessary by the Director to comply with the goals and requirements of the Clean Water Act.

Changes requested by the Director shall be made in writing, set forth the time schedule for the permittee(s) to develop the changes, and offer the permittee(s) the opportunity to propose alternative program changes to meet the objective of the requested modification. All changes required by the Director shall be made in accordance with OAC 252:605-1-5(b)(4)(D) adopted and incorporated by reference 40 CFR 124.5, OAC 252:605-1-5(b)(3)(Z) adopted and incorporated by reference 40 CFR 122.62, or as appropriate OAC 252:605-1-5(b)(3)(AA) adopted and incorporated by reference 40 CFR 122.63.

4. Transfer of Ownership, Operational Authority, or Responsibility for SWMP Implementation: The permittee(s) shall implement the SWMP on all new areas added to their portion of the MS4 (or for which they become responsible for implementation of storm water quality controls) as expeditiously as practicable, but not later than three years from addition of the new areas. Implementation may be accomplished in a phased manner to allow additional time for controls that cannot be implemented immediately.

   Prior to land annexation, the permittee(s) shall include a schedule for extending the SWMP to the annexed areas in the SWMP. At least 30 days prior to transfer of operational authority or responsibility for SWMP implementation, all parties shall prepare a schedule for transfer of responsibility for SWMP implementation on the affected portions of the MS4.

H. Retention of SWMP Records

The permittee shall retain the SWMP developed in accordance with Parts II and III for at least three (3) years after coverage under this permit terminates.

PART III. SCHEDULES FOR IMPLEMENTATION AND COMPLIANCE

The Permittee(s) shall comply with the following schedules for SWMP implementation and augmentation, and permit compliance.

A. Implementation and Augmentation of SWMP(s)

SWMP COMPONENT	ACTIVITY	RESPONSIBLE PERMITTEE(S)	DATE DUE/ FREQUENCY
1. SWMP Document	a. Provide copy of each permittee's SWMP revised as necessary to reflect final permit conditions.	All [1]	October 15, 2001
2. Post-Construction Storm Water Management in New and Re-Development	a. Review criteria and procedures for determining and enforcing requirements for structural and non-structural controls on new and significant re-development to address post-construction runoff. The program must ensure that controls are in place that would prevent or minimize water quality impacts.	Oklahoma City	March 1, 2002
	b. Complete any necessary revisions to ordinances or rules and update SWMP to include criteria and procedures for determining and enforcing requirements for structural and non-structural controls on new and significant redevelopment to address post-construction runoff.	Oklahoma City	August 1, 2002
	c. Review criteria and procedures for determining requirements for structural and non-structural controls on new and significant re-construction of roads and highways to address post-construction runoff.	All	March 1, 2002
	d. Update SWMP to include criteria and procedures for determining requirements for structural and non-structural controls on new and significant re-construction of roads and highways to address post-construction runoff.	All	August 1, 2002

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SWMP COMPONENT	ACTIVITY	RESPONSIBLE PERMITTEE(S)	DATE DUE/ FREQUENCY
3. Flood Control Projects and Structural Controls	a. Submit schedule and criteria for evaluating placement of structural controls (or retrofitting existing structures) on developed areas.	All	October 15, 2001
	b. Complete any necessary revisions to ordinances or rules and update SWMP to include schedule and criteria for evaluating placement of structural controls (or retro-fitting existing structures) on developed areas and a schedule for inspection and maintenance of such structural controls.	All	March 1, 2002
4. Construction Site Runoff	a.Review construction site runoff pollution prevention program. Identify any necessary modifications to local ordinances regulating runoff from construction sites.	All	August 1, 2002
	b.Complete any necessary revisions to ordinances or rules and update SWMP to include necessary modifications to programs regulating runoff from construction sites.	All	October 15, 2003
5. Roadway Operation and Maintenance	a.Review SWMP to identify any necessary modifications to address the roadway operation and management program.	All	October 15, 2001
	b.Complete any necessary revisions to ordinances or rules and update SWMP to include any necessary modifications address the roadway operation and management program	All	March 1, 2002
6. Household Hazardous Wastes / Used Motor Vehicle Fluids	a. Provide summary of evaluation and assessment of results from various collection / recycling/safe disposal program options currently underway to determine any necessary modifications to the program.	Oklahoma City lead permittee; ODOT and OTA - supporting permittees	October 15, 2001
	b. Implement any necessary modifications to the program and update SWMP.	Oklahoma City	August 1, 2002

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SWMP COMPONENT	ACTIVITY	RESPONSIBLE PERMITTEE(S)	DATE DUE/ FREQUENCY
7. Floatables	a. Continue public education program.	All	Year Round
	b. Provide a status report documenting implementation of structural controls for floatables.	All	October 15, 2001 Annually
8. Illicit Discharges and Improper Disposal	a. Continue public education program.	All	Year Round
	b. Submit, with the Annual Report, the results of the allowable non-storm water discharge assessment for each of the non-storm water discharges listed at Part II.A.6.a. and any proposed modifications to the SWMP to implement necessary prohibitions or conditions for acceptance of non-storm water discharges to the Municipal Separate Storm Sewer System.	All	October 15, Annually
	c. Review the SWMP to identify any necessary modifications to provide for identification of illicit discharges, the expeditious elimination of any such identified sources, spill response and cleanup procedures, and programs to limit seepage from sanitary sewers into storm sewers.	All	October 15, 2001
	d. Implement any necessary modifications to the program and update SWMP.	All	March 1, 2002
9. Wet Weather Screening Program	a. Submit an approvable monitoring plan for the Watershed Characterization Project	All	60 Days from effective date of permit
	b. Complete characterization of at least 10% of the MS4 microwatersheds.	All	August 1, 2002 Subject to Fiscal Year

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SWMP COMPONENT	ACTIVITY	RESPONSIBLE PERMITTEE(S)	DATE DUE/ FREQUENCY
	c. Complete characterization of at least 20% (cumulative) of the MS4 microwatersheds.	All	August 1, 2003 Subject to Fiscal Year
	d. Complete characterization of at least 30% (cumulative) of the MS4 microwatersheds.	All	August 1, 2004 Subject to Fiscal Year
	e. Complete characterization of at least 40% (cumulative) of the MS4 microwatersheds.	All	August 1, 2005 Subject to Fiscal Year
	f. Complete characterization of at least 50% (cumulative) of the MS4 microwatersheds.	All	August 1, 2006 Subject to Fiscal Year
10. Industrial and High Risk Runoff	Provide a status report on actions taken and results of the program to identify, monitor, and control pollutants from targeted facilities.	All	October 15, 2001 Annually
11. Pesticide, Herbicide, and Fertilizer Application	Provide at least one annual training/education event for employees on pesticide and fertilizer management techniques. Report on implementation in the Annual Report.	All	October 15, 2001 Annually
12. Supporting Permit Conditions, Monitoring Programs, and Documents	a.Submit completed interjurisdictional agreement(s) between permittees.	All	December 1, 2001
	b.Continue existing roadway operation and maintenance practices to reduce pollutants discharges in storm water and insure compliance with construction site runoff controls consistent with the requirements of the February 1, 1999, OPDES general permit for storm water discharges from construction sites.	ODOT OTA	On Going
	c. Submit copy of adopted comprehensive Storm Water Ordinance.	Oklahoma City	October 15, 2003

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SWMP COMPONENT	ACTIVITY	RESPONSIBLE PERMITTEE(S)	DATE DUE/ FREQUENCY
	d. Based on results of the watershed characterization project, submit supplemental monitoring plan for collection of additional data on any pollutants present at levels of concern for potential water quality impacts.	All	October 15, 2003

[1] All - Oklahoma City, ODOT, and OTA.
[2] EPA Region 6 Minimum Quantification Level (MQL) protocol may be used in the evaluation.

B. Compliance With Effluent Limitations (Reserved)

C. Updating SWMP.

The permittee(s) shall update the SWMP(s) as appropriate. In response to changes required by Part III A. Such updates shall be made in accordance with Part II G.2

PART IV. DISCHARGE LIMITATIONS

A. Discharge Limitations. (Reserved)

PART V. MONITORING AND REPORTING REQUIREMENTS

A. Watershed Characterization Project

1. The goals of the Watershed Characterization Project are to:
   a. Protect, maintain, and restore high quality chemical, physical, and biological conditions in the waters of the City of Oklahoma City;
   b. Reverse the past trends of stream deterioration through improved water management practices;
   c. Maintain physical, chemical, biological, and stream habitat conditions in City streams that support aquatic life, along with appropriate recreational, water supply, and other water uses;
   d. Restore streams damaged by inadequate water management practices of the past by re-establishing the flow regime, chemistry, physical conditions, and biological diversity of natural stream systems as closely as possible; and
   e. Promote and support educational and volunteer initiatives that enhance public awareness and increase direct participation in stream stewardship and the reduction of water pollution.
2. Within the permit area, 197 micro-watersheds have been identified. The Watershed Characterization Project will allow a comprehensive assessment of each micro-watershed to be completed on a rotating basis. A wet weather analytical monitoring component and a biological monitoring component are included.
3. Wet Weather Analytical Monitoring Requirements
   a. Monitoring shall be conducted at a representative in-stream location within the micro-watershed to characterize the quality of storm water discharges from the Municipal Separate Storm Sewer System. Analytical monitoring requirements are detailed in Table V.A.3. Analytical monitoring shall be conducted at least once per year in the micro-watershed. At least 10% of the micro-watersheds will be monitored each year.
   b. Quantitative data shall be collected to estimate pollutant loadings and event mean concentrations for each parameter sampled. Records shall be maintained of all analytical results, the date and duration (in hours) of the storm event(s) sampled; rainfall measurements or estimates (in inches) of the storm event which generated the sampled runoff; the duration (in hours) between the storm event sampled and the end of the previous measurable (greater than 0.1 inch rainfall) storm event; and an estimate of the total volume (in gallons) of the discharge sampled. The estimates of pollutant loadings of the watersheds characterized shall be included in the Annual Report.

Table V.A.3. - Analytical Monitoring Requirements:

PARAMETERS[1]	REPORT FOR EACH MONITORING PERIOD (each sample type)			SAMPLE TYPE(S)	
	Min.	Ave	Max.	Grab	Composite
Biochemical Oxygen Demand (BOD_5) (mg/L)		Yes	Yes		Yes
Chemical Oxygen Demand (COD) (mg/L)		Yes	Yes		Yes
Oil and Grease (mg/L)		Yes	Yes	Yes	
Total Suspended Solids (TSS) (mg/L)		Yes	Yes		Yes
Total Dissolved Solids (TDS) (mg/L)		Yes	Yes		Yes
Total Nitrogen (mg/L)		Yes	Yes		Yes
Total Kjeldahl Nitrogen (TKN) (mg/L)		Yes	Yes		Yes
Total Phosphorus (mg/L)		Yes	Yes		Yes
Dissolved Phosphorus (mg/L)		Yes	Yes		Yes
Total Cadmium (ug/L) (MQL 1 ug/L)1		Yes	Yes		Yes
Total Copper (ug/L) (MQL 10 ug/L) 1		Yes	Yes		Yes
Total Lead (ug/L) (MQL 5 ug/L) 1		Yes	Yes		Yes
Total Zinc (ug/L) (MQL 20 ug/L) 1		Yes	Yes		Yes
Fecal Coliform (colonies/100 ml)		Yes	Yes	Yes	
PH (S.U.)	Yes		Yes	Yes	
Hardness (as CaCO3) (mg/L)	Yes	Yes	Yes	Yes	
Temperature (°C)	Yes	Yes	Yes	Yes	
Diazinon (ug/L) (MQL 0.1 ug/L) 1		Yes	Yes		Yes
Total Mercury (ug/L) (MQL 0.2 ug/L) 1		Yes	Yes		Yes
Total Thallium (ug/L) (MQL 10 ug/L) 1		Yes	Yes		Yes

[1] If any individual analytical test result is less than the minimum quantification level (MQL) listed for that parameter then a value of zero (0) may be used for that test result for the calculation and reporting requirements.

c. Composite Samples: Flow weighted composite samples shall be collected as follows:

   (1) Composite Method - Flow-weighted composite samples may be collected manually or automatically. For both methods, equal volume aliquots may be collected at the time of sampling and then flow-proportioned and composted in the laboratory, or the aliquot volume may be collected based on the flow rate at the time of sample collection and composted in the field.
   (2) Sampling Duration - Samples shall be collected for at least the first three (3) hours of discharge. Where the discharge lasts less than three (3) hours, the entire discharge must be sampled.
   (3) Aliquot Collection - A minimum of three aliquots per hour, separated by at least fifteen (15) minutes, shall be collected. Where more than three aliquots per hour are collected, comparable intervals between aliquots shall be maintained (e.g. six (6) aliquots per hour, at least seven (7) minute intervals).

d. Grab Samples: Grab samples shall be taken during the first two hours of discharge.

e. Representative Storm Events: Samples shall be collected from the discharge resulting from a storm event that is greater than 0.1 inches in magnitude and that occurs at least 72 hours from the previously measurable (greater than 0.1 inch rainfall) storm event. The required 72 hour storm event interval is waived where the preceding measurable storm event did not result in a measurable discharge. The required 72 hour storm event interval is also waived where the permittee(s) documents that less than a 72 hour interval is representative for local storm events during the season when sampling is being conducted.

f. Analytical Methods: Analysis and collection of samples shall be done in accordance with the methods specified at OAC 252.605-1-5(b)(7) adopting and incorporating by reference 40 CFR Part 136. Where an approved Part 136 method does not exist, any available method may be used unless a particular method or criteria for method selection (such as sensitivity) has been specified in the permit.

4. Biological Monitoring Requirements

   a. The permittee(s) shall obtain all necessary aquatic wildlife collection permits from appropriate State and/or Federal agencies (e.g. U.S. Fish and Wildlife Service, Oklahoma Department of Wildlife Conservation).

   b. The biological monitoring program will include aquatic habitat surveys, fish collections, and macroinvertebrate collections at representative in-stream locations within the micro-watershed. Procedures contained in Oklahoma's Standardized Bioassessment Protocol (SBP) will be utilized. At least 10% of the micro-watersheds will be monitored each year.

   c. Each station will be monitored at least once per year. A summary data sheet will be developed for each monitoring station.

   d. At least three reference streams within the permit area will be identified. Reference streams will be monitored seasonally, at least three times per year.

5. Watershed Characterization Monitoring Program

   Within 60 days from the effective date of this permit, the permittee(s) shall submit an approvable watershed characterization monitoring program to DEQ. The monitoring program will detail the micro-watershed rotation schedule, monitoring station selection criteria, biological metrics to be utilized, recordkeeping procedures, quality assurance and quality control procedures, identification of reference streams, and other details of the Watershed Characterization Project. Unless disapproved by the Director within 60 days of submission, the plan shall be deemed approved and shall be implemented by the permittee(s).

B. Floatables Monitoring

The permittee(s) shall establish two (2) monitoring locations for removal of floatable material in discharges to or from the Municipal Separate Storm Sewer System. Floatable material shall be collected at the frequency necessary for maintenance of the removal devices, but not less than twice per year. The amount of material collected shall be estimated in cubic yards and shall be reported in the Annual Report required by Part V.C.

C. Annual Report

Each permittee shall contribute to the preparation of an annual system-wide report to be submitted no later than October 15th, with the first report due October 15, 2001. The report shall cover the previous year from August 1st to July 31th and include the following separate sections, with an overview for the entire Municipal Separate Storm Sewer System and subsections for each permittee:

1. The status of implementing the storm water management program(s) (status of compliance with any schedules established under this permit shall be included in this section);
2. Proposed changes to the SWMP(s);
3. Revisions, if necessary, to the assessments of controls and the fiscal analysis reported in the permit application under OAC 252.605-1-5(b)(3)(L) adopted and incorporated by reference 40 CFR 122.26(d)(2)(iv) and (d)(2)(v);
4. A summary of the data, including monitoring data, that is accumulated throughout the reporting year;
5. Annual expenditures for the reporting period, with a breakdown for the major elements of the SWMP, and the budget for the year following each annual report;
6. A summary describing the number and nature of enforcement actions, inspections, and public education programs; and
7. Identification of water quality impacts.
8. The year five (5) annual report shall contain a comprehensive assessment of the Watershed Characterization Project, the findings and impacts identified, responses taken, and any modifications recommended to enhance the usefulness or efficiency of the Project.

Preparation and submittal of a system-wide annual report shall be coordinated by the City of Oklahoma City. The report shall indicate which, if any, permittee(s) have failed to provide required information on the portions of the Municipal Separate Storm Sewer System for which they are responsible to the City of Oklahoma City by forty-five (45) days prior to the report due date. Joint responsibility for report submission shall be limited to participation in preparation of the overview for the entire system and inclusion of the identity of any permittee who failed to provide input to the annual report. Each individual permittee shall be individually responsible for content of the report relating to the portions of the Municipal Separate Storm Sewer System for which they are responsible and for failure to provide information for the system-wide annual report in a timely manner. Each permittee shall sign and certify the annual report in accordance with Part VI.H and include a statement or resolution that the permittee's governing body or agency (or delegated representative) has reviewed or been appraised of the content of the Annual Report.

D. Certification and Signature of Reports.

All reports required by the permit and other information requested by the Director shall be signed and certified in accordance with Part VI.H.

E. Reporting: Where and When to Submit.

1. Representative monitoring results (Part V.A.) obtained during the reporting period running from August 1st to July 31th shall be submitted along with the annual report required by Part V.D. (due October 15th).
2. Signed copies, required under Part V., the Annual Report required by Part V.D., and all other reports required herein, as well as updates shall be submitted to:

Oklahoma Department of Environmental Quality
Water Quality Division
P.O. Box 1677
Oklahoma City, Oklahoma 73101-1677

PART VI. STANDARD PERMIT CONDITIONS

A. Duty to Comply.

The permittee(s) must comply with all conditions of this permit insofar as those conditions are applicable to each permittee, either individually or jointly. Any permit noncompliance constitutes a violation of the Act and is grounds for enforcement action; for permit termination, revocation and reissuance, or modification; or for denial of a permit renewal application.

B. Penalties for Violations of Permit Conditions

1. Criminal Penalties.

   a. Negligent Violations: The Act provides that any person who negligentlyviolates permit conditions implementing Sections 301, 302, 306, 307, 308, 318, or 405 of the Act is subject to a fine of not less than $2,500 nor more than $25,000 per day of violation, or by imprisonment for not more than 1 year, or both.

   b. Knowing Violations: The Act provides that any person who knowingly violates permit conditions implementing Sections 301, 302, 306, 307, 308, 318, or 405 of the Act is subject to a fine of not less than $5,000 nor more than $50,000 per day of violation, or by imprisonment for not more than 3 years, or both.

   c. Knowing Endangerment: The Act provides that any person who knowingly violates permit conditions implementing Sections 301, 302, 306, 307, 308, 318, or 405 of the Act and who knows at that time that he is placing another person in imminent danger of death or serious bodily injury is subject to a fine of not more than $250,000, or by imprisonment for not more than 15 years, or both.

   d. False Statement: The Act provides that any person who knowingly makes any false material statement, representation, or certification in any application, record, report, plan, or other document filed or required to be maintained under the Act or who knowingly falsifies, tampers with, or renders inaccurate, any monitoring device or method required to be maintained under the Act, shall upon conviction, be punished by a fine of not more than $10,000 or by imprisonment for not more than 2 years, or by both. If a conviction is for a violation committed after a first conviction of such person under this paragraph, punishment shall be by a fine of not more than $20,000 per day of violation, or by imprisonment of not more than 4 years, or by both (See Section 309(c)(4) of the Act.

2. Civil lPenalties. The Act provides that any person wh violates a permit condition implementing Sections 301, 302, 306, 307, 308, 318, or 405 of the Act is subject to Civil Penalties. The Act provides that any person who violates a permit condition implementing Sections 301, 302, 306, 307, 308, 318, or 405 of the Act is subject to a civil penalty not to exceed $25,000 per day for each violation.

3. Administrative Penalties. The Act provides that any person who violates a permit condition an administrative penalty, as follows:

   a. Class I penalty: Not to exceed $10,000 per violation nor shall the maximum amount exceed $60,000.

   b. Class II penalty: Not to exceed $10,000 per day for each day during which the violation continues nor shall the maximum amount exceed $125,000.

C. Duty to Reapply

If the permittee wishes to continue an activity regulated by this permit after the permit expiration date, the permittee must apply for and obtain a new permit. The application shall be submitted at least 180 days prior to expiration of this permit. The Director may grant permission to submit an application less than 180 days in advance but no later than the permit expiration date. Continuation of expiring permits shall be governed by regulations promulgated at OAC 252.605-1-5(b)(3)(F) adopted and incorporated by reference 40 CFR 122.6 and any subsequent amendments.

D. Need to Halt or Reduce Activity Not a Defense

It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

E. Duty to Mitigate.

The permittee(s) shall take all reasonable steps to minimize or prevent any discharge in violation of this permit that has a reasonable likelihood of adversely affecting human health or the environment.

F. Duty to Provide Information

The permittee(s) shall furnish to the Director, within a time specified by the Director, any information that the Director may request to determine compliance with this permit. The permittee(s) shall also furnish to the Director upon request copies of all required records kept by the permittee(s).

G. Other Information.

When the permittee becomes aware that he or she failed to submit any relevant facts or submitted incorrect information in any report to the Director, he or she shall promptly submit such facts or information.

H. Signatory Requirements

All Discharge Monitoring Reports, SWMPs, reports, certifications or information either submitted to the Director or that this permit requires be maintained by the permittee(s), shall be signed by:

1. for a municipality, State, or other public agency: by either a principal executive officer or ranking elected official; or
2. a duly authorized representative of that person. A person is a duly authorized representative only if:
    a. The authorization is made in writing by a person described above and submitted to the Director.
    b. The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity, such as the position of manager, operator, superintendent, or position of equivalent responsibility or an individual or position having overall responsibility for environmental matters for the company. A duly authorized representative may thus be either a named individual or any individual occupying a named position.

c. If an authorization is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new written authorization satisfying the requirements of this paragraph must be submitted to the Director prior to or together with any reports, information, or applications to be signed by an authorized representative.

3. Certification: Any person signing documents under this section shall make the following certification: "I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

I. Penalties for Falsification of Monitoring Systems

The Act provides that any person who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required to be maintained under this permit shall, upon conviction, be punished by fines and imprisonment described in Section 309 of the Act.

J. Oil and Hazardous Substance Liability

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee is or may be subject under section 311 of the Act or section 106 of CERCLA.

K. Property Rights.

The issuance of this permit does not convey any property rights of any sort, nor any exclusive privileges, nor does it authorize any injury to private property nor any invasion of personal rights, nor any infringement of Federal, State or local laws or regulations.

L. Severability

The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit shall not be affected thereby.

M. Requiring a Separate Permit.

1. The Director may require any co-permittee authorized by this permit to obtain a separate OPDES permit. Any interested person may petition the Director to take action under this paragraph. The Director may require any co-permittee authorized to discharge under this permit to apply for a separate OPDES permit only if the co-permittee has been notified in writing that a permit application is required. This notice shall include a brief statement of the reasons for this decision, an application form (as necessary), a statement setting a deadline for the co-permittee to file the application, and a statement that on the effective date of the separate OPDES permit, coverage under this permit shall automatically terminate. Separate permit applications shall be submitted to the address shown in Part V.F. The Director may grant additional time to submit the application upon request of the applicant. If an owner or operator fails to

submit in a timely manner a separate OPDES permit application as required by the Director, then the applicability of this permit to the co-permittee is automatically terminated at the end of the day specified for application submittal.

2. Any co-permittee authorized by this permit may request to be excluded from the coverage of this permit by applying for a separate permit. The co-permittee shall submit a separate application as specified by OAC 252.605-1-5(b)(3)(L) adopted and incorporated by reference 40 CFR 122.26(d) with reasons supporting the request to the Director. Separate permit applications shall be submitted to the address shown in Part V.F. The request may be granted by the issuance of a separate permit if the reasons cited by the co-permittee are adequate to support the request.

N. State Environmental Laws

1. Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable State law or regulation under authority preserved by Section 510 of the Act.
2. No condition of this permit shall release the permittee from any responsibility or requirements under other environmental statutes or regulations.

O. Proper Operation and Maintenance.

The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to achieve compliance with the conditions of this permit and with the requirements of SWMPs. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. Proper operation and maintenance requires the operation of backup or auxiliary facilities or similar systems, installed by a permittee only when necessary to achieve compliance with the conditions of the permit.

P. Monitoring and Records

1. Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity.
2. The permittee shall retain records of all monitoring information including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of the reports required by this permit, and records of all data used to complete the application for this permit, for a period of at least 3 years from the date of the sample, measurement, report or application. This period may be extended by request of the Director at any time.
3. Records of monitoring information shall include:
   a. The date, exact place, and time of sampling or measurements;
   b. The initials or name(s) of the individual(s) who performed the sampling or measurements;
   c. The date(s) analyses were performed;
   d. The time(s) analyses were initiated;
   e. The initials or name(s) of the individual(s) who performed the analyses;

f. References and written procedures, when available, for the analytical techniques or methods used; and

g. The results of such analyses, including the bench sheets, instrument readouts, computer disks or tapes, etc., used to determine these results.

Q. Monitoring Methods

Monitoring must be conducted according to test procedures approved under OAC 252.605-1-5(b)(7) adopted and incorporated by reference 40 CFR Part 136, unless other test procedures have been specified in this permit.

R. Inspection and Entry

The permittee shall allow the Director or an authorized representative of EPA, or the State, upon the presentation of credentials and other documents as may be required by law, to:

1. Enter the permittee's premises where a regulated facility or activity is located or conducted or where records must be kept under the conditions of this permit;
2. Have access to and copy at reasonable times, any records that must be kept under the conditions of this permit;
3. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this permit; and
4. Sample or monitor at reasonable times, for the purposes of assuring permit compliance or as otherwise authorized by the Act, any substance or parameters at any location.

S. Permit Actions

This permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by the permittee for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not stay any permit condition.

T. Additional Monitoring by the Permittee

If the permittee monitors more frequently than required by this permit, using test procedures approved under OAC 252.605-1-5(b)(7) adopted and incorporated by reference 40 CFR Part 136 or as specified in this permit, the results of this monitoring may be included in the calculation and reporting of the data submitted.

U. Archeological and Historical Sites (Reserved)

PART VII. PERMIT MODIFICATION.

A. Modification of the Permit

The permit may be reopened and modified during the life of the permit to address:

1. changes in the State's Water Quality Management Plan, including Water Quality Standards;
2. changes in state or federal statutes or regulations;
3. any additional provisions necessary to comply with requirements of an approved TMDL.
4. add a new permittee who is the owner or operator of a portion of the MS4;
5. changes in portions of the SWMP that are considered permit conditions; or
6. other modifications deemed necessary by the Director to meet the requirements of the Act.

All modifications to the permit will be made in accordance with OAC 252.605-1-5(b)(3)(Z), (AA), and (4)(D) adopted and incorporated by reference CFR 122.62, 122.63, and 124.5.

B. Termination of Coverage for a Single Permittee

Permit coverage may be terminated, in accordance with the provisions of OAC 252.605-1-5(b)(3)(BB) incorporating by reference 40 CFR 122.64 and OAC 252.605-1-5(b)(4)(D) adopted and incorporated by reference 40 CFR 124.5, for a single permittee without terminating coverage for other permittees.

C. Modification of SWMP(s)

Only those portions of the SWMPs specifically required as permit conditions shall be subject to the modification requirements of OAC 252.605-1-5-(b)(4)(D) adopted and incorporated by reference 40 CFR 124.5. Addition of components, controls, or requirements by the permittee(s); replacement of an ineffective or infeasible BMP implementing a required component of the SWMP with an alternate BMP expected to achieve the goals of the original BMP; and changes required as a result of schedules contained in Part III shall be considered minor changes to the SWMP and not modifications to the permit. (See also Part II.G.)

D. Changes in Monitoring Outfalls

Changes in monitoring outfalls, other than those with specific numeric effluent limitations shall be considered minor modifications to the permit and will be made in accordance with the procedures at OAC 252.605-1-5(b)(3)(AA) adopted and incorporated by reference 40 CFR 122.63.

PART VIII. DEFINITIONS

All definitions contained in Section 502 of the Act shall apply to this permit and are incorporated herein by reference. Unless otherwise specified, additional definitions of words or phrases used in this permit are as follows:

A. **"Best Management Practices" ("BMPs")** means schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the United States. BMPs also include treatment requirements, operating procedures, and practices to control facility site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

B. **"CWA" or "The Act"** means Clean Water Act (formerly referred to as the Federal Water Pollution Control Act or Federal Water Pollution Control Act Amendments of 1972) Pub. L. 92-500, as amended Pub. L. 95-217, Pub. L 95-576, Pub. L 96-483 and Pub. L. 97-117, 33 U.S.C. 1251 et.seq.

C. **"Co-permittee"** is defined at OAC 252.605-1-5(b)(3)(L) adopted and incorporated by reference 40 CFR 122.26(b)(1).

D. **"Core Municipality"** means, for the purpose of this permit, the municipality whose corporate boundary (unincorporated area for counties and parishes) defines the Municipal Separate Storm Sewer System. (ex. City of Dallas for the Dallas Municipal Separate Storm Sewer System, Harris County for unincorporated Harris County).

E. **"Director"** means the Executive Director of the DEQ or an authorized representative.

F. **"Discharge"** for the purpose of this permit, unless indicated otherwise, refers to discharges from the Municipal Separate Storm Sewer System (MS4).

G. **"Flow-Weighted Composite Sample"** means a composite sample consisting of a mixture of aliquots collected at a constant time interval, where the volume of each aliquot is proportional to the flow rate of the discharge.

H. **"Illicit Connection"** is defined at OAC 252.605-1-5(b)(3)(L) adopted and incorporated by reference 40 CFR 122.26(b)(2) and means any man-made conveyance connecting an illicit discharge directly to a municipal separate storm sewer.

I. **"Individual Residence"** refers, for the purposes of this permit, to single or multi-family residences. (e.g. single family homes and duplexes, town homes, apartments, etc.)

J. **"Landfill"** means an area of land or an excavation in which wastes are placed for permanent disposal, and which is not a land application unit, surface impoundment, injection well, or waste pile.

K. **"Land Application Unit"** means an area where wastes are applied onto or incorporated into the soil surface (excluding manure spreading operations) for treatment or disposal.

L. **"Large or Medium Municipal Separate Storm Sewer System"** is defined at OAC 252.605-1-5(b)(3)(L) adopted and incorporated by reference 40 CFR 122.26(b)(4) & (7).

M. **"MEP"** is an acronym for "Maximum Extent Practicable," the technology-based discharge standard for Municipal Separate Storm Sewer Systems established by CWA §402(p).

N. **"MS4"** is an acronym for "Municipal Separate Storm Sewer System" and is used to refer to either a Large or Medium Municipal Separate Storm Sewer System (e.g. "the Oklahoma City MS4"). And is also defined at OAC 252.605-1-5(b)(3)(L) adopted and incorporated by reference 40 CFR 122.26(b)(8).

O. **"Part ' # ' "** refers, unless otherwise indicated, to Part " # " of this permit (e.g. Part V.F.2.).

P. **"Permittee"** refers to any "person," as defined at OAC 252.605-1-5(b)(3)(B) adopted and incorporated by reference 40 CFR 122.2, authorized by this OPDES permit to discharge to Waters of the United States.

Q. **"Point Source"** means any discernible, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel or other floating craft from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture or agricultural storm water runoff.

R. **"Storm Sewer"**, unless otherwise indicated, refers to a municipal separate storm sewer.

S. **"Storm Water"** means storm water runoff, snowmelt runoff, and surface runoff and drainage.

T. **"Storm Water Discharge Associated with Industrial Activity"** is defined at OAC 252.605-1-5(b)(3)(L) adopted and incorporated by reference 40 CFR 122.26(b)(14).

U. **"SWMP"** refers to a comprehensive program to manage the quality of storm water discharged from the Municipal Separate Storm Sewer System. For the purposes of this permit, the SWMP is considered a single document, but may actually consist of separate programs (e.g. "chapters") for each permittee.

V. **"Time-weighted Composite"** means a composite sample consisting of a mixture of equal volume aliquots collected at a constant time interval.

W. **"Waters of the United States"** is defined at OAC 252.605-1-5(b)(3)(B) adopted and incorporated by reference 40 CFR 122.2.

NPDES Permit No. DC0000221
Issuance Date: August 19, 2004
Effective Date: August 19, 2004

AUTHORIZATION TO DISCHARGE UNDER THE
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
MUNICIPAL SEPARATE STORM WATER SEWER SYSTEM PERMIT NO. DC0000221

AMENDMENT NO. 1

In compliance with the provisions of the Clean Water Act, 33 U.S.C. 1251 et seq.

Government of the District of Columbia
The John A. Wilson Building
1350 Pennsylvania Avenue, N.W.
Washington, D.C. 20004

is authorized to discharge from all portions of the municipal separate storm sewer system owned and operated by the District of Columbia to receiving waters named

Potomac River, Anacostia River, Rock Creek,
And Tributaries

in accordance with the approved Storm Water Management(s), effluent limitations, monitoring requirements, and other conditions set forth in this Amendment No. 1 herein to Parts I, III, VII, IX, and X of Parts I through X of the previously issued Permit.

The effective issuance date of this Amendment No. 1 is March 14, 2006

This Amendment No. 1 to the Permit and the authorization to discharge shall expire at midnight, on August 18, 2009.

Signed this 13th day of March, 2006.

Jon M. Capacasa, Director
Water Protection Division
United States Environmental Protection Agency
Region III

A018190

PART I. DISCHARGES AUTHORIZED UNDER THIS PERMIT

C. Limitations to Coverage (Prohibitions) [Replace existing language of C including Title with this]

Section 402(p)(3)(B)(ii) of the Clean Water Act specifically prohibits non-storm water entering the MS-4. The Permit does not authorize the Permittee to discharge pollutants from the MS4 as described herein:

1. Non-Storm Water and Phase I and Phase II Storm Water

Discharges of non-storm water (other than those listed in Part I.B. of this permit) are prohibited except where such discharges comply with all other terms and conditions of this permit and are:

a. Regulated with a General NPDES permit for Phase I or Phase II storm water discharges, or

b. Regulated with a individual NPDES permit.

2. All discharges of pollutants to or from the MS4 system, not regulated by a general or an individual NPDES permit, that cause or contribute to the lowering of water quality from current conditions within the District of Columbia are prohibited.

D. Effluent Limits

[replace existing Subpart D with the following]

1. MEP Effluent Limit - The permittee shall implement the controls, Best Management Practices (BMPs), and other activities necessary to reduce pollutants as set forth in the Upgraded Storm Water Management Plan dated October 19, 2002. Unless and until modified consistent with Part VII.P (Reopener Clause for Permits) of this Permit, the Upgraded Storm Water Management Plan requirements expressed in the form of BMPs, represent the controls necessary to reduce the discharge of pollutants to the Maximum Extent Practicable (MEP) in accordance with 40 CFR Part 122.44(k)(2).

2. WQBEL Limit - The permittee shall implement the controls, Best Management Practices (BMPs), and other activities necessary to reduce pollutants to the Maximum Extent Practicable as set forth in the Upgraded Storm Water Management Plan dated October 19, 2002, and all other requirements of this Permit (including but not limited to the narrative prohibitions on discharge of pollutants from the MS4 set forth in I.C. of this Permit). EPA reserves the authority to modify this effluent limit as described below in Part VII.P (Reopener Clause for Permits) of this Permit.

3. Effluent Limits Consistent with TMDL WLA - The permittee shall implement controls, Best Management Practices (BMPs), and other activities necessary to reduce pollutants to the Maximum Extent Practicable as set forth in the Upgraded Storm Water Management Plan dated

October 19, 2002, and to comply with all other requirements of this Permit (including but not limited to the narrative prohibitions on discharge of pollutants from the MS4 set forth in I.C. of this Permit). As further described in Part IX.B. of this Permit, in addition to complying with the effluent limits I.C. and I.D. of this Permit, the Permittee is required to submit and, unless instructed otherwise by EPA, implement the recommendations of implementation plans specific to the Anacostia River Total Maximum Daily Load (TMDL) wasteload allocations (WLAs) and Rock Creek TMDL WLAs in accordance with the schedule set forth in Part III.A. Table 1 of this Permit.

PART III. STORM WATER MANAGEMENT PLAN (SWMP)

C. Annual SWMP Reporting

The [Annual] Report shall include the following separate sections:

6. [keep existing part and add the following - remember this is cross referenced to Part III.D first paragraph] this identification shall include but not be limited to the permittee's calculation of pollutant loads and reductions from the MS4 system in those watershed(s) for which there are applicable TMDL WLAs using the methods described in Part IX.B.

PART VII. STANDARD PERMIT CONDITIONS FOR NPDES PERMITS

P. Reopener Clause for Permits

c. [replace first sentence of existing language with the following; concluding sentence of VII.P unchanged] The Permit may be modified in accordance with 40 C.F.R. Part 124.5, or revoked and reissued to incorporate additional controls in the event that EPA determines that further controls, under the iterative approach, are necessary to (1) ensure that the effluent limits are sufficient to prevent a further lowering of water quality from current conditions and/or (2) to ensure that the effluent limits are consistent with any applicable TMDL WLA allocated to discharge of pollutants from the MS4.

PART IX OTHER APPLICABLE PROVISIONS

A. Waivers and Exemptions

[unchanged, but add additional sentence] As part of its Annual Report to EPA under Part III.C. of this Permit, the permittee shall describe each and every instance in which the District authorized such an exemption and/or granted such a waiver, the nature and location of the activity for which each exemption or waiver was granted, the justification for each exemption or waiver, and the District's basis for finding that the exemption or waiver was consistent with the Federal Clean Water Act and other pertinent guidance, policies, and regulations.

B. TMDL WLA Implementation Plans and Compliance Monitoring

[replace first paragraph of 2004 Permit with the following]

In addition to the duty to comply with the narrative effluent limits in Part I of this Permit, the permittee shall demonstrate compliance as described in this Part and in Part IV (Monitoring and Reporting Requirements). In accordance with the schedule identified in Part III.A. (Compliance Schedule) and Table 1 and below, Permittee shall further submit implementation plans to reduce discharges consistent with any applicable EPA-approved waste load allocation (WLA) component of any established Total Maximum Daily Loadings (TMDL). An applicable TMDL WLA for this Permit means any MS4 WLA established on or before the effective date of this Permit for a receiving stream, segment of a stream, or other waterbody within the District of Columbia as described below.

[next 2 paragraphs, identifying applicable WLAs and associated reductions left unchanged]
[the following paragraph to replace the third paragraph of Part IX.B in 2004 permit]

Demonstration of compliance (as specified in Parts IV and VIII of the Permit) will be calculated using the procedures (i.e., Simple Method) identified in the Upgraded SWMP dated October 19, 2002 (or other procedures approved by EPA via permit modification and shown to be scientifically sound and reliable in estimating actual load reductions), and will be reported by comparing the calculated load for each pollutant to the approved pollutant specific WLAs and its associated storm water load reductions for the receiving waterbody as specified in the Fact Sheet.

[the following two paragraphs to replace the last paragraph of Part IX.B. in 2004 permit]

The TMDL Implementation Plans shall consist of documenting all previous and on-going efforts at achieving the specific pollutant reductions identified in the TMDL WLA and further demonstrating additional controls sufficient to achieve those reductions through an established performance based benchmark. This benchmark shall be applied against annual projected performance standards for purposes of achievement of adequate reductions.

The Permittee shall submit to EPA the applicable TMDL Implementation Plans for the Anacostia River TMDLs within six months of the effective date of this permit and shall implement such Plan. The Permittee shall submit to EPA the applicable TMDL Implementation Plan for the Rock Creek TMDLs within twelve months after the effective issuance date of this Permit and shall implement such Plan.

PART X. PERMIT DEFINITIONS

[Add new definitions]

"Benchmark" or "measurable performance standard"- The term when used in Parts III.C.6. (Annual SWMP Reporting), III.D. (Annual SWMP Implementation Plan) and IX.B (TMDL WLA Implementation Plans and Compliance Monitoring) of the Permit refers to a criteria-based management evaluation tool described in Part IX.B (including but not limited to the Simple Method) for the purpose of making the determination each year as required in Part III.C.6 and

Part III.D. during the term of the Permit:

"Current Conditions"- Refers to a trend analysis which compares existing or baseline data to future data collected through the MS4 monitoring program as described in Part IV (Monitoring and Reporting Requirements) of the Permit to assess the overall performance (i.e., selection of BMPs/LID projects, setting of narrative/numeric effluent limits to MEP and/or water quality based standards) of the Storm Water Management Program within the District of Columbia.

NPDES Permit No. DC0000221

AUTHORIZATION TO DISCHARGE UNDER THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM MUNICIPAL SEPARATE STORM WATER SYSTEM PERMIT NO. DC0000221

In compliance with the provisions of the Clean Water Act, 33 U.S.C. 1251 et seq.

Government of the District of Columbia
The John A. Wilson Building
1350 Pennsylvania Avenue, N.W.
Washington, D.C. 20004

is authorized to discharge from all portions of the municipal separate storm sewer system owned and operated by the District of Columbia to receiving waters named

Potomac River, Anacostia River,
and tributaries

in accordance with the upgraded Storm Water Management Program(s), effluent limitations, monitoring requirements and other conditions set forth in Parts I through X herein.

The effective issuance date of this permit is

This permit and the authorization to discharge shall expire at midnight, on

Signed this day of August 2004

Jon M. Capacasa, Director
Water Protection Division
U.S. Environmental Protection Agency
Region III

A018195

PERMIT FOR THE DISTRICT OF COLUMBIA'S
MUNICIPAL SEPARATE STORM SEWER SYSTEM

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X. PERMIT DEFINITIONS

PART I. DISCHARGES AUTHORIZED UNDER THIS PERMIT

A. Permit Area

This permit covers all areas within the corporate boundary of the District of Columbia served by, or otherwise contributing to discharges from, municipal separate storm sewers owned or operated by the District of Columbia.

B. Authorized Discharges

This permit authorizes all existing or new storm water point source discharges to waters of the United States from the municipal separate storm water sewer system of the District of Columbia. This permit also authorizes the discharge of storm water commingled with flows contributed by process wastewater, non-process wastewater, or storm water associated with industrial activity provided such discharges are authorized under separate NPDES permits.

Nothing in this permit prohibits the following sources when properly managed so that water quality is not impaired and that the requirements of the Clean Water Act and EPA regulations are met: clear water flows, roof drainage, water line flushing, landscape irrigation, diverted stream flows, rising ground waters, uncontaminated ground water infiltration to separate storm sewers, uncontaminated pumped ground water, discharges from potable water sources, foundation drains, air conditioning condensation, irrigation waters, springs, footing drains, lawn watering, individual resident car washing, flows from riparian habitats and wetlands, dechlorinated swimming pool discharges, street wash water, fire fighting activities, and similar types of activities.

C. Limitations to Coverage

Section 402(p)(3)(B)(ii) of the Clean Water Act specifically prohibits non-storm water entering the MS-4. The Permit does not authorize the Permitee to discharge pollutants from the MS4 as described herein:

1. Non-Storm Water and Phase I and Phase II Storm Water

Discharges of non-storm water (other than those listed in Part I.B. of this permit) are prohibited except where such discharges are:

a. Regulated with a General NPDES permit for Phase I or Phase II storm water discharges, or

b. Regulated with a individual NPDES permit.

2. All other discharges of pollutants to the MS4 system that cause or contribute to the exceedance of the District of Columbia water quality standards are prohibited and not authorized by this Permit.

D. Effluent Limits

1. MEP Effluent Limit - The permittee shall implement the controls, Best Management Practices (BMP), and other activities necessary to reduce pollutants as set forth in the Upgraded Storm Water Management Plan dated October 19, 2002. Unless and until modified consistent with Part VII.P (Reopener Clause for Permits) of this Permit, the Upgraded Storm Water Management Plan requirements expressed in the form of BMPs, represent the controls necessary to reduce the discharge of pollutants to the Maximum Extent Practicable in accordance with 40 CFR Part 122.44(k)(2).

2. WQBEL Effluent Limit - The permittee shall implement the controls, Best Management Practices (BMPs), and other activities necessary to reduce pollutants as set forth in the Upgraded Storm Water Management Plan dated October 19, 2002, and all other requirements of this Permit (including but not limited to the narrative prohibition on discharge of pollutants from the MS4 set forth in I.C. of this Permit). Unless and until modified consistent with Part VII.P (Reopener Clause for Permits) of this Permit, EPA has determined that these controls are sufficient to achieve compliance with applicable water quality standards in accordance with existing Federal rules and regulations.

3. Effluent Limits Consistent with TMDL WLA - The permittee shall implement the controls, Best Management Practices (BMPs), and other activities necessary to reduce pollutants as set forth

in the Upgraded Storm Water Management Plan dated October 19, 2002, and all other requirements of this Permit (including but not limited to the narrative prohibition on discharge of pollutants from the MS4 set forth in I.C. of this Permit). Based on limited information, and until and unless this Permit is modified in accordance with the Reopener Clause of Part VII.P of this Permit, EPA has determined that these controls are appropriate effluent limits consistent with the assumptions and requirements of the approved waste load allocations (WLAs) established in various total maximum daily loads specifically described and discussed in the MS4 Fact Sheet. Based on EPA review of the Permittee's submission of the Total Maximum Daily Loading (TMDL) Implementation Plan(s) as required by Part IX.B. of this Permit, EPA shall reconsider and determine whether these controls are consistent with applicable water quality standards and approved WLAs in accordance with existing Federal requirements. EPA specifically reserves the right to formally modify this Permit's effluent limit in accordance with Reopener Clause of Part VIII.P. of this Permit in the event that EPA determines further controls are necessary to address the WLAs and/or water quality standards.

Part II. SOURCE IDENTIFICATION

During the period beginning on the effective date and lasting through the expiration date of this permit:

The permittee shall continue to compile and submit pertinent information on pollution sources, including significant changes(see EPA's approved definition in First Annual Review dated April 19,2001)in the identification and mapping of storm sewer system (MS4) outfalls consisting of those identified as "major" and "others" in the upgraded SWMP dated October 19,2002, and changes affecting the District's separate storm system (MS4) due to: land use activities, population estimates, runoff characteristics, major structural controls, landfills, publicly owned lands, and industries. This information shall be submitted in each of the Annual Reports/Implementation Plans to EPA pursuant to the procedures in Part III of this permit. Analysis of data for these pollution sources shall be reported according to Part V for the Storm Water Model.

Part III. STORM WATER MANAGEMENT PROGRAM (SWMP)

A. COMPLIANCE SCHEDULE

Each year on the effective date of the Permit, the permittee shall provide EPA with a written Annual Report as required by 40 CFR 122.42(c)using the implemented upgraded and amended Storm Water Management Plan dated October 19, 2002 developed by the District as the basis for the Report. In addition to the Annual

Report, the permittee shall at the same time provide EPA with a Discharge Monitoring Report as described in Part IV of this Permit and an Implementation Plan as described in Part III.D of this Permit summarizing how each category of MS4 activities identified within this Permit was implemented during the previous year along with implementation plans for each activity in the following year. As described in Part IX.2 of this Permit, the permittee shall also submit Implementation Plan(s)for the Anacostia River Total Maximum Daily Loads(TMDLs)six months after the effective issuance date of the Permit and for the Rock Creek TMDLs twelve months after the effective issuance date of the Permit. Six months prior to the expiration date of the Permit, the permittee shall provide EPA an Upgraded Storm Water Management Plan (SWMP) as described in Part III.B and E of this Permit. All these efforts, which are identified in Table I below as "submittals",have deadlines and are subject to EPA approval as set forth below at Parts III.E and IX.2.

TABLE 1

Submittal	Deadline
Outfall Discharge Monitoring Report *	Each year on the effective date of the permit (EDOP) consistent with Paragraph IV.A.1.
Annual Report	Each year on the EDOP
Annual Implementation Plan	Each year on the EDOP
Anacostia River TMDL Implementation Plan(s)	6 months after the EDOP
Rock Creek TMDL Implementation Plan(s)	12 months after the EDOP
Upgraded SWMP and MS4 Permit Application	6 months prior to the permit expiration date.

* Samples shall be taken at least three times a year within the subwatershed being monitored for that particular year as provided in Tables 4 and 5 of Part IV.A.1 of the permit.

Deadlines may be adjusted by written agreement by both EPA and the permittee up to 120 days (see minor modification provision). However, this permit places no obligation on EPA to expand the above schedule. The Outfall Discharge Monitoring Report shall be submitted each year, incorporating the reporting requirements in Part VIII.E.(Reporting of Monitoring Results).

All the requirements in Table 2 in Part III.B of this permit are to be used in the development of the upgraded SWMP. The District's October 19, 2002(upgraded SWMP) is also incorporated by reference into this permit.

B. COMPONENTS OF STORM WATER MANAGEMENT PROGRAM (SWMP)

The SWMP shall be implemented in a manner consistent with the following guidelines provided for the 12 management plan components. In carrying out the SWMP, the permittee shall issue no exemption, waiver, or variance that would violate the Clean Water Act or EPA regulations. This Permit does not authorize any discharge based on such exemption, waiver, or variance. To the extent that this permit makes reference to or incorporates the District's Storm Water Management Plan (SWMP)(defined in Part X of this permit), that portion of the plan is hereafter incorporated into this permit by reference.

The permittee shall implement the controls, procedures, Best Management Practices (BMPs) set forth in the current Upgraded SWMP dated October 19, 2002 in order to reduce the pollutant load to the extent necessary to meet the requirements of 40 CFR 122.26 (d)(2)(iv) and the provisions of the Clean Water Act for all areas within the District according to Table 2 below. The controls described in the October 19, 2002, document are effluent limitations that EPA has determined are adequate to ensure that the discharges do not cause or contribute to exceedences of applicable water quality standards.

TABLE 2

Required Program Element	Regulatory References (40 CFR 122.26)
Adequate Legal Authority	(d)(2)(I)(C)-(F)
Characterization Data	(d)(2)(iii)(B)-(D),40 CFR 122.21(g)(7)
Application Requirements	(d)(2)(iv)(A)(1)
Assessment of Controls	(d)(2)(v)
Structural Controls	(d)(2)(iv)(A)(1)
Areas of new development and significant redevelopment	(d)(2)(iv)(A)(2)
Roadways	(d)(2)(iv)(A)(3)
Flood Control Projects	(d)(2)(iv)(A)(4)
Pesticides, Herbicides, and Fertilizers Application	(d)(2)(iv)(A)(6)
Illicit Discharges and Improper Disposal	(d)(2)(iv)(B)(1)-(5), (iv)(B)(7)
Industrial and High Risk Runoff	(d)(2)(iv)(C), (iv)(A)(5)
Identify Priority Industrial Facilities	122.26(d)(2)(iv)(C)(1)
Municipal Waste Sites	(d)(2)(iv)(A)(5)
Spills	(d)(2)(IV)(B)(4)
Infiltration of Seepage	122(d)(2)(iv)(B)(7)
Construction Site Runoff	(d)(2)(iv)(D)

Public Education	(d)(2)(iv)(A)(6), (iv)(B)(5), (iv)(B)(6)
Monitoring Program	(d)(2)(iv)(B)(2), (iii), iv(A), (iv)(C)(2)

Table 3's reporting requirements apply to each of the 12 components of the District's SWMP as defined in Part X of this permit.

TABLE 3

SWMP Component	Reporting Requirement (1)	Reporting Deadline
1. Management Plan for Commercial, Residential, and Government Areas	implement and update in accordance with the October 19, 2002, SWMP	AnnualReport/ Implementation Plan
2.Management Plan for Industrial Facilities	implement and update in accordance with the October 19, 2002, SWMP	AnnualReport/ Implementation Plan
3. Management Plan for Construction Sites	implement and update in accordance with the October 19, 2002, SWMP	AnnualReport/ Implementation Plan
4. Flood Control Projects	implement and update in accordance with the October 19, 2002 SWMP	Annual Report/ Implementation Plan
5. Monitor and Control of Pollutants from Municipal Landfills or Other Municipal Waste Facilities	implement and update in accordance with the October 19, 2002 SWMP	Annual Report/ Implementation Plan
6. Monitor and Control Pollutants from Hazardous Waste Sites	implement and update in accordance with the October 19, 2002 SWMP	Annual Report/ Implementation Plan

7. Pesticides, Herbicide, and Fertilizer Application	implement and update in accordance with the October 19, 2002 SWMP	Annual Report/ Implementation Plan
8. Deicing Activities	implement and update in accordance with the October 19, 2002 SWMP	Annual Report/ Implementation Plan
9. Snow Removal	implement and update in accordance with the October 19, 2002 SWMP	Annual Report/ Implementation Plan
10. Management Plan to Detect and Remove Illicit Discharges	implement and update in accordance with the October 19, 2002 SWMP	Annual Report/ Implementation Plan
11. Enforcement Plan	implement and update in accordance with the October 19, 2002 SWMP	Annual Report/ Implementation Plan
12. Public Education	implement and update in accordance with the October 19, 2002 SWMP	Annual Report/ Implementation Plan

(1) These reporting requirements are governed by the schedules presented on Table 1.

1. Management Plan for Commercial, Residential, and Federal and District Government Areas

The District shall implement the SWMP (as described in the District's October 19, 2002,SWMP)to reduce the discharge of pollutants from commercial, Federal and District government owned/operated facilities, and residential areas into the District's storm sewer system (MS4). The permittee shall continue current practices of road, street, and highway maintenance as described in the SWMP and evaluate low impact development practices for inclusion with either new or retrofitted District and/or Federal highway construction projects. Applicable Federal programs for this purpose include, but are not limited to provisions for funding under the Transportation and Enhancement Fund, the Transportation Equity Act for the 21st Century, or other authorized/appropriated funding from future National Transportation Bills.

Control for government, commercial, and residential storm water runoff shall consist of a mix of program activities addressing trash, debris and other storm water pollutants, including but not limited to:

- A shift in focus from just the minimum storm water controls required under local ordinances and guidelines to programs that encourage the use of functional landscape to enhance the aesthetic and habitat value at new parking lots and/or new developments;

- Low impact development practices such as improved tree boxes, reduced road length and width, use of infiltration trenches, porous pavements, grassy swales and filter strips where appropriate;

- A coordinated catch basin cleaning and street-sweeping strategy that optimizes reduction of storm water pollutants;

- Coordination with solid waste program to include leaf collections;

- Preventative maintenance inspections for all existing storm water management facilities;

- Development and implementation of a rain leader disconnection program;

- Development of a phased approach to storm water public education which includes collecting pet feces and environmentally-friendly fertilizing and landscaping techniques;

- Modeling of storm water impacts;

- Developing a simple method for measuring the performance of these activities; and

- Strengthening the erosion control program for new construction.

The permittee shall implement a program to control storm water discharges from Federal and District-government areas to the same extent as that for commercial, residential, and industrial areas. The status of this program shall be reported in each Annual Report/Implementation Plan required by Part III.C. and D. of this permit. Information shall be provided as to how the implementation of these procedures will meet the requirements of the Clean Water Act. The implementation of a program to control discharges from Federal and District-government areas is dependent on the active cooperation of all federal agencies responsible for operating and maintaining facilities within the District. The District will continue to pursue partnerships with federal departments and agencies (e.g., National Park Service, Department of Agriculture, Department of Defense, and General Services Administration) responsible for facilities in the District designed to highlight the District's commitment to "lead by example" in managing storm water runoff.

The permittee shall maintain the authority to control all types of discharges into the waters of the District.

2. Management Plan for Industrial Facilities

The permittee shall implement a program to monitor and control pollutants in storm water discharged to the D.C. MS4 from Industrial Facilities, pursuant to the requirements in 40 CFR 122.26(d)(2)(iv)(C). These facilities shall include, but are not limited to:

- Private Solid Waste Transfer Stations
- Hazardous Waste Treatment, Disposal, and/or Recovery Plants
- Industrial Facilities subject to SARA or EPCRA Title III
- Industrial Facilities with NPDES Permits
- Industrial facilities with a discharge to the MS4

The permittee shall continue to maintain and update the industrial facilities database. The permittee shall continue to perform or provide on-site assistance/inspections and outreach focused on the development of storm water pollution prevention plans and NPDES permit compliance.

The permittee shall continue to refine and implement procedures to govern the investigation of facilities suspected of contributing pollutants to the MS4, including a review, if applicable, of monitoring data collected by the facility pursuant to its NPDES permit. These procedures shall be submitted as part of each Annual Report/Implementation Plan required by Part III. C. and D. of this permit.

The wet weather screening described in Part IV. C. of this permit includes collecting data on the discharges from industrial sites. This information shall be used by the permittee in identifying problem industrial categories to better target outreach.

The program to prevent, contain, and respond to spills that may discharge to the MS4 shall continue to be implemented, and a report on this implementation submitted in each Annual Report/Implementation Plan. The spill response program may include a combination of spill response actions by the permittees (and/or another public or private entity).

Progress in developing and carrying out industrial related programs shall be reported in each Annual Report/Implementation Plan required by Part III.C. and D. of this permit. An explanation shall be provided as to how the implementation of these procedures will meet the requirements of the Clean Water Act.

The permittee shall continue to implement the prohibition against illicit discharges, control spills, and prohibit dumping.

3. Management Plan for Construction Sites

The permittee shall continue implementation of the Program that addresses the discharge of pollutants from construction sites. An evaluation shall be made and reported in the Annual Report/Implementation Plan to determine if the existing practice meets the requirements given in 40 CFR 122.26(d)(2)(iv)(A) and (D). The permittee shall continue the review and approval process of the sediment and erosion control plans under this program. The permittee shall submit its inspection and enforcement procedures to EPA in the Annual Report/Implementation Plan. The permittee shall continue with regular construction site inspections. When a violation of local erosion and sediment control ordinances occurs, the permittee shall follow existing enforcement procedures and practices. The permittee shall continue with educational measures for construction site operators (Part III.A.12 of this permit) that consist, at a minimum, of providing guidance manuals and technical publications.

Progress in developing and carrying out the above construction related programs shall be reported in each Annual Report/Implementation Plan required by Part III.D. and E. of this permit. An explanation shall be provided as to how the implementation of these procedures will meet the requirements of the Clean Water Act. An explanation shall be provided as to how the implementation of these procedures, particularly with regard to District "waivers and exemptions", will meet the requirements of the Clean Water Act.

Public streets, roads, and highways shall be operated and maintained in a manner to reduce the discharge of pollutants in accordance with the SWMP requirements. Standard road repair practices shall include limiting the amount of soil disturbance to the immediate area under repair. Storm water conveyances which are denuded should be resodded or reseeded and mulched for rapid revegetation, and these areas should have effective erosion control until stabilized. The program shall establish procedures that address spill prevention, material management practices, and good housekeeping measures at all equipment and maintenance shops that support maintenance activities.

4. Flood Control Projects

Potential impacts on the water quality and the ability of the receiving water to support beneficial uses shall be assessed for all flood management projects. The feasibility of retrofitting existing flood control devices to provide additional pollutant removal from storm water shall be evaluated.

The above assessment, mapping program, and feasibility studies shall be reported in the Annual Report/Implementation Plan (Part III.C. and D.). The flood control measures necessary to meet the requirements of the Clean Water Act shall also be submitted with these Reports/Plans.

All development proposed in flood plains shall be reviewed by the District to ensure that the impacts on the water quality of receiving water bodies has been properly addressed. Information regarding impervious surface area located in the flood plains shall be used (in conjunction with other environmental indicators) as a planning tool. The District shall collect data on the percentage of impervious surface area located in flood plain boundaries for all proposed development after the effective date of this permit. The District shall collect similar data for existing development in flood plain areas, in accordance with the mapping program and other activities designed to improve water quality. Critical unmapped areas shall be prioritized by the District with an emphasis on developed and developing acreage. Reports of this work shall be summarized in the Annual Report/Implementation Plan. An explanation shall be provided as to how the implementation of these procedures will meet the requirements of the Clean Water Act

5. Control of Pollutants from Municipal Landfills or Other Municipal Waste Facilities

The permittee shall implement a program to identify measures to evaluate, inspect, enforce, and monitor to reduce pollutants in storm water discharges from facilities that handle municipal waste, including sewage sludge, and report the results of this activity in each Annual Report/Implementation Plan. As part of this program, the permittee shall reduce pollutants in the storm water discharges from District-operated or owned solid waste transfer stations, maintenance and storage yards for waste transportation fleets and equipment, publicly owned treatment works, and sludge application and/or disposal sites which are not covered by an NPDES permit, and report the results of this effort in each Annual Report/Implementation Plan. The permittee shall provide an explanation as to how the implementation of these procedures will meet the requirements of the Clean Water Act for the above facilities.

6. Control Pollutants from Hazardous Waste Sites

The permittee shall implement procedures that provide for monitoring and controlling pollutants in storm water discharges to the MS4 from: hazardous waste recovery, treatment, storage, and disposal facilities; facilities subject to Section 313 of the Emergency Planning and Right-to-Know Act; and any other industrial facility that either the permittee or the Regional Administrator determines is contributing a substantial pollutant loading to the MS4. This work shall be reported in each Annual Report/Implementation Plan.

The permittee shall complete an identification of industrial and high risk runoff facilities and develop procedures to map and record details of the facilities. Procedures to identify, map, and record the high risk facilities shall be completed by the end of this permit term.

The permittee shall implement procedures to govern the investigation of the identified facilities suspected of contributing pollutants to the MS4,including a review, if applicable, of monitoring data collected by the facility pursuant to its NPDES permit. Procedures governing the investigation of identified facilities and the method, schedule, and progress in implementing those procedures shall be submitted as part of each Annual Report/Implementation Plan. An explanation shall be provided as to how the implementation of these procedures will meet the requirements of the Clean Water Act.

7. Pesticide, Herbicide, and Fertilizer Application

The permittee shall continue to control the application of pesticides, fertilizers, and the use of other toxic substances according to current procedures and practices described in the October 19, 2002, SWMP and regulations. Such controls shall reduce the discharge of pollutants related to the storage and application of pesticides, herbicides, and fertilizers applied by employees or contractors, to public right of ways, parks, and other District property. The permittee shall implement programs to encourage the reduction of the discharge of pollutants related to the application and distribution of pesticides, herbicides, and fertilizers, pursuant to the SWMP dated October 19, 2002.

A report on the implementation of the above application procedures, a history of the improvements in the control of these materials, and an explanation on how these procedures will meet the requirements of the Clean Water Act shall be included in each Annual Report/Implementation Plan.

A screening characterization shall be completed to determine the sources of pesticides, herbicides, and fertilizers that contaminate the storm water runoff. This screening characterization shall be part of the outfall monitoring plan and performed according to that plan's schedule identified in Table 1. Levels of storm water pollution from this runoff at locations within the District shall be used to develop a priority system for control of these pollutants. Procedures for reducing these pollutants shall be developed, implemented, and reported in each Annual Report/Implementation Plan.

8. Deicing Activities

The permittee shall continue to evaluate the use, application and removal of chemical deicers, salt, sand, and/or sand/deicer mixtures in an effort to minimize the impact of these materials on water quality. Techniques available for reducing pollution from deicing salts in snowmelt runoff and runoff from salt storage facilities shall be investigated and implemented. This evaluation shall be made a part of an overall investigation of ways to meet the requirements of the Clean Water Act and reported in each Annual Report/Implementation Plan. In addition, an explanation shall be provided annually as to how the implementation of procedures resulting from this investigative effort will meet the requirements of the Clean Water Act.

9. Snow Removal

The permittee shall implement a program and operating plan to ensure excessive quantities of snow and ice control materials do not enter the District's waterbodies. Progress in implementing the program and plan shall be reported in each Annual Report/Implementation Plan. The District shall avoid snow dumping in areas adjacent to water bodies, wetlands, and areas near public or private drinking water wells which would ultimately reenter the MS4 system except during a declared Snow Emergency when the foremost concern of snow removal activities is public health and safety.

10. <u>Management Plan to Detect and Remove Illicit Discharges</u>

The permittee shall implement an ongoing program to detect illicit discharges, pursuant to the SWMP dated October 19, 2002. and Part IV.B., of this permit, and prevent improper disposal into the storm sewer system, pursuant to 40 CFR 122.26(d)(2)(iv)(B)(1). The accomplishments of this program shall be reported in each Annual Report/Implementation Plan.

The permittee shall implement a program to prevent illicit discharges, as defined at 40 CFR 122.26(b)(2). However, those discharges listed at 40 CFR 122.26(d)(2)(iv)(B)(1) are to be addressed where such discharges are identified by the permittee as sources of pollutants to the waters of the United States.

The permittee shall ensure the implementation of a program to further reduce the discharge of floatables (e.g. litter and other human-generated solid refuse). The floatables program shall include source controls and, where necessary, structural controls.

The District shall continue to implement the prohibition against the discharge or disposal of used motor vehicle fluids, household hazardous wastes, grass clippings, leaf litter, and animal waste into separate storm sewers. The permittee shall ensure the implementation of programs to collect used motor vehicle fluids (at a minimum oil and anti-freeze) for recycle, reuse, and proper disposal and to collect household hazardous waste materials (including paint, solvents, pesticides, herbicides, and other hazardous materials) for recycle, reuse, or proper disposal. Such programs shall be readily available to all private residents and shall be publicized and promoted on a regular basis, pursuant to the Public Education Plan in this permit at Part III.B.12.

Detection and elimination of illicit discharges shall include, but not be limited to, the following mix of strategies:

- Implementation of an illicit connection detection and enforcement program to perform dry weather flow inspections in target areas;
- Visual inspections of targeted areas; and
- Issuance of fines, tracking and reporting illicit discharges, and reporting progress on stopping targeted illicit discharges, and in appropriate cases, chemical

testing immediately after discovery of an illicit discharge.

The District shall implement an enforcement plan for illicit discharges set forth in the following plan in paragraph 11, Enforcement Plan, of this part of the permit. A justification shall be provided for the control plan in the Annual Report/Implementation Plan in terms of meeting the requirements of the Clean Water Act.

The permittee shall carry out all necessary inspection, surveillance, and monitoring procedures to remedy and prevent illicit discharges. The District shall carry out the necessary monitoring activities with the goal of meeting the requirements of the Clean Water Act. The permittee shall submit an inspection plan, inspection criteria, and documentation regarding protocols and parameters of field screening as a part of each Annual Report/Implementation Plan. The inspection plan shall include a schedule and allocation of resources.

The permittee shall implement procedures to prevent, contain, and respond to spills that may discharge into the MS4. The permittee shall provide for the training of appropriate personnel in spill prevention and response procedures. The implementation of this program shall be reported in each of the Annual Reports/Implementation Plans.

11. Enforcement Plan

The permittee shall implement an enforcement plan for carrying out the objectives of the SWMP dated October 19, 2002. A listing of all violations and enforcement actions shall be used to assess the effectiveness of the Enforcement Program in each Annual Report/Implementation Plan. Enforcement shall be maintained at its current level.

12. Public Education

The permittee shall implement a public education program. There are many components of a storm water public education program required by federal regulations at 40 CFR 122.26. The permittee will address all topics and related audiences including the following requirements:

A household hazardous waste educational and outreach program shall control illicit discharges to the MS-4 as required under Part III.B.10. This permit requires the permittee to implement programs and materials during the term of the permit to inform and educate the public on proper management and disposal of used oil, other automotive fluids, and household chemicals.

A residential and commercial pesticide and fertilizer educational and outreach program shall address the use and application of pesticides and fertilizer under Part III.A.7. This program shall promote the proper use of pesticides, herbicides, and fertilizers through the development and dissemination of either new or existing educational materials.

An industrial facility outreach program shall be implemented as a means of monitoring and controlling pollutants in storm water from industrial facilities as required under Part III.A.2. An industrial facility outreach program should focus on informing industries within the District's watersheds about storm water permitting and pollution prevention plans. This program should also inform industries of the requirement that they develop structural and non-structural control systems, pursuant to regulations at 40 CFR 122.26(d)(2)(iv)(C) and (iv)(A)(5).

A construction site operators education and outreach program shall provide construction site operators with technical guidance documents. The permittee shall continue providing these types of outreach and educational materials.

The permittee shall develop public educational materials in cooperation and coordination with other agencies and organizations in the District with similar responsibilities and goals. Public education materials shall be developed in an easy-to-understand format and at a technical level appropriate for the target audience. Progress reports on public education shall be included in the Annual Report/Implementation Plan. An explanation shall be provided as to how this effort will reduce pollution loadings to meet the requirements of the Clean Water Act.

The permittee shall submit copies of all records and reports to the Martin Luther King, Jr. Public Library, to be kept in a single location for public review. This requirement shall extend at a minimum to all pertinent records and reports required to be filed with EPA.

C. <u>Annual SWMP Reporting</u>

The permittee shall prepare an Annual Report to be submitted on the effective yearly date of the permit for the duration of the permitting cycle. The report shall include the following separate sections:

1. A review of the status of program implementation and compliance (or non-compliance) with all schedules of compliance contained in this permit;

2. A review of monitoring data and any trends in estimated cumulative annual pollutant loadings;

3. An assessment of the effectiveness of controls established by the October 19, 2002,SWMP;

4. An assessment of the projected cost of the October 19, 2002, SWMP and a description of the permittee's budget for existing storm water programs, including an overview of the permittee's financial resources and budget, overall indebtedness and assets, and sources for funds for storm water programs.

5. A summary describing the number and nature of enforcement actions, inspections, and public education programs and installation of control systems;

6. Identification of water quality improvements or degradation through application of a measurable performance standard identified in the first paragraph of Part III.D (Annual SWMP Implementation Plan);

7. Results of storm and water quality modeling, and its use in planning installation of control systems and maintenance and other activities.

8. An assessment of any October 19, 2002,SWMP modifications needed to reduce the discharge of pollutants to meet the requirements given in 40 CFR 122.26(d)(2)(iv).

9. Revisions, if necessary, to the assessments of controls and the fiscal analysis reported in the permit application under 40 CFR 122.26(d)(2)(iv) and (v).

10. A cost benefit and affordability analysis to determine the commitments for the next year;

11. Methodology to assess the effects of the October 19, 2002 Storm Water Management Program (SWMP) in reducing pollution and achieving the requirements of the Clean Water Act and the requirements of 40 CFR 122.26(D)(2)(iv),(v), and(vi);

12. Annual expenditures and budget for the year following each annual report;

13. A summary of commitments for the next year and evaluation of the commitments from the previous year;

14. A summary of the monitoring data for storm water and ambient sampling that is collected in the previous year and the plan, including identification of monitoring locations, to collect additional data for the next year;

The permittee shall sign and certify the Annual Report in accordance with Part VII.F. and include a statement or resolution that the permittee's governing body or agency (or delegated representative) has reviewed or been appraised of the content of the Annual Report. The permittee shall provide a description of the procedure used to meet the above requirement.

D. <u>ANNUAL SWMP IMPLEMENTATION PLAN</u>

The permittee shall submit, an Annual SWMP Implementation Plan, which is to be provided to EPA on the effective yearly date of the permit for the duration of the permitting cycle. The Implementation Plan is to analyze in detail the work to be done in each successive one year increment by identifying and evaluating the previous year's efforts based on a cost benefit and affordability analysis. The Plan shall include an established measurable performance standard for each of the MS4 program activities identified in Table 3 of this Permit which will be used for responding to Part III.C.6 of the Annual SWMP Reporting requirement. The basis for each of the performance standards which will be used as tools for evaluating environmental results and determining the success of each MS4 activity listed in the Plan shall be described incorporating, when practicable, an integrated program approach that considers all programs and projects which have a direct as well as an indirect affect on storm water management quantity and quality within the District. The Plan shall also provide an update of the fiscal analysis for each year of the permit as required by 40 CFR 122.26(d)(2)(vi).

Appropriate management officials within the Government of the District of Columbia shall develop and recommend to higher Authorities within the District the level of expenditures necessary for the Annual SWMP Reports and the SWMP Implementation Plans based on a cost benefit analysis and a partitioning of expenditures between the CSOs and storm sewers. If the recommended Report(s)/Plan(s) are not funded by the Mayor, the City Council, the Control Board, and/or Congress, then a written explanation will be provided to EPA and the D.C. Environmental Health Administration (EHA) within 30 days after a decision is reached by higher authorities. A written report on the above requests and decisions will also be incorporated into each Annual Report(s) and Implementation Plan(s). In each submittal, an explanation will indicate why the recommended funding was not approved. Once the SWMP Annual Implementation Plan and SWMP Annual Report are developed by this procedure, failure by the District to carry out the minimum requirements in the Reports or Plans would be a violation of this permit.

Based on the level of funding available and a cost benefit analysis, an evaluation shall be made in each Annual SWMP

Implementation Plan as to the benefit of implementing various types of structural and non-structural controls. The effect of the number and type of annual maintenance, inspections, and other program requirements will also be taken into account. Several alternatives will be considered in searching for the optimum approach. The alternatives will be evaluated in terms of a cost benefit analysis, taking into account the availability of funding and other environmental obligations of the District. Affordability cannot be used as a defense for noncompliance with conditions of this Permit.

Each Annual SWMP Report and SWMP Implementation Plan may be revised with written approval by EPA. The revised Report or Plan will become effective after its approval.

Failure to submit an Annual SWMP Report and/or Annual SWMP Implementation Plan, according to the signatory requirements in Part VII.F. and by the deadlines identified in Table 1, is a violation of this permit.

In reviewing any submittal identified in Table 1, EPA shall approve or disapprove each submittal. If EPA disapproves any submittal, EPA shall provide comments to the permittee. The permittee shall address such comments in writing within thirty (30) days of receipt of the disapproval from EPA. If EPA determines that the permittee has not adequately addressed the disapproval/comments, EPA may revise that submittal or portions of that submittal. Such revision by EPA is effective thirty (30) days from receipt by the permittee. Once approved by EPA, or in the event of EPA disapproval, as revised by EPA, each submittal shall be an enforceable element of this permit.

E. SWMP UPGRADE

The permittee shall develop an Upgraded SWMP based on the findings presented in each of the Annual SWMP Reports, and Annual SWMP Implementation Plans submitted during the permitting cycle. All the improvements and modifications to the District's existing SWMP dated October 19, 2002,shall be made in the Upgraded SWMP to be submitted six months prior to the expiration date of the permit. The Upgraded SWMP shall define the goals of the SWMP and provide an analysis to assure EPA that these goals will be achieved according to the schedule to be included in the Upgraded Plan. The Upgraded SWMP shall define what has to be done to meet the requirements of the Clean Water Act and a schedule for accomplishing these tasks.

One of the purposes of the Updated SWMP is to develop a master plan pursuant to 40 CFR 122.26(d)(2)(iv)(A) to determine the structural and source measures to reduce pollutants from runoff. Such control systems shall include those given in the SWMP dated October 19, 2002.

F. <u>LEGAL AUTHORITY AND RESOURCES</u>

The permittee shall ensure legal authority exists to control discharges to and from the Municipal Separate Storm Sewer System (MS4). Any changes/deficiencies in Legal Authority shall be given in each Annual Report/Implementation Plan. The legal authority may be a combination of statute, ordinance, permit, certification, contract, order, or inter-jurisdictional agreements with existing legal authority to:

1. Prohibit illicit discharges to the municipal separate storm sewer;

2. Control the discharge of spills and the dumping or disposal of materials other than storm water into the MS4;

3. Require compliance with conditions in ordinances, permits, certifications, contracts, or orders;

4. Carry out all inspection, surveillance, and monitoring procedures necessary to determine compliance with NPDES permit conditions;

5. Carry out adequate enforcement actions, including fines, penalties, orders, and development of compliance schedules for storm water dischargers pursuant to 40 CFR 122.26(d)(2)(C).

6. Monitor and control pollutants in storm water discharges to municipal storm sewers from industrial facilities and other sources (pursuant to the above regulations) that the permittee determines are contributing a substantial pollutant loading to the municipal storm system.

7. Search out unpermitted discharges, require that they apply for NPDES permits, and take appropriate enforcement actions.

The permittee shall provide adequate finances, staff, equipment, and support capabilities to implement the existing Storm Water Management Program (SWMP) dated October 19, 2002 and the Upgraded SWMP to be developed in accordance with the compliance schedule set forth in Table I.

PART IV. MONITORING AND REPORTING REQUIREMENTS

A. <u>STORM EVENT DISCHARGES</u>

The permittee shall implement a wet-weather monitoring program for the Municipal Separate Storm Sewer System (MS4) to provide data necessary to assess and report the effectiveness and adequacy of control measures implemented under the Storm Water Management Program (SWMP)dated October 19, 2002; estimate annual cumulative pollutant loadings from the MS4 subwatershed monitored for that particular year; estimate and report the event mean concentrations and seasonal pollutants in discharges from major outfalls; identify and prioritize portions of the MS4 requiring additional controls; and identify water quality improvements or degradation. The sampling plan being implemented by the permittee shall be consistent with the monitoring requirements at 40 CFR 122.26 (d)(2)(iii).

The permittee is responsible for conducting any additional monitoring necessary to accurately characterize the quality and quantity of pollutants discharged from the municipal separate storm sewer system. Improvement in the quality of discharges from the MS4 will be assessed based on the monitoring information required by this Part of the permit, plus any additional monitoring conducted by the permittee.

1. Representative Monitoring

The permittee shall monitor and provide an Outfall Discharge Monitoring Report(refer to the schedule in Table I, Part III.A)of representative outfalls, internal sampling stations, and/or instream monitoring locations to characterize the quality of storm water discharges from the Municipal Separate Storm Sewer System (MS4). The sampling plan being implemented by the permittee shall be consistent with the monitoring requirements at 40 CFR 122.26 (d) (2) (iii). Table 4 shows the required parameters and their monitoring frequency.

TABLE 4
Monitoring Requirements

Parameter*	Monitoring Frequency *
pH	3/year
temperature	3/year
total ammonia nitrogen, organic nitrogen, and total nitrogen	3/year
volatile organic compounds	3/year
acid extractable compounds	3/year

base/neutral extractable compounds	3/year
pesticides/PCBs	3/year
metals, cyanide, and phenols	3/year
conventional pollutants	3/year
hardness	3/year

* Refer to Discharge Monitoring Report dated April 19, 2002 for a listing of parameters being monitored. Monitoring frequency shall be at least three times per year at a minimum.

TABLE 5 Representative Monitoring Outfall Locations
A. Anacostia River Sub Watershed Monitoring Sites
1. Stickfoot Sewer (Suitland Parkway)-2400 block of Martin Luther King, Jr. Ave., SE, near Metro bus entrance.
2. O St. Storm Water Pump Station - 125 O St., 125 O SE-just outside front gate at O St. Pump Station
3. Anacostia High School/Anacostia Recreation Center - corner of 17th St. and Minnesota Ave. SE
4. Gallatin & 14th St.,NE-across from the intersection of 14th St. and Gallatin St. in a large outfall
5. Varnum and 19th Place,NE-2100 Block of Varnum St.
6. Nash Run-intersection of Anacostia Drive and Polk St.,NE.
7. East Capitol St.-200 Block of Oklahoma Ave.,NE.
8. Ft. Lincoln-Newtown BMP-in the brush along the side of New York Ave. West (coming into city) after the bridge.
9. Hickey run-33rd and V Streets, NE.

B. Rock Creek Subwatershed Monitoring Sites
1. Walter Reed (Fort Stevens Drive)
2. Military Road and Beach Drive
3. Soapstone Creek (Connecticut Avenue and Ablemarle Street)
4. Melvin Hazen Valley Branch (Melvin Hazen Park and Quebec Street)
5. Klingle Valley Creek (Devonshire Place and 30th Street)
6. Normanstone Creek (Normanstone Drive and Normanstone Parkway)

C. Potomac River Subwatershed Monitoring Sites
1. Battery Kemble Creek-49th and Hawthorne Streets, NW.
2. Foundary Branch-at Van Ness and Upton Streets, NW in the park.
3. Dalecarlia Tributary-Van Ness Street and Dalecarlia Parkway.
4. Oxon Run-Mississippi Avenue and 15th Street, SE
5. Tidal Basin-17th Street and Constitution Avenue, NW
6. Washington Ship Channel-Washington Marina parking lot, SW
7. C and O Canal-Potomac Avenue and Foxhall Road, NW

One of the subwatersheds listed in Table 5 along with their associated MS4 monitoring stations shall be selected for yearly sampling in accordance with the District's current monitoring program and reassessed every third year utilizing the watershed approach recommended by the EPA. The current watershed based monitoring approach which is on-going for rotating the MS4 stations continues to be the Anacostia River in calendar years 2005 and 2008, Rock Creek in calendar year 2006, and the Potomac River in calendar years 2004 and 2007. All changes to the above MS4 monitoring stations and/or sites for any reason shall be considered a major modification to the permit subject to the reopener clause.

2. Storm Event Data

In addition to the parameters listed above, the permittee shall maintain records of the date and duration (in hours) of the storm events sampled; rainfall measurements or estimates (in inches) of the storm event which generated the sampled runoff; the duration (in hours) between the storm event sampled and the end of the previous measurable (greater than 0.1 inch rainfall) storm event; and a calculated flow estimate of the total volume (in gallons) and nature of the discharge sampled.

3. Sample Type, Collection, and Analysis

The following requirements apply only to samples collected for Part IV.A.1. - Representative Monitoring.

a. For discharges from holding ponds or other impoundments with a retention period greater than 24 hours, (estimated by dividing the volume of the detention pond by the estimated volume of water discharged during the 24 hours previous to the time that the sample is collected) a minimum of one grab sample may be taken for pH, temperature, cyanide, oil and grease, fecal coliform, fecal streptococcus, total phenols, residual chlorine, and (at the permittee's option) volatile organics. For all other parameters, data shall be reported for weighted composite samples of the entire event of the discharge pursuant to 40 CFR 122.21(g)(7).

b. All such samples shall be collected from the discharge resulting from a storm event that is greater than 0.1 inches in magnitude and that occurs at least 72 hours from the previously measurable (greater than 0.1 inch rainfall) storm event. Composite samples may be taken with a continuous sampler or as a combination of a minimum of three sample aliquots taken in each hour of discharge for the entire discharge, with each aliquot being separated by a minimum period of fifteen minutes.

c. Analysis and collection of samples shall be done in accordance with the methods specified at 40 CFR Part 136.

4. Sampling Waiver

Grab samples taken during the first two hours of discharge shall be used for the analysis of pH, temperature, cyanide, oil and grease, fecal coliform, fecal streptococcus, total phenols, residual chlorine, and (at the permittee's option) volatile organics.

When a discharger is unable to collect samples due to adverse climatic conditions, the discharger must submit in lieu of sampling data a description of why samples could not be collected, including available documentation of the event.

Adverse climatic conditions which may prohibit the collection of samples includes weather conditions that create dangerous conditions for personnel (such as local flooding, high winds, hurricane, tornadoes, electrical storms, etc.) or otherwise make the collection of a sample impracticable (drought, extended frozen conditions, etc.).

B. DRY WEATHER MONITORING

1. Dry Weather Screening Program

The permittee shall continue ongoing efforts to detect the presence of illicit connections and improper discharges to the MS4 pursuant to the District SWMP dated October 19, 2002. All sewersheds (but not necessarily all outfalls in those sewersheds) of the MS4 must be screened at least once during the permit term. The screening shall be sufficient to estimate the frequency and volume of dry weather discharges and their environmental impact.

2. Screening Procedures

Screening may be developed and/or modified based on experience gained during actual field screening activities and need not conform to the protocol at 40 CFR 122.26(d)(1)(iv)(D). A description of the protocol actually used shall be provided in each Annual Report with a justification for its use. The procedures described in the October 19, 2002 SWMP shall be used as guidance.

3. Follow-up on Dry Weather Screening Results

The permittee shall continue to implement a program to locate and eliminate suspected sources of illicit connections and improper disposal identified during dry weather screening activities, and report the results of that implementation in each Annual Report.

Follow-up activities may be prioritized on the basis of:

a. magnitude and nature of the suspected discharge;

b. sensitivity of the receiving water; and

c. other relevant factors.

C. WET WEATHER SCREENING PROGRAM

The permittee shall implement a program to identify, investigate, and address areas within its jurisdiction that may be contributing excessive levels of pollutants to the MS4. The Wet Weather Outfall Monitoring Program in the District's October 19, 2002 SWMP shall include the above Wet Weather Screening Program.

As part of the Wet Weather Screening Program, the permittee shall:

a. screen the Municipal Separate Storm Sewer System, in accordance with existing procedures identified in the SWMP dated October 19, 2002 at least once during the permit term.

b. specify the sampling and non-sampling techniques (such as observations or quantitative methods), to be used for initial screening and follow-up purposes. For samples collected for screening purposes only, sample collection and analysis need not, pursuant to 40 CFR 122.26 (1)(d)(iv)(D), conform to the requirements of 40 CFR Part 136.

PART V. STORM WATER MODEL

The permittee shall report all progress made in developing a Storm Water Model and Geographical Information System (GIS) to EPA on an annual basis as an attachment to each

Annual Report/Implementation Plan in Part III.C. and D.

PART VI. HICKEY RUN

Monitoring for oil and grease at the Hickey Run MS4 site identified in Table 5.A of this Permit shall be performed on a rotating basis in the same year as the other Anacostia River MS4 locations identified in the Table are sampled using the procedures and methodology described and outlined in the Permit's Monitoring Program. To determine the effectiveness and performance of the planned Hickey Run BMP discussed below, the permittee shall provide in the Annual Report for EPA review and approval a detailed post construction BMP monitoring plan of sampling and protocol requirements. The results of the BMP monitoring and BMP performance in addressing the requirements of the Hickey Run TMDL shall be presented in the Annual Discharge Monitoring Report required by this Permit when the Anacostia River MS4 monitoring stations are sampled. In the event, monitoring station THR01 downstream on Hickey Run shows violations for oil and grease (above water quality standard criterion of 10mg/l), the Hickey Run MS4 site and BMP shall be sampled in accordance with the Permit's Monitoring Program on an annual basis rather than every third year under the current watershed based monitoring program until monitoring shows remedial actions effective to achieve compliance with the TMDL.

The effluent limits applicable to the Hickey Run Outfalls consistent with the TMDL WLAs consist of the BMPs set forth in the Upgraded SWMP and the narrative effluent limits set forth above.

The permittee shall continue to use their best efforts to negotiate an agreement with all parties to construct a multi purpose BMP for ensuring compliance with the Hickey Run TMDL document to the maximum extent practicable at this location and have it operational and ready for monitoring its effectiveness during the permitting cycle. The permittee shall inform EPA of changes to the above through Annual Reports and Implementation Plans required by the Permit. The final Hickey Run BMP Compliance Plan and the sampling program component for monitoring the effectiveness and performance of the BMP shall be submitted to EPA for approval prior to the sampling of the BMP being initiated.

PART VII STANDARD PERMIT CONDITIONS FOR NPDES PERMITS

A. DUTY TO COMPLY

The permittee must comply with all conditions of this permit. Any permit noncompliance constitutes a violation of the Clean Water Act and may result in an enforcement action; permit termination, revocation and reissuance, or modification; and denial of a permit renewal application.

B. PENALTIES FOR VIOLATIONS OF PERMIT CONDITIONS

The Clean Water Act provides any person who violates any permit condition or limitation implementing Sections 301, 302, 306, 307, 308, 318, or 405 of the Clean Water Act, or any permit condition or limitation implementing of such section, and any person who violates any Order issued by EPA under Section 301(a) of the Act, shall be subject to a civil penalty not to exceed $32,500 per day for each violation, and to an action for appropriate relief including a permanent or temporary injunction.

Any person who negligently violates Section 301, 302, 305, 307, 308, 318, or 405 of the Clean Water Act, any permit condition or limitation implementation any such section, shall be punished by a fine of not less than $5,000 nor more than $50,000 per day of such violation, or by imprisonment for not more than 3 years, or by both. Any person who knowingly violates any permit condition or limitation implementing Section 301, 302, 305, 307, 308, 318, or 405 of the Clean Water Act, and who knows at the time that he thereby places another person in imminent danger of death or serious bodily injury, shall, upon conviction, be subject to a fine of not more than $250,000, or by imprisonment of not more than 15 years, or by both.

C. DUTY TO MITIGATE

The permittee shall take all reasonable steps to minimize or correct any adverse impact on the environment resulting from noncompliance with this permit.

D. PERMIT ACTIONS

This permit may be modified, revoked and reissued, or terminated for cause including, but not limited to, the following:

1. Violation of any terms or conditions of this permit;

2. Obtaining this permit by misrepresentation or failure to disclose fully all relevant facts;

3. A change in any condition that requires either a temporary or permanent reduction or elimination of the authorized discharge;

4. Information newly acquired by the Agency, including but not limited to the results of the studies, planning, or monitoring described and/or required by this permit;

5. Material and substantial facility modifications, additions, and/or expansions;

6. Any anticipated change in the facility discharge, including any new significant industrial discharge or changes in the quantity or quality of existing industrial discharges that will result in new or increased discharges of pollutants; or

7. A determination that the permitted activity endangers human health or the environment and can only be regulated to acceptable levels by permit modification or termination.

8. The effluent limitations are based on the District of Columbia's water quality standards in accordance with Clean Water Act. In the event of a revision of the District of Columbia's water quality standards this permit may be modified by EPA to reflect this revision.

The filing of a request by the permittee for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance, does not stay any permit condition. When a permit is modified, only conditions subject to modification are reopened.

E. CIVIL AND CRIMINAL LIABILITY

Nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance.

F. SIGNATORY REQUIREMENTS

All Discharge Monitoring Reports, storm water pollution prevention plans, reports, certifications or information either submitted to the Director or that this permit requires be maintained by the permittee, shall be signed by:

1. For a municipality: State, Federal, or other public agency: by either a principal executive officer or ranking elected official; or

a. a duly authorized representative of that person. A person is a duly authorized representative only if:

b. The authorization is made in writing by a person described above and submitted to the Director.

c. The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity, such as the position of manager, operator, superintendent, or position of equivalent responsibility or an individual or position having overall responsibility for environmental matters for the company. (A duly authorized representative may thus be either a named individual or any individual occupying a named position).

d. If an authorization is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new notice satisfying the requirements of this paragraph must be submitted to the Director prior or together with any reports, information, or applications to be signed by an authorized representative.

G. OIL AND HAZARDOUS SUBSTANCE LIABILITY

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee is or may be subject under Section 311 of the Act.

H. DISTRICT LAWS

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable District law or regulation identified in Chapter 2 of the SWMP dated October 19, 2002. In cases of "exemptions and waivers" under District law, Federal law and regulation shall be applicable.

I. PROPERTY RIGHTS

The issuance of this permit does not convey any property rights of any sort, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State or local laws or regulations.

J. SEVERABILITY

The provisions of this permit are severable, and if any provisions of this permit, or the application of any provision of this permit to any circumstances, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

K. TRANSFER OF PERMIT

In the event of any change in ownership or control of facilities from which the authorized discharge emanates, the permit may be transferred to another person if:

1. The current permittee notifies the EPA, in writing of the proposed transfer at least 30 days in advance of the proposed transfer date;

2. The notice includes a written agreement, between the existing and new permittee containing a specific date for transfer of permit responsibility, coverage, and liability between them; and

3. The EPA does not notify the current permittee and the new permittee of intent to modify, revoke and reissue, or terminate the permit and require that a new application be submitted.

L. CONSTRUCTION AUTHORIZATION

This permit does not authorize or approve the construction of any onshore or offshore physical structures or facilities or the undertaking of any work in any navigable waters.

M. HISTORIC PRESERVATION

During the design stage of any project by the Government of the District of Columbia within the scope of this permit that may include ground disturbance, new construction, or demolition of a structure, the Government of the District of Columbia shall notify the Historic Preservation liaison and provide the liaison planning documents for the proposed undertaking. The documents shall include project location; scope of work or conditions; photograph of the area/areas to be impacted and the methods and techniques for accomplishing the undertaking. Depending on the complexity of the undertaking, sketches, plans and specifications shall also be submitted for review. The documentation will enable the liaison to assess the applicability of compliance procedures associated with Section 106 of the National Historic Preservation Act. Among the steps in the process are included:

a. The determination of the presence or absence of significant historic properties (architectural, historic or prehistoric). This can include the evaluation of standing structures and the determination of the need for an archaeological survey of the project area.

b. The evaluation of these properties in terms of their eligibility for nomination to the National Register of Historic Places.

c. The determination of the effect that the proposed undertaking will have on these properties.

d. The development of mitigating measures in conjunction with any anticipated effects.

All such evaluations and determinations will be presented to the Government of the District of Columbia for their concurrence.

If an alternate Historic Preservation procedure is approved by EPA in writing during the term of this permit, the alternate procedure will become effective after its approval.

N. ENDANGERED SPECIES

The U.S. Fish and Wildlife Service (FWS) has indicated that Hay's Spring Amphipod, a Federally listed endangered species, and the bald eagle, a Federally listed threatened species, occur at several locations near, or in, the District of Columbia. The National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA Fisheries) has indicated that the endangered shortnose sturgeon occurs in the Potomac River drainage and may occur within the District of Columbia. The FWS and NOAA Fisheries indicate that at the present time there is no evidence that the ongoing storm water discharges covered by this permit are adversely affecting these Federally listed species. Storm water discharges, construction, or any other activity that adversely affects a Federally listed endangered or threatened species are not authorized under the terms and conditions of this permit.

The monitoring required by this permit will allow further evaluation of potential effects on these threatened and endangered species once monitoring data has been collected and analyzed. EPA requires that the permittee submit to NOAA Fisheries at the same time it submits to EPA each Annual Outfall Discharge Monitoring Report of the monitoring data which will be used by EPA and NOAA Fisheries to further assess effects on endangered or threatened species. If these data indicate it is appropriate, requirements of this NPDES permit may be modified to prevent adverse impacts on habitats of endangered and threatened species.

The above referenced annual Report of monitoring data is required under this permit to be sent on an annual basis to:

The United States Environmental Protection Agency
Region III (3WP13)
Water Protection Division
1650 Arch Streets
Philadelphia, Pennsylvania 19103-2029

National Marine Fisheries Service
Protected Resource Division
One Blackburn Drive
Gloucester, Massachusetts 01930-2298
Attn: Ms. Julie Crocker

O. TOXIC POLLUTANTS

If a toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is established under section 307(a) of the Act for a toxic pollutant which is present in the discharge and such standard or prohibition is more stringent than any limitation for such pollutant in this permit, the permittee shall comply with such standard to the maximum extent practicable or prohibition even if the permit has not yet been modified to comply with the requirement.

The permittee shall comply with effluent standards or prohibitions established under section 307(a)of the Clean Water Act for toxic standards prohibitions, even if the permit has not yet been modified to incorporate the requirement.

P. <u>Reopener Clause for Permits</u>

The permit may be modified or revoked and reissued, to incorporate any applicable effluent standard or limitation issued or approved under Sections 301, 304, or 307 of the Clean Water Act, and any other applicable provision as provided by Chesapeake Bay Agreement of 2000 based on water quality considerations, and if the effluent standard or limitation so issued or approved:

a. Contains different conditions or is otherwise more stringent than any effluent limitation in the permit: or

b. Controls any pollutant not limited in the permit. The permit, as modified or reissued under this paragraph, shall also contain any other requirements of the Act then applicable.

c. The permit may be modified, or revoked and reissued to incorporate additional controls that are necessary to ensure that the permit effluent limits are consistent with any applicable TMDL WLA allocated to the discharge of pollutants from the MS4.

This permit may also be reopened, modified, or revoked and reissued as specified in 40 C.F.R. Parts 122.44(c), 122.62, 122.63, 122.64, and 124.5.

<u>Q. Duty to Reapply</u>

If the permittee wishes to continue an activity regulated by this permit after the expiration date of this permit, the permittee must apply for and obtain a new permit. The application shall be submitted at least 180 days before the expiration date of this permit. The Director may grant permission to submit an application less than 180 days in advance but no longer than the permit expiration date. In the event that a timely and complete reapplication has been submitted and the Director is unable through no fault of he permittee, to issue a new permit before the expiration date of this permit, the terms and conditions of this permit are automatically continued and remain fully effective and enforceable.

PART VIII. MONITORING AND RECORDS

A. REPRESENTATIVE SAMPLING

Samples and measurements taken as required herein shall be representative of the volume and nature of the monitored discharge. All samples shall be taken at the monitoring points specified in this permit. Monitoring points shall not be changed except through permit modification.

B. FLOW MEASUREMENTS

Appropriate flow measurement devices and methods consistent with accepted scientific practices shall be selected and used to insure the accuracy and reliability of measurements of the volume of monitored discharges. The devices shall be installed, calibrated, and maintained to insure that the accuracy of the measurements are consistent with the accepted capability of that type of device.

C. MONITORING PROCEDURES

1) Monitoring must be conducted according to test procedures approved under 40 CFR 136, unless other test procedure have been specified in the permit.

2) PCBs have been identified in the contaminated sediments of the Anacostia River and in airborne particular matter deposited within the District of Columbia. The Permittee shall continue to use Method 608 for PCB monitoring. In the event that EPA approves a test method for compliance monitoring purposes of measuring PCB concentrations in storm water with a minimum level of less than 1.0 ug/L, EPA reserves the right to modify the Permit to require the Permittee to use such EPA approved test method in place of Method 608.

D. PENALTIES FOR TAMPERING

The Clean Water Act provides that any person who falsifies or knowingly renders inaccurate, any monitoring device, required device, or method required to be maintained under this permit shall upon conviction, be punished by a fine of not more than $10,000 per violation, or by imprisonment for not more than 6 months per violation, or by both.

E. REPORTING OF MONITORING RESULTS

Monitoring results must be reported annually on a Discharge Monitoring Report (DMR) form (EPA No. 3320-1). Monitoring results obtained during the previous year shall be summarized and reported on a DMR form postmarked no later than the effective date of the permit of the following year. Duplicate copies of DMR's signed and certified as required by Part VI.F., shall be submitted to the United States Environmental Protection Agency Region III, and the District of Columbia's Department of Health at the following addresses:

U.S. EPA Region III(3WP13)	District of Columbia Government
Water Protection Division	Department of Health
NPDES DMRS	Environmental Health Administration
1650 Arch Street	5th Floor/51 N. Street, N.E.
Philadelphia, PA 19103-2029	Washington, D.C. 20002

F. ADDITIONAL MONITORING BY THE PERMITTEE

If the permittee monitors (for the purposes of this permit) any pollutant more frequently than required by this permit, using test procedures approved under 40 CFR 136 or as specified in this permit, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the annual Discharge Monitoring Report (DMR) forms. Such frequency shall also be indicated.

G. RETENTION OF RECORDS

The permittee shall retain records of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for this permit, for a period of at least five (5)years from the date of the sample, measurement, report or application. This period may be extended by request of the Director at any time.

H. RECORD CONTENTS

Records of monitoring information shall include:

1. The date, exact place, time and methods of sampling or measurements:

2. The individual(s) who performed the sampling or measurements;

3. The date(s)analyses were performed;

4. The individual(s)who performed the analyses;

5. The analytical techniques or methods used; and

6. The results of such analyses.

I. INSPECTION AND ENTRY

The permittee shall allow the Director, or an authorized representative, upon the presentation of credentials and other documents as may be required by law, to:

1. Enter upon the permittee's premises at reasonable times where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this permit;

2. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit;

3. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), processes, or operations regulated or required under this permit; and

4. Sample or monitor at reasonable times, for the purpose of assuring permit compliance or as otherwise authorized by the Clean Water Act, any substances or parameters at any location.

PART IX OTHER APPLICABLE PROVISIONS

A. Waivers and Exemptions

This permit does not authorize the discharge of any pollutant from the MS4 which arises from or is based on any of the various existing "waivers and exemptions" that may otherwise apply and are not consistent with the Federal Clean Water Act and other pertinent guidance, policies, and regulations. This narrative prohibition on the applicability of such waivers and exemptions extends to any activity that would otherwise be authorized under District law but which impedes the reduction or control of pollutants through the use of BMPs to the maximum extent practicable and/or prevents compliance with the narrative effluent limits of this Permit. Any such discharge not otherwise authorized may constitute a violation of this permit.

B. TMDL WLA Implementation Plans and Compliance Monitoring

In addition to the duty to comply with the narrative effluent limits in Part I.D.3 of this Permit, the permittee shall demonstrate compliance as described in this Part and in Part IV, Monitoring and Reporting Requirements. In accordance with the schedule identified in Part III.A. Compliance Schedule and Table 1, Permittee shall further submit implementation plans to reduce discharges consistent with any applicable EPA-approved waste load allocation (WLA) component of any established Total Maximum Daily Loadings (TMDL). An applicable TMDL WLA for this Permit means any TMDL established on or before the effective date of this Permit for a receiving stream, segment of a stream, or other waterbody within the District of Columbia to which the MS4 system discharges, and for which the MS4 receives a WLA, for purposes of achieving compliance with applicable requirements under the Clean Water Act.

EPA has identified all applicable TMDL WLAs and the associated reductions from current estimated loadings as described in Appendix A to the Fact Sheet. EPA provides the following list for informational purposes only: Upper and Lower Anacostia River Biochemical Oxygen Demand TMDL (50 per cent reduction); the Upper and Lower Anacostia River Total Suspended Solids TMDL (77 per cent reduction); Upper and Lower Anacostia River, Watts Branch, Fort Dupont Creek, Fort Chaplin Tributary, Fort Davis Tributary, Fort Stanton Tributary, Hickey Run, Nash Run, Popes Branch, and Texas Avenue Tributary Fecal Coliform Bacteria TMDL (27-90)per cent reduction); and the Anacostia River, Fort Chaplin Tributary, Fort Davis Tributary, Fort Dupont Creek, Fort Stanton Tributary, Hickey Run, Nash Run, Popes Branch, Texas Avenue Tributary, and Watts Branch Organics and Metals TMDL (0-98 per cent reduction). The same implementation procedures will apply to the approved TMDL WLAs for Rock Creek which includes the Upper and Lower Rock Creek Metals (0-86 per cent reduction subject to adjustment for the margin of safety); Rock Creek Fecal Coliform Bacteria (95 per cent reduction); and Rock Creek Tributary Organics for Broad Branch, Dumbarton Oaks, Fenwick Branch, Klingle Valley, Luzon Branch, Melvin Hazen, Normanstone Creek, Pinehurst Branch, Piney Branch, Portal Branch, and Soapstone Creek (0-99.9 per cent reduction subject to adjustment for the margin of safety).

Demonstration of compliance (as specified in Parts IV and VIII of the Permit) will be calculated using the procedures (i.e., Simple Method) identified in the Upgraded SWMP dated October 19, 2002, unless specified otherwise by EPA, and will be reported by comparing the monitoring data for that pollutant to the approved pollutant specific WLAs and its associated storm water load reductions for the receiving waterbody as specified in the Fact Sheet.

The permittee shall report to EPA the results of this analysis in accordance with the compliance schedule in Part III.A and Table 1 of this permit. If the analysis concludes that the MS4 discharge monitored for that specific pollutant is causing or contributing to an exceedance of the criteria under the approved pollutant-specific WLAs, the permittee shall develop a TMDL implementation

Plan and schedule in accordance with the compliance schedule in Part III.A and Table 1 of this permit. The Plan shall consist of documenting all previous and on-going efforts at achieving the specific pollutant reductions identified in the TMDL WLA and further demonstrating additional controls sufficient to achieve those reductions through an established performance based benchmark. This benchmark shall be applied against annual projected performance standards for purposes of completing the final implementation plan when determining measurable progress to achieve adequate reduction. EPA reserves the right after a review and approval of each Plan to modify this permit for purposes of requiring additional numeric and/or narrative effluent controls on the discharge of pollutants from the MS4. EPA shall make the results of any such determination(s) in writing available to the Permittee and other interested persons including, but not limited to members of the District of Columbia MS4 Task Force. Upon approval by EPA, the TMDL implementation plan(s)shall be incorporated into the upgraded SWMP in accordance with the compliance schedule in Part III.A (Table I)and Part III.E (SWMP Upgrade) of this Permit.

The Permittee shall submit to EPA the applicable TMDL Implementation Plans for the Anacostia River TMDLs within six months and for the Rock Creek TMDLs twelve months after the effective issuance date of this Permit.

C. Compliance Monitoring with Water Quality-Based Effluent Limitations

The Permit is water quality based and as such is written to impose controls (in Part I of this Permit) sufficient to ensure compliance with applicable District of Columbia water quality standards. EPA reserves the right to modify the Permit as needed, when monitoring results (as set forth in Parts IV and VIII of the permit) show that the current BMP controls required by this permit are not sufficient to ensure compliance with the applicable water quality standards.

PART X. PERMIT DEFINITIONS

"Best Management Practices" ("BMP") means schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of the United States. BMP also include treatment requirements, operating procedures, and practices to control facility site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

"CSMP" means Construction Site Management Plan

"CWA" means Clean Water Act (formerly referred to as the Federal Water Pollution Control Act or Federal Water Pollution Control

Act Amendments of 1972) Pub.L. 92-500, as amended Pub. L. 95-217, Pub. L. 95-576, Pub. L. (6-483 and Pub. L. 97-117, 33 U.S.C. 1251 et.seq.

"Director" means the Regional Administrator or an authorized representative.

"Discharge" for the purpose of this permit, unless indicated otherwise, refers to discharges from the Municipal Separate Storm Sewer System (MS4).

"Maximum Extent Practicable (MEP) Standard" means a technology based level of pollution reduction achieved through the use of a combination of non structural and/or structural best management practices (BMPs) for controlling the quantity as well as the quality of a particular pollutant or pollutants in storm water at their sources before entering the MS4 system.

"Flow-weighted composite sample" means a composite sample consisting of a mixture of aliquots collected at a constant time interval, where the volume of each aliquot is proportional to the flow rate of the discharge.

"Goal" means the end results the permittee is to strive to achieve.

"Guidance" means assistance in achieving a goal.

"Illicit connection" means any man-made conveyance connecting an illicit discharge directly to a municipal separate storm sewer.

"Illicit discharge" means any discharge to a municipal separate storm sewer that is not composed entirely of storm water except discharges pursuant to a NPDES permit (other than the NPDES permit for discharges from the municipal separate storm sewer) and discharges resulting from clear water flows, roof drainage, water line flushing, landscape irrigation, diverted stream flows, rising ground waters, uncontaminated ground water infiltration to separate storm sewers, uncontaminated pumped ground water, discharges from potable water sources, foundation drains, air conditioning condensation, irrigation waters, springs, footing drains, lawn watering, individual resident car washing, flows from riparian habitats and wetlands, dechlorinated swimming pool discharges, street wash water, fire fighting activities, and similar types of activities.

"Internal Sampling Station" means a monitoring site which is located within the Municipal Separate Storm Sewer System (MS4) upstream of an outfall pipe which discharges storm water directly into a receiving waterbody.

"Landfill" means an area of land or an excavation in which wastes are placed for permanent disposal, and which is not a land application unit, surface impoundment, injection well, or waste pile.

"Land application unit" means an area where wastes are applied onto or incorporated into the soil surface (excluding manure spreading operations) for treatment or disposal.

"MS4" refers to either a Large or Medium Municipal Separate Storm Sewer System.

"Large or Medium municipal separate storm sewer system" means all municipal separate storm sewers that are either:

(i) located in an incorporated place (city) with a population of 100,000 or more as determined by the latest Decennial Census by the Bureau of Census (these cities are listed in Appendices F and G of 40 CFR Part 122); or (ii) located in the counties with unincorporated urbanized populations of 100,000 or more, except municipal separate storm sewers that are located in the incorporated places, townships or towns within such counties (these counties are listed in Appendices H and I of 40 CFR Part 122); or (iii) owned or operated by a municipality other than those described in paragraph (i) or (ii) and that are designated by the Director as part of the large or medium municipal separate storm sewer system.

"Municipal Separate Storm Sewer" means a conveyance, or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains): (i) owned or operated by a State, city, town, borough, county, parish, district, association, or other public body (created by or pursuant to State Law) having jurisdiction over disposal of wastes, storm water, or other wastes, including special districts under State Law such as a sewer district, flood control district or drainage district, or similar entity, or an Indian Tribe or an authorized Indian tribal organization, or a designated and approved management agency under section 208 of the CWA that discharges to waters of the United States.

"Permittee" refers to the Government of the District of Columbia and all subordinate District and independent agencies directly accountable and responsible to the City Council and Mayor as authorized under the Storm Water Permit Compliance Amendment Act of 2000 and any subsequent amendments for administrating, coordinating, implementing, and managing storm water for MS4 activities within the boundaries of the District of Columbia.

"Point Source" means any discernible, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, substances designated under section 101(14) of CERCLA; any chemical the facility is required to report pursuant to Section 313 of Title III of SARA; fertilizers; pesticides; and waste products such as ashes, slag and sludge that have the potential to be released with storm water discharges.

"Pollutant of concern" means a pollutant in an MS4 discharge that may cause or contribute to the violation of a water quality criterion for that pollutant downstream from the discharge.

"Significant spills" includes, but is not limited to: releases of tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel or other floating craft from which pollutants are or may be discharges. This term does not include return flows from irrigated agriculture or agricultural storm water runoff.

"RSAT" is an acronym for Rapid Stream Assessment Techniques.

"SWMP" is an acronym for Storm Water Management Plan/Program. For purposes of this permit, the term includes all storm water activities described in the District's SWMP dated October 19, 2002,and all other documents and related correspondences embodied under the tier of the program document from the previous Permit and to be generated from this Permit.

"Section 313 water priority chemical" means a chemical or chemical categories which: 1) are listed at 40 CFR 372.65 pursuant to Section 313 of Title III of the Superfund Amendments and Reauthorization Act (SARA) of 1986, also titled the Emergency Planning and Community Right-to-Know Act of 1986; 2) are present at or above threshold levels at a facility subject to SARA Title III, Section 313 reporting requirements; and 3) that meet at least one of the following criteria: i) are listed in Appendix D of 40 CFR 122 on either Table II (organic priority pollutants), Table III (certain metals, cyanides, and phenols) or Table V (certain toxic pollutants and hazardous substances); (ii) are listed as a hazardous substance pursuant to section 311(b)(2)(A) of the CWA at 40 CFR 116.4; or (iii) are pollutants for which EPA has published acute or chronic water quality criteria.

"Significant materials" includes, but is not limited to: raw materials; fuels; materials such as solvents, detergents, and plastic pellets; finished materials such as metallic products; raw materials used in food processing or production; hazardous oil or hazardous substances in excess of reportable quantities under section 311 of the CWA(see 40 CFR 110.10 and CFR 117.21) or section 102 of CERCLA (see 40 CFR 302.4).

"Storm Water" means storm water runoff, snow melt runoff, and surface runoff and drainage.

"Total Maximum Daily Load (TMDL) Units" means for purposes of this Permit, the waste load allocations (WLAs) are expressed in pollutant pounds of a total average annual load unless specifically identified otherwise in an EPA approved TMDL report covered under the Permit.

"Time-weighted composite" means a composite consisting of a mixture of equal volume aliquots collected at a constant time interval.

"Upgraded Storm Water Management Program (SWMP)" is a modified and improved SWMP based on the existing SWMP and on information in each of the Annual Reports/Implementation Plans/Discharge Monitoring Reports. The goal of the Upgraded SWMP is to describe the list of activities that need to be done to meet the requirements of the Clean Water Act, an explanation as to why these activities will meet the Clean Water Act requirements, and a schedule for those activities, taking into account the cost benefit and affordability analysis to be done in each of the Annual Implementation Plans.

"Waste pile" means any non-containerized accumulation of solid, nonflowing waste.

"Waters of the United States" is identified at 40 CFR 122.2.

Re: Fact Sheet (To be Supplemented with Final Fact Sheet from DCMS4 NPDES Permit No. DC0000221 Dated August 19, 2004)
National Pollutant Discharge Elimination System (NPDES)
Proposed/Amendment No. 1 to NPDES Permit No. DC0000221

NPDES PERMIT NUMBER: DC0000221, AMENDMENT NO. 1

FACILITY NAME AND MAILING ADDRESS:

Government of the District of Columbia
The John A. Wilson Building
1350 Pennsylvania Avenue, N.W.
Washington, D.C. 20004

FACILITY LOCATION:

District of Columbia's
Municipal Separate Storm Sewer System (MS4)

RECEIVING WATERS:

Potomac River, Anacostia River,
Rock Creek, and Tributaries

FACILITY BACKGROUND AND DESCRIPTION:

The Government of the District of Columbia (the District) owns and operates a Municipal Separate Storm Sewer System (MS4) which discharges storm water during wet weather events from various outfall locations throughout the District into its waterways. On April 19, 2000, the United States Environmental Protection Agency Region III (EPA) issued the District its first Storm Water Phase I National Pollutant Discharge Elimination System (NPDES) Permit for the control and management of storm water discharges originating from these outfalls. (The collective permit for these various outfalls is known as an "MS4" permit). The Permit was issued for a three-year period and administratively extended from April 19, 2003, until August 19, 2004. (The Permit is hereafter referred to as the 2000 MS4 Permit). On August 19, 2004, EPA issued the District its second Storm Water Phase I NPDES Permit, which is valid for a five-year period and covers all discharges within the corporate boundaries of the District. This service area includes discharges served by, or otherwise contributing to, discharges from the MS4 system. The MS4 Permit does not cover the District's combined or sanitary sewer systems.

Since EPA first issued the Phase I MS4 Permit to the District in 2000, the District has made a number of accomplishments, including: (1) establishment of an infrastructure for addressing storm water activities, (2) development of a watershed-based rotating monitoring program to evaluate the chemical parameters and physical characteristics of the municipal storm water being discharged from representative outfalls in the MS4 system, (3) performance of assessments of existing MS4 activities which contribute to the runoff being discharged into the MS4 system, (4) development of implementation measures for managing and enforcing MS4 activities within the District, and (5) upgrading its previous Storm Water Management Program (SWMP) based on these findings. The District's upgraded SWMP (which EPA approved in October 2003, and which was used as the basis for the MS4 Permit issued in August 2004) sets forth a framework for a long-term storm water management control program for determining compliance with applicable water quality standards to the maximum extent practicable through the use of best management practices (BMPs).

The current MS4 Permit requires a combination of narrative and BMP controls for addressing storm water at its sources. These mechanisms are also used to characterize storm water because of its indiscriminate nature. In general, EPA views the MS4 NPDES permit program as an iterative process requiring reexamination of ongoing controls and continued improvements to the respective storm water management programs while continuing to adequately protect the water quality of the receiving stream. The MS4 Permit builds on existing MS4 inventories, databases, baseline monitoring data, partnerships, pilot projects, and increased MS4 activity implementation as the upgraded SWMP approach for managing the quantity and enhancing the quality of storm water throughout the District. Moreover, the Permit requires measurable performance standards to be developed and assessed, and implementation plans for reducing the storm water components of waste load allocations of Total Maximum Daily Loads to be implemented, all of which are intended to evaluate the effectiveness of the District's programs.

PROPOSED ACTION TO BE TAKEN:

On July 21, 2005, EPA proposed to issue an amendment, hereafter referred to as Amendment No. 1, to the District's MS4 Permit which became effective on August 19, 2004. This action is being taken in part in response to issues raised by a permit appeal filed by petitioners Earthjustice on behalf of the Friends of the Earth and Defenders of Wildlife with the Environmental Appeals Board (EAB) on September 20, 2004. In that appeal, the petitioners argued that the District of Columbia Water and Sewer Authority (WASA or the Authority), which has been given responsibility for storm water management under the MS4 system, should be identified as a co-permittee along with the Government of the District of Columbia in the Permit. The petitioners' argument for making WASA a co-permittee was based on the fact that the WASA Board is not "directly accountable and responsible to the City Council and Mayor" and to ensure that the Authority is held legally accountable for its actions under the Permit. The petitioners also argued that the "maximum extent practicable" standard, the water quality-based effluent limits, and the total maximum daily waste load allocation narrative effluent limits specified in the MS4 Permit were not sufficient to adequately assure compliance with applicable water quality standards, let alone demonstrate that MS4 activities under the District's storm water management program will account for and reduce pollutant loadings from the MS4 system.

Furthermore, the petitioners went on to explain in the petition that the waiver, exemption, and variance provisions in the District's water quality standards and storm water regulations conflicted with the Clean Water Act and EPA rules, and that the provisions could undermine the integrity of the MS4 Permit and the District's storm water management program. Finally, the petitioners raised concerns that the monitoring program in the MS4 Permit violates EPA rules in that the program does not explicitly require monitoring from each MS4 outfall and does not require that the monitoring be representative of the monitored MS4 activity.

In October 2004, Earthjustice and EPA, Region III, began to discuss between themselves the issues on appeal, many of which had been raised during the petitioners' previous appeal of the 2000 MS4 Permit (which resulted in a decision by the EPA Environmental Appeals Board (EAB)); see Order Denying Review in Part and Remanding in Part at http://www.epa.gov/eab/disk11/dcms4.pdf (Feb. 20, 2002) and Order Granting Motion for Partial Reconsideration at http://www.epa.gov/eab/orders/dcms4recon.pdf (May 10, 2002). The parties' discussions immediately began to prove beneficial and they therefore jointly requested that the EAB defer action on the appeal to give them time to work through their differences on the issues. After several additional extensions of time, the parties reached settlement in principle on the issues on May 10, 2005, whereby the Region would propose and public notice Amendment No.1 to the current MS4 Permit and consider any comments received during the public review period before making the document final. That Permit Amendment was therefore public noticed in July 2005.

Concurrent with the review and comment period of draft Amendment No. 1 to the MS4 Permit, EPA Region III will be requesting that the District of Columbia's Department of Health certify the amendment under Section 401 of the Clean Water Act, 33 U.S.C. § 1341. EPA also has requested that the offices of the Fish and Wildlife Service (part of the Department of Interior) and the National Marine Fisheries Service (part of the National Ocean and Atmospheric Administration) review the document for compliance with the Federal Endangered Species Act, 42 U.S.C. §§ 460 *et seq.*

The proposed modifications to the August 19, 2004 MS4 Permit is summarized in the Table below:

Table 1. (Modifications to August 19, 2004, DC MS4 Permit)

Permit Part and Title	Effect of Amendment No.1
Part I.C (Limitations to Coverage)	Emphasizes that the limitations to coverage are actually prohibitions and expands on the types of discharges that are permitted to occur from the MS4 system;

Part I.D (Effluent Limits)	Clarifies the types of effluent limits to be addressed through the MS4 Permit, how these limits will be implemented through the upgraded SWMP, and the authority on which EPA will rely in implementing potential permit modifications to ensure that these limits result in an effective program as well as linking the appropriate parts of the MS4 Permit back to these limits;
Part III.C (Annual SWMP Reporting)	Describes annual reporting requirements for calculating pollutant loads and reductions from the MS4 system in those watersheds with approved total maximum daily loadings;
Part VII.P (Reopener Clause for Permits)	Describes additional requirements for opening the MS4 Permit through modifications;
Part IX.A (Waivers and Exemptions)	Requires accountability and reporting of waivers and exemptions;
Part IX.B (TMDL WLA Implementation Plans and Compliance Monitoring)	Describes how the total maximum daily loadings methodologies for complying with the effluent limits of the MS4 Permit and demonstration of compliance to ensure successful achievement of waste load reductions will be addressed;
Part X (Permit Definitions)	Adds a "measurable performance standard" definition for evaluating the effectiveness of the District's MS4 activities under their storm water management program.

During the public review period, EPA Region III received four comment letters regarding proposed Amendment No.1. The Region considered these comments, when issuing the final document, by making modifications to account for existing ambient water quality conditions, placing emphasis on reducing pollutants to the maximum extent practicable, and by adding a clarifying definition. A summary of the comments along with the EPA response is contained in the responsive summary which supplements this fact sheet. The Region received comments from the District of Columbia Department of Health through its Section 401 certification letter which is addressed in the responsiveness summary. The United States Fish and Wildlife Service and the National Ocean and Atmospheric Administration's National Marine Fisheries Service both concurred with the Region's Biological Evaluation which concluded that Amendment No.1 would not adversely affect endangered or threatened species that reside within the District of Columbia by letters dated August 18, 2005, and October 6, 2005. The draft documents along with the final documents now complete the administrative record for the project and are available to the public for review at the Martin Luther King, Jr. Public Library which is located at 901 G Street, N.W. in Washington, D.C..

For additional information, contact Mr. Garrison D. Miller, Mail Code 3WP13, District of Columbia/Maryland/Virginia Branch, Office of Watersheds, EPA Region III, United States Environmental Protection Agency, 1650 Arch Street, Philadelphia, Pennsylvania 19103-2029.

Re: Fact Sheet
National Pollutant Discharge Elimination System (NPDES)
NPDES Permit Renewal (Storm Water)

NPDES PERMIT NUMBER: DC0000221

FACILITY ADDRESS:

Office of the City Administrator
Government of the District of Columbia
The John A. Wilson Building
1350 Pennsylvania Avenue, NW
Washington, DC 20004

FACILITY LOCATION:

District of Columbia
Municipal Separate Storm Sewer System (MS4)

RECEIVING STREAM:[1]

Potomac River, Anacostia River,
And Tributaries

FACILITY BACKGROUND AND DESCRIPTION:

The Government of the District of Columbia owns and operates a Municipal Separate Storm Sewer System (MS4) which discharges storm water during wet weather events from various outfall locations throughout the District into its waterways. The District of Columbia Government was issued its first MS4 Permit in April, 2000, which required the permittee to implement its existing Storm Water Management Plan (SWMP) over the next three years and during that time review and propose an improved SWMP. In that time, the District has established and refined the infrastructure for dealing with MS4 permit compliance activities within their jurisdiction through passage of the District of Columbia Storm Water Permit Compliance Amendment Act of 2000 (DC Law #13-311) in June, 2001; developed a monitoring program to determine the chemical and physical characteristics of the municipal storm water being discharged from the MS4 outfalls; performed an assessment of existing MS4 activities which contribute to the runoff being discharged into the MS4 system; provided an implementation plan for managing the MS4 activities within the District; and submitted an upgrade to their existing SWMP. The Permit coverage extends to all areas within the corporate boundaries of the District of Columbia served by, or otherwise contributing discharges, from the MS4 system, but does not include the District's combined or sanitary sewer systems. Rather than establishing specific numeric outfall effluent limits, the Environmental Protection Agency (EPA) has established a combination of narrative and best management practices as the effluent limits in this permit in Section I requiring implementation of the Upgraded SWMP as a non numeric effluent limit consistent with 40 CFR Part 122.44(k)(2). As explained below EPA has determined that the Upgraded SWMP represents (1) the technology based level of pollution reduction achieved through the combination of best management practices (BMPs) controlling the quantity as well as the quality of pollutants in the MS4 to the maximum extent practicable (MEP); and (2) the implementation of the Upgraded SWMP (in conjunction with narrative prohibition in Section I.C. of the permit) is sufficient to ensure compliance with applicable water quality standards. The MS4 Permit characterizes and controls storm water, and because of the indiscriminate nature of storm water focuses on controls of the sources of pollutants through the use of Best Management Practices (BMPs) under existing Federal rules and regulations. EPA has also identified an effluent limit consistent with the applicable total maximum daily loads (TMDLs) waste load allocations (WLAs).

EPA's implementing regulations for Section 301(b)(1)(C) among other things prohibit the issuance of an NPDES permit "when imposition of conditions cannot ensure compliance with the applicable water quality requirements" and to ensure that adequately protective NPDES effluent limits are imposed whenever "a discharge causes, has the reasonable potential to cause or contributes to an in-stream excursion about the allowable ambient concentration" of an applicable water quality standard. See 40 CFR §§ 122.4(d) and 122.44(d)(1)(iii). EPA views the MS4 NPDES permit program as an iterative process requiring reexamination of ongoing controls and continued improvements to the respective storm water management programs of each facility while continuing to adequately protect the water quality of the receiving stream.

When the MS4 Permit was issued on April 19, 2000, it was subsequently appealed for a number of reasons. After the parties fully briefed the issues, the appeal resulted in two decisions finally by the Environmental Appeals Board (EAB) in February, 2002 and upon reconsideration in May, 2002. The focus of those appeals was on a total of nine issues which included compliance with water quality standards through the use of BMPs, rather than through establishing numeric effluent limits; aggregate versus single outfall discharge limits and monitoring procedures for the Hickey Run Total Maximum Daily Load (TMDL) in the Permit; EPA's determination that the MS4 would reduce storm water pollutant discharges to the Maximum Extent Practicable (MEP); the process for addressing SWMP deliverables and modifications during the Permit cycle; and the conflict in the use of "waivers and exemptions" between District and Federal storm water regulations. One of the issues which the EAB agreed with EPA included the finding that MS4 permits may have BMPs as permit effluent controls sufficient to meet water quality standards, specifically affirming the Agency's position that NPDES permits are not required to have numeric effluent limits (especially storm water permits) but rather may contain BMPs as permit controls. The EAB also observed that the numeric limit for the Hickey Run TMDL in the Permit saying that the Permit was not necessarily required to have outfall specific limits. On BMPs and MEP, EPA's position was upheld on our determinations that the SWMP and BMPs represent the controls sufficient to achieve reduction of pollutants to "the maximum extent practicable"(MEP); that the Permit properly allowed for improvements and upgrades; that EPA properly allowed a three year compliance schedule; and that the Permit properly considers cost benefit information.

With regard to permit modifications, the EAB upheld the compliance schedule and extension of time provisions which were up to 120 days in the Permit. Issues remanded to the Region included establishing a record justifying that the MS4 effluent limits will "ensure compliance" necessary to meet applicable water quality standards; inclusion in the Permit of the methodology for monitoring procedures and requirements for either a narrative or the numeric standard to address the Hickey Run TMDL; revise the Permit to explain how major and minor modifications with regard to MS4 monitoring location and SWMP changes will be addressed; and clarification of the District's "waivers and exemptions"clause in the Permit. Since that time, consistent with the EAB's ruling on this issue, EPA has clarified through Amendment Numbers 1and 2 to the 2000 MS4 Permit how the MS4 is to be modified and addressing the different types of changes that may be required during the life of the permit. Amendment Number 2 also authorized a change in monitoring stations from the Anacostia watershed to the Rock Creek watershed. This Permit reflects those changes to the modification procedures and the monitoring stations. EPA has addressed the other remand issues in the fact sheet and/or in the reissued MS4 Permit.

ACTION TAKEN:

This action involves reissuing a second round National Pollutant Discharge Elimination System (NPDES) MS4 Permit to the Government of the District of Columbia. The reissued MS4 Permit will replace the one originally issued on April 19, 2000, and subsequently changed by Amendment Number 1 issued on January 12, 2001, and Amendment Number 2 issued on March 19, 2003. The reissued draft MS4 Permit was public noticed on November 14, 2003, for a thirty day review and comment period. EPA received four multiple comment letters from interested parties during the public comment period and has prepared individual responses to each of those letters (refer to MS4 Responsiveness Summary document). This permit incorporates information and schedules contained in the Upgraded SWMP as the primary pollutant control mechanism for addressing storm water issues during the next permitting cycle. Changes in the permit and Upgraded SWMP reflect information set forth in the District's First Annual Review dated April 19, 2001; the 2002 Annual Report dated April 19, 2002; the 2002 Implementation Plan dated April 19, 2002; and the Discharge Monitoring Report dated April 19, 2002; and which is supplemented by the 2003 Annual Report, the 2003 Implementation Plan, and the 2003 Discharge Monitoring Report, all of which are dated April 19, 2003. The Permit will require action and implementation of all MS4 activities by the permittee as set forth in this Permit and the Upgraded SWMP. The Permit promotes the demonstration of the effectiveness of various BMPs. The requirements of this Permit build on existing MS4 inventories, databases, and studies which support implementation of MS4 activities. Finally this Permit continues to require the development, collection and reporting of baseline and trend monitoring data under the District's current MS4 watershed-based monitoring program. Besides compliance with the conditions of this Permit, such information will be used to evaluate the overall effectiveness of current controls and direct the developments of additional controls to be taken to enhance the District's storm water management program and provide further protection for water quality.

Based on the information available as described above for this Permit, EPA has determined that the District's Upgraded Storm Water Management Plan establishes controls that will reduce the discharge of pollutants to the maximum extent practicable consistent with EPA's MS4 storm water program requirements of Section 402(p)(3)(B)(iii) of the CWA. In reaching this conclusion, EPA reviewed not only the monitoring information discussed above, the TMDLs and resulting wasteload allocations (detailed in the Fact Sheet) but also the District's Annual Reports dated April 19, 2002 and April 19, 2003. In addition EPA also reviewed the District's Implementation Plans dated April 19, 2002 and April 19, 2003; the District's fifth Semi-Annual Report to the Mayor and City Council dated December 2003. To implement these requirements in the Permit, EPA has revised Part I.D. to clarify that the effluent limits for this permit are to implement the requirements set forth in the Upgraded Storm Water Management Plan. EPA has also provided a clarifying definition of the "maximum extent practicable" standard for the specific purposes in this MS4 Permit. The narrative effluent limits provide the performance-based standard for evaluating the environmental outcome of the storm water management activity which is being monitored for compliance. The Region finds that the Permit effluent limits and other requirements (such as those establishing "measurable performance standards" in Parts III.C.6 and III.D of the Permit) adequately hold the Permittee to continue meeting quantifiable outcomes tied to pollution reduction and real achievable results under the current system of annual permit deliverables.

Based on the following discussion, EPA finds that the Upgraded SWMP and the Permit effluent limits to implement that SWMP are sufficient to ensure compliance with applicable water quality standards. Because of continued uncertainty and lack of data regarding the efficiency of various BMPs, this Permit also includes substantial monitoring to verify and inform EPA's findings.

The District's Upgraded SWMP which EPA approved on October 29, 2003, set forth a framework for a long term storm water management control program under the reissued Permit for assessing its effectiveness in ensuring compliance with applicable water quality standards to the maximum extent practicable. The basic strategy for assessing the effectiveness of the Upgraded SWMP in meeting the applicable District water quality standards has been and continues to be dependent on the cyclic watershed monitoring and assessment program established under the current permit for assessing long term water quality impacts and trends, on specific BMP monitoring, where appropriate, and on the direct (i.e., number of BMPs installed; removal efficiencies; storm water volume reduction; event mean concentration reduction; pollutant loading reduction) and indirect (i.e., education of the public; monitoring for illicit discharges and construction impacts; cleaning of catch basin and streets; removal of floatables from District waterways) measurement systems of storm water management controls currently being implemented within the District. Within the next two years, the District will complete their initial baseline monitoring under the MS4 Permit and start with their next round of monitoring in the Anacostia, Rock Creek, and Potomac watersheds to be in a position to evaluate the effectiveness of the storm water controls being implemented annually in achieving compliance with applicable water quality standards. This monitoring will serve to further inform and/or verify to EPA whether the Permit controls (including BMP effectiveness) are sufficient to ensure compliance with applicable water quality standards.

While the recommendations for each of the MS4 activities identified in the Upgraded SWMP will continue to be implemented during the reissued Permit cycle to ensure compliance with applicable water quality standards, District studies and reports indicate that there are over 350 BMPs installed currently to reduce the MS4 pollutants being discharged to the system, up to 60 tons per month during heavy rainfall periods of floating debris being removed from District waterways, 700 tons of trash per month being collected from 2,000 litter cans placed at bus stops and in heavy pedestrian traffic areas, approximately 6,000 tons of trash being cleaned annually through the catch basin program, and 5,298 construction sites inspected in FY2001 with 234 enforcement actions taken for violations of storm water regulations. Functional landscaping and low impact development (LID) practices will continue to be promoted and offered as cost effective means of addressing storm water management through site design modifications and implementation of BMPs. These practices encourage development in a hydrologically functional manner, consistent with the natural landscape. Between January, 2001, and February, 2002, the District's Department of Health approved 21 LID storm water management plans as demonstration projects. The 8th Street, S.E., pilot project scheduled for completion during FY 2004 by the Department of Transportation incorporates LID principles and will be used to evaluate the effectiveness of LID techniques within transportation capital projects to reduce storm water runoff and improve storm water quality. (Refer to Chapters 5 and 6 of the Storm Water Management Plan dated October 19, 2002, for additional information regarding MS4 activities).

As previously mentioned, the Permit to be reissued will build through implementation of BMPs and numeric criteria and program standards, where appropriate, on current projects already underway for each of the MS4 activities outlined in Part III.B of the existing Permit. This will be achieved through institutional and other accomplishments to date which included passage of the District's "Storm Water Permit Compliance Amendment Act of 2000" that created a permanent management infrastructure and funding source for implementing MS4 activities and additional actions under the existing Permit that increased District inspection and enforcement of MS4 activities; integrated BMPs and low impact development projects into all MS4 activities; enhanced informational databases for MS4 activities to support implementation; established programs to deal with source characterization and identification, snow and ice removal, and illicit discharge detection and correction; created a sampling program to monitor representative MS4 outfalls on a rotating subwatershed basis for the Anacostia River, Rock Creek, and Potomac River; and developed programs for educating the public and private sectors to effectively manage storm water.

On January 12, 2001, the Region issued Amendment No.1 to the existing Permit which clarified when the Permit would be reopened and modified in accordance with current NPDES permit regulations. The Amendment was subsequently appealed to the EAB and packaged with the original appeal to be decided along with the February, 2002 ruling. The reissued Permit clarifies through the use of a reopener clause when modifications are appropriate and specifies throughout the Permit when major modifications to the Permit will be required. On March 19, 2003, the Region issued Amendment No. 2 to the existing Permit which authorized changes to the District's monitoring program shifting the stations and associated MS4 outfall locations from the Anacostia River subwatershed to the Rock Creek subwatershed and further discussed the modification issue. The outstanding issues remanded to the Region by the EAB which still remain are discussed below along with an explanation of how they are to be addressed in the reissued Permit.

Hickey Run is a very small tributary to the Anacostia River. The drainage area is a mere 1.7 square miles. The upper reach is essentially a closed stream and the lower reach an open channel. The headwaters of Hickey Run consist of underground storm sewer pipes with outfalls that are very close to each other. Through four outfalls, the storm sewer gives way to an open stream channel. The stream flows through the National Arboretum for less than a mile before meeting the Anacostia River. The stream has been historically plagued by illegal oil and grease dumping. Above the open stream, there are a number of transportation-related facilities in the watershed (gas stations, repair shops, etc.), many of which have not properly disposed of waste oil in the past. Also, oil and grease flush into the storm sewer system during rain storms.

While much of the oil and grease originates from nonpoint sources in the upper half of the Hickey Run watershed upstream from the four outfalls, these pollutants find their way to the storm sewer system and are thus classified as point sources in the Hickey Run TMDL. The open channel that flows through the National Arboretum in the lower half of the watershed picks up oil and grease from groundwater and sediments as well as occasional illegal dumping. These sources make up the nonpoint source load. The following table shows the percent of the total load of the pollutants from point and nonpoint sources.

Source	Percent of Total Load	
	Existing Conditions	After the TMDL
Point Source (4 outfalls)	88.9%	44%
Nonpoint Source	11.1%	31%
Margin of Safety	0.0%	25%

The TMDL required a wasteload allocation of 11.9 lbs/day of oil and grease at a stream flow in Hickey Run of 0.5 cubic feet per second representing the load from these four sewer outfalls. The effluent limit is 11.9 lbs per day for the MS4 discharge to Hickey Run.

Monitoring for oil and grease in Hickey Run is presently conducted by the District at their ambient sampling site identified as THRO1 and the MS4 site identified in the existing Permit.
Current monitoring data collected at both locations indicate that this parameter consistently meets the water quality standard criteria of 10 mg/l and should be no longer be considered a pollutant of concern. The improved conditions for oil and grease within the Hickey Run subwatershed are attributed to the use of source controls and effective enforcement actions. Work will still continue in the Hickey Run subwatershed under this Permit by implementing

additional techniques designed to identify violators and structural controls for ensuring TMDL requirements are met on a continuous basis. One of the measures which the District intends to pursue under this Permit is the establishment of a BMP structure below the largest outfall from Hickey Run prior to it becoming an open channel through the National Arboretum as a means to ensuring full compliance with the applicable water quality standard criterion. Development of a monitoring program for measuring the effectiveness and performance of the BMP in achieving the TMDL endpoint of 10mg/l for oil and grease is a provision of the Memorandum of Understanding which was signed in January, 2004 with the agencies responsible for the project. The aggregate approach and the setting of one limit at this outfall for monitoring the TMDL was decided based on the configuration of the enclosed stream, the volume of storm water that the outfall contributes to the open channel and that the ambient monitoring site downstream of the four outfalls that comprise Hickey Run has not shown oil and grease violations.

When the oil and grease TMDL for Hickey Run was developed, a single wasteload allocation (WLA) was assigned to the combined four outfalls that comprised the man-made reconfigured piped stream prior to it becoming a natural waterway in the vicinity of the National Arboretum. The 2000 MS4 Permit based a numeric effluent limit on that WLA and determined that the single numeric effluent limit was an appropriate control for all four outfalls because as discussed below the three downstream outfalls of the current MS4 monitoring site were not considered to be contributors to the oil and grease problem. That limit had a three year compliance schedule before it became effective. Because of the NPDES permit appeal and subsequent remand, that limit never became effective.

EPA now has two years of water quality monitoring data from the representative MS4 site for Hickey Run which demonstrates that the numeric criteria of 10mg/l is being met during wet weather events. Further evidence that the oil and grease criteria is being met is shown through monitoring records from the long established Hickey Run ambient sampling site further downstream which is maintained by the District of Columbia Department of Health under their Section 106 Program. EPA further notes that the improvement can be attributed to the source controls through the use of effective BMPs in the upper parts of the subwatershed in reducing the wasteload allocations initially entering each of the four outfalls to which the wasteload allocations in the TMDL were assigned (at the point of reentry into the main stream at the National Arboretum). Based on the above information regarding current achievement of the WLA through the SWMP BMPs, the Region has reconsidered the specific numeric effluent limit and has adopted a non-numeric narrative effluent limit (subsumed in the Part I.D.1, 2 and 3 narrative effluent limits) consistent with EPA regulations and the applicable WLA. EPA has also identified continued representative monitoring for Hickey Run to ensure that the current effluent limits are sufficient to protect water quality consistent with the WLA in Part VI of the Permit. EPA notes that in addition the District has committed to install a structural floatable control BMP in the lower part of the Hickey Run subwatershed and to develop a comprehensive MS4 retrofit program in the headwaters of the subwatershed which is discussed in Chapter 3.0 of the 2004 Annual Report included in the final administrative record for the reissued Permit. This BMP will also further control oil and grease. While the installation of this control device is not a requirement of the Permit, the structure will reinforce the permittee's goal of continuing to maintain compliance with the oil and grease criteria established in the water quality standards and the WLA. Since EPA has adopted a narrative effluent limit applicable to the Hickey Run outfalls and representative monitoring consistent with 40 CFR 122.26 and 122.44 (k)(2), the EAB's remand of the numeric effluent limit and requisite monitoring procedures is moot.

Initiated two years ago, the District's continuous monitoring program under the MS4 has been limited to the sampling of representative MS4 sites in the Anacostia River subwatershed which includes the Hickey Run station. While the program is being designed to rotate the sampling to encompass the Rock Creek and Potomac River subwatersheds to establish baseline information and trend data to evaluate MS4 performance, the Region reaches the following conclusions based on the storm water data sampled to date from the Anacostia River subwatershed. The storm water data sampled reveals minor or no loads of volatile organic compounds, acid extractable compounds, base/neutral compounds, pesticides, polychlorinated biphenyls (PCBs), or dioxin. A number of metals are contributed in minor amounts; highest among these are copper and zinc. Moderate loads of nutrients were contributed, while significant loads of suspended and dissolved solids, fecal coliforms, and fecal streptococcus should be noted. Oil and grease, even at the Hickey Run storm water monitoring site, are no longer major pollutants of concern based on the available data and according to the draft 303(d) list mentioned previously in the fact sheet. While this information represents only one of the three watersheds to be monitored, it would appear that sediments, bacteria, and nutrients pose the greatest concern from the MS4 discharges at this time and that the potential for causing or contributing to water quality standard exceedances from the other parameters being monitored are relatively low.

The monitoring results from the April 19, 2002, and 2003, Discharge Monitoring Reports show the water quality standard criteria for oil and grease (10mg/l) being met during storm water sampling events at the MS4 representative station for Hickey Run. This would indicate that Best Management Practices (BMPs)required by the previous Permit applied throughout the Hickey Run watershed are being effectively managed providing adequate controls to ensure achievement of the applicable water quality criteria and TMDL wasteload allocation. The signed agreement between the District of Columbia Government and the National Arboretum to install a BMP project to control oil and grease and trash is viewed as a further measure of compliance on Hickey Run as the stream reestablishes itself to a viable waterway before crossing National Arboretum property prior to entering the Anacostia River.

The strategy and approach set forth in the Upgraded SWMP has been successfully demonstrated in the Hickey Run watershed. In that watershed a series of source controls and enforcement actions have resulted in achievement of the applicable water quality criteria and applicable wasteload allocation of 10mg/l water based on the monitoring data collected over the last two years.(see Discharge Monitoring Reports dated April19, 2002 and April 19, 2003) Based on that monitoring data, the criteria is being met during storm water events even through the low flow (base flow) was used in the Hickey Run TMDL effluent limit calculations. The District has determined that oil and grease is no longer a pollutant of concern as demonstrated by the District's draft 303(d) list (the list of impaired waterbodies). In that list, the District has proposed delisting the Hickey Run as a waterbody impaired by oil and grease as identified on previous 303(d) lists. Based on the information described above, the Region has thus determined that consistent with 40 CFR 122.44(d)(1) and EPA's Technical Support Document for Water Quality-Based Toxics Control that the BMP controls provided by the reissued Permit will be sufficient to ensure that the discharge from the Hickey Run outfalls will not cause or contribute to an exceedance of applicable water quality criteria for oil and grease. Work will still continue under the reissued Permit in the watershed however, through continued implementation of techniques for identifying and enforcing against illicit discharges, source control measures, and structural BMPs to provide preventative control measures for ensuring compliance with the applicable oil and grease water quality standard.

To further ensure compliance with water quality standards in addition to the non numeric limit requiring the use of BMPs identified in the SWMP, the Permit establishes narrative effluent limits identified in Parts I.C. and I.D of the reissued Permit which prohibits the permittee from discharging pollutants from the MS4 system to District waterways that could cause or result in an exceedance of applicable water quality standards. In further support of our determination that this MS4 Permit requires controls to reduce the discharge of pollutants to the "maximum extent practicable" (MEP) in accordance with Section 402(p)(3)(B)(iii) of the Clean Water Act which was specified previously in the fact sheet, EPA has added a definition of MEP in Part X of the reissued Permit. The permittee is also required in Part IX.B and IX.C. of the reissued Permit to demonstrate compliance with the effluent limits through the Annual Discharge Monitoring Report with the storm water component of any approved TMDL within the District [Refer to November 22, 2002, memorandum entitled, "Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water Sources and NPDES Permit Requirements Based on Those WLAs] and when an exceedance occurs, to recommend a remedial course of action through the Annual Implementation Plan for correction to the maximum extent practicable within the permitting cycle. Language has been included in Part IX.A of the reissued Permit to say that "waivers and exemptions" under District law that are not consistent with applicable Clean Water Act requirements, regulations, policy, or guidance are prohibited; and, as such, this Permit does not authorize the discharge of any pollutant through such waivers, etc. The District's monitoring program for establishing baseline and trend data in the reissued Permit for determining BMP performance and compliance with water quality standards includes a complete set of MS4 representative sampling sites for the Anacostia and Potomac Rivers and Rock Creek.

Based in part on comments and on the analysis set forth above regarding the effluent limits developed to ensure compliance with water quality standards, EPA has adopted a narrative effluent limit to the Part I.D.3 of the Permit that EPA has determined to be consistent with the applicable TMDL WLAs. EPA has determined that a combination of the narrative prohibition on discharges that "cause or contribute to the exceedance of the District's water quality standard in Part I.C.2 of the Permit along with the effluent limitations identified in Part I.D.2 (primarily through implementation of the Upgraded Storm Water Management Plan) are sufficient to ensure compliance with the those water quality standards and are moreover consistent with the applicable TMDL WLAs. Since no implementation plan was part of the approved TMDL or WLA (nor is such a plan a requisite element of a TMDL), EPA has determined that in addition to the effluent limits it is appropriate that the Permit require the development of an implementation plan to determine whether the controls are sufficient and/or whether additional controls are necessary to further reduce the discharge of particular pollutants. The Permit is written as an action document to require implementation and to minimize delays. Part III.A of the Permit requires submission of these implementation plans as part of the compliance schedule. The Permittee is required to submit implementation plans for all of the applicable TMDL WLAs in the Anacostia River and Rock Creek watersheds. (Hickey Run is addressed in a separate Section VI of the Permit.) The Permit also requires the Permittee to describe the past practices and activities that have been implemented to achieve the reductions, the environmental benchmarks by which performance may be appropriately measured and any additional practices or controls that may be necessary for achieving the necessary reductions identified in the applicable WLA. The Permit requires submission of these plans to EPA and a review and decision to approve or disapprove (and resubmit the plan) by the Region. The Permit includes a specific Permit reopener authorizing EPA to formally modify the Permit in the event that EPA determines additional NPDES controls are necessary to be consistent with the WLAs. The Region expects that such additional may be necessary for some parameters but not others, but is moving forward to gather that information and make an informed decision.

To clarify the narrative effluent limits developed consistent with the applicable TMDL wasteload allocations identified in Part I.D.3 of the reissued Permit, EPA has identified all applicable TMDL WLAs with their associated reductions from the most current estimated loadings available at this time and included them in the attached table, hereafter known as Appendix A, to the fact sheet. Appendix A is intended to summarize the applicable approved TMDL WLA information as it relates to the DC MS4 as of the effective date of the Permit. Each waterbody is identified by its pollutant(s) of concern, the existing baseline loads estimated to originate from the MS4s, corresponding units for these loads, and the load reduction percentage associated with each TMDL WLA. The figures relate only to the MS4 portion of the total stormwater load allocation, and associated reduction for each waterbody. The TMDL WLA for the MS4 were determined by estimating total MS4 loads through modeling, identifying the dimensions of each permitted watershed, and proportionally assigning pollutant loads to each MS4 sewershed for each waterbody. Appendix A is a compilation of data extracted from the final District of Columbia TMDLs, EPA TMDL decision rationales, and supporting information. Appendix A is for informational purposes only and is intended as a guide to assist the permittee with implementing and evaluating the effectiveness of MS4 Permit controls developed consistent with the approved WLAs. The applicable approved TMDL documents should be consulted regarding specific details concerning the development and explanation of the MS4 WLA information identified in Appendix A.

In response to the remand from the EAB and various commenters to the draft Permit, EPA has adopted a Permit provision IX.A that specifically prohibits any discharge that the District could otherwise allow through such a waiver or exemption issued under District laws. Such a discharge would not be authorized by this Permit and as such could constitute a violation of the terms of this Permit.

In its decision of the appeals of the 2000 MS4 Permit, the EAB remanded to the Region that the District's Section 401 certification could not be relied on solely as a mechanism for concluding that the document would in fact achieve water quality standards (WQS) and that an additional record of support would be needed by the Region. In response, EPA requested Section 401 certification of the second round draft MS4 Permit from the District's Department of Health at the time of the public comment and review period. The information used as the basis for our rationale discussed in the fact sheet and comments received during the public noticing period which are addressed in the responsiveness summary to comments as well as the Upgraded SMWP and associated MS4 Permit deliverables has been used by the Department to establish a record of support for their decision. The Section 401 certification which EPA Region III received from the Department of Health and which is part of the administrative record concludes that the second round draft MS4 Permit will ensure compliance with applicable WQS. The EPA Regional office accepts the Section 401 certification from the Department of Health with the understanding that the Region is not basing its reliance solely on the certification but on the record of support which is discussed above that the Department used during this process to arrive at the conclusions which are stated in the certification letter.

EPA consultations under the Endangered Species Act with the United States Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration Marine Fisheries Service (NOAA Fisheries) were conducted as part of the public comment on the draft Permit. Both Services agreed with the findings of the biological evaluation prepared by the Region that the storm water discharges covered under the MS4 Permit would not adversely affect Federally listed endangered and/or threatened species located within the permitted area. EPA has included copies of the correspondence (letters dated December 30, 2003, from NOAA Fisheries and dated February 11, 2004, from USFWS) in the final administrative record for the reissued Permit.

For more information, contact Mr. Garrison D. Miller, mail code 3WP13, Office of Watersheds, EPA Region III, Environmental Protection Agency, 1650 Arch Street, Philadelphia, Pennsylvania 19103-2029.

Attachment (Appendix A)
District of Columbia MS4 Waste Load Allocations (WLAs) with Legend of Terms

Re: Responsiveness Summary
National Pollutant Discharge Elimination System (NPDES)
Draft Municipal Separate Storm Sewer System (MS4) Permit

NPDES PERMIT NUMBER: DC0000221 (MS4)

FACILITY NAME:

Government of the District of Columbia
The John A. Wilson Building
1350 Pennsylvania Avenue, N.W.
Washington, D.C. 20004

FACILITY LOCATION:

District of Columbia's
Municipal Separate Storm Sewer System (MS4)

RECEIVING STREAM:

Potomac River, Anacostia River, Rock Creek
And Tributaries

PUBLIC COMMENT PERIOD:

November 14, 2003 to December 17, 2003

EPA Region III received four multiple comment letters during the public comment period from interested parties regarding the Government of the District of Columbia (Permittee) draft Municipal Separate Storm Sewer System (MS4) NPDES Permit. A summary of the comments and EPA Region's III responses to those comments are provided below. In reaching its decision regarding the issuance of the final MS4 Permit, the Region considered these comments and made certain modifications in response to those comments in the permit and fact sheet.

A) Comment Letter Number 1. Commentor: Government of the District of Columbia by Acting Storm Water Administrator Michael Marcotte of the District of Columbia Water and Sewer Authority : Correspondence dated December 17, 2003, was received from the permittee during the public comment period. This commentor also provided additional follow up information in a letter dated March 19, 2004 that EPA considered. EPA Region III provides the following responses to the specific issues raised by the District of Columbia Water and Sewer Authority.

Specific comments on Permit:

Comment No. 1- "When discussing water quality requirements throughout the permit, EPA should develop a record to support its determination that compliance with a requirement is practicable or it should include language that the requirement must be completed with to the "maximum extent practicable"

EPA Response: EPA agrees that the record for this permit needs to clearly support our determination that this MS4 permit requires controls to reduce the discharge of pollutants to the "maximum extent practicable" (MEP) in accordance with Section 402(p)(3)(B)(iii) of the Clean Water Act (CWA). EPA has made that determination and has identified the basis of our determination that the MS4 Permit has met this requirement in the fact sheet supporting this Permit. EPA has also made modifications to Part I. D. Effluent Limits Sections of the Permit and added a definition of MEP in Part X. Definitions in response to this and other comments received below to better clarify EPA's position regarding the relationship between the MEP requirements and the requirements in Section 301(b)(1)(C) of the CWA to protect the water quality of the receiving streams.

EPA's implementing regulations for Section 301(b)(1)(C) among other things prohibits the issuance of an NPDES permit "when imposition of conditions cannot ensure compliance with the applicable water quality requirements" and to ensure that adequately protective NPDES effluent limits are imposed whenever "a discharge causes, has the reasonable potential to cause or contributes to an in-stream excursion about the allowable ambient concentration" of an applicable water quality standard. See 40 CFR §§ 122.4(d) and 122.44(d)(1)(iii). EPA views the MS4 NPDES permit program as an iterative process requiring reexamination of ongoing controls and continued improvements to the respective storm water management programs of each facility while continuing to adequately protect the water quality of the receiving stream. EPA has not to date adopted the finding of certain courts that Section 402(p)(3)(B)(iii) of the CWA gives EPA authority to "require less than strict compliance with state water quality standards" such as those imposed by Section 301(b)(1)(C). See Defenders of Wildlife v. Browner, 191 F.3d 1159 (9th Cir. 1999) and In re: Gov't of the District of Columbia . NPDES Appeal Nos. 00-14 & 01-09 (EAB, February 20, 2002), 10 E.A.D. ___, fn. 19.

With respect to the discharges from the MS4 outfalls, EPA now has available some additional water quality information (including certain systemwide allocations from various total maximum daily loads [TMDLs] established during this period) compared with April 2000 when EPA issued the first MS4 permit to the District. The 2000 Permit required the collection of monitoring data from six representative MS4 outfall locations throughout the District including sampling in both wet and dry weather. (The Permit also required collection of samples from Hickey Run which is discussed further below.) The Permit required samples to be collected during at least three storm events per year as specified in that Permit. The 2000 Permit required samples to be analyzed for the following parameters: pH, temperature, total ammonia nitrogen, organic nitrogen, total nitrogen, volatile organic compounds, acid extractable compounds, base/neutral extractable compounds, pesticides, PCBs, metals, cyanide, phenols, conventional pollutants and hardness. As part of Amendment No. 2 to the 2000 Permit, EPA changed the original six representative monitoring locations to six watershed monitoring locations in the Rock Creek subwatershed based on EPA's determination that a rotating basin monitoring strategy would optimize the data collection. Not only will such an approach better characterize each the MS4 discharges to each of the three watersheds, it will provide more data that can be used in the development of TMDLs and the evaluation of the effectiveness of BMPs used in the MS4. Data to date has been collected and analyzed for the nine stations in the Anacostia River subwatershed and for stations in the Rock Creek watersheds.

So in summary, while EPA has better information it is still far from robust (especially compared with what is generally available for traditional NPDES permittee's discharges). As required by the 2000 Permit, the District has submitted an Upgraded Storm Water Management Plan identifying additional controls and refining existing practices. Based on the limited information available for this Permit, EPA has determined that the District's Upgraded Storm Water Management Plan establishes controls that will reduce the discharge of pollutants to the maximum extent practicable consistent with EPA's MS4 storm water program requirements of Section 402(p)(3)(B)(iii) of the CWA. In reaching this conclusion, EPA reviewed not only the monitoring information discussed above, the TMDLs and resulting wasteload allocations (detailed in the Fact Sheet) but also the District's Annual Reports dated April 19, 2002 and April 19, 2003. In addition, EPA also reviewed the District's Implementation Plans dated April 19, 2002 and April 19, 2003; the District's fifth Semi-Annual Report to the Mayor and City Council dated December 2003. To implement these requirements in the Permit, EPA has revised Part I.D to clarify that the effluent limits for this permit are to implement the requirements set forth in the Upgraded Storm Water Management Plan. EPA has also provided a clarifying definition of the "maximum extent practicable" standard for the specific purposes in this MS4 Permit.

EPA has reviewed the same materials with special attention on the TMDLs and associated waste load allocations to determine whether these controls are sufficient to ensure compliance with the applicable District water quality standards. Based on the best professional judgement of the permit writer as described in more detail in the Fact Sheet, recognizing the limitations of the current water quality information and additional requirements in the upgraded water quality management plan, EPA has determined that a combination of a narrative prohibition on discharges that "cause or contribute to the exceedance of the District's water quality standard in Part I.C.2 of the Permit along with the effluent limitations identified in Part I.D (primarily through implementation of the Upgraded Storm Water Management Plan) are sufficient to ensure compliance with the those water quality standards. EPA discussed in detail below why these controls are also consistent with the applicable wasteload allocations established by the respective TMDLs.

Comment Nos. 2,3,4,and 5- The Permittee provides additional information describing how the components of the Storm Water Management Program will continue to be implemented, how implementation of MS4 activities under the Storm Water Management Program will be reported through the Annual Report and the Annual Implementation Plan, how the District will continue to implement a sampling program to monitor representative outfalls on a rotating subwatershed basis, and how measures are continuing to be implemented in the Hickey Run subwatershed now that the fact sheet notes that the oil and grease standard under the Total Maximum Daily Load for Hickey Run is being met.

EPA Response: The Region appreciates the comments made by the Permittee to further clarify these items and show its support by acknowledging the Permit requirements. See below in Response to Hickey Run TMDL for further discussion on how the new information regarding Hickey Run has been addressed.

Comment Nos. 6, 7, 8, and 9- The Permittee noted several sections of the draft Permit where there were topographical and formatting problems and recommended corrective changes.

EPA Response: To facilitate reading of the final MS4 Permit, the Region made the following changes: realignment of tabs for Sections A through D in the Table of Contents; change the word, "insure" to "ensure" in the Legal Authority and Resources subpart; and revised the text to read "A. Storm Event Discharges" and "B. Dry Weather Monitoring" under the Monitoring and Reporting Requirements section.

Specific Comments on the Fact Sheet:

Comment Nos. 1, 2, 3, 4, 5, and 6- The Permittee provided a number of comments to clarify wording within the fact sheet, to update projected dates for completion of MS4 activities, and to facilitate the reading of the document by suggesting changes in the formatting.

EPA Response: The Region appreciates these editorial suggestions. The following revisions have been made to the final fact sheet: the pages have been numbered to facilitate the reading of the document, the word, "permit" has been added after MS4 and National Pollutant Discharge Elimination System in the Facility Background and Description and Proposed Action to be Taken sections, FY 2003 has been changed to FY 2004 for the 8th Street, S.E. pilot project in the Proposed Action to be Taken section, and the clause "....many of which do not properly dispose of waste oil." in the Proposed Action to be Taken section was revised to read, "....many of which have not properly disposed of waste oil in the past."

B) Comment Letter Number 2. Commentor: DC Appleseed Center: Correspondence dated December 16, 2003, was received from this organization during the public comment period. EPA Region III provides the following responses to the specific issues raised by the DC Appleseed Center.

Comment No. 1(noted as I and I.A)-The draft Permit should be modified to enhance accountability for permit compliance by including the District of Columbia Water and Sewer Authority (WASA) as a co-permittee. This comment was also raised by the Natural Resources Defense Council and Earthjustice in their letters each of which were dated December 15, 2003.

EPA Response: WASA was originally created in 1996 by District government as an independent District authority to provide water distribution and sewage collection, treatment and disposal. See Title 34, Chapter 22 of District Code. The passage of the Storm Water Compliance Amendment Act of 2000 by District government during the first permitting cycle created a permanent management infrastructure and funding source for implementing the District's Storm

Water Management Program. See D.C. Code Section 34-2202.06a. That legislation specifically identified WASA as responsible for administration and coordination of the storm water program by District government. The Government of the District of Columbia, unlike its counterpart arrangement with WASA for the sanitary sewers and treatment system, has stated in a letter dated February 17, 2004 that as a result of the passage of this legislation the role of permittee in applying for the MS4 Permit and holds all District agencies including WASA directly responsible for its implementation. The Act also established a Storm Water Permit Compliance Enterprise Fund for the Storm Water Administration's MS4 Permit implementation activities. To capitalize the Fund, the Act authorized the WASA to collect a flat storm water fee from all retail customers within the District. The Act further requires WASA along with the other MS4 District agencies to transmit a report every six months following the effective date of the Act to the Mayor and Council detailing the expenditures from the Fund, and expenditures on related storm water activities from annual appropriations, federal grants, and the Water and Sewer Enterprise Fund.

EPA Region III considers the interpretation of District law provided is a reasonable interpretation. That legislation adequately provides for WASA 's accountability and role as part of the Government of the District of Columbia role as Permittee in this Permit. The Region's experience with the District government and WASA's active and more prominent role in the stormwater program since the passage of that legislation also are factors that the Region has considered. Based on the above discussion, the Region does not agree with the commentor that it is necessary to identify WASA as a separate co-permittee to the Permit as the comment suggests. In response to this comment (and others received as noted) and to provide further clarity on this issue, the Region has modified the definition of the Permittee from the proposed definition of "the Government of the District of Columbia" to the following definition in the final Permit Section X: *"Permittee" refers to the Government of the District of Columbia and all subordinate District and independent agencies directly accountable and responsible to the City Council and Mayor as authorized under the Storm Water Permit Compliance Amendment Act of 2000 and any subsequent amendments for administrating, coordinating, implementing, and managing storm water for MS4 activities within the boundaries of the District of Columbia.*

Comment No. 2(noted as I.B)-The draft Permit should be modified to mandate development of an implementation plan for the storm water management program that includes deadlines, benchmarks, and quantifiable outcomes tied to appropriate pollution reduction and volume limiting standards. This comment was also raised by the Natural Resources Defense Council and Earthjustice in their letters each of which were dated December 15, 2003.

EPA Response: EPA Region III disagrees with the commentors to the extent that the Upgraded Stormwater Management Plan (SWMP) does identify an implementation to perform a wide range of practices and controls to reduce the quantity of pollutants discharged from the MS4 system. This Permit requires the District to implement all aspects of that SWMP as a narrative effluent limit of the Permit Section I.D. The Region refers the commentor to further discussion of this issue in the Permit's Fact Sheet under the section entitled, "Proposed Action to be Taken," which provides a number of examples to illustrate the issue raised by the commentors. Examples of such activities include the District's street and alley sweeping and catch basin cleaning programs. The narrative effluent limits which are required to be met through the Permit provides the performance based standard for evaluating the environmental outcome of the of the storm water management activity which is being monitored for compliance. The Region finds that the Permit effluent limits and other requirements (such as those establishing "measurable performance standards" in Parts III.C.6 and III.D of the Permit) adequately hold the Permittee to continue meeting quantifiable outcomes tied to pollution reduction and real achievable results under the current system of annual permit deliverables.

Comment No. 3(noted as II and II.A)-The draft Permit should clarify that low impact development (LID) practices are mandated for new development as well as redevelopment and must be included in road, street, and highway maintenance and construction projects unless there is a specific finding that such practices would be inappropriate.

EPA Response: The CWA and implementing regulations have no specific requirement that MS4 permits mandate low impact development (LID) practices. EPA agrees that these practices are effective infiltration reduction tools that address many storm water issues. EPA Region III expects and encourages permittees to consider LID practices and identify how the permittee incorporates those practices (where storm water benefits are achievable through the use of these practices) as part of its application for the respective MS4 Permit. Successful LID practices will provide information for future incorporation of these practices especially in local highway construction projects. EPA actively works with the National Highway Program requirements for LID practices, and strongly advocates consideration of storm water runoff practices which can accomplished through LID projects. Currently, the District of Columbia Department of Health has signed agreements with the District of Columbia Department of Transportation and the General Services Administration which requires federal contractors working on buildings or highway improvements to comply with the District's erosion and sediment control regulations. As described in Chapter 4.0 of the 2004 Annual Report which is part of the administrative record, the compliance process promotes and encourages the use of LID techniques. In response to the commentor's concern and to better clarify the Permittee's obligation to consider LID in new or retrofitted highway projects, EPA has added language to the first paragraph in Part III.B.1 (Management Plan for Commercial, Residential, and Federal and District Government Areas) of the final Permit. While EPA recognizes the value of LID in stormwater control, many development issues are beyond the scope of the MS4 Permit and the CWA.

Comment No. 4(noted as II.B)-The draft Permit does not require wetland and/or riparian buffer restoration. Such restoration requirements are valuable storm water management tools and the Permit should include these requirements as EPA has approved such requirements in other MS4 permits.

EPA Response: The CWA and implementing regulations do not specifically require such restoration as part of the MS4 permit requirements. EPA agrees with the comment that such restoration has positive environmental impacts and often can provide significant reduction in the discharge of pollutants from the MS4. Region III encourages MS4 permittees to consider the use of such tools in the development of their respective SWMPs. For this Permit the Region notes that the Permittee and other District entities have already engaged in significant wetland and riparian buffer restoration. These entities have taken advantage of the on-going activities and funding available through such other programs as the Nonpoint Source Management Program currently well established and in place within the District. EPA believes the restoration techniques being planned and implemented to date throughout the District under the other programs indirectly benefits the District's storm water management program by providing the necessary protection to assist in the reduction of pollutants at the MS4 outfalls. The streams, rivers, and wetlands within the District of Columbia have become the focus of several critical habitat and wetland restoration and enhancement efforts and endeavors in partnership with other State and federal agencies, nonprofits, and community groups resulting in many environmental beneficial uses including those associated with storm water runoff. This effort was manifested through the signing of the Chesapeake Bay Agreements and the Anacostia Watershed Restoration Agreements with much of these efforts being planned and implemented through EPA's Section 319 Non Point Source Program (refer to the District's Non Point Source Management Plan). Presently, District-owned lands in the Anacostia River subwatershed are being protected through a number of wetland and riparian buffer restoration projects designed to address an array of environmental impacts ranging from river dredge material to storm water runoff. Currently, the District's strategy is to extend these efforts to the Federally owned lands which comprise the majority of the subwatershed. Some project examples include the Kenilworth Marsh, Kingman Lake, Watts Branch, the JFK storm water BMP, and the Anacostia Sea Wall modifications. EPA will continue to encourage these kind of beneficial projects. As in the last issue discussed, while EPA recognizes the value of such restoration in stormwater control, many of the development issues are beyond the scope of the MS4 Permit and the CWA

C) Comment Letter Number 3. Commentor: Natural Resources Defense Council: Correspondence dated December 15, 2003, was received from this organization during the public comment period. EPA Region III provides the following responses to the specific issues raised by the Natural Resources Defense Council.

Comment No.1(noted as II.A)-The draft Permit should be modified to enhance accountability for permit compliance by including the District of Columbia Water and Sewer Authority as a co-permittee and by requiring an implementation plan to demonstrate progress towards compliance with the Clean Water Act. This comment was also raised by the DC Appleseed Center and Earthjustice in their letters of December 16, 2003, and December 15, 2003, respectively.

EPA Response: See response as provided above in comment number one to DC Appleseed Center correspondence dated December 16, 2003.

Comment No. 2 (noted as III.A and B)- The District of Columbia Municipal Separate Storm Sewer System Permit needs to set objective performance standards based on Clean Water Act requirements. The Permittee must reduce pollutants to the maximum extent practicable. The

Permittee's discharges must also comply with water quality standards, implementing the applicable TMDL's. All discharges of pollutants to the MS4 system that cause or contribute to the exceedance of DC's water quality standards must be prohibited, regardless of the intent of the discharger.

EPA Response: In part as a response to various comments and to better clarify the effluent limits in this Permit, the Region has modified the effluent limits Section I.D. EPA Region believes that the final "Maximum Extent Practicable" (MEP) effluent limit in Part I.D (Effluent Limits) requiring implementation of the Upgraded Storm Water Management Plan (SWMP) provides sufficient objective performance criteria to achieve compliance with water quality standards. The commentor's concern that a range of options for pollutant reduction be consulted and that the one that reduces pollutants to the maximum extent must be employed unless determined not to be practicable undermines EPA's preferred approach for MS4 permits used in establishing the MS4 implementing regulations. See e.g. 64 Fed. Reg. 68754 (12/8/99) (MEP standard as "iterative process") and EPA various guidance documents on establishing MS4 controls including the NPDES Permit Writer's Manual and Wayland and Hanlon memo dated November 22, 2002 "Establishing TMDL WLAs for Storm Water Sources and NPDES permit Requirements Based on those WLAs." EPA finds that the District has consistently followed EPA's recommended approach throughout the development and implementation of the Upgraded SWMP.

The comment concerning the prohibition of discharges into the MS4 system in Part I.C.2 has been addressed by eliminating the word, "intentionally" in the final Permit.

Comment No. 3(noted as IV)-The commentor provides a number of recommendations for improving the District's Storm Water Management Plan (SWMP).

EPA Response: EPA Region III appreciates the Natural Resources Defense Council's recommendations for improving the District's SWMP and their overall Program. We have requested the Permittee by letter to incorporate a response to these comments and include it in their addendum to the Upgraded SWMP.

D) Comment Letter Number 4. Commentor: Earthjustice: Correspondence dated December 15, 2003, was received from this organization during the public comment period. EPA Region III provides the following responses to the specific issues raised by Earthjustice.

Comment No. 1 (Entities and Discharges Covered)- The commentor notes that because of the District of Columbia Water and Sewer Authority's agency status to the District government that they should be named a co-permittee to the Municipal Separate Storm Sewer System (MS4) Permit. In the same comment, Earthjustice notes that the Permittee has not identified some 627 outfalls of the 1,131 major outfalls identified previously by the District. Also, Earthjustice notes that word "intentionally" should be deleted from Part I.C.2 of the draft Permit which states that "[a]ll other discharges of pollutants to the MS4 system that intentionally cause or contribute to the exceedance of the District of Columbia water quality standards are prohibited and not authorized by this Permit."

EPA Response: The comment regarding the co-permittee status was also raised by the DC
Appleseed Center and the Natural Resources Defense Council in their letters of December 16, 2003, and December 15, 2003. The commentor is referred to the same response as provided in comment number one to the Appleseed Center correspondence dated December 16, 2003. The District has identified through the use of maps 447 major MS4 outfalls and has identified the location of the 627 "other" outfalls. The field verification of the MS4 infrastructures and outfalls are continuing with the goal of completing 50% of the system by the end of FY 2004 and the remainder during the next permitting cycle. The 447 MS4 outfalls currently covered by this Permit correspond to the MS4 storm drain pipe network operated and maintained by the District. At this time EPA lacks sufficient data to expand the scope of the MS4 beyond that identified in the Annual Report dated April 19, 2003.

The "other" classification in the Table presented in the Upgraded Storm Water Management Plan does not designate "unknown", but rather stormwater outfalls other than those currently identified and authorized by this MS4 permit. Based on current information, EPA believes that these outfalls are from storm water systems other than the District's MS4 including, but not limited to, those owned by private or federal entities. The outfalls do not qualify as Major MS4 Outfalls in accordance with 40 CFR 122.26(b)(5). The District continues to field verify these "other" outfalls to further confirm their initial findings and to ensure no parts of the MS4 infrastructure or outfalls have been overlooked. A similar comment concerning the word, "intentionally" was raised by the Natural Resources Defense Council in their letter and EPA Region III in their response to their comment and to the one raised by Earthjustice has decided to delete it in the final version of the Permit.

Comment No. 2 (Compliance with Water Quality Standards) In this comment, Earthjustice notes that the draft Permit must include effluent limitations adequate to assure compliance with water quality standards stating why the MS4 discharges cause and contribute to violations of the DC water quality standards and why the water quality standards language in the Permit conflicts with the CWA and EPA rules.

EPA Response: As discussed above, EPA has considered this comment and others and have provided modifications to the Part I.D Effluent Limits, to better clarify the nature of the Permittee's obligations. EPA has determined that a combination of the narrative prohibition on discharges that "cause or contribute to the exceedance of the District's water quality standard in Part I.C.2 of the Permit along with the effluent limitations identified in Part I.D. (primarily through implementation of the Upgraded Storm Water Management Plan) are sufficient to ensure compliance with the those water quality standards and are consistent with the applicable TMDL WLAs. The previous MS4 Permit cycle initiated programs for monitoring three subwatersheds to determine the pollutants of concern and for evaluating the appropriateness of BMPs for use and effectiveness in reducing the identified pollutants of concern to comply with water quality standards. The draft Permit continues these efforts through implementation and revisiting of these subwatersheds to compare with baseline data the effectiveness of the installed BMPs in achieving compliance with water quality standards prior to setting numeric limits if information obtained demonstrates that it is feasible to do so. The draft Permit also requires the Permittee to continue to perform representative monitoring, evaluate the effectiveness of the Upgraded SWMP and develop and submit to EPA implementation plans to identify whether and if further controls are necessary to achieve the applicable TMDL WLAs. EPA will review these implementation plans along with the monitoring results and make a finding in writing. If EPA determines that the Upgraded SWMP is not sufficient to ensure compliance with water quality standards or is does not provide controls consistent with the applicable TMDL WLA, EPA intends to reopen the Permit and propose an amendment to add the additional controls necessary to achieve the applicable water quality standard and/or WLAs. To that end EPA has included a Permit provision authorizing the modification of the Permit for that specific reasons.

The controls instituted by the Permittee initiated during the 2000 Permit in the Hickey Run subwatershed (refer to fact sheet) for addressing the oil and grease TMDL demonstrates that the use of narrative effluent limits and the use of BMPs for achieving compliance with water quality standards can be effective and successful in addressing a majority of storm water related management problems. EPA Region did consider the commentor's suggestion regarding the change in the wording to the sentence in Part IX.3 of the draft Permit and will make those changes in the final version of the document.

Comment 2c on Page 8 (Hickey Run)-The commentor states that the draft Permit illegally
deletes the existing Hickey Run effluent limit of 11.9 pounds per day for oil and grease, the Fact Sheet seeks to justify such a rollback by asserting that a limit is no longer needed because no violations of oil and grease limits have been measured in Hickey Run in the last 2 years, and the remand order from the Environmental Appeals Board (EAB) is being compromised.

EPA Response: The Region notes first that numeric effluent limits for the Hickey Run outfalls set forth in the 2000 Permit never became effective during that Permit because of (1) a compliance schedule of one day short of three years; and (2) the 2000 Permit appeals and subsequent remand of several issues regarding that effluent limit. Because that limit never became effective, the Region exercised its discretion to consider whether other permitting controls would be sufficiently protective and appropriate in place of the numeric limits. The Region does not interpret the EAB's remand to exclude the exercise of the Region's judgement consistent with 40 CFR 122.44(k)(2) in determining appropriate BMP effluent limits. The Region respectfully disagrees with the commenter that the EAB required EPA to establish numeric effluent limits for these outfalls, only that if EPA had effectively imposed those numeric effluent limits then EPA would need to address the additional monitoring requirements identified in the Board's remand.

Based upon monitoring data collected over the last several years in the Hickey Run watershed, the data demonstrates that the TMDL WLA and water quality criteria have been achieved in both dry and wet weather situations. The monitoring results from the April 19, 2002, and 2003, Discharge Monitoring Reports show the water quality standard criteria for oil and grease (10mg/l) are achieved during storm water sampling events at the MS4 representative station for Hickey Run. The Permittee has achieved this success through implementation of the first SWMP requirements for structural and nonstructural controls in the upper part of the Hickey Run subwatershed (including enforcement efforts). The Region has determined based on a review of the data and the BMPs implemented by the Permittee consistent with the 2000 Permit requirements were sufficient to ensure compliance with the oil and grease water quality criteria of 10 mg/l and consistent with the TMDL WLA. Consistent with 40 CFR 122.44(d)(1) and EPA's Technical Support Document for Water Quality-based Toxics Control (EPA 1991), the Region has determined that the BMP controls provided by this 2004 Permit are sufficient to ensure that the discharge from the Hickey Run outfalls do not cause or contribute to an exceedance of applicable water quality criteria for oil and grease, and are consistent with the requirements and assumptions of the applicable TMDL WLAs.

Based on this finding the Region proposed a set of BMP controls as set forth in the Permit applicable to Hickey Run outfalls in the draft 2003 Permit to replace the previously established (but never effective) numeric limits. The Region also notes that an agreement which is part of the final administrative record between the District of Columbia Government and the National Arboretum has been signed to install an additional BMP to further control oil and grease as well as trash as a further measure to ensure compliance with applicable criteria and WLAs on Hickey Run as the stream reestablishes itself to a viable waterway before crossing National Arboretum property prior to entering the Anacostia River. This additional control will add another dimensional BMP within the subwatershed for ensuring further compliance with the TMDL and floatables which are the major concerns within the lower part of the subwatershed. Due to the success which has occurred within the Hickey Run subwatershed regarding the oil and grease TMDL, Section VI in the draft Permit has been shortened, but still requires monitoring, and reassessment of additional BMPs to ensure continued compliance with the water quality requirements. The use of the ambient and the MS4 monitoring stations to assess the successes within this subwatershed and the followup implementation required under the Permit to ensure compliance with the requirements of the TMDL, EPA believes, goes beyond what the EAB decision had envisioned now that the supporting document is available to substantiate EPA claims made to the Board at that time.

Comment No. 3 (Reductions to the Maximum Extent Practicable)-The commentor states that the District has not demonstrated that its Storm Water Management Plan will reduce storm water pollutant discharges to the maximum extent practicable and the draft Permit does not establish measurable goals to ensure that they will be met.

EPA Response: See Response to Comments B-2, C-2 [Appleseed and NRDC] The Region notes several specific additions for this comment. The Region notes that the Permit and the Upgraded Storm Water Management Plan require that those BMPs such as in the District's Storm Water Management Guidebook which have been evaluated for effectiveness reduce pollutants to the "maximum extent practicable" be implemented and the second round of monitoring be completed to confirm that the MEP standard set is achieving compliance with water quality based limits in the draft Permit. Other examples of BMPs and other MS4 controls include, but are not limited to, the comparison of sand filters and bioretention structures for effectiveness of operation, the use of Ice Ban as a melting agent for use on District highways, implementation of District innovative catch designs, implementation by the District of EPA's Region I Innovative Storm Water technologies, and evaluation of storm water management practices at transportation facilities, construction sites, snow removal operations, the 8th Street pilot project, infiltration basins, trenches, and vegetated biofilters and swales.

Comment No. 4 (Deferral of Complete Program)-The draft Permit allows the District to defer submittal of measures to provide for compliance with already-adopted TMDLs. The Clean Water Act and EPA rules do not allow this deferred approach.

EPA Response: As discussed above the Region has determined specific interim effluent controls I.D.3 to address this issue. The essential component to establishing appropriate NPDES controls consistent with the approved TMDL WLAs is an adequate implementation plan to achieve the necessary reductions. Since no implementation plan was part of the approved TMDL or WLA (nor is such a plan a requisite element of a TMDL), EPA has determined that in addition to the effluent limits it is appropriate that the Permit require the development of an implementation plan to determine whether the controls are sufficient and/or whether additional controls are necessary to further reduce the discharge of particular pollutants. The Permit is written as an action document to require implementation and to minimize delays. Part III.A of the Permit requires submission of these implementation plans as part of the compliance schedule. The Permittee is required to submit implementation plans for all of the applicable TMDL WLAs in the Anacostia River and Rock Creek watersheds. (Hickey Run is addressed in a separate Section VI of the Permit and a previous comment.) The Permit also requires the Permittee to describe the past practices and activities that have been implemented to achieve the reductions, the environmental benchmarks by which performance may be appropriately measured and any additional practices or controls that may be necessary for achieving the necessary reductions identified in the applicable WLA. The Permit requires submission of these plans to EPA and a review and decision to approve or disapprove (and resubmit the plan) by the Region. The Permit includes a specific Permit reopener to formally modify the Permit in the event that EPA determines additional NPDES controls are necessary to be consistent with the WLAs. The Region expects that such additional may be necessary for some parameters but is moving forward to gather that information and make an informed decision.

Comment No. 5 (Pesticides and Fertilizer)-The Storm Water Management Plan (SWMP) does not contain or describe a program to reduce and fertilizer pollution to the maximum extent practicable, as required by EPA rules.

EPA Response: EPA disagrees. The permittee is required through the Permit to implement programs to reduce the discharge of pollutants related to the application and distribution of pesticides, herbicides, and fertilizers in all media where these substances are used and to report annually on the implementation of application procedures, the improvements in the control of these materials for reducing these pollutants to enhance water quality, and how these procedures meet the requirements of the CWA and other pertinent regulations based on a screening characterization to determine the source(s) of the contaminates. The current Program requires the licensing and training of pesticide applicators in the District and enforcement of regulations through issuance of on-site notices of violations. Specific DCMR citations include 20 DCMR 2211.1 which states that: "no person shall dispose, discard, or store any pesticide container, or rinsate, in a manner that may cause injury to humans, vegetation, crops, livestock, wildlife, pollinating insects, or to pollute any waterway supply or waterway. 20 DMCR 2211.3 also goes on to state that no person shall handle, transport store, display, or distribute any pesticide in a manner that endangers man and the environment, or that endangers food, feed, or any other products that may be transported, stored, displayed, or distributed with the products. EPA Region III appreciates Earthjustice's comment on the Upgraded (SWMP) and has requested the Permittee by letter to further elaborate on the specifics of their fertilizer and pesticides programs through addendum to the Plan.

Comment No. 6 (Illicit Connections)-The CWA expressly requires Municipal Separate Storm Sewer System (MS4) permits to "include a requirement to effectively prohibit non-stormwater discharges into the storm sewers". Although the draft Permit requires the District to prepare plans and implement programs to prevent illicit discharges, it does not expressly include this requirement.

EPA Response: EPA disagrees that the Permit does not contain such a narrative prohibition. The commentor is referred to Part I of the draft Permit and specifically, Part I.B (Authorized Discharges) and the fourth paragraph of Part III.B.10 (Management Plan to Detect and Remove Illicit Discharges) concerning the prohibitions on non-storm water discharges into the storm sewers. As part of the District's continuing illicit connection and discharge programs, "unusual flows" which include foam, oil sheen, smells (i.e.,chemical, organic), and/or water flow in areas where ground water is not expected to be encountered during dry weather are reported by catch basin and inspection crews and followed up by field inspection crews to trace the discharge back to its source(s) utilizing specific tracer measures. The Permittee has indicated in their correspondence to EPA dated August 29, 2003 responding to comments on the Upgraded SWMP that additional details would be included in the addendum to the Plan to expand on their dry weather monitoring and inspection programs for identifying and eliminating illicit connections and discharges.

Comment No. 7 (Lack of New Structural Controls)-The Upgraded SWMP and the draft Permit do not appear to require any new structural controls to address storm water pollution which does not comply with mandates of the Clean Water Act.

EPA Response: The Permit (including the implementation of the Upgraded SWMP and other narrative requirements) provide the control measures the EPA has identified as necessary and sufficient to meet the NPDES requirements of the CWA. The District has incorporated structural and non structural controls in its Upgraded SWMP that have proven effective to date in addressing storm water pollution. This does not mean the District has excluded or has stopped considering adding other such controls from the universe of such controls. In addition to the controls being applied through the MS4 program, other ongoing programs (i.e., nonpoint source) within the District apply different types of controls to address other problems which will ultimately benefit the storm water program by reducing erosion and/or by reducing the discharge of pollutants from the MS4. The District has evaluated many of the reports and other documents which have been produced to address the storm water pollution problem to get to this point of implementing effective controls. The commentor is encouraged to continue discussing specific structural and non structural controls measures with the Permittee which may have possibilities for use in the District's Storm Water Management Program in the future.

Comment No. 8 (Endangered Species)-Pursuant to Section 7 of the Endangered Species Act (ESA), EPA must consult with the United States Fish and Wildlife Service (USFWS) regarding the potential impact of the draft Permit on threatened and endangered species within the District.

EPA Response: As noted in the fact sheet, EPA has completed consultation with the Services in accordance with Section 7 of the ESA. Specifically EPA consulted whether this reissuance of this permit would adversely affect the Bald Eagle and the Hay's Spring Amphipod (with the USFWS) and Short Nosed Sturgeon (with the National Marine Fisheries Service, known now as NOAA Fisheries). EPA received concurrence from each Service respectively.

Comment No. 9 (Waivers and Exemptions)-The "waiver and exemption" language in the draft Permit does not correct the Environmental Appeals Board remand and violates the Clean Water Act and other applicable EPA regulations.

EPA Response: Based in part on the comment and to further clarify this issue with respect to the remand of the EAB, EPA has modified the Permit in Part IX.A to specifically prohibit any discharge in that the District could otherwise allow through such a waiver or exemption issued under District laws. Such a discharge would not be authorized by this Permit and as such could constitute a violation of the terms of this Permit. The Region notes that the District is considering its waiver and exemption provisions to amend them in order to avoid conflicts with the Clean Water Act and with existing applicable Federal storm water regulations.

Comment No. 10 (Monitoring)-The commentor notes that the monitoring program must take into account the volume of effluent discharged from each outfall and the representative monitoring stations are not true indicators of the expected storm water discharges.

EPA Response: The Region finds that the rotating watershed approach of representative monitoring set forth in this Permit maximizes the limited resources available to provide for increased data. This approach is consistent with EPA guidance [i.e., Water-Based National Pollutant Discharge Elimination System (NPDES) Permitting Implementation Guidance] and discussion of the watershed approach (i.e., 1994 NPDES Watershed Strategy) that given the limited resources, any intensive watershed monitoring by watershed rotation gives overall better results than a few points for each. For representative land uses in the monitoring of MS4s, etc., the commentor is referred to Part 122.26(d)(2)(iii) of the NPDES regulations for establishing how the outfalls are designated. In response to this comment on monitoring the volume, EPA agrees that the draft permit was not clear. EPA has modified Part VIII.A and B of this Permit to better account for the volume and nature of the flow from the effluent discharge. The Region has also added clarifying language in Part IV.A.2 on this issue. Based on the above, EPA has determined that the monitoring locations set forth in the Permit are consistent with these requirements.

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
MUNICIPAL SEPARATE STORM SEWER SYSTEM (MS4) DISCHARGE PERMIT

Oregon Department of Environmental Quality
Northwest Region
2020 SW 4th Avenue, Portland OR 97201-4987
Telephone: 503-229-5263

Issued pursuant to Oregon Revised Statute 468B.050 and the Federal Clean Water Act

ISSUED TO CO-PERMITTEES:
City of Portland
Multnomah County
Port of Portland

SOURCES COVERED BY THIS PERMIT:
All Existing and New Discharges of Storm Water from the Municipal Separate Storm Sewer System within the City of Portland Urban Services Boundary

RECEIVING STREAM INFORMATION:
Basin: Willamette, Columbia
Subbasin: Lower Willamette, Tualatin
Streams: Willamette River*#, Columbia River* #, Columbia Slough*#, Tualatin River #, Fanno Creek#, Balch Creek, Johnson Creek*, Tryon Creek*
County: Multnomah

* These water bodies have been designated water quality limited or discharge into water quality limited water bodies.

\# Total Maximum Daily Loads (TMDLs), Wasteload Allocations, and Load Allocations have been established for these water bodies. The TMDLs for the Tualatin Subbasin and the Columbia Slough establish Wasteload Allocations for urban storm water. See Tualatin Subbasin TMDL approved by EPA on 7 August 2001 and Columbia Slough TMDL approved by EPA November 25, 1998. These allocations are addressed in Schedule D.

EPA REFERENCE NO.: ORS 108015
Issued in response to Application No. 989553 received on February 29, 2000 and amended in response to the Petition for Reconsideration granted May 17, 2004.
Permit Expiration Date: February 28, 2009
This permit is issued based on the land use findings in the permit record.

Neil Mullane
Neil Mullane, Manager,
Water Quality Source Control Section

Date 7/27/05

PERMITTED ACTIVITIES

Until this permit expires or is modified or revoked, the co-permittee is authorized to implement a storm water management program to reduce the contribution of pollutants in storm water to the maximum extent practicable (MEP), to address where applicable TMDL wasteload allocations, and to discharge storm water to waters of the State, in conformance with all the requirements and conditions set forth in the attached schedules as follows:

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Schedule E – Pretreatment Program Conditions	not applicable
Schedule F – General Conditions	18

Unless authorized by another National Pollutant Discharge Elimination System permit, other direct and indirect discharge to public waters is prohibited.

SCHEDULE A
Controls and Limitations for Storm Water Discharges from Municipal Separate Storm Sewer Systems

1) Each co-permittee must implement all applicable provisions in the Storm Water Management Plan (SWMP) and the associated Monitoring Program. Applicable provisions are those relating to requirements, programs, and operations of the municipal separate storm sewer system (MS4) over which the co-permittee has jurisdiction or control. For the permit, the SWMP (including the associated Monitoring Program) is located in DEQ File Number 108015 and is the following:

   a) The 1995 SWMP approved under the previous NPDES permit, with co-permittee changes made in annual compliance reports;
   b) Modifications to the Port of Portland SWMP and Monitoring Program submitted to the Department October 15, 1996 and April 8, 1998;
   c) Modifications to the permit approved by the Department on April 29, 1998 in response to the City of Portland's request;
   d) Proposed BMP revisions included in the co-permittees' permit renewal submittal to the Department on February 29, 2000; and,
   e) Any changes made to the SWMP in accordance with Schedules B(1)(b), B(2)(a), B(2)(b), D(2)(a), D(2)(b), D(2)(d), D(2)(e) and D(2)(f). These SWMP revisions will also be located in DEQ File Number 108015.

   The SWMP (and associated Monitoring Program) is hereby incorporated into the permit by reference.

   The SWMP and associated Monitoring Program include best management practices (BMPs), monitoring triggers, narrative conditions, adaptive management and other elements designed to reduce the introduction of pollutants into waters of the State from the MS4 to the maximum extent practicable (MEP). The SWMP also includes evaluation and reporting requirements designed to measure the effectiveness of the control measures and other programs. The specific components that establish the basis for the SWMP are given in the federal regulations at 40 CFR 122.26(d)(2) and in Schedules B and D of this permit. Schedule C, Table C-1 provides a summary of the major compliance conditions and schedules for implementation.

2) Each co-permittee must reduce the discharge of the pollutants from the MS4 to the maximum extent practicable. Compliance with the permit and implementation of the SWMP is deemed to be compliance with this MEP requirement, unless or until the Department reopens the permit as provided in Oregon Administrative Rule (OAR) 340-045-0040 and 0050 to require additional controls.

3) Each co-permittee must effectively prohibit non-storm water discharges into the MS4 unless such discharges are otherwise permitted by an existing NPDES permit. Unless identified by any co-permittee, or the Department, the following non-storm water discharges need not be addressed by the co-permittee's illicit discharge program, provided appropriate BMPs, if needed, to minimize the impacts of such sources are developed under the SWMP: water line flushing; landscape irrigation; diverted stream flows; rising ground waters; uncontaminated groundwater infiltration; uncontaminated pumped ground water; discharges from potable water sources; start up flushing of groundwater wells; aquifer storage and recovery (ASR) wells; potable groundwater monitoring wells; draining and flushing of municipal potable water storage reservoirs; foundation drains; air conditioning condensate; irrigation water; springs; water from crawl space pumps; footing drains; lawn watering; individual residential car washing; flows from riparian habitats and wetlands; dechlorinated swimming pool discharges; street wash waters; discharges of treated water from investigation, removal and remedial actions selected or approved by the Department pursuant to Oregon Revised Statute (ORS) Chapter 465, the state's environmental cleanup law; and discharges or flows from emergency fire fighting activities where discharges or flows from fire fighting are identified as not significant sources of pollutants to waters of the state.

SCHEDULE B
Monitoring and Reporting Requirements

1) Monitoring Component Requirements

   a) The co-permittees must conduct the monitoring as described in the monitoring component of the approved SWMP and associated Monitoring Program as summarized in Tables B-1 and B-2. The monitoring requirements may be coordinated between the co-permittees and assign monitoring responsibilities to selected co-permittees, via Intergovernmental or other agreement. The monitoring components in the SWMP and Tables B-1 and B-2 are not effluent limits. The Department has determined that the monitoring component of the accepted SWMP meets the monitoring requirements of 40 CFR 122.48(b). The co-permittee must maintain compliance with the requirements of 40 CFR 122.48(b) throughout the term of this permit.

Table B-1
Monitoring Types and Locations

Monitoring Type	Locations	Minimum Monitoring Frequency	Responsible Co-Permitee[1]
MS4 Discharge	NE Portland (Columbia Slough) NW Portland (Willamette River) SE Portland (Johnson Creek)	2 times per year	City of Portland
Ambient	Columbia Slough Fanno Creek Johnson Creek Tryon Creek Willamette River	3 times per year	City of Portland

[1] Monitoring requirements coordinated between co-permittees.

Table B-2
Analytical Parameters for MS4 Discharge and Ambient Monitoring

Monitoring Type	Parameters
CONVENTIONAL	Total Suspended Solids (TSS) Hardness
FIELD	pH Conductivity Dissolved Oxygen (DO) [1] Temperature
TOTAL METALS	Copper (Cu) Lead (Pb) Zinc (Zn)
DISSOLVED METALS	Copper (Cu) Lead (Pb) Zinc (Zn)
NUTRIENTS	Nitrate-Nitrogen (NO_3) Total Phosphorus (TP)
BIOLOGICAL	E. coli
OIL AND GREASE	Non-Polar oil and grease [2] Total oil and grease [2]

Notes: Listed parameters apply to both ambient and MS4 discharge samples except as noted below:
[1] Ambient samples only
[2] MS4 discharge samples only

b) Each co-permittee must review and, if necessary, update its monitoring components to address the objectives in (i) through (vi) below. Each co-permittee must submit any proposed modifications to its monitoring components(s) with the Interim Evaluation Report. Modifications to the monitoring components in the SWMP (as summarized in Tables B-1 and B-2) are part of the ongoing adaptive management process required by this permit. Such modifications are subject to the approval and public process requirements of Schedules D(2)(f)-(g). The updated monitoring component described in the Interim Evaluation Report must be designed to track the long-term progress of the SWMP towards achieving improvements in receiving water quality, including progress towards meeting pollutant load reduction benchmarks associated with TMDL parameters as specified in Schedule D(2)(d). The updated monitoring component must explain how the proposed monitoring program fulfills each of the primary program objectives listed in (i) through (vi) below.

To achieve the objectives listed below, the co-permittee's monitoring activities must continue to include MS4 discharge monitoring and in-stream monitoring. The co-permittee may propose to the Department the use of alternative sources of data the co-permittee believes can adequately support conclusions associated with some of these objectives.

i) Determine the status of implementing the components of the SWMP;
ii) Evaluate the effectiveness of BMPs for specific source controls;
iii) Evaluate the source of specific pollutants;
iv) Assess the chemical, biological, and physical effects of MS4 runoff on receiving waters;
v) Characterize MS4 runoff discharges; and
vi) Evaluate long-term trends in receiving water quality associated with storm water discharges.

The updated monitoring component must address ongoing long-term monitoring and may address short-term special studies. The results of the monitoring component must be used to support the adaptive management process and lead to refinements of the SWMP.

If representative of the entire area subject to these permit requirements, the co-permittees may develop a cooperative MS4 discharge and in-stream monitoring strategy that assigns monitoring responsibilities to selected co-permittees.

c) The following information must be included in the monitoring component of the SWMP:

i) Program monitoring:
  (1) A list of activities to be monitored, and
  (2) A list of monitored performance indicator metrics (e.g., number of miles of streets swept, number of cross-connections found, tons of material removed from storm sewers, etc.).
ii) Environmental monitoring:
  (1) A list of monitoring sites;
  (2) A list of constituents to be analyzed;
  (3) The media sampled;
  (4) Sample collection frequency and any targeted conditions (such as hydrologic or meteorological).

Protocols for quality assurance/quality control for sample collection and analysis must be consistent with the quality assurance protocols described in the Department's *2004 303(d) List/Delist Data Submittals Minimum Data Requirements*.

d) In the event the co-permittee is unable to collect or analyze any sample or pollutant parameter due to circumstances beyond the co-permittee's control, a written explanation of the circumstances that prevented the collection or analysis must be submitted to the Department in the annual report. The co-permittee must exercise due diligence in collecting and analyzing all samples as required by Schedule B. Circumstances beyond the control of the co-permittee may include abnormal climatic conditions (e.g., fewer storms in the annual reporting period than typically are representative of climatic conditions, or the lack of sufficient dry weather in between sampling events.); weather conditions that make the collection or analysis of samples unsafe or impracticable (e.g., storms of such intensity that sampling would present an unreasonable safety risk); or unavoidable equipment failures caused by weather conditions or other conditions beyond the reasonable control of the co-permittee (provided that operator error is not a condition beyond the control of the co-permittee).

2) Reporting Requirements

a) Annual Report
The co-permittees must submit by November 1 of each year a system-wide report for the time period July 1 through June 30. The report must be coordinated between the co-permittees by the City of Portland. Each annual report must contain:
i) The status of implementing the components of the storm water management program;
ii) Proposed changes to the SWMP components, including new BMPs identified through implementing adaptive management. Such proposed changes must be consistent with 40 CFR §122.26(d)(2)(iv). A timeline for the implementation of new BMPs must also be included in the report;
iii) A summary of total storm water program expenditures and funding sources over the reporting fiscal year, and those anticipated in the next fiscal year;
iv) A summary of data, including monitoring data that is accumulated throughout the reporting year;
v) A summary describing the number and nature of enforcement actions, inspections, and public education programs;
vi) Identification of water quality improvements or degradation;
vii) Demonstration of continued legal authority to implement the programs outlined in the SWMP; and
viii) An overview, as related to MS4 discharges, of concept planning, land use changes and new development activities that occurred within the Urban Growth Boundary (UGB) expansion areas during the previous year, those forecast for the following year, and an evaluation for consistency with the requirements of Schedule D(2)(c)(i)(2).

b) Requirements for Interim Evaluation Report
The Interim Evaluation Report must be submitted to the Department by May 1, 2006. The Report must contain the following:
i) An evaluation of, and proposed revisions to, the SWMP that addresses the requirements of Schedules D(2)(b) and B(1)(b), including the rationale supporting the proposed revisions.
ii) A description of the current source identification components of the SWMP and the rationale regarding the adequacy of these components.
iii) For each of the listed non-storm water discharges [Schedule A(3)] expected to occur in a co-permittee's area, the co-permittee must identify the appropriate control measures and the rationale for the selection of these BMPs (or the rationale for why BMPs are deemed not necessary).
iv) The required information regarding TMDL pollutants as described in Schedule D(2)(d)(v) and the corresponding proposed revisions to the SWMP, and/or the required information regarding 303(d) listed pollutants as described in Schedule D(2)(e) and the corresponding proposed revisions to the SWMP.
v) An executive summary of the SWMP, no more than 15 pages in length, that describes the main elements of the SWMP.
vi) Maps providing updated information as described in 40 CFR §122.26(d)(1)(iii)(B), where applicable.

Any Proposed SWMP revisions contained in the Interim Evaluation Report must be approved by the Department in accordance with Schedule D(2)(f).

c) MS4 Permit Renewal Submittal
180 days prior to permit expiration the co-permittees must submit a permit renewal application package that synthesizes the implementation and findings of the current permit cycle to support the proposed SWMP for the renewed permit. The application documents must evaluate the adequacy of the SWMP in reducing pollutants to the maximum extent practicable. This application must contain:

i) An updated evaluation of the SWMP as outlined in Schedule D(2)(b), including proposed changes to the plan and the underlying rationale for the proposal(s).
ii) An updated estimate of total annual storm water pollutant loads for the original pollutants of concern listed in the Part 2 of the original application, or other storm water pollutants on the 303(d) list as directed by the Department. The co-permittee will be notified of such a requirement no later than two (2) years prior to the expiration of the permit.
iii) Estimates of the changes of various land use areas within the co-permittees jurisdictional boundaries, the storm water runoff from those changed areas for the appropriate design storm criteria, and volume

and percentage of storm water runoff from those changed areas that is treated using structural and nonstructural controls that have occurred since the previous permit renewal submittal.

iv) A suggested storm water management program focus, if appropriate, (e.g. land use, storm water system function, system management practice) for the next permit cycle.

v) For each of the listed non-storm water discharges [Schedule A(3)] expected to occur in a co-permittee's area, the co-permittee must identify the appropriate BMPs and the rational for the selection of these BMPs (or the rationale for why BMPs are deemed not necessary).

vi) An evaluation of overall program effectiveness, including non-structural BMP activities. This analysis will include an analysis of monitoring and other data, including a water quality trend analysis and a discussion of likely or potential factors for the presence of observed trends in water quality.

vii) A fiscal evaluation summarizing program expenditures for the current permit term and projected program allocations for next permit cycle based on the proposed SWMP.

viii) If TMDL wasteload allocations were established at the time of permit issuance, an evaluation of progress towards achieving applicable waste load allocations to the maximum extent practicable. Progress will be measured through the TMDL performance measures and benchmarks established in accordance with Schedule D(2)(d).

ix) Any evaluation conducted on the effectiveness of activities designed to reduce, to the maximum extent practicable, pollutants on the Department's 2002 303(d) list for waterbodies to which the co-permittee's MS4 discharges storm water. Although such an evaluation is not a requirement of this permit, the co-permittee may choose to demonstrate progress in reducing potential future TMDL pollutants.

x) Maps providing updated information as described in 40 CFR §122.26(d)(1)(iii)(B), where applicable.

xi) A description and summary of the public involvement process and response to comments on the revised draft SWMP.

xii) An update of the source identification portions of the co-permittees' original Parts 1 and 2 NPDES MS4 Permit Application.

SCHEDULE C
Compliance Conditions and Dates

Each co-permittee must implement the Storm Water Management Plan (SWMP) referenced in Schedule A(1) of this permit. Table C-1 summarized certain program components described in the SWMP, the specific permit conditions that relates to each component, the dates by which each component must be implemented, and the corresponding regulation, where applicable. The evaluation, revision and implementation of listed program components are part of the ongoing adaptive management process. Table C-1 is intended to summarize the program components; for specific implementation requirements and responsible co-permittee, see the referenced permit provision(s) and SWMP.

TABLE C-1[1]
Storm Water Management Plan – Schedules for Implementation and Compliance

Relevant Permit Provisions/ NPDES Regulation	Program Component	Implementation Component[2]	Compliance Date[3]
STORM WATER MANAGEMENT PLAN (SWMP) COMPONENTS			
D(2)(c)(i) 40 CFR § 122.26(d)(2)(iv)(A)	(i) Structural and source control measures to reduce pollutants from runoff from commercial and residential areas.	Update the City of Portland Stormwater Management Manual (SWMM) Implement New Development BMPs Conduct a public opinion/awareness survey Implement Structural Control BMP Implement Operations and Maintenance BMPs	December 2008 Submit implementation status November 1 each year December 2006 Submit implementation status November 1 each year Submit implementation status November 1 each year
D(2)(c)(ii) 40 CFR § 122.26(d)(2)(iv)(B)	(ii) A program to detect and remove (or require the discharger to the MS4 to obtain a separate NPDES permit for) illicit discharges and improper disposal into the storm sewer.	Implement Illicit Discharge and Elimination Program Implement Spill Response Hotline	Submit implementation status November 1 each year
D(2)(c)(iii) 40 CFR § 122.26(d)(2)(iv)(C)	(iii) A program to monitor and control pollutants in storm water discharges to municipal systems from municipal landfills, hazardous waste treatment, disposal and recovery facilities, industrial facilities that are subject to section 313 of SARA, and industrial facilities that the permittee determines are contributing substantial pollutant loading to the MS4.	Implement the Industrial Storm water Permitting Program administered pursuant to the 2000 Memorandum of Agreement between DEQ and the City of Portland	Submit implementation status November 1 each year
D(2)(c)(iv); 40 CFR § 122.26(d)(2)(iv)(D)	(iv) A program to implement and maintain structural and non-structural best management practices to reduce pollutants in storm water runoff from construction sites to the MS4.	Implement Erosion Control (New Development) BMP	Submit implementation status November 1 each year

Notes:
[1] The evaluation, revision and implementation of listed program components are part of the ongoing adaptive management process, and may be modified during the permit term.
[2] Implementation components are implemented by one or more co-permittees; see SWMP for responsible co-permittee.
[3] SWMP components are satisfied through ongoing implementation and improved through adaptive management.

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TABLE C-1[1]
Storm Water Management Plan – Schedules for Implementation and Compliance

Relevant Permit Provisions/ NPDES Regulation	Program Component	Implementation Component[2]	Compliance Date[3]
ANNUAL REPORTS			
B(2)(a) 40 CFR § 122.42(c)	A system wide report for each co-permittee.	Where and to the extent applicable, the co-permittee's report shall include a description of: (i) status of implementing components of storm water management plan; (ii) proposed changes to SWMP components identified through adaptive management, consistent with 40 CFR § 122.26(d)(2), including timeline for implementation; (iii) summary of total storm water program expenditures; (iv) summary of monitoring data; (v) summary of enforcement actions, inspections and public education programs; (vi) identification of water quality improvements or degradation; and (vii) overview of land use changes and new development activities.	Submit by November 1 of each year
INTERIM EVALUATION REPORT			
B(2)(b)	Evaluate SWMP and revise as needed based on Interim Evaluation Report requirements in Schedule B(2)(b).	Submit Interim Evaluation Report	May 1, 2006
B(1)(b)	Review monitoring components in SWMP and recommend proposed improvements and/or modifications.	Submit Interim Evaluation Report	May 1, 2006
B(2)(b)(ii)	Describe the current source identification components of the SWMP and the rationale regarding the adequacy of these components.	Submit Interim Evaluation Report	May 1, 2006
B(2)(b)(iii); A(3)	For each of the listed non-storm water discharges in Schedule A(3) that are expected to occur in a co-permittee's area, identify the appropriate BMPs or explain why BMPs are deemed not necessary.	Submit Interim Evaluation Report	May 1, 2006

Notes;
[1] The evaluation, revision and implementation of listed program components are part of the ongoing adaptive management process, and may be modified during the permit term.
[2] Implementation components are implemented by one or more co-permittees; see SWMP for responsible co-permittee.
[3] SWMP components are satisfied through ongoing implementation and improved through adaptive management.

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TABLE C-1[1]
Storm Water Management Plan – Schedules for Implementation and Compliance

Relevant Permit Provisions/ NPDES Regulation	Program Component	Implementation Component[2]	Compliance Date[3]
B(2)(b)(iv); D(2)(d)(v); D(2)(d)(i)(1)-(2)	If TMDL wasteload allocations have been established for pollutant parameters associated with the MS4 discharges at the time of permit issuance, then the co-permittee must develop pollutant load reduction benchmark(s) and performance measures in the SWMP as defined in Schedules D(2)(d)(i)(1) and (2).	Submit Interim Evaluation Report	May 1, 2006
B(2)(b)(iv); D(2)(e)	For receiving waters without established TMDL wasteload allocations, the co-permittee must review the pollutants that are on the 2002 303(d) list that are relevant to the MS4 discharges and submit a summary as defined in Schedule D(2)(e).	Submit Interim Evaluation Report	May 1, 2006
B(2)(b)(vi) 40 CFR § 122.26(d)(1)(iii)(B)	Submit maps providing updated information as described in 40 CFR § 122.26(d)(1)(iii)(B), where applicable.	Submit Interim Evaluation Report	May 1, 2006
D(2)(g)	Develop public involvement component of SWMP to provide process for obtaining input from the public on significant on-going adaptive management changes to the SWMP.	Submit Interim Evaluation Report	May 1, 2006
MS4 PERMIT RENEWAL SUBMITTAL			
B(2)(c)	Evaluate the adequacy of the SWMP in reducing pollutants to the maximum extent practicable as described in Schedule B(2)(c). Update evaluation of SWMP as outlined in Schedule D(2)(b), including review of the required SWMP components listed in Schedule D(2)(c). Submit detail on how each of the components is, or will be, addressed and the rationale for any revisions. Include proposed changes to the SWMP and the underlying rationale for the proposed changes.	Submit renewal package	Not less than 180 days prior to permit expiration

Notes:
[1] The evaluation, revision and implementation of listed program components are part of the ongoing adaptive management process, and may be modified during the permit term.
[2] Implementation components are implemented by one or more co-permittees; see SWMP for responsible co-permittee.
[3] SWMP components are satisfied through ongoing implementation and improved through adaptive management.

TABLE C-1[1]
Storm Water Management Plan – Schedules for Implementation and Compliance

Relevant Permit Provisions/ NPDES Regulation	Program Component	Implementation Component[2]	Compliance Date[3]
B(2)(c)(ii)	Update estimate of total annual storm water pollutant loads for original pollutants of concern listed in Part 2 of the original permit application, or other pollutants on the 303(d) list as directed by the Department.	Submit renewal package	Not less than 180 days prior to permit expiration
B(2)(c)(iii)	Estimate changes of land use areas within co-permittee' jurisdictional boundaries, the storm water runoff from those changed areas for the appropriate design storm criteria, and volume and percent of runoff from the changed areas that are treated using structural and nonstructural controls that have occurred since the previous permit renewal submittal.	Submit renewal package	Not less than 180 days prior to permit expiration
B(2)(c)(iv)	Suggest storm water management plan focus for the next permit cycle.	Submit renewal package	Not less than 180 days prior to permit expiration
B(2)(c)(v); A(3)	For each of the listed non-storm water discharges in Schedule A(3) that are expected to occur in a co-permittee's area, identify the appropriate BMPs or explain why BMPs are deemed not necessary.	Submit renewal package	Not less than 180 days prior to permit expiration
B(2)(c)(vi)	Evaluate overall program effectiveness, including non-structural BMP activities, including analysis of monitoring and other data, and including discussion of likely or potential factors for observed trends in water quality.	Submit renewal package	Not less than 180 days prior to permit expiration
B(2)(c)(vii); 40 CFR 122.26(d)(2)(vi)	Fiscal evaluation summarizing program expenditures for the current permit term and projected program allocations for the next permit cycle.	Submit renewal package	Not less than 180 days prior to permit expiration
B(2)(c)(viii), D(2)(d)(i)	Evaluate progress towards achieving, to the maximum extent practicable, waste load allocations that were established at the time of permit issuance using performance measures and benchmarks established pursuant to Schedule D(2)(d)(i).	Submit renewal package	Not less than 180 days prior to permit expiration

Notes:
[1] The evaluation, revision and implementation of listed program components are part of the ongoing adaptive management process, and may be modified during the permit term.
[2] Implementation components are implemented by one or more co-permittees; see SWMP for responsible co-permittee.
[3] SWMP components are satisfied through ongoing implementation and improved through adaptive management.

TABLE C-1[1]
Storm Water Management Plan – Schedules for Implementation and Compliance

Relevant Permit Provisions/ NPDES Regulation	Program Component	Implementation Component[2]	Compliance Date[3]
B(2)(c)(x)	Update maps providing information required under 40 CFR § 122.26(d)(1)(iii)(B), where applicable.	Submit renewal package	Not less than 180 days prior to permit expiration
B(2)(c)(xi)	Summarize public involvement process and response to the revised draft SWMP.	Submit renewal package	Not less than 180 days prior to permit expiration.
B(2)(c)(xii)	Update source identification portions of the original Parts 1 and 2 NPDES MS4 Permit Application.	Submit renewal package	Not less than 180 days prior to permit expiration

Notes:
[1] The evaluation, revision and implementation of listed program components are part of the ongoing adaptive management process, and may be modified during the permit term.
[2] Implementation components are implemented by one or more co-permittees; see SWMP for responsible co-permittee.
[3] SWMP components are satisfied through ongoing implementation and improved through adaptive management.

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SCHEDULE D
Special Conditions

1) Adequate Legal Authority
Each co-permittee must maintain adequate legal authority, through ordinance(s), interagency agreement(s) or other means, to effectively implement and enforce the provisions of this permit. The legal authority must enable the co-permittee to:

a) Control through ordinance, permit, contract, order or similar means, the contribution of pollutants to the municipal storm sewer by storm water discharges associated with industrial activity and the quality of storm water discharged from sites of industrial activity.

b) Prohibit through ordinance, order or similar means, illicit discharges to the municipal separate storm sewer.

c) Control through ordinance, order or similar means the discharge to a municipal separate storm sewer of spills, dumping or disposal of materials other than storm water.

d) Control through interagency agreements among the co-permittees the contribution of pollutants from one portion of the municipal system to another portion of the municipal system.

e) Require compliance with conditions in ordinances, permits, contracts or orders.

f) Carry out all inspection, surveillance and monitoring procedures necessary to determine compliance and noncompliance with permit conditions including the prohibition on illicit discharges to the municipal separate storm sewer.

2) Storm Water Management Plan (SWMP)

a) Adaptive Management
Adaptive management is the appropriate process for assessing new opportunities for improving program effectiveness in controlling storm water pollution to the maximum extent practicable. The co-permittee is required to use adaptive management to assess options for improving controls on storm water discharges. The co-permittee must use the monitoring data and analyses required under this permit as well as applicable information from other sources in the adaptive management process. Where TMDL wasteload allocations have been established for pollutant parameters associated with the co-permittee's MS4 discharges, the co-permittee must use the estimated pollutant load reductions (benchmarks) established in the SWMP to guide the adaptive management process. The co-permittee must also use the evaluation of progress towards these TMDL benchmarks, due with the permit renewal submittal [Schedule B(2)(c)(viii)], to guide the adaptive management process in the next permit term. Any revisions to BMPs derived from the adaptive management process must be implemented by the co-permittee, to the maximum extent practicable.

Adaptive management requires the co-permittee to assess and modify, as necessary, any or all existing SWMP components and adopt new or revised SWMP components to optimize reductions in storm water pollutants to the maximum extent practicable, through an iterative process. The iterative process includes routine assessment of the need to further improve water quality and protection of beneficial uses, review of available technologies and practices to accomplish the needed improvement, and evaluation of resources available to implement the technologies and practices. Changes to the SWMP are considered a part of adaptive management, and such changes do not require modification of this permit unless the Department determines the changes meet the criteria referenced in Schedule D(2)(f)(iv).

b) Evaluation of SWMP
The specific components that established the basis for the co-permittee's original SWMPs are given in the federal rules at 40 CFR §122.26(d)(2)(iv)(A) through (D) and in Schedule D(2)(c) of this permit.

Each co-permittee must review Schedule D(2)(c) and, for each component, determine whether implementation of the components in the SWMP as submitted is sufficient to reduce the discharge of pollutants to the maximum extent practicable. Each co-permittee must submit to the Department details on how each of the components are, or will be, addressed and the rationale for the continued existing or revised level of implementation. (If certain components are not included in the plan, then the rationale for exclusion must also be submitted.) The level of implementation for each component must, when practicable, have measurable performance indicators to assist with the reporting on the status of implementation as part of the annual reports.

During this evaluation, it may be found that the SWMP will need improvement and/or modification to ensure continued reduction of pollutants to the maximum extent practicable. The results of the evaluation, including any proposed revisions to the SWMP, must be reported to the Department as described in Schedule B(2)(b).

c) SWMP Elements for Interim Evaluation Report
Pursuant to Schedule D(2)(b) above, the following elements must be addressed in the SWMP review and revision as part of the Interim Evaluation Report.

i) Structural and source control BMPs to reduce pollutants from runoff from commercial and residential areas that are discharged from the municipal storm sewer system that are to be implemented during the life of the permit, accompanied with an estimate of the expected reduction of pollutant loads and a proposed schedule for implementing such controls. At a minimum, the elements must include:
(1) Maintenance activities and a maintenance schedule for structural controls to reduce pollutants (including floatables) in discharges from municipal separate storm sewers.
(2) Planning procedures including a comprehensive master plan to develop, implement and enforce controls to reduce the discharge of pollutants from municipal separate storm sewers that receive discharges from areas of new development and significant redevelopment. Such a plan must address controls to reduce pollutants in discharges from municipal separate storm sewers after construction is completed. Controls to reduce pollutants in discharges from municipal separate storm sewers containing construction site runoff are addressed in paragraph Schedule D(2)(c)(iv).
(3) Practices for operating and maintaining public streets, roads and highways and procedures for reducing the impact on receiving waters of discharges from municipal storm sewer systems, including pollutants discharged as a result of deicing activities.
(4) Procedures to assure that flood management projects assess the impacts on the water quality of receiving water bodies and that existing structural flood control devices have been evaluated to determine if retrofitting the device to provide additional pollutant removal from storm water is feasible.
(5) A program to monitor pollutants in runoff from operating or closed municipal landfills or other treatment, storage or disposal facilities for municipal waste. The description must identify priorities and procedures for inspections and establishing and implementing control measures for such discharges (this program can be coordinated with the program developed under Schedule D(2)(c)(iii)).
(6) A program to reduce to the maximum extent practicable, pollutants in discharges from municipal separate storm sewers associated with the application of pesticides, herbicides and fertilizer that will include, as appropriate, controls such as educational activities, permits, certifications and other measures for commercial applicators and distributors, and controls for application in public right-of-ways and at municipal facilities.

ii) A program, including a schedule, to detect and remove (or require the discharger to the municipal separate storm sewer to obtain a separate NPDES permit for) illicit discharges and improper disposal into the storm sewer. The proposed program must include:
(1) A program, including inspections, to implement and enforce an ordinance, orders or similar means to prevent illicit discharges to the municipal separate storm sewer system; this program description must address all types of illicit discharges, however the following category of non-storm water discharges or flows must be addressed where such discharges are identified by the municipality as sources of pollutants to waters of the United States: water line flushing, landscape irrigation, diverted stream flows, rising ground waters, uncontaminated ground water infiltration, uncontaminated pumped ground water, discharges from potable water sources, start up flushing of groundwater wells, aquifer storage and recovery (ASR) wells, potable groundwater monitoring wells, draining and flushing of municipal potable water storage reservoirs, foundation drains, air conditioning condensation, irrigation water, springs, water from crawl space pumps, footing drains, lawn watering, individual residential car washing, flows from riparian habitats and wetlands, dechlorinated swimming pool discharges, street wash waters, discharges of treated water

from investigation, removal and remedial actions selected or approved by the Department pursuant to Oregon Revised Statute (ORS) Chapter 465, the state's environmental cleanup law; and discharges or flows from emergency fire fighting activities where discharges or flows from fire fighting are identified as not significant sources of pollutants to the waters of the state.

(2) Procedures to conduct on-going field screening activities during the life of the permit, including areas or locations that will be evaluated by such field screens;

(3) Procedures to be followed to investigate portions of the separate storm sewer system that, based on the results of the field screen, or other appropriate information, indicate a reasonable potential of containing illicit discharges or other sources of non-storm water [such procedures may include: sampling procedures for constituents such as e. coli, surfactants (MBAS), residual chlorine, fluorides and potassium; testing with fluorometric dyes; or conducting in storm sewer inspections where safety and other considerations allow.] Such a description must include the location of storm sewers that have been identified for such evaluation.

(4) Procedures to prevent, contain, and respond to spills that may discharge into the municipal separate storm sewer.

(5) A program to promote, publicize, and facilitate public reporting of the presence of illicit discharges or water quality impacts associated with discharges from municipal separate storm sewers.

(6) Educational activities, public information activities, and other appropriate activities to facilitate the proper management and disposal of used oil and toxic materials.

(7) Controls to limit infiltration of seepage from municipal sanitary sewers to municipal separate storm sewer systems where necessary.

iii) A program to monitor and control pollutants in storm water discharges to municipal systems from municipal landfills, hazardous waste treatment, disposal and recovery facilities, industrial facilities that are subject to section 313 of title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA), and industrial facilities that the co-permittee determines are contributing a substantial pollutant loading to the municipal storm sewer system. The program must:

(1) Identify priorities and procedures for inspections and establishing and implementing control measures for such discharges.

(2) Describe a monitoring program for storm water discharges associated with the industrial facilities identified in Schedule D(2)(c)(iii), to be implemented during the term of the permit, including, at a minimum, the submission of quantitative data on the pollutant parameters included in the Department's NPDES 1200-Z industrial general stormwater permit.

iv) A program to implement and maintain structural and non-structural best management practices to reduce pollutants in storm water runoff from construction sites to the municipal storm sewer system that must include:

(1) Procedures for site planning which incorporate consideration of potential water quality impacts.

(2) Requirements for nonstructural and structural best management practices.

(3) Procedures for identifying priorities for inspecting sites and enforcing control measures that considers the nature of the construction activity, topography, and the characteristics of soils and receiving water quality.

(4) Appropriate educational and training measures for construction site operators.

d) <u>Total Maximum Daily Loads (TMDLs)</u>

The requirements of this section apply to co-permittee's MS4 discharges to receiving waters with established TMDLs and associated allocations as noted on page 1 of this permit. It is the intent of this section to ensure that pollutant discharges for those parameters listed in the TMDL are reduced to the maximum extent practicable. Adequate progress toward achieving assigned wasteload allocations (WLAs) will be demonstrated through the implementation of best management practices that are targeted at TMDL-related pollutants.

i) Progress towards reducing TMDL pollutant loads must be evaluated by the co-permittee through the use of performance measures and pollutant load reduction benchmarks developed and listed in the SWMP.

(1) Performance measures are estimates of the effectiveness of various best management practices (BMPs) implemented by the co-permittees as per the SWMP; and they are not numeric effluent limits. Performance measures must, where appropriate, be pollutant reduction estimates. The performance measures for the BMPs addressing TMDL pollutants may be based on the same

metrics developed in accordance with the program effectiveness monitoring requirements in Schedule B(1)(c)(i).

(2) A benchmark is a total pollutant load reduction estimate for each parameter or surrogate, where applicable, for which a WLA is established at the time of permit issuance. A benchmark is used to measure the overall effectiveness of the storm water management plan in making progress toward the wasteload allocation (this estimate will be related to the statistical variability of the underlying data and may be stated as a range), and is intended to be a tool for guiding adaptive management activities. A benchmark is not a numeric effluent limit; rather it is a goal that is subject to the maximum extent practicable standard. The co-permittee must provide the rationale for the proposed benchmark, which includes an explanation of the relationship between the benchmarks and the TMDL wasteload allocations. Any limiting factors related to the development of a benchmark, such as data availability and data quality, must also be included in this rationale.

ii) The SWMP must describe a program that includes BMPs, monitoring triggers, narrative conditions, or other elements, designed to achieve reductions in the TMDL pollutants. The SWMP must include a specific strategy for implementing monitoring designed to enable the co-permittee to gauge the effectiveness of the SWMP in reducing TMDL pollutant loads to the maximum extent practicable.

iii) When the co-permittee applies for permit renewal, the co-permittee must include an evaluation of the effectiveness of the storm water management plan with respect to all pollutant parameters addressed in an applicable TMDL. This evaluation must assess progress towards meeting the pollutant load reductions (benchmarks) using the reporting and monitoring programs and other methods described in Schedules B(1), B(2) and D(2)(d)(v) of this permit. If the co-permittee has failed to meet the estimated pollutant load reductions during the permit term, they must use the adaptive management process described in Schedule D(2)(a)of this permit to reassess the SWMP and determine what additional or alternative BMPs are practicable. The co-permittee must update the SWMP to include these BMPs. The co-permittee must submit the evaluation and any SWMP revisions to the Department as specified in Schedule D(2)(d)(v).

iv) If within three (3) years following permit issuance a TMDL is approved by the Environmental Protection Agency (EPA) and the TMDL has wasteload allocations assigned to storm water within the geographic area covered by this permit, the co-permittee must, at the time of the next permit renewal application, complete a review and strategy development, and propose changes, if appropriate, to the SWMP to address the urban storm water discharges.

v) If, at the time of permit issuance, TMDL wasteload allocations have been established for pollutant parameters associated with the MS4's discharges, each co-permittee must, as appropriate, review their SWMP to determine its adequacy in reducing TMDL pollutant discharges to the maximum extent practicable and develop pollutant load reduction benchmark(s) and performance measures in the SWMP as defined in Schedule D(2)(d)(i)(1) and (2). As part of the SWMP review and benchmark and performance measure development process, the co-permittee must document, and subsequently report in accordance with Schedule B(2)(b), the following information:

(1) A description of the methodology and rationale used to develop and select pollutant reduction benchmarks and performance measures. The methodology must address current estimated discharge loadings and TMDL wasteload allocations.

(2) Any proposed modifications to the SWMP resulting from the adaptive management process [Schedule D(2)(a)] necessary to give reasonable assurance that the SWMP is designed to reduce TMDL pollutants to the maximum extent practicable. This must include selection of BMPs and any assumptions related to the proposed BMPs.

(3) Any proposed modifications to the monitoring component of the SWMP that are necessary to ensure adequate data and information are collected to assess SWMP implementation, BMP effectiveness, progress towards the pollutant load reduction benchmarks, discharge characterization, and impacts on receiving waters.

(4) A description of the public participation process, including a summary of material public comments and the responses to those comments.

e) <u>303(d) Listed Pollutants</u>
The requirements of this section apply to receiving waters without established TMDL wasteload allocations. The co-permittee must qualitatively review the pollutants that are on the 2002 303(d) list that are relevant to the co-permittee's MS4 discharges. This review and corresponding summary of proposed

actions must be incorporated into the interim evaluation report. The review and summary must accomplish the following:

i) Determine whether there is a reasonable likelihood for storm water from the MS4 to cause or contribute to water quality degradation of receiving waters through the discharge of pollutants on the 2002 303(d) list. Provide the rationale for the conclusion, including the results of an evaluation.
ii) If the discharges from the MS4 is a contributor to specific listed pollutants, determine and describe the relationship between the 303(d) listed pollutant and the MS4 discharges.
iii) Determine whether the BMPs in the existing SWMP are effective to address the 303(d) pollutants. If not, describe how the plan could be adapted to more appropriately address these pollutants. A summary of the rationale for this determination must also be included in the report.

If sufficient information is not available to make the determinations required above, the co-permittee must compile pertinent information necessary to adequately complete these determinations.

f) SWMP Revision Procedures

(i) All storm water must be managed in accordance with the current SWMP approved by the Department. Revisions to the SWMP may result from use of the adaptive management process in Schedule D(2)(a) and the SWMP Evaluation process in Schedules D(2)(b) and B(2)(b). Revisions to the SWMP are part of the adaptive management requirement of this permit, and such revisions do not require a permit modification unless initiated by the Department pursuant to (f)(iv) below.

(ii) The co-permittee must submit all proposed SWMP revisions to the Department for approval. If the co-permittee proposes to substitute one BMP for another, or eliminate or reduce the level of implementation of a BMP, it must submit the rationale for making the change to the Department. Proposed SWMP revisions may be submitted to the Department as part of the Annual Report, or at any time during the permit term. Except for SWMP revisions that are proposed in the Interim Evaluation Report, the Department will review and take action regarding the proposed revisions within 30 days of receipt of the proposed revisions. If the Department fails to approve or disapprove the proposal within 30 days, and does not notify the co-permittee of its intent to initiate a permit modification process within the same 30-day period, the proposed SWMP revision is deemed approved by the Department. The proposed SWMP revisions are not effective until approved by the Department.

(iii) For SWMP revisions proposed in the Interim Evaluation Report, the Department will review and take action regarding the proposed revisions within 90 days of receipt of the Interim Evaluation Report. If the Department fails to approve or disapprove the proposal within 90 days, and does not notify the co-permittee of its intent to initiate a permit modification process within the same 90-day period, the proposed SWMP revision is deemed approved by the Department. The proposed SWMP revisions are not effective until approved by the Department.

(iv) The Department will initiate a permit modification process if it determines that the magnitude of proposed SWMP revisions substantially change the nature or scope of the SWMP. The Department will conduct this permit modification process in accordance with OAR 340-045-0040 and 0055.

g) Public Involvement Requirements

Each co-permittee must conduct public involvement in the manner prescribed below if it proposes to modify its approved SWMP based on on-going adaptive management, or as a result of assessments required by this permit.

i) Interim Evaluation Report and MS4 Permit Renewal Submittal

For the Interim Evaluation Report/SWMP Revision [Schedule B(2)(b)] and MS4 Permit Renewal Submittal [Schedule B(2)(c)], the co-permittee's public input solicitation process must include the following: A public notice placed in a local newspaper and, if it's actively maintained, the co-permittee's web site outlining how the public may obtain information and provide comments to the MS4 co-permittee on the proposed SWMP revisions. Each co-permittee shall make copies of the proposed revisions available to interested parties upon request and make the proposed revisions available on the MS4 co-permittee's website if the website is actively maintained. The co-permittee shall provide the public with a minimum of 30 days to provide comments on the proposed revisions prior to submission to the Department. The information may also be presented to the Stormwater Advisory Committee, or other advisory group, in order to solicit input during the development of the proposed SWMP revision. The co-permittee must include in the Interim Evaluation Report and permit renewal submittal a summary of material public comments and how these comments were addressed.

ii) On-Going Adaptive Management

Notwithstanding the public review process provided pursuant to Schedule D(2)(g)(i), the co-permittee shall also implement a public review process for proposed revisions to the SWMP that are made as a part of their on-going adaptive management program. The public review process shall include one or more of the following elements: A notice in a local paper that includes information on the proposed change and how to comment, or a review by an advisory group that has broad community representation, or other established process described in the SWMP for obtaining public input. This public review requirement does not apply to adding BMPs, and revisions or updates to existing BMPs that do not change the substance of the BMPs.

iii) Interested Persons List

Within 7 days of initiating the public involvement activities required by Schedule D.2.g.i and D.2.g.ii of the permit the permittee must submit the proposed SWMP revision(s), or a summary of the revision(s), to the Department for the purpose of notifying other interested persons. The Department will maintain a list of persons interested in receiving notification about SWMP revisions and opportunities for involvement in the revision process. The Department will forward any comments it receives from interested persons to the permittee for consideration.

3) Each co-permittee must be responsible for the portion of the system-wide report applicable to their individual jurisdiction. Each co-permittee is responsible for compliance with the permit only within its jurisdiction, and is not responsible for compliance outside its jurisdiction.

4) Permit coverage may be terminated for a single co-permittee without terminating coverage for other co-permittees.

SCHEDULE F
NPDES PERMIT GENERAL CONDITIONS
FOR MUNICIPAL SEPARATE STORM SEWER SYSTEMS

SECTION A. STANDARD CONDITIONS

1. Duty to Comply with Permit
The co-permittees must comply with all conditions of this permit. Failure to comply with any permit condition is a violation of the Clean Water Act and Oregon Revised Statutes (ORS) 468B.025, and 40 Code of Federal Regulations (CFR) Section 122.41(a), and grounds for an enforcement action. Failure to comply is also grounds for the Department to modify, revoke, or deny renewal of a permit.

2. Penalties for Water Pollution and Permit Condition Violations
ORS 468.140 allows the Department to impose civil penalties up to $10,000 per day for violation of a term, condition, or requirement of a permit. Additionally 40 CFR 122.41 (A) provides that any person who violates any permit condition, term, or requirement may be subject to a federal civil penalty not to exceed $25,000 per day for each violation.

Under ORS 468.943 and 40 CFR 122.41(a), unlawful water pollution, if committed by a person with criminal negligence, is punishable by a fine of up to $25,000 imprisonment for not more than one year, or both. Each day on which a violation occurs or continues is a separately punishable offense.

Under ORS 468.946, a person who knowingly discharges, places, or causes to be placed any waste into the waters of the state or in a location where the waste is likely to escape into the waters of the state is subject to a Class B felony punishable by a fine not to exceed $200,000 and up to 10 years in prison. Additionally, under 40 CFR 122.41(a) any person who knowingly discharges, places, or causes to be placed any waste into the waters of the state or in a location where the waste is likely to escape into the waters of the state is subject to a federal civil penalty not to exceed $100,000, and up to 6 years in prison.

3. Duty to Mitigate
The co-permittees must take all reasonable steps to minimize or prevent any discharge or sludge use or disposal in violation of this permit that has a reasonable likelihood of adversely affecting human health or the environment. In addition, upon request of the Department, the permittee must correct any adverse impact on the environment or human health resulting from noncompliance with this permit, including such accelerated or additional monitoring as necessary to determine the nature and impact of the noncomplying discharge.

4. Duty to Reapply
If any or all of the co-permittees wishes to continue an activity regulated by this permit after the expiration date of this permit, the permittee must apply for and have the permit renewed. The application must be submitted at least 180 days before the expiration date of this permit.

The Department may grant permission to submit an application less than 180 days in advance but no later than the permit expiration date.

5. Permit Actions
This permit may be modified, revoked and reissued, or terminated for cause including, but not limited to, the following:
a. Violation of any term, condition, or requirement of this permit, a rule, or a statute
b. Obtaining this permit by misrepresentation or failure to disclose fully all material facts
c. A change in any condition that requires either a temporary or permanent reduction or elimination of the authorized discharge
d. The permittee is identified as a Designated Management Agency or allocated a wasteload under a Total Maximum Daily Load (TMDL)
e. New information or regulations
f. Modification of compliance schedules
g. Requirements of permit reopener conditions
h. Correction of technical mistakes made in determining permit conditions
i. Determination that the permitted activity endangers human health or the environment
j. Other causes as specified in 40 CFR 122.62, 122.64, and 124.5

The filing of a request by the co-permittee for a permit modification, revocation or reissuance, termination, or a notification of planned changes or anticipated noncompliance, does not stay any permit condition.

6. Toxic Pollutants
The co-permittee must comply with any applicable effluent standards or prohibitions established under Oregon Administrative Rules (OAR) 340-041-0033 for toxic pollutants within the time provided in the regulations that establish those standards or prohibitions, even if the permit has not yet been modified to incorporate the requirement.

7. Property Rights and Other Legal Requirements
The issuance of this permit does not convey any property rights of any sort, or any exclusive privilege, or authorize any injury to persons or property or invasion of any other private rights, or any infringement of federal, tribal, state, or local laws or regulations.

8. Permit References
Except for effluent standards or prohibitions established under OAR 340-041-0033 for toxic pollutants and standards for sewage sludge use or disposal established under Section 405(d) of the Clean Water Act, all rules and statutes referred to in this permit are those in effect on the date this permit is issued.

9. Permit Fees
The co-permittee must pay the fees required by Oregon Administrative Rules.

SECTION B. OPERATION AND MAINTENANCE OF POLLUTION CONTROLS

1. Proper Operation and Maintenance
The co-permittee must at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) that are installed or used by the permittee to achieve compliance with the conditions of this permit. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems that are installed by the permittees only when the operation is necessary to achieve compliance with the conditions of the permit.

2. Need to Halt or Reduce Activity Not a Defense
It shall not be a defense for the permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with this permit.

3. Removed Substances
Solids or other pollutants removed in the course of maintaining the MS4 must be disposed of in such a manner as to prevent any pollutant from such materials from entering waters of the state, causing nuisance conditions, or creating a public health hazard.

SECTION C. MONITORING AND RECORDS

1. Representative Sampling
Sampling and measurements taken as required herein must be representative of the volume and nature of the monitored discharge. All samples must be taken at the monitoring points specified in this permit, and shall be taken, unless otherwise specified, before the effluent joins or is diluted by any other waste stream, body of water, or substance. Monitoring points may not be changed without notification to and the approval of the Department.

2. Monitoring Procedures
Monitoring must be conducted according to test procedures approved under 40 CFR part 136, unless other test procedures have been specified in this permit or subsequent permit actions.

3. Penalties of Tampering
The Clean Water Act provides that any person who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required to be maintained under this permit may, upon conviction, be punished by a fine of not more than $10,000 per violation, imprisonment for not more than two years, or both. If a conviction of a person is for a violation committed after a first conviction of such person, punishment is a fine not more than $20,000 per day of violation, or by imprisonment of not more than four years, or both.

4. Additional Monitoring by the Co-permittees
If the co-permittees monitor any pollutant more frequently than required by this permit, using test procedures approved under 40 CFR part 136 or as specified in this permit, the results of this monitoring must be included in the calculation and reporting of the data submitted in annual reports required by Schedule B. Such increased frequency must also be indicated.

5. Retention of Records
The co-permittees must retain records of all monitoring information, including: all calibration, maintenance records, all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for this permit for a period of at least 3 years from the date of the sample, measurement, report, or application. This period may be extended by request of the Department at any time.

6. Records Contents
Records of monitoring information must include:
   a. The date, exact place, time, and methods of sampling or measurements;
   b. The individual(s) who performed the sampling or measurements;
   c. The date(s) analyses were performed;
   d. The individual(s) who performed the analyses;
   e. The analytical techniques or methods used; and
   f. The results of such analyses.

7. Inspection and Entry
The co-permittees must allow the Department representative upon the presentation of credentials to:
   a. Enter upon a co-permittee's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this permit;
   b. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit;
   c. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this permit, and
   d. Sample or monitor at reasonable times, for the purpose of assuring permit compliance or as otherwise authorized by state law, any substances or parameters at any location within the MS4.

SECTION D. REPORTING REQUIREMENTS

1. Planned Changes
The permittee must comply with OAR chapter 340, division 52, "Review of Plans and Specifications" and 40 CFR Section 122.41(l) (1). Except where exempted under OAR chapter 340, division 52, no construction, installation, or modification involving disposal systems, treatment works, sewerage systems, or common sewers may be commenced until the plans and specifications are submitted to and approved by the Department. The permittee must give notice to the Department as soon as possible of any planned physical alternations or additions to the permitted facility.

2. Anticipated Noncompliance
The co-permittees must give advance notice to the Department of any planned changes in the permitted facility or activities that may result in noncompliance with permit requirements.

3. Transfers
This permit may be transferred to a new co-permittee(s) provided the transferee(s) acquires a property interest in the permitted activity and agrees in writing to fully comply with all the terms and conditions of the permit and the rules of the Commission. No permit may be transferred to a third party without prior written approval from the Department. The Department may require modification, revocation, and reissuance of the permit to change the name of the permittee and incorporate such other requirements as may be necessary under the Clean Water Act (see 40 CFR §122.61; in some cases, modification or revocation and reissuance is mandatory). The co-permittees must notify the Department when a transfer of property interest takes place that results in a change of co-permittee(s).

4. Compliance Schedule
Reports of compliance or noncompliance with, or any progress reports on interim and final requirements contained in any compliance schedule of this permit must be submitted no later than 14 days following each schedule date. Any reports of noncompliance must include the cause of noncompliance, any remedial actions taken, and the probability of meeting the next scheduled requirements.

5. Duty to Provide Information
The co-permittees must furnish to the Department within a reasonable time any information that the Department may request to determine compliance with this permit.. The co-permittees must also furnish to the Department, upon request, copies of records required to be kept by this permit.

   Other Information: When a co-permittee becomes aware that it has failed to submit any relevant facts or has submitted incorrect information in a permit application or any report to the Department, it must promptly submit such facts or information.

6. Signatory Requirements
All applications, reports or information submitted to the Department must be signed and certified in accordance with 40 CFR Section 122.22.

7. Falsification of Information
Under ORS 468.953, any person who knowingly makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this permit, including monitoring reports or reports of compliance or noncompliance, is subject to a Class C felony punishable by a fine not to exceed $100,000 per violation and up to 5 years in prison. Additionally, according to 40 CFR 122.41(k)(2), any person who knowingly makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this permit including monitoring reports or reports of compliance or non-compliance shall, upon conviction, be punished by a federal civil penalty not to exceed $10,000 per violation, or by imprisonment for not more than 6 months per violation, or by both.

SECTION E. DEFINITIONS

1. CFR means Code of Federal Regulations.
2. Clean Water Act or CWA means the Federal Water Pollution Control Act enacted by Public Law 92-500, as amended by Public Laws 95-217, 95-576, 96-483 and 97-117; 33 U.S.C. 1251 et seq.
3. Department means Department of Environmental Quality.
4. Director means Director of the Department of Environmental Quality.
5. Flow-Weighted Composite Sample means a sample formed by collection and mixing discrete samples taken periodically and based on flow.
6. Grab Sample means an individual discrete sample collected over a period of time not to exceed 15 minutes.
7. Illicit Discharges means any discharge to a municipal separate storm sewer that is not composed entirely of storm water except discharges pursuant to a NPDES permit (other than the NPDES permit for discharges from the municipal separate storm sewer) and discharges resulting from fire fighting activities.
8. Major Outfall means a municipal separate storm sewer outfall that discharges from a single pipe with an inside diameter 36 inches or more or its equivalent (discharge from a single conveyance other than circular pipe which is associated with a drainage area of more than 50 acres); or for municipal separate storm sewers that receive storm water from lands zoned for industrial activities (based on comprehensive zoning plans or the equivalent), an outfall that discharges from a single pipe with an inside diameter of 12 inches or more or from its equivalent (discharge from other than a circular pipe associated with a drainage area of 2 acres or more).

9. mg/L means milligrams per liter.
10. mL/L means milliliters per liter.
11. MS4 means a municipal separate storm sewer system.
12. Municipal Separate Storm Sewer means a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, manmade channels, or storm drains):
    a. Owned or operated by a State, city, town, borough, county, parish, district, association, or other public body (created by or pursuant to State Law) having jurisdiction over disposal of sewage, industrial wastes, storm water or other wastes, including special districts under State Law such as a sewer district, flood control district or drainage district, or similar entity, or an Indian tribe or an authorized Indian Tribal organization, or a designated and approved management agency under §208 of the CWA that discharges to waters of the United States;
    b. Designed or used for collection or conveying storm water;
    c. Which is not a combined sewer; and
    d. Which is not part of a Publicly Owned Treatment Works (POTW) as defined by 40 CFR §122.2.
13. Outfall means a point source as defined by 40 CFR §122.2 at the point where a municipal separate storm sewer discharges to waters of the United States and does not include open conveyances connecting two municipal separate storm sewers, or pipes, tunnels or other conveyances which connect segments of the same stream or other waters of the United States and are used to convey waters of the United States.
14. Permit means the NPDES municipal separate storm sewer system (MS4) permit specified herein, authorizing the co-permittees listed on Page 1 of this permit to discharge from the MS4.
15. Storm Water means storm water runoff, snowmelt runoff, and surface runoff and drainage.
16. Year means calendar year except where otherwise defined.

Portland National Pollutant Discharge Elimination System (NPDES)
Municipal Separate Storm Sewer System (M4) Permit

SUMMARY OF CURRENT STORMWATER MANAGEMENT PLAN REQUIREMENTS: BEST MANAGEMENT PRACTICES AND TASKS

March 2005

Permit # 101314
DEQ File # 108015

A018291

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Section 1: INTRODUCTION

This document describes the current Stormwater Management Plans (SWMPs) that are being implemented by the City of Portland, Port of Portland, and Multnomah County, as approved by the Oregon Department of Environmental Quality (DEQ). The current SWMPs are based on the original SWMPs approved under the City of Portland's first NPDES permit issued in 1995, with subsequent modifications and revisions as a result of an ongoing adaptive management process (as defined in Schedule A of Permit No. 101314, as modified by DEQ on reconsideration). The purpose of this document is to consolidate those cumulative changes and present the resulting best management practices (BMPs) in one place for the convenience of the reader.

The remainder of this Introduction gives an overview of the NPDES MS4 permit and describes the evolution of the SWMPs since they were initially developed. Sections 2, 3, and 4 then present the current BMPs and associated tasks for the City of Portland, Port of Portland, and Multnomah County, respectively.

Overview of NPDES Permit

DEQ issued an NPDES MS4 permit to seven[1] co-permittees on September 7, 1995. By federal law, the initial term of the permit is five years, and is administratively extended until renewed. The City of Portland, Port of Portland, and Multnomah County submitted a renewal application as required (180 days before the date of permit expiration) in February 2000. DEQ issued the permit renewal in March 2004, beginning a new five-year permit term.

Stormwater Management Plans

The 1993 permit application included each co-permittee's original Stormwater Management Plan. The permit issued in September 1995 incorporated the SWMPs by reference.

The SWMPs identify the BMPs to be implemented to reduce the discharge of pollutants to the "maximum extent practicable," protect water quality, and satisfy the applicable requirements of the Clean Water Act.

The 1993 permit application also included a Stormwater Monitoring Plan. Implementation of the plan is included as a BMP in the City of Portland's SWMP. The Port of Portland and Multnomah County participate in the monitoring program via intergovernmental agreements.

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[1] The seven original co-applicants/co-permittees, which all operate separate stormwater conveyance systems within Portland's urban services boundary, were the City of Portland, Port of Portland, Multnomah County, Oregon Department of Transportation (ODOT), Multnomah County Drainage District No. 1, Peninsula Drainage District No. 1, and Peninsula Drainage District No. 2. In 2000, ODOT obtained a statewide NPDES permit and was removed as a Portland co-permittee. The three drainage districts established memoranda of agreement to fulfill their stormwater management responsibilities, and were removed as Portland co-permittees in 2003.

As the co-permittees have implemented their SWMPs, they have evaluated the effectiveness of the BMPs and assessed new opportunities for improvement. As a result of this adaptive management process, the BMPs have been revised as needed to continue to reduce pollutant discharges to the maximum extent practicable.

The current SWMPS are:

- The 1995 SWMPs approved under the previous NPDES permit, with co-permittee changes made in annual compliance reports.
- Modifications to the Port of Portland SWMP and monitoring program submitted to DEQ October 15, 1996 and April 8, 1998.
- Modifications to the permit (Addendum No. 1) approved by DEQ on April 29, 1998, in response to the City of Portland's request to modify its monitoring plan.
- Proposed BMP revisions included in the co-permittees' permit renewal submittal to DEQ on February 29, 2000.

Attachment A provides more information about these and other documents relevant to the permit. These documents are contained in DEQ File No. 108015.

Current Best Management Practices

The current SWMPs comprise eight categories of BMPs, which are common to all of the co-permittees. These common categories serve as an overall framework and promote consistency and coordination among the co-permittees. Under each category, each co-permittee identifies its own BMPs and associated tasks. The relevant NPDES regulatory requirements satisfied by each BMP are also identified. Table 1 on pages 1-3 through 1-6 is a summary comparison of all of the co-permittees' BMPs with the regulatory requirements.

Table 1
COMPARISON OF BMPS WITH NPDES REGULATORY REQUIREMENTS

NPDES REGULATION 40 CFR 122.26 (d) (2) (iii)	City BMPs	Port BMPs	County BMPs
(D) Include *(in the permit application)* a proposed monitoring program for representative data collection for the term of the permit that describes the location of outfalls or field screening points to be sampled, why the location is representative, the frequency of sampling, parameters to be sampled, and a description of sampling equipment.	OA1	OA3	N/A
NPDES REGULATION 40 CFR 122.26 (d) (2) (iv)	**City BMPs**	**Port BMPs**	**County BMPs**
Proposed Management Program. ...It shall include a comprehensive planning process which involves public participation and where necessary intergovernmental coordination, to reduce the discharge of pollutants to the maximum extent practicable using management practices, control techniques and systems, design and engineering methods, and such other provisions which are appropriate...	All City BMPs	All Port BMPs	All applicable County BMPs
...Such programs shall be based on: (A) A description of structural and source control measures to reduce pollutants from runoff from commercial and residential areas that are discharged from the municipal separate storm system (MS4s) that are to be implemented during the life of the permit,...	OM3 OM4 STR1 STR2 PS3	OM1 OM2 OM3 ND1 STR1	OM1 STR1
...the description shall include: (A)(1) A description of maintenance activities and a maintenance schedule for structural controls to reduce pollutants (including floatables) in discharges from MS4s;	OM1 OM2 PS1	OM1 OM3	OM1 OM5 OA3
(A)(2) A description of planning procedures including a comprehensive master plan to develop, implement and enforce controls to reduce the discharge of pollutants from MS4s which receive discharges from areas of new development and significant redevelopment. Such plans shall address controls to reduce pollutant discharges from MS4s after construction is complete...	ND2 STR2 PS1 PS2 PS3	PI2 OM1 OM3 ND1 STR1 OA1 OA2 OA3	PI4 ILL4 OA1 OA2 OA3
(A)(3) A description of practices for operating and maintaining public streets, roads, and highways and procedures for reducing the impact on receiving waters of discharges from MS4s, including pollutants discharged as a result of deicing activities;	OM2	OM2	OA3

NPDES REGULATION 40 CFR 122.26 (d) (2) (iv)	City BMPs	Port BMPs	County BMPs
(A)(4) A description of procedures to assure that flood management projects assess the impacts on water quality of receiving water bodies and that existing structural flood control devices have been evaluated to determine if retrofitting the device to provide additional pollutant removal from stormwater is feasible;	STR1 STR2	N/A	PI7 STR1 STR2
(A)(5) A description of a program to monitor pollutants in runoff from operating or closed landfills or other treatment, storage or disposal facilities for municipal waste, which shall identify priorities and procedures for inspections and establishing and implementing controls measures for such discharges;	IND1	N/A	N/A
(A)(6) A description of a program to reduce to the maximum extent practicable, pollutants in discharges from the MS4s associated with the application of pesticides, herbicides, and fertilizers which will include, as appropriate, controls such as educational activities, permits, certifications and other measures for commercial applicators and distributors, and controls for application in the public rights-of-way and municipal facilities.	PI1 PSI	PI2 OM3 ILL2	PI3 PI4 PS1
(B) A description of a program, including a schedule, to detect and remove (or require the discharger to the MS4s to obtain a separate NPDES permit for) illicit discharges and improper disposal into the storm system.	PI1 OM3 OM4 IND1 ILL2	ILL3 IND1	ILL5 ILL7 ILL8
(B)(1) A description of a program, including inspections, to implement and enforce an ordinance, order or similar means to prevent illicit discharges to the MS4s; this program description shall address all types of illicit discharges,...flows shall be addressed where such discharges are identified by the municipality as sources of pollutants to the waters of the U.S....	ILL2	ILL3	ILL1 ILL3 ILL4 ILL6 ILL7 ILL8
(B)(2) A description of procedures to conduct ongoing field screening activities during the life of the permit, including areas or locations that will be evaluated by such field screens;	ILL2	OA3 ILL3	OM1 STR5 OA3
(B)(3) A description of procedures to be followed to investigate portions of the MS4s that, based on the results of the field screen, or other appropriate information, indicate a reasonable potential of containing illicit discharges or other sources of non-stormwater (such procedures may include: sampling...such as fecal...Such description shall include the location of storm sewers that have been identified for such evaluation);	ILL2	OA3 ILL3	ILL1 ILL3 ILL5 OM1 STR5
(B)(4) A description of procedures to prevent, contain, and respond to spills that may discharge into the MS4s;	ILL1	ILL1 ILL2	ILL1 ILL6

NPDES REGULATION 40 CFR 122.26 (d) (2) (iv)	City BMPs	Port BMPs	County BMPs
(B)(5) A description of a program to promote, publicize, and facilitate public reporting of the presence of illicit discharges or water quality impacts associated with discharges from MS4s;	PI1 ILL1	PI1 PI2 ILL1 ILL3 ILL4	PI1 PI2 PI3 PI4 PI5 PI6 PI8 ILL1 ILL3 ILL6
(B)(6) A description of educational activities, public information activities, and other appropriate activities to facilitate the proper management and disposal of used oil and toxic materials;	PI1	PI1 PI2 ILL2	PI1 PI2 PI3 PI4 PI5 PI6 PI8
(B)(7) A description of controls to limit infiltration of seepage from municipal sanitary sewers to MS4s where necessary;	OM1	OM1 ILL3 OA1	N/A
(C) A description of a program to monitor and control pollutants in stormwater discharges to MS4s from municipal landfills, hazardous waste treatment, disposal, and recovery facilities, industrial facilities that are subject to section 313 of Title III of the Superfund Amendments ...and industrial facilities that the municipal permit applicant determines are contributing a substantial pollutant loading to the MS4s. The program shall:	IND1	IND1	N/A
(C)(1) Identify priorities and procedures for inspections and establishing and implementing control measures for such discharges;	IND1	IND1	N/A
(C)(2) Describe a monitoring program for stormwater discharges associated with the industrial facilities identified in paragraph (C)...to be implemented during the term of the permit...	IND1 OA1	OA3	N/A
(D) A description of a program to implement and maintain structural and nonstructural best management practices to reduce pollutants in stormwater runoff from construction sites to the MS4s, which shall include:	ND1	PI2 ND1 STR1	ILL7 ILL8
(D)(1) A description of procedures for site planning which incorporate consideration of potential water quality impacts;	ND1	ND1	ILL4 ILL9 STR1
(D)(2) A description of requirements for nonstructural and structural best management practices;	ND1	ND1 STR1	ILL4 ILL7 ILL9

NPDES REGULATION 40 CFR 122.26 (d) (2) (iv)	City BMPs	Port BMPs	County BMPs
(D)(3) A description of procedures for identifying priorities for inspecting sites and enforcing control measures which consider the nature of the construction activity, topography, and the characteristics of soils and receiving water quality;	ND1	ND1	ILL7 ILL8 ILL9
(D)(4) A description of appropriate educational and training measures for construction site operators.	ND1	PI2 ND1	PI4 ILL3 ILL7 ILL8 ILL9
NPDES REGULATION 40 CFR 122.42 (c)	**City BMPs**	**Port BMPs**	**County BMPs**
Municipal separate storm sewer systems. The operator of a large or medium municipal separate storm sewer system or a municipal separate storm sewer that has been designated by the Director under Sec. 122.26(a)(1)(v) of this part must submit an annual report....	OA2		OA1

BMP Category: INDUSTRIAL/COMMERCIAL CONTROLS (IND)

Purpose: To reduce and control industry and commercial discharges to the storm system from stormwater runoff and production practices.

Overview:
Some industrial and commercial uses have high potential to contribute pollutants to the storm drainage system. The best management practice (IND-1) in this category focuses on reducing the discharge of pollutants in stormwater runoff from certain commercial and industrial sites through permitting, inspection, and enforcement, as well as through outreach and technical assistance programs.

IND-1 Implement the City's Industrial Stormwater Management Program to control the discharge of pollutants to the MS4 from existing and developing industries; continue to provide educational materials; and continue to develop and implement permitting or policies for identified non-stormwater discharges that are creating negative impacts.

RELEVANT NPDES REGULATORY REQUIREMENTS SATISFIED BY THIS BMP	
40 CFR 122.26(d)(2)(iv)	
(A)(5)	A description of a program to monitor pollutants in runoff from operating or closed municipal landfills or other treatment, storage or disposal facilities for municipal waste, which shall identify priorities and procedures for inspections and establishing and implementing control measures for such discharges.
(B)	A description of a program, including a schedule, to detect and remove (or require the discharger to the municipal separate storm sewer to obtain a separate NPDES permit for) illicit discharges and improper disposal into the storm sewer.
(C)	A description of a program to monitor and control pollutants in storm water discharges to municipal systems from municipal landfills, hazardous waste treatment, disposal and recovery facilities, industrial facilities that are subject to section 313 of title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA), and industrial facilities that the municipal permit applicant determines are contributing a substantial pollutant loading to the municipal storm sewer system. The program shall:
(C)(1)	Identify priorities and procedures for inspections and establishing and implementing control measures for such discharges;
(C)(2)	Describe a monitoring program for storm water discharges associated with the industrial facilities identified in paragraph (C)...to be implemented during the term of the permit...

Summary of Current IND-1 Tasks

Task 1: Continue to administer NPDES industrial stormwater permits within Portland's urban services boundary. Continue to inspect all permitted industries in the City once per year.

Task 2: Continue to develop and distribute written materials both to facilities permitted under the Industrial Stormwater Management Program and facilities not covered under the program.

Task 3: Continue to inspect non-permitted industries discharging to the MS4 to evaluate the need for permits.

Task 4: Continue certifications in the Eco-Logical Business Program with the Pollution Prevention Team and Advisory Groups.

STATE OF FLORIDA
MUNICIPAL SEPARATE STORM SEWER SYSTEM PERMIT

PERMIT NUMBER: FLS000018 Major Facility

ISSUANCE DATE: November 18, 2002

EXPIRATION DATE: November 17, 2007

Palm Beach County – Municipal Separate Storm Sewer System Permittee(s):

CO-PERMITTEE(S):

Palm Beach County
Palm Beach County ERM
3323 Belvedere Road, Bld. 502
West Palm Beach, FL 33406

City of Atlantis
Department of Public Works
260 Orange Tree Drive
Atlantis, Florida 33462

City of Belle Glade
Water/Sewer Department
110 S.W. Avenue E
Belle Glade, Florida 33430-3997

City of Boca Raton
Department of Public Works
201 West Palmetto Park Road
Boca Raton, Florida 33432

City of Boynton Beach
Utility Department
124 East Woolbright Road
Boynton Beach, Florida 33435

City of Delray Beach
Env. Serv. Dept./Engineering Div.
434 S. Swinton Avenue
P.O. Box 310
Delray Beach, Florida 33444-2698

City of Greenacres
Public Works Department
518 Martin Avenue
Greenacres, Florida 33463

City of Lake Worth
Lake Worth Utilities
1749 3rd Avenue South
Lake Worth, Florida 33460

City of Pahokee
Public Services Department
171 North Lake Avenue
Pahokee, Florida 33476

City of Palm Beach Gardens
Public Works Department
10500 North Military Trail
Palm Beach Gardens, FL 33410

City of Riviera Beach
Public Works Department
P.O. Box 10682
Riviera Beach, Florida 33419

City of South Bay
City Public Works Department
335 S.W. 2nd Avenue
South Bay, Florida 33493

City of West Palm Beach
Eng. and Public Works Dept
1000 45th Street, Suite 15
P.O. Box 3366
West Palm Beach, Florida 33407

Town of Cloud Lake
Town Hall
100 Lang Road
West Palm Beach, FL 33406

Town of Palm Beach
Public Works Department
P.O. Box 2029
360 South Century Road
Palm Beach, Florida 33480

Town of Juno Beach
Town Hall
340 Ocean Drive
Juno Beach, Florida 33408

Town of Haverhill
Public Works Department
4585 Charlotte Street
West Palm Beach, FL 33417

Town of Highland Beach
Utilities Department
3614 South Ocean Boulevard
Highland Beach, Florida 33487

Town of Jupiter
Public Service Department
210 Military Trail
Jupiter, Florida 33458

Town of Jupiter Inlet Colony
Town Hall
P.O. Box 728
Jupiter, Florida 33468-0728

Town of Lake Clarke Shores
Town Utilities Department
1701 Barbados Road
West Palm Beach, FL 33406

Town of Lake Park

Town of Lantana

Town of Ocean Ridge

Department of Public Works
650 Old Dixie Hwy
Lake Park, Florida 33403

Town of Manalapan
Env. Resources Management
600 South Ocean Boulevard
Manalapan, Florida 33462

Town of Palm Beach Shores
Building Department
247 Edwards Lane
Palm Beach Shores, FL 33404

Town of South Palm Beach
Town Hall
3577 South Ocean Boulevard
South Palm Beach, Florida 33480

Village of Tequesta
Public Works Department
P.O. Box 3273
Tequesta, Florida 33469-0273

Florida Department of Transportation
District Four
3400 West Commercial Blvd.
Fort Lauderdale, FL 33309-3421

Department of Public Works
500 Greynolds Circle
Lantana, Florida 33462

Town of Mangonia Park
Public Works Commission
1755 East Tiffany Drive
West Palm Beach, FL 33407

Village of Palm Springs
Utilities Department
226 Cypress Lane
Palm Springs, Florida 33461

Village of Wellington
Public Works
14000 Greenbriar Boulevard
Wellington, Florida 33414

South Indian River Water Control District
Public Works & Utilities Dept
15600 Jupiter Farms Road
Jupiter, Florida 33478

Florida Department of Transportation
Turnpike District
P.O. Box 9828
Fort Lauderdale, FL 33310

Department of Public Safety
6450 North Ocean Boulevard
Ocean Ridge, Florida 33435

Town of Gulf Stream
Town Hall
100 Sea Road
Gulf Stream, Florida 33483

Village of North Palm Beach
Department of Public Services
501 U.S. Highway One
North Palm Beach, FL 33408

Village of Royal Palm Beach
Public Works
1050 Royal Palm Beach Boulevard
Royal Palm Beach, Florida 33411

Indian Trail Improvement District
Field Operations
13476 61st Street North
West Palm Beach, FL 33412-1915

Northern Palm Beach County Improvement District
Maintenance Department
357 Hiatt Drive
Palm Beach Gardens, Florida 33418

This permit is issued pursuant to Section 403.0885, Florida Statutes (F.S.), and rules promulgated thereunder. The Department of Environmental Protection (DEP) implements the stormwater element of the federal National Pollutant Discharge Elimination System (NPDES) as part of the Department's Wastewater Facility and Activities Permitting program. The stormwater element of the federal NPDES program is mandated by Section 402(p) of the Clean Water Act which is set out in the federal statutes at 33 U.S.C. Section 1342(p) and implemented through federal regulations including 40 Code of Federal Regulations (CFR) 122.26.

Authorized by Section 403.0885, F.S., the Department's federally approved NPDES stormwater program is set out in various provisions within Chapters 62-4, 62-620, 62-621 and 62-624 of the Florida Administrative Code (F.A.C.). Chapter 62-624, F.A.C., specifically addresses Municipal Separate Storm Sewer Systems (MS4s).

The above named permittee(s) are hereby authorized to discharge to waters of the state, in accordance with the approved Stormwater Management Program(s), effluent limitations, monitoring requirements, and other provisions as set forth in this permit, the application and other documents attached hereto or on file with the Department and made a part hereof, from all portions of the Municipal Separate Storm Sewer System owned or operated by any permittee listed above.

PART I. DISCHARGES AUTHORIZED UNDER THIS PERMIT

A. **Permit Area.** This permit covers all areas located within the political boundary of the Palm Beach County MS4 that is served by the municipal separate storm sewer system owned or operated by the Permittee(s) identified above.

B. **Authorized Discharges.** Except for discharges prohibited under Part I.D., this permit authorizes all existing or new stormwater point source discharges to waters of the state from those portions of the Municipal Separate Storm Sewer System (MS4) owned or operated by the Permittee(s).

C. **Permittee(s) Responsibility.**

1. Permittee(s) are individually responsible for:

    a. Compliance with permit conditions relating to discharges from portions of the MS4 where they are the operator;

    b. Stormwater management program implementation on portions of the MS4 where they are the operator;

    c. Where permit conditions are established for specific portions of the MS4, the permittee(s) need only comply with the permit conditions relating to those portions of the MS4 for which they are the operator; and

    d. A plan of action to assume responsibility for implementation of stormwater management and monitoring programs on their portions of the MS4 should inter-jurisdictional agreements allocating responsibility between permittee(s) be dissolved or in default. (See Part II.G.3., of this permit also.)

2. Each permittee is jointly responsible for:

    a. Submission of annual reporting requirements as specified in Part V.C. (ANNUAL REPORT);

    b. Collection of monitoring data as required by Part V.B.,

    c. Insuring implementation of system-wide management program elements, including any system-wide public education efforts.

D. **Limitations on Coverage.** Pursuant to Section 403.0885, and rules promulgated thereunder, and consistent with Section 402(p)(3)(B)(ii) of the Clean Water Act, this permit must include a requirement to effectively prohibit non-stormwater discharges into the storm sewers within the permittee's MS4. Consequently, the following discharges are not authorized by this permit:

1. *Non-stormwater:* discharges of non-stormwater, except where such discharges are:

    a. authorized under the provisions of Chapter 373 or 403, F.S., or rules promulgated thereunder; or

    b. identified by and in compliance with Part II.A.7.a.

2. *Spills*: discharges of material resulting from a spill, except where such discharges are:

a. the result of an Act of God where reasonable and prudent measures have been taken to minimize the impact of the discharge; or

b. an emergency discharge required to prevent imminent threat to human health or prevent severe property damage, where reasonable and prudent measures have been taken to minimize the impact of the discharge.

E. **Exemption to Coverage** – Permittees are exempt from the requirements of this permit in the event of any of the following occurring within the permittee's jurisdiction:

1. A declared State of Emergency

2. A designated Natural Disaster Area

3. An act of war or terrorism

PART II. STORMWATER POLLUTION PREVENTION & MANAGEMENT PROGRAMS

As required by Rule 62-624.440(2), F.A.C., which adopts 40 CFR 122.26(d)(2)(iv), the permittee(s) shall implement a comprehensive Stormwater Management Program (SWMP) that shall include pollution prevention measures, treatment or removal techniques, stormwater monitoring, use of legal authority, and other appropriate means to control the quality of stormwater discharged from the MS4.

Controls and activities in the SWMP shall identify areas of permittee jurisdiction. The SWMP shall include controls necessary to effectively prohibit the discharge of non-stormwater into municipal separate storm sewers and reduce the discharge of pollutants from the MS4 to the Maximum Extent Practicable (MEP). Compliance with this SWMP shall be reported annually in the ANNUAL REPORT discussed in Part V.C. of this permit.

Implementation of the SWMP may be achieved through participation with other permit holders, public agencies, or private entities in cooperative efforts to satisfy the requirements of Part II and Part III of the permit in lieu of creating duplicate program elements for each individual permittee. The SWMP, taken as a whole, shall achieve the "effective prohibition" requirements and "MEP" standards from Section 402(p)(3)(B) of the Clean Water Act, as implemented pursuant to Section 403.0885, F.S., and rules promulgated thereunder.

The SWMP covers the term of the permit and shall be updated as necessary, or as required by the Department, to ensure that it complies with Section 403.0885, F.S., and rules promulgated thereunder, and is consistent with Section 402(p)(3)(B) of the Clean Water Act. Modifications to the SWMP shall be made in accordance with Part II.G. of this permit. Compliance with the SWMP and the compliance schedules in Part III shall be deemed in compliance with Parts II.A. and II.B. of the permit. **FDOT's Statewide Stormwater Management Plan for MS4 Permits, dated 1997 and all approved updates, are hereby incorporated into this permit by reference and thus are enforceable elements of the permit.** Specific components of these Stormwater Management Programs are identified in Parts II and III to serve as measurable and enforceable elements of this permit.

A. Stormwater Management Program (SWMP) Requirements.

1. *Structural Controls and Stormwater Collection System Operation:* The MS4 and any stormwater structural control shall be operated in a manner to reduce the discharge of pollutants to the *Maximum Extent Practicable* (*MEP*).

   a. The permittee(s) shall comply whenever feasible with the suggested maintenance requirements in Table II.A.1.a for these controls. In addition, the permittee(s) shall maintain an internal record keeping system to track inspections and maintenance activities performed during the permit term. If these activities are performed by others under a contractual agreement, then the permittee(s) shall retain copies of the contractual agreement which specifies the maintenance activities to be performed and the schedule of frequency. Inspection and maintenance records shall be retained by the permittee(s) in accordance with Part V.G. of this permit. Annual evaluations shall be made to assess the appropriateness of the inspection and maintenance schedule and to ensure the optimization of equipment use. A summary of the annual evaluation shall be included within each ANNUAL REPORT required under Part V.C. of this permit.

TABLE II.A.1.a

SUGGESTED INSPECTION AND MAINTENANCE SCHEDULE ACTIVITIES

STRUCTURAL CONTROL	FREQUENCY OF INSPECTION	FREQUENCY OF MAINTENANCE	MAINTENANCE ACTIVITY
Storm Water Treatment Ponds (Dry Retention)	Semi-Annually	Semi-Annual Inspections Items	°Inspect facility for signs of prolonged wetness and damage to structures including diversion devices and inflow and outflow structures and pipes. °Note any critically eroded areas on banks and pond bottom. °Schedule for stabilization. °Undercutting at the point of discharge and signs of piping in the vicinity of the control structure or inlets, flumes, diversion structures or pipes should be noted and scheduled for immediate repair. °Dead or dying grass on the pond bottom are indications of potential clogging and reduced infiltration capacity. When observed the facility should be checked to insure that it percolates completely within 2-3 days following storms. Scrapping, discing or otherwise aerating pond bottom may be required to restore the infiltration capacity of the soil. °Note any signs of excessive petroleum hydrocarbon contamination and handle appropriately. (1)
		As Needed	°Mowing, litter and debris removal. °Stabilization of eroded banks. °Repair undercut or eroded areas at inflow and diversion structures or conveyances. °Nutrient and pesticide use management. (2) °Dethatch pond bottom and remove thatching. Dispose via composting and land application. As an alternative, remove grass clippings following mowing.
		Annually	°Disk or otherwise aerate pond bottom.
		5-Year Revolving Schedule	°Scrape pond bottom and remove sediment with proper sediment disposal. Restore original cross-section and infiltration rate. (1,3) °Seed or sod to restore ground cover.

TABLE II.A.1.a

SUGGESTED INSPECTION AND MAINTENANCE SCHEDULE ACTIVITIES

STRUCTURAL CONTROL	FREQUENCY OF INSPECTION	FREQUENCY OF MAINTENANCE	MAINTENANCE ACTIVITY
Storm Water Treatment Pond (Wet Detention Facility)	Annual	Annual Inspection Items	°Inspect facility for damage. Close attention should be given to the control structure and the point of discharge (POD). °Undercutting at the POD and evidence of piping (erosion of soil into the pipe junctions) and/or erosion in the vicinity of inflow pipes, the outlet control structure, or flumes should be noted and scheduled for immediate repair. °Note signs of excessive total petroleum hydrocarbon contamination and handle appropriately. (1) °Schedule cleaning of UD pipes via mechanical means or high-pressure water jets as appropriate. Also inspect for damage to caps from mowing accidents or any breaks in seals to prevent short-circuiting of the filter.
	Semi-Annually	Semi-Annual Inspection Items	°Detention facilities that include constructed wetlands (littoral shelf) components should be monitored carefully to avoid invasive aquatic plant problems. Schedule removal of invasive species or chemical control when necessary to prevent excessive competition with beneficial or desired plants. (2) °Note those areas within the littoral zone where the spread or overcrowding of beneficial plants necessitates management and harvesting.
		As needed	°Repair and stabilize undercut and eroded areas near structures and banks. °Stabilize eroded banks. °Mowing side slopes with litter and debris removal from banks. °Nutrient and pesticide management. (2)
		Monthly	°Clean and remove debris from orifices, weirs, stand pipes, drop inlets and screens.
		Semi-Annually	°Invasive aquatic plant control. (2)

TABLE II.A.1.a

SUGGESTED INSPECTION AND MAINTENANCE SCHEDULE ACTIVITIES

STRUCTURAL CONTROL	FREQUENCY OF INSPECTION	FREQUENCY OF MAINTENANCE	MAINTENANCE ACTIVITY
Storm Water Treatment Pond (Wet Detention Facility) ***Cont.***	Semi-Annually	5 year revolving schedule or as needed.	°Removal of sediment from forebays or sediment sumps and dispose of properly. (1, 3) Sediment "clean out" should not be higher than 1 foot below the invert elevation of the bay or sump nor should the storage volume be reduced by more than 60 percent of original design, (i.e. Cleanout Level = .2 in/acre drainage area remaining storage volume in most cases.)
		10-15 years or as needed to maintain adequate storage volume and treatment.	°Monitor sediment accumulations and remove when ¼ storage volume is filled or when hypereutrophic conditions become apparent. Sediment must be disposed of or used properly. (1, 3)
		Annually or as needed	°Aquatic plant management and harvesting. Manage constructed wetland components to prevent overcrowding of beneficial plants to maintain adequate open water area for aesthetics, light penetration and oxygenation. It is also important to avoid excessive cover for insect (mosquito) larvae, which enhances production and inhibits predation. Not more than a 50 percent reduction in open water area is recommended prior to mechanical harvesting and reduction of macrophyte cover to its original level (i.e., 30-35 percent in most instances). °Constructed wetland management (regular selective harvesting) to encourage sites for active growth and enhanced pollution assimilation is recommended.
Pump Stations	Semi-Annually	As Needed	°Where bar screens are used to protect the pump, remove screens and clean. Properly dispose of litter and debris collected. °Inspect pump for proper operation and perform necessary mechanical repairs. °Remove any sediment collected and provide proper disposal.

TABLE II.A.1.a

SUGGESTED INSPECTION AND MAINTENANCE SCHEDULE ACTIVITIES

STRUCTURAL CONTROL	FREQUENCY OF INSPECTION	FREQUENCY OF MAINTENANCE	MAINTENANCE ACTIVITY
Exfiltration Trench	Semi-Annually	Semi-Annual Inspection Items	Monitor facility for sediment accumulation in the pipe (when used) and storage volume recovery (i.e., drawdown, capacity). Observation wells and inspection ports should be checked following 3 days minimum dry weather. Failure to percolate stored runoff to the design treatment volume level within 72 hour indicates binding of soil in the trench walls and/or clogging of geotextile liner with fine solids. Reductions in storage volume due to sediment in the distribution pipe, also reduces efficiency. Minor maintenance measures can restore infiltration rates to acceptable levels short term. Major maintenance (total rehabilitation) is required to remove accumulated sediment in most cases or to restore recovery rate when minor measures are no longer effective or can not be performed due to design configuration. °Inspect appurtenances such as sedimentation and oil and grit separation chambers of catch basins as well as diversion devices and overflow weirs when used. Diversion facilities and overflow weirs should be free of debris and ready for service. Sedimentation and oil/grit separators should be scheduled for cleaning when sediment depth approaches cleanout level. Cleanout levels should be established not less than 1 foot below control elevation of the chamber.
		As Needed	°Remove sediment from sediment/oil and grease chamber of each catch basin inlets, and dispose of properly. (1,3) °Remove debris from the outfall or "Smart Box" (diversion device in the case of off-line facilities).
Exfiltration Trench **Cont.**	Semi-annually	As needed to maintain storage capacity within 2/3 of the design treatment volume and 72 hour exfiltration rate limit.	°Total rehabilitation or trench. Excavate and remove perforated or slotted pipe, surrounding coarse aggregate envelope (bedding) and geotextile fabric (wrap). In most cases renovation will require replacement with new material of equivalent grade and quality. Trench walls should be excavated to expose clean soil. Sediment, contaminated soil, coarse aggregate, and filter cloth should be disposed of properly. (1,3)

TABLE II.A.1.a

SUGGESTED INSPECTION AND MAINTENANCE SCHEDULE ACTIVITIES

STRUCTURAL CONTROL	FREQUENCY OF INSPECTION	FREQUENCY OF MAINTENANCE	MAINTENANCE ACTIVITY
		5 years or as needed to prolong service.	°When bypass capability is available, minor maintenance measures such as extended dry periods may be used to provide short-term recovery of exfiltration rate. °Remove accumulated sediment from facilities constructed with manholes or other appurtenant structures to facilitate cleanout. Sediment should be disposed of properly. (1,3) This process normally involves facilities with large pipes. Cleanout may be performed by suction hose and tank truck and/or by high-pressure jet washing.
Channel Control Structures	Quarterly	As Needed	°Litter and debris removal. °Sediment removal with proper sediment disposal. (1,3)
Pollution Control Boxes	Annually	As Needed	°Remove oil and grease, litter, debris, and sediment and dispose of properly. (1,3)
Grass Swales (Dry)	Semi-Annual Inspection Items	Semi-Annually	°Inspect swales for signs of prolonged wetness and damage to structures including diversion devices, inflow pipes, driveway culverts, and swale blocks. °Note any critically eroded areas on banks and front or back slope and swale bottom. Schedule for stabilization. °Undercutting at the point of discharge and paved flumes or pipes and culverts should be noted and scheduled for immediate repair. °Dead or dying grass and saturation of the swale bottom are indications of potential clogging and reduced infiltration capacity. When observed the facility should be checked to insure that it percolates completely within 3 days following storms to comply with State regulations. Scraping, discing or otherwise aerating the bottom may be required to restore the infiltration capacity of the soil. For best performance swales should percolate within one day following storms. °Note any signs of excessive petroleum hydrocarbon contamination and handle appropriately (2).
		As Needed	°Mowing and litter and debris removal. °Stabilization of eroded side slopes and bottom.

TABLE II.A.1.a

SUGGESTED INSPECTION AND MAINTENANCE SCHEDULE ACTIVITIES

STRUCTURAL CONTROL	FREQUENCY OF INSPECTION	FREQUENCY OF MAINTENANCE	MAINTENANCE ACTIVITY
			°Repair undercut or eroded areas at culverts, flumes, or swale blocks. °Nutrient and pesticide use management (2). °Dethatch swale bottom and remove thatching. Dispose via composting and land application. As an alternative, remove grass clippings following mowing.
Swirl Box	Quarterly	As Needed	°Remove accumulated sediment from structures to facilitate box cleanout. Sediment should be disposed of properly. (1,3) Cleanout may be performed by suction hose and tank truck and/or by high-pressure jet washing.

Notes: 1. Excessive petroleum hydrocarbon contamination can present severe sediment disposal/cleanup problems. Evidence of such pollution includes very dark oily stains, particularly at inlet and outlet structures and strong odors of gasoline, etc. The source of such inputs should be determined and removed if possible. Otherwise, pretreatment practices should be used as necessary to insure that influent runoff water is not contaminated beyond levels normally observed in runoff from highways and parking lots.

2. Use only pesticides approved by US EPA and FDACS for aquatic sites to control weed pests in and around treatment facilities. Use of pesticides and chemicals for the control of invasive species and common undesirable aquatic plants should be minimized. Careful herbicide selection and application is essential to minimize harm to desirable plants and animals. If done on a routine basis mechanical removal can help control unwanted aquatics and minimize the use of chemicals. However, experienced trained applicators can selectively control many undesirable plants with minimum harm to desirable vegetation and possible downstream contamination. FDEP regional biologist, with the Bureau of Aquatic Plant Management and/or County Cooperative Extension Service should be contracted for assistance.

Soil amendments (fertilizer) should be used as needed to establish and maintain healthy and vigorous cover on the banks of treatment facilities. However, normal rates of fertilization should be lowered in the immediate vicinity of treatment facilities to avoid over-enrichment of the soil and adjacent waters. Apply soil amendments only when grass shows signs of distress once ground cover is well established. Clippings should be removed periodically to prevent the buildup of nutrients in vegetation subject to periodic or frequent inundation.

Problem areas susceptible to chronic erosion require more intense measures for protection and establishment of permanent vegetative cover. These special considerations may include the use of sod in lieu of seeding and/or the use of higher rates of soil amendments and supplemental moisture during dry weather conditions to insure more rapid establishment or vigorous growth in bank vegetation. Experts in soil conservation are available for assistance by contacting the Natural Resources Conservation Service with USDA.

3. Sediments associated with storm water treatment devices should be regarded as contaminated well beyond the levels in runoff itself. As such, if disposed of haphazardly, this material may become a source of pollution for substances like heavy metals, petroleum hydrocarbons, other organic compounds and pesticides, as well as infectious organisms, nutrient and oxygen demanding substances. However, absent the regular addition of reuse, paints, solvents cleaning agents, pesticide and fuel spills, etc., there is little probability that these materials would be concentrated to the extent so as to be considered "hazardous waste". In most cases, sediment removed from basins may be land spread on-site in areas of restricted access, provided proper practices are used to limit wind and water erosion such that off-site discharge is minimized. Off-site disposal must be either to an approved landfill (landfill cover) or an approved sludge application site. Sediment from facilities serving major urban highways, industrial facilities, commercial facilities, and fuel transfer facilities should be tested to determine the proper level of precaution for disposal. Contact FDEP Storm Water and NPS Management Section for more information regarding appropriate testing and disposal methods.

1. *Structural Controls and Stormwater Collection System Operation:* (continued)

   b. Additionally, to satisfy the requirements of this section, the permittee(s) shall continue to implement the Stormwater Management Programs identified in Part III.A.1. of this permit.

2. *Areas of New Development and Significant Redevelopment:* Continue the comprehensive master planning process (or equivalent) to reduce to the *Maximum Extent Practicable (MEP)* the discharge of pollutants from MS4s, which receive discharges from areas of new development and significant redevelopment, after construction is completed. The master planning process shall limit the increases in the discharge of pollutants in stormwater as a result of new development, and shall reduce the discharge of pollutants in stormwater from redeveloped areas, consistent with the requirements set forth in Rule 62-40, F.A.C.

   a. To satisfy the requirements of this section, the permittee(s) shall continue to implement the Stormwater Management Programs identified in Part III.A.2. of this permit.

3. *Roadways:* Public streets, roads, and highways shall be operated and maintained in a manner to reduce to the *Maximum Extent Practicable (MEP)* the discharge of pollutants in stormwater.

   a. To satisfy the requirements of this section, the permittee(s) shall continue to implement the Stormwater Management Programs identified in Part III.A.3. of this permit. The permittee(s) shall continue to implement standard road repair practices to reduce the pollutants in stormwater runoff from areas associated with road repair and maintenance.

4. *Flood Control Projects:* Water quality impacts on receiving water shall continue to be assessed and minimized for all flood management projects identified in the basin master planning process or comparable planning process. Water quality treatment will be provided for all flood control projects as required by the rules of the applicable water management district. The feasibility of retrofitting existing structural flood control devices to provide additional pollutant removal from stormwater shall be evaluated.

   a. To satisfy the requirements of this section, the permittee(s) shall continue to implement the Stormwater Management Programs identified in Part III.A.4 of this permit.

5. *Municipal waste treatment, storage, or disposal facilities not covered by an NPDES stormwater permit:* The permittee(s) shall continue to implement a program to monitor and reduce to the *Maximum Extent Practicable (MEP)* pollutants in stormwater discharges from facilities that handle municipal waste, including sewage sludge.

   a. To satisfy the requirements of this section, the permittee(s) shall continue to implement a program as identified in Part III.A.5 of this permit to reduce pollutants in the stormwater discharges from municipally-operated solid waste transfer stations, maintenance and storage yards for waste transportation fleets and equipment, publicly owned treatment works (POTWs), and sludge application and/or disposal sites which are not covered by NPDES stormwater permits. The program shall continue procedures to evaluate, inspect, and monitor these sites.

6. *Pesticide, Herbicide, and Fertilizer Application:* Each permittee shall continue to implement controls to reduce to the *MEP*, the stormwater discharge of pollutants related to the storage and application of pesticides, herbicides, and fertilizers applied, by employees or contractors, to public

property. Permittee(s) shall implement programs to encourage the reduction of the discharge of pollutants related to application and distribution of pesticides, herbicides, and fertilizers.

a. To satisfy the requirements of this section, the permittee shall continue to implement the Stormwater Management Programs identified in Part III.A.6. of this permit.

7. *Illicit Discharges and Improper Disposal:* The permittee(s) shall continue the ongoing program to detect and eliminate (or require the discharger to the MS4 to eliminate) illicit discharges and improper disposal into the storm sewer system.

a. *Inspection, Ordinances, and Enforcement Measures:* Non-stormwater discharges to the MS4 shall be effectively prohibited by the permittee(s) through the use of inspections, ordinances, and enforcement. The permittee, however, may allow the following non-stormwater discharges to the MS4 where they are not identified as a source of pollutants to waters of the state:

- water line flushing;
- landscape irrigation;
- diverted stream flows;
- rising ground waters;
- uncontaminated ground water infiltration (as defined at 40 CFR 35.2005(20)) to separate storm sewers;
- uncontaminated pumped ground water;
- discharges from potable water sources;
- foundation drains;
- air conditioning condensate;
- irrigation water;
- springs;
- water from crawl space pumps;
- footing drains;
- lawn watering;
- individual residential car washing;
- flows from riparian habitats and wetlands;
- dechlorinated swimming pool discharges;
- street wash waters;
- discharges or flows from emergency fire fighting activities; and
- reclaimed water line flushing authorized pursuant to a permit issued under authority of Rule 62-610, F.A.C.
- flows from uncontaminated roof drains
- uncontaminated residential pressure cleaning

To satisfy the requirements of this section, the permittee(s) identified in Part III.A.7.a. of the permit shall:

(1) Continue assessment of the non-stormwater discharges listed under Part II.A.7.a. (above), as well as any other non-stormwater discharges, which will be allowed to be discharged to the MS4. Conditions to be placed on these allowable discharges shall be discussed in each subsequent ANNUAL REPORT.

(2) Enforce ordinances which prohibit illicit connections and illegal dumping into the MS4. As per the schedule in Part III.A.7.a. of this permit, the permittee(s) shall implement the inspection program developed to identify illicit connections to the MS4. The program shall include an annual schedule for inspections and an allocation of staff and resources. The permittee(s) shall maintain an internal log documenting the inspections performed and enforcement actions taken. The annual inspection schedule, allotment of staff and resources, inspections performed, and enforcement actions taken shall all be summarized for each permit year and provided within each ANNUAL REPORT. Because the potential for illicit discharges and improper disposal is generally higher for areas of older development, areas with many automobile-related industries, and areas with significant numbers of heavy industrial facilities, the permittee(s) shall consider the specific land use and age of development when determining inspection priorities and inspection schedules for this program component. Facility inspections may be carried out in conjunction with other municipal programs (e.g. pretreatment inspections of industrial users, health inspections, fire inspections, etc.), but must include random inspections for facilities not normally visited by the municipality.

b. *Dry Weather Field Screening Program:* ****RESERVED****

c. *Investigation of Suspected Illicit Discharges and/or Improper Disposal:* The permittee(s) shall continue the ongoing program to implement standard procedures to be followed to investigate portions of the MS4 that, based on the results of the dry-weather field screening conducted under the first permit term as part of the application process, or other appropriate information, indicate a reasonable potential of containing illicit discharges or other sources of non-stormwater.

(1) To satisfy the requirements of this section, the permittee(s) identified in Part III.A.7.c. of this permit shall implement standard investigative procedures to identify and terminate the source of the illicit connection or discharge in accordance with the schedule provided in Part III.A.7.c. of this permit. Upon the identification of responsible parties, the standard procedures implemented shall require the immediate cessation of improper disposal practices and the elimination of the illicit connection as expeditiously as possible. Where the elimination of an illicit connection or the submittal of a permit application pursuant to Chapter 373 or 403, F.S., or rules promulgated thereunder is not possible within a specified time frame determined by the permittee, the standard procedures shall require that the responsible parties submit for approval a written compliance schedule for the removal of the discharge. The permittee shall require the operator of the illicit discharge to take all reasonable and prudent measures to minimize the discharge of pollutants to the MS4.

(2) Additionally, to satisfy the requirements of this section, FDOT shall implement the Stormwater Management Programs identified in Part III.A.7.c. of this permit.

d. *Spill Prevention and Response:* The permittee(s) shall continue to implement procedures to prevent, contain, and respond to spills that may discharge into the MS4.

(1) To satisfy the requirements of this section, the permittee(s) shall continue to implement the Stormwater Management Programs identified in Part III.A.7.d. of this permit.

e. *Public Notification:* The permittee(s) shall continue to implement a program to promote, publicize, and facilitate public reporting of illicit discharges.

(1) To satisfy the requirements of this section, the permittee(s) shall continue to implement the Stormwater Management Programs identified in Part III.A.7.e. of this permit to facilitate public reporting of illicit discharges and improper disposal of materials into the MS4.

f. *Oils, Toxics, and Household Hazardous Waste Control:* The permittee(s) shall effectively prohibit the discharge or disposal of used motor vehicle fluids, household hazardous wastes, grass clippings, leaf litter, and animal wastes into the MS4.

(1) To satisfy the requirements of this section, the permittee shall continue to implement the Stormwater Management Programs identified in Part III.A.7.f. of this permit.

g. *Limitation of Sanitary Sewer Seepage:* The permittee(s) shall prevent (or require the operator of the sanitary sewer to minimize) unpermitted discharges of dry and wet weather overflows from sanitary sewers into the MS4. Each permittee shall minimize the infiltration of seepage from sanitary sewers into the MS4.

(1) To satisfy the requirements of this section, the permittee(s) shall continue to implement the Stormwater Management Programs identified in Part III.A.7.g. of this permit.

8. *Industrial and High Risk Runoff:* The permittee(s) shall continue to implement a program to identify and control pollutants in stormwater discharges to the MS4 from any municipal landfill(s); hazardous waste treatment, storage, disposal and recovery facilities; facilities that are subject to EPCRA Title III, Section 313; and any other industrial or commercial discharge which the permittee(s) determine is contributing, or has the potential to contribute, a substantial pollutant loading to the MS4.

To satisfy the two (2) requirements of this section, the permittee(s) shall:

a. *Identification of priorities and procedures for inspections:* In accordance with the schedule provided in Part III.A.8.a., the permittee(s) shall continue to identify all targeted facilities and determine priority sites. Inspection procedures and schedules for the identified facilities shall be implemented. Also, the permittee(s) shall provide a listing in each ANNUAL REPORT of additionally identified industrial facilities which discharge stormwater into the MS4 which have not been previously reported.

b. *Monitoring for High Risk Industries:* To satisfy the requirements of this section, the permittee(s) shall continue to implement the Stormwater Management Programs identified in Part III.A.8.b. of this permit.

9. *Construction Site Runoff:* The permittee(s) shall continue to implement a program to reduce the discharge of pollutants from construction sites.

a. *Site Planning and Non-structural & Structural Best Management Practices:* The permittee(s) shall require the use and maintenance of appropriate structural and non-structural best management practices to reduce pollutants discharged to the MS4 during the time of construction consistent with the requirement of Rule 62-40, F.A.C.

(1) To satisfy the requirements of this section, the permittee(s) shall implement the Stormwater Management Programs identified in Part III.A.9.a. of this permit.

b. *Inspection and Enforcement:* The permittee(s) shall develop and implement a program for inspecting construction sites and for enforcing the requirement for control measures.

(1) To satisfy the requirements of this section, the permittee(s) shall implement the Stormwater Management Programs identified in Part III.A.9.b. of this permit.

c. *Site Operator Training:* The permittee(s) shall conduct appropriate education and training measures for construction site operators, and those associated with the implementation of proper stormwater, sediment & erosion control measures at construction sites.

(1) To satisfy the requirements of this section, the permittee(s) shall implement the Stormwater Management Program(s) identified in Part III.A.9.c. of this permit.

B. **Area-specific Stormwater Management Program Requirements.**

Reserved

C. **Deadlines for Program Compliance.** Except as provided in Part III, compliance with the stormwater management program shall be required upon permit issuance.

D. **Roles and Responsibilities of Permittee(s).** The Stormwater Management Program, together with any interagency agreements or interagency agreements developed subsequent to the effective date of the permit, shall clearly identify the roles and responsibilities of the permittee, where applicable. Following the issuance of the permit, interagency agreements developed and implemented must be included in the ANNUAL REPORT covering the permit year in which the agreement became effective.

E. **Legal Authority.** To the extent allowed by law, each permittee shall ensure legal authority to control discharges to and from those portions the Municipal Separate Storm Sewer System (MS4) over which it has jurisdiction. This legal authority may be a combination of statute, ordinance, permit, contract, order or inter-jurisdictional agreements between permittee(s) with adequate existing legal authority to accomplish Items 1 - 6 below.

1. Control the contribution of pollutants to the MS4 by Stormwater Discharges Associated with Industrial Activity and the quality of stormwater discharged from sites of industrial activity;

2. Prohibit illicit discharges to the MS4;

3. Control the discharge of spills and the dumping or disposal of materials other than stormwater (e.g., industrial and commercial wastes, trash, used motor vehicle fluids, leaf litter, grass clippings, animal wastes, etc.) into the MS4;

4. Control through interagency or inter-jurisdictional agreements among permittee(s) the contribution of pollutants from one portion of the MS4 to another;

5. Require compliance with conditions in ordinances, permits, contracts or orders; and

6. Carry out all inspection, surveillance and monitoring procedures necessary to determine compliance with permit conditions.

F. **Stormwater Management Program Resources.** Each permittee shall provide adequate finances to implement their activities under the Stormwater Management Program. Each permittee shall also have a source of funding for implementing all other requirements included within this NPDES stormwater permit.

G. **Stormwater Management Program Review and Modification.**

1. *Program Review:* Each permittee shall continue to participate in an annual review of the current Stormwater Management Program (SWMP) in conjunction with preparation of the ANNUAL REPORT required under Part V.C. of the permit.

2. *Program Modification:* Each permittee may modify the SWMP during the life of the permit in accordance with the following procedures:

   a. Modifications adding (but not subtracting nor replacing) components, controls, or requirements to the approved SWMP may be made by the permittee(s) at any time. A description of the modification shall be included within the subsequent ANNUAL REPORT.

   b. Modifications replacing or deleting components, controls, or requirements (such as an ineffective or unfeasible BMP or maintenance schedule) with an alternate BMP or schedule may be requested by the permittee(s) in any ANNUAL REPORT. A description of the replacement BMP or schedule shall be included in the ANNUAL REPORT along with the following information:

      (1) an analysis of why the former BMP or schedule was ineffective or infeasible (including cost prohibitive);

      (2) expectations on the effectiveness of the replacement BMP or schedule; and

      (3) an analysis of why the replacement BMP or schedule is expected to achieve the goals of the BMP which was replaced.

   c. Written approval from the Department must be received prior to implementing a modification requested pursuant to sub-paragraph b., above.

   d. Modifications requested within the ANNUAL REPORT shall be signed in accordance with Rule 62-620.305, F.A.C., by the directly affected permittee(s), and shall include a certification that all affected permittee(s) were given an opportunity to comment on proposed changes.

3. *Transfer of Ownership, Operational Authority, or Responsibility for Stormwater Management Program Implementation:* The permittee(s) shall implement the SWMP on all new areas added to their portion of the municipal separate storm sewer system (or for which they become responsible for implementation of stormwater quality controls) as expeditiously as practicable. Transfer of ownership shall be in accordance with Rule 62-624.700, F.A.C.

PART III. SCHEDULES FOR IMPLEMENTATION AND COMPLIANCE

The permittee(s) shall comply with the following schedules for Stormwater Management Program implementation and permit compliance.

A. **IMPLEMENTATION OF STORMWATER MANAGEMENT PROGRAMS**

STORMWATER MANAGEMENT PROGRAM:
1. *Operation and Maintenance of Structural Controls and Stormwater Collection Systems.*

PERMITTEE(S)	ACTIVITY	DATE DUE/ FREQUENCY
All Except FDOT	Conduct inspections and maintenance of structural controls as per Table II.A.1.a., of the permit. Maintain an internal record keeping system to schedule and document inspections and maintenance activities performed on structural controls owned, operated and maintained by Co-Permittees. Provide a summary of inspections and maintenance in each Annual Report (report quantifiable items in the Summary Table).	Annual Requirement
FDOT	Perform inspections and maintenance of the structural controls discharging to the MS4 within FDOT's jurisdictional area. Maintain an internal record keeping system to track inspections and maintenance activities performed on the structural controls. Annually assess the accomplishments of the inspection and maintenance program as compared to the suggested maintenance schedule outlined in the Section 4.0 – Maintenance Plan of the statewide FDOT Stormwater Management Plan dated September 1997; Annual Requirements.	Annual Requirement

STORMWATER MANAGEMENT PROGRAM:
2. *Control of Discharges from Areas of New Development and Significant Redevelopment.*

PERMITTEE(S)	ACTIVITY	DATE DUE/ FREQUENCY
All Except FDOT	Continue to adhere to the Policies/Ordinances/Comprehensive Plans which are designed to protect the MS4's natural resources and minimize the effects of new development and significant re-development on stormwater quality. During Years 1 and 2, each Co-Permittee shall conduct a review of their current Land Development Regulations to determine where changes can be made to reduce the stormwater impact of new development. In particular, focus on changes to the code that will promote: reductions in impervious surfaces, the use of swales, the incorporation of low impact development principles, stormwater reuse, and adherence to the principles of the Florida yards and Neighborhoods program in new landscaping. In the Year 3 ANNUAL REPORT, provide a summary of recommended changes to the code with a schedule for implementation.	Date of Permit Issuance
	Continue to employ the requirements of the Policies/Ordinances/Comprehensive Plans that require new development to meet certain design criteria including on-site stormwater retention systems which provide for some filtration and removal of pollutants before discharging into a surface water body.	Date of Permit Issuance
	Continue procedures for post-development maintenance and proper operation of stormwater related improvements within areas of new development or significant re-development in the MS4 jurisdictional area.	Date of Permit Issuance

STORMWATER MANAGEMENT PROGRAM:
2. ***Control of Discharges from Areas of New Development and Significant Redevelopment.***

PERMITTEE(S)	ACTIVITY	DATE DUE/ FREQUENCY
Palm Beach County	Continue to perform drainage studies on the MS4s that receive discharges from areas of new development and significant re-development. Include in each subsequent annual report an updated map of the existing municipal-owned stormwater drainage system.	Annual Requirement
FDOT	Continue to employ the FDOT Drainage Connection Permit requirements which include a "certification of water quality" to be provided by the connecting entity. Connecting entities will be required to maintain the discharge of acceptable water quality for the duration of the FDOT Drainage Connection permit. Connecting entities failing to meet this requirement after sufficient warning by FDOT, will be reported to FDEP, SFWMD, and where applicable, to the local municipality to regulate the stormwater quality through State rules, ordinances, and codes.	Date of Permit Issuance

STORMWATER MANAGEMENT PROGRAM:
3. *Roadways.*

PERMITTEE(S)	ACTIVITY	DATE DUE/ FREQUENCY
All Except FDOT	Continue the street maintenance program, that may include a street sweeping program within each Co-Permittee's jurisdictional area and properly dispose of the collected material.	Date of Permit Issuance
	Continue to provide a description of the litter control programs employed in each Co-Permittee's jurisdictional area. Implement the program and provide proper disposal of collected material.	Date of Permit Issuance
	Provide a copy within each Annual Report of the Co-Permittee's schedule for the approaching year for routine inspections land maintenance as required to maintain optimal working conditions of stormwater structures (i.e., catch basins) and roadside ditches.	Annual Requirement
	Continue to implement standard practices employed to reduce the pollutants in stormwater from areas associated with road repair and from municipally-owned and operated equipment yards and maintenance shops that support road maintenance activities.	Date of Permit Issuance
All including FDOT	Continue to perform scheduled maintenance on catch basins, grates and other storm water structures and roadside ditches and properly dispose of the accumulated sediments. Maintain an internal log documenting the maintenance activities.	Date of Permit Issuance
FDOT	Continue the Litter Control Program for highways and streets within jurisdictional area and properly dispose of collected material.	Date of Permit Issuance
	Continue coordinating the Adopt-A-Highway program for local organizations to be identified with specific highway cleanup and beautification projects.	Date of Permit Issuance

STORMWATER MANAGEMENT PROGRAM:
4. Ensure Flood Control Projects Consider Water Quality Impacts.

PERMITTEE(S)	ACTIVITY	DATE DUE/ FREQUENCY
All Except FDOT	For new flood control projects, adhere to the treatment performance standards set forth in the State Water Policy. In addition, comply with any additional or more stringent design requirements in local codes. Assure that all flood control projects include stormwater treatment consistent with the requirements of South Florida Water Management District rules.	Date of Permit Issuance
	Continue with procedures to verify that flood management projects under the control of the permittee assess the impacts on the water quality of the receiving water. Provide, in each subsequent Annual Report, a copy of the procedures and programs (or updated versions upon development) for incorporation into the permit.	Date of Permit Issuance
	Maintain a schedule for the flood control & water quality improvements. Maintain a list of the priority projects proposed for design and construction during the five year term of this permit. Provide additions and/or deletions to this list in each subsequent Annual Report.	Date of Permit Issuance
FDOT	Continue to update the Five Year Work Program. Provide a summary of currently approved projects and construction schedules for FDOT District One in each Annual Report (report quantifiable items in the Summary Table.)	Date of Permit Issuance

STORMWATER MANAGEMENT PROGRAM:

5. ***Identification, Monitoring, and Control of Discharges from Municipal Waste Treatment, Storage, or Disposal (TSD) Facilities not covered by an NPDES stormwater permit.***

PERMITTEE(S)	ACTIVITY	DATE DUE/ FREQUENCY
All Except FDOT	Continue evaluation, via monitoring and inspection, of municipally-owned and operated solid waste transfer stations and waste transportation fleet maintenance & storage yards to determine the necessary control measures and procedures to be implemented. The program shall identify these facilities, and shall determine the necessary control measures and procedures to be employed at each facility.	Date of Permit Issuance
	Continue implementation of the program to control discharges from municipal waste treatment, storage and disposal facilities.	Date of Permit Issuance

STORMWATER MANAGEMENT PROGRAM:

6. *Control of Pollutants Related to Application of Pesticides, Herbicides, and Fertilizers.*

PERMITTEE(S)	ACTIVITY	DATE DUE/ FREQUENCY
All Except FDOT	Continue the program and procedures to minimize the use of pesticides, herbicides, and fertilizers and to properly apply, store and mix these products. The program shall include implementation of proper training and procedures for municipal employees who apply, store, and mix these products. Training and certification for municipal employees who handle these products can be done through cooperation with the University of Florida IFAS Cooperative Extension Service. The program should also consider including components such as adopting landscaping ordinances which encourage xeriscaping and the use of native Florida plants and slow release fertilizers. The Co-Permittee shall maintain a list of the material safety data sheets for each chemical used and shall store chemicals indoors in secure facilities.	Date of Permit Issuance
	Continue implementation of standardized procedures to store and mix pesticides, herbicides, and fertilizers.	Annual Requirement
All including FDOT	Require evidence of proper certification and licensing for all applicators contracted to apply pesticides, herbicides, and fertilizers on municipal and FDOT property.	Annual Requirement
	Continue outreach programs to encourage the public to reduce their use of pesticides, herbicides, and fertilizers. The program should consider including xeriscaping planning assistance and promoting voluntary use of native Florida plantings, organic soil amendments such as compost, proper nutrient management, and the use of slow-release fertilizers. Compliance with this requirement may be satisfied through participation, support, and promoting the implementation of the Florida Yards and Neighborhoods program administered by the Palm Beach County Extension Service.	Date of Permit Issuance
	Provide a summary of the public education programs, including the number of participants, where applicable, in subsequent Annual Reports.	Annual Requirement

STORMWATER MANAGEMENT PROGRAM:

7. a.) Illicit Discharges and Improper Disposal - Inspections, Ordinances, and Enforcement Measures.

PERMITTEE(S)	ACTIVITY	DATE DUE/ FREQUENCY
All Except FDOT	Continue to implement inspection programs to enforce ordinances prohibiting illicit connections and illegal dumping into the MS4. Maintain an internal log documenting inspections and enforcement actions performed and provide a summary of these records in each Annual Report.	Date of Permit Issuance
	Where applicable, strengthen the legal authority to control illegal dumping and spills into the MS4 and to require compliance with conditions in ordinances, permits, contracts and orders. Include copies of newly issued or developed signed ordinances within the subsequent Annual Reports after adoption.	Date of Permit Issuance
FDOT	Instruct maintenance crews and contractors to be alert for illicit connections and suspicious flows during routine maintenance activities. FDOT shall investigate observances found within the right of way. Those located outside of the right of way shall be reported to the applicable municipality for further investigation and enforcement action.	Date of Permit Issuance

STORMWATER MANAGEMENT PROGRAM:
7. b.) Illicit Discharges and Improper Disposal - Field Screening.

PERMITTEE(S)	ACTIVITY	DATE DUE/ FREQUENCY
All	***RESERVED***	Date of Permit Issuance

STORMWATER MANAGEMENT PROGRAM:
7. c.) Illicit Discharges and Improper Disposal - Investigation of Suspected Illicits and/or Improper Disposal.

PERMITTEE(S)	ACTIVITY	DATE DUE/ FREQUENCY
All Except FDOT	Continue to implement the standard investigative procedures to identify and terminate the source(s) of illicit connections or discharges to the MS4. Formalize the reporting process for all field personnel through the development of explicit written procedures and designation of a single, central reporting point which will have the responsibility for maintaining all reports. Based upon reports received, investigate suspected illicit discharges. Through additional sampling and systematically tracing the source upstream from the point of initial detection, identify the source and begin enforcement action to correct or eliminate the problem. Provide a summary in each Annual Report of the results of the investigations conducted and the follow-up on enforcement actions.	Within 12 months of permit issuance
	Continue to implement a periodic training course to educate municipal personnel and field staff to identify and report conditions in the stormwater facilities that may indicate the presence of illicit discharges to the MS4.	Date of Permit Issuance
FDOT	Continue to implement standard procedures to identify the source(s) of illicit connections or discharges to the FDOT MS4 within the FDOT right-of-way. Suspected illicit connections or discharges located outside of the FDOT right-of-way shall be reported to the applicable municipality for further investigation and enforcement action.	Date of Permit Issuance

STORMWATER MANAGEMENT PROGRAM:
7. d.) Illicit Discharges and Improper Disposal - Spill Prevention and Response.

PERMITTEE(S)	ACTIVITY	DATE DUE/ FREQUENCY
Palm Beach County	Train firefighters dealing with hazardous materials and spill management (Palm Beach County Hazardous Material Response Teams) biennially to heighten awareness of water quality issues and potential pollutant discharges to surface waters.	Date of Permit Issuance
FDOT	Implement the FDOT Procedures for Hazardous Materials or Petroleum spills, incidences and Management or Reporting of Damage Repair and the emergency Management Program which effectively mitigate potential pollutant discharges to surface waters.	Date of Permit Issuance
All except FDOT & Palm Beach County	Continue the training of appropriate personnel in spill preventions and response procedures and in techniques to mitigate pollution discharge from spills to the MS4 and surface waters, within each Co-Permittees jurisdictional area. Personnel shall be trained to recognized and quickly assess the nature of spills and to properly report all spills to the appropriate authority. For hazardous spills, municipalities shall endeavor the follow the procedures of the Palm Beach County Hazardous Material Response Teams.	Date of Permit Issuance

STORMWATER MANAGEMENT PROGRAM:
7. e.) Illicit Discharges and Improper Disposal - Public Notification.

PERMITTEE(S)	ACTIVITY	DATE DUE/ FREQUENCY
All Except FDOT	Continue to maintain dedicated phone line for citizen reporting of suspected illicit discharges and dumping. This requirement may be satisfied through cooperative efforts with other Co-Permittees, supported by written agreement. Each Co-Permittee shall publicize the existence of this "illicit discharge reporting hotline number" on a quarterly basis and shall include information on the problems associated with illicit connections or discharges, how to spot them, and how to report incidents. The municipal newsletter, utility bill inserts, radio, or television may be utilized in the publicity program.	Date of Permit Issuance
	Evaluate and where applicable, include an illicit discharge component to the existing "Crime Watch" guide for citizens and neighborhood leaders/contact persons.	Date of Permit Issuance
All Including FDOT	Maintain the citizen complaint log documenting all reports of illicit discharges and what actions were taken to investigate and resolve the problem. Include a summary of the log in each Annual Report.	Date of Permit Issuance
FDOT	Maintain the direct dial local telephone number at the District Office to be used specifically for the reporting of illicit connections, accidental spills, illegal dumping, or other water quality violations to the District NPDES Coordinator for investigations and action as needed. This requirement may be satisfied through cooperative efforts with other permittees.	Date of Permit Issuance

STORMWATER MANAGEMENT PROGRAM:
7. f.) Illicit Discharges and Improper Disposal - Oils, Toxics, and Household Hazardous Waste Control.

PERMITTEE(S)	ACTIVITY	DATE DUE/ FREQUENCY
All Except FDOT	Continue implementation of the outreach programs to instruct the public on the proper disposal of used motor oil, leftover hazardous household products and lead acid batteries, and to publicize the locations of the Palm Bach County operated collection sites for these products. This requirement may be satisfied through cooperative efforts with other Co-Permittees, supported by written agreement.	Date of Permit Issuance
	Evaluate and where applicable, implement or continue to actively promote the voluntary stenciling program for all Co-Permittee storm sewer inlets which discharge directly or indirectly into surface waters.	Date of Permit Issuance

STORMWATER MANAGEMENT PROGRAM:
7. g.) Illicit Discharges and Improper Disposal - Limitation of Sanitary Sewer Seepage.

PERMITTEE(S)	ACTIVITY	DATE DUE/ FREQUENCY
All Except FDOT	Continue to update and identify areas served by septic systems. Advise appropriate agency of potential violation if constituents common to wastewater contamination due to malfunctioning septic tank systems are discovered in the MS4 during any inspection.	Date of Permit Issuance
All Including FDOT	Advise appropriate utility owner of potential violation if constituents common to wastewater contamination are discovered in the MS4 during any inspection.	Date of Permit Issuance

STORMWATER MANAGEMENT PROGRAM:

8. a.) Industrial and High Risk Runoff - Identification of priorities and procedures for inspections.

PERMITTEE(S)	ACTIVITY	DATE DUE/ FREQUENCY
All Except FDOT	Maintain an inventory of all existing high risk facilities discharging in the MS4. The inventory shall identify the outfall and surface waterbody into which each high risk facility discharges. Prioritize identified high risk facilities. Include an update in each Annual Report.	Date of Permit Issuance
	Continue inspection program procedures for high risk facilities to determine compliance with all appropriate aspects of the stormwater program (e.g., no illicit connections, compliance with local stormwater regulation requirements, and if the facility is required to have NPDES permit coverage, a copy of the SWPPP is on site). Maintain a log of the inspections performed.	Date of Permit Issuance
All Including FDOT	Instruct and train maintenance personnel and contractors to be alert for signs of illicit connections and suspicious flows during routine maintenance activities in areas which have been identified to contain high risk facilities. FDOT will investigate suspect flows.	Date of Permit Issuance
FDOT	Maintain an inventory of all existing high risk facilities discharging into the FDOT MS4 and include an update in each Annual Report of any additional identified industrial facilities not previously listed. This inventory shall identify the outfall and surface waterbody into which each high risk facility drains. High risk facilities shall include municipal landfills, hazardous waste treatment storage, disposal and recovery facilities, facilities that are subject to EPCRA Title III, Section 313, and any other industrial or commercial discharge which the permittee determines is contributing a substantial pollutant loading to the FDOT MS4.	Date of Permit Issuance

STORMWATER MANAGEMENT PROGRAM:
8. b.) Industrial and High Risk Runoff - Monitoring for High Risk Industries.

PERMITTEE(S)	ACTIVITY	DATE DUE/ FREQUENCY
All Including FDOT	Monitoring may be required on an as-needed basis in the event that inspections of high risk facilities disclose suspected illicit discharges to the MS4. New high-risk industrial facilities as defined in 40CFR122.26(d)(2)(iv)(C) must be evaluated to determine if the new discharge is contributing a substantial pollutant load to the MS4. The evaluation may include site-specific monitoring.	Date of Permit Issuance

STORMWATER MANAGEMENT PROGRAM:
9. a.) Construction Site Runoff - Site Planning & Structural and Non Structural Controls.

PERMITTEE(S)	ACTIVITY	DATE DUE/ FREQUENCY
All Except FDOT	Implement the Co-Permittee Ordinances and Land Development Codes which require construction site planning approval and the structural and non-structural controls during construction to reduce pollutants to receiving waters.	Date of Permit Issuance
	Continue to require all new development obtain stormwater or Environmental Resource Permit from the South Florida Water Management District or DEP district office, prior to land clearing. Require that the NOI be submitted to DEP for coverage under the NPDES Generic Permit for construction activities related to new development within the County & Co-Permittees jurisdiction.	Date of Permit Issuance.
	Continue to evaluate innovative structural and non-structural BMPs and new technologies as they evolve to determine their efficiency and effectiveness in the field. Continue to adopt those requirements suitable for use in Co-Permittee projects.	Date of Permit Issuance
	Provide a summary of the program to review and verify compliance with construction plans, and report the number of construction projects reviewed in each Annual Report (report quantifiable items in the Summary Table.)	Annual Requirement
FDOT	Require entities connecting to the FDOT MS4 system that are subjected to the NPDES Stormwater regulations to provide FDOT a copy of the notice of Intent (NOI) requesting coverage under FDEP's general permit for construction activities.	Date of Permit Issuance

STORMWATER MANAGEMENT PROGRAM:
9. b.) Construction Site Runoff - Inspection and Enforcement.

PERMITTEE(S)	ACTIVITY	DATE DUE/ FREQUENCY
All Except FDOT	Continue to implement the inspection program for construction projects, to ensure compliance with local stormwater requirements and the Co-Permittee's development requirements. Maintain an internal log documenting inspections conducted. Report the number of construction inspections and enforcement activities performed by the each Co-Permittees for each year of permit coverage and report the results in each ANNUAL REPORT.	Date of Permit Issuance
	Implement the formalized checklist covering current stormwater management and water quality inspection items in order to standardize the inspection process. Include verification that the construction sites subject to the NPDES Stormwater regulations have a Stormwater Pollution Prevention Plan.	Date of Permit Issuance
	Maintain training and supporting materials to present an annual course for all inspectors on proper building and construction stormwater management and erosion and sediment control BMPs for construction sites and on protocol to facilitate compliance.	Date of Permit Issuance
	Maintain the inspector's role to include inspections for compliance with erosion and sediment control BMPs on construction sites.	Date of Permit Issuance

STORMWATER MANAGEMENT PROGRAM:
9. b.) Construction Site Runoff - Inspection and Enforcement (cont.)

PERMITTEE(S)	ACTIVITY	DATE DUE/ FREQUENCY
All Except FDOT and Special Districts	Maintain enforcement of inspection program by issuing a violation notice and/or a stop work order to those construction site operators which repeatedly do not maintain compliance with the approved erosion and sediment control BMPs and permit conditions.	Date of Permit Issuance
Special Districts	Maintain an inspection program of those construction site operators which repeatedly do not maintain compliance with the approved erosion and sediment control BMPs and permit conditions. Upon identification of possible permit violation, notify the jurisdictional authority of the possible violation. This requirement may be satisfied through cooperative efforts with other Co-Permittees, supported by written agreement.	Date of Permit Issuance
FDOT	Implement the developed inspection program. Refer connection entities, who are found or suspected of discharging stormwater of unacceptable quality during or following construction, to FDEP, and/or SFWMD. Maintain an internal log documenting the inspections conducted.	Date of Permit Issuance

STORMWATER MANAGEMENT PROGRAM:
9. c.) Construction Site Runoff - Site Operator Training.

PERMITTEE(S)	ACTIVITY	DATE DUE/ FREQUENCY
All Except FDOT	Continue the stormwater erosion and sediment control training/outreach program for construction site operators, Engineers, and inspectors. This requirement may be satisfied via cooperative efforts with public or private entities, including establishing a FDEP approved local training team and by providing supporting materials to present the stormwater erosion and control training/outreach program. Conduct one or more classes each year for public and private personnel involved in the construction or inspection of stormwater, erosion and sediment controls.	Within 18 Months of Permit Issuance
	Implement developed procedures to notify building permit applicants, in developments subject to the stormwater regulations, of their responsibilities under the State NPDES permitting program for construction site run off.	Date of Permit Issuance

PART V. MONITORING AND REPORTING REQUIREMENTS

A. Seasonal Loadings and Event Mean Concentrations.

1. As per Rule 62-624.500(1), F.A.C., which adopts by reference 40 CFR 122.26(d)(2)(iii)(C), the permittee(s) shall provide estimates of the seasonal pollutant load and of the event mean concentration of a representative storm for the constituents listed in Table V.A.1. for each "major watershed" within the MS4. The seasonal pollutant load and event mean concentration for each major watershed may be estimated from the representative monitoring locations, from regional or State data, or from pooling results from other nearby Florida MS4 monitoring activities and shall take into consideration land uses and drainage areas for the watershed. The estimates of seasonal loadings and event mean concentrations shall be included in the ANNUAL REPORT for Year Three of the permit.

TABLE V.A.1. - PARAMETERS	
Biochemical Oxygen Demand (BOD_5) (mg/l)	Dissolved Phosphorus (mg/l)
Chemical Oxygen Demand (COD) (mg/l)	Total Phosphorus (mg/l)
Total Suspended Solids (TSS) (mg/l)	Total Recoverable Copper (mg/l)
Total Dissolved Solids (TDS) (mg/l)	Cadmium (mg/l)
Total Kjeldahl Nitrogen (as N) (mg/l)	Total Recoverable Zinc (mg/l)

B. Monitoring Data Collection.

1. *Monitoring:* The monitoring program is intended to assist in determining the effectiveness of the stormwater management program being implemented under this permit and shall assist in identifying and prioritizing portions of the MS4 requiring additional controls. The monitoring program is also intended to help identify local sources where urban stormwater is adversely affecting surface water resources. It is the intent of FDEP to use the monitoring information collected to evaluate any trends in the reduction in pollutant loads discharged to waters of the state during the term of the permit. The pollutant loading trends will be used to evaluate the effectiveness of the permittee(s)' Stormwater Management Program to reduce the discharge of pollutants to the Maximum Extent Practicable (MEP).

   a. Within six months of permit issuance, the permittee(s) shall develop a monitoring plan and submit it to FDEP for review and approval. The monitoring plan will be developed in cooperation with FDEP's Bureau of Watershed Management in order to establish or continue a monitoring program compatible with the Bureau's rotating basin or watershed approach to monitoring. FDEP will review the monitoring plan within 60 days of its receipt and will either approve the plan or notify the permittee(s) of deficiencies that must be corrected. The permittee(s) shall make corrections and re-submit the monitoring plan within 60 days of FDEP's notification of deficiencies. The approved monitoring program shall be effective for the five-year term of this permit.

   b. Details of the monitoring program agreed upon during the first year of this permit shall be submitted to FDEP in the subsequent ANNUAL REPORT.

   c. The previously approved monitoring program shall continue to be implemented by the permittee(s) upon issuance of this permit, and shall continue until a new program is established under paragraph a. of this sub-section.

d. Develop and maintain a GIS layer which attaches water quality information to receiving waters identified within existing land use. Use this information to provide evidence of trends on an annual basis.

2. *Monitoring Data:* For Part V.B.1., records shall be maintained of all analytical results.

3. *Sample Analysis:* All samples collected for Part V.B.1. shall be analyzed in accordance with the methods specified at 40 CFR Part 136 as incorporated by reference by Rule 62-620.100(3)(j), F.A.C. and the Department's quality Assurance requirements as detailed in Rule 62-160, F.A.C.

4. *Sampling Waiver.* When a discharger is unable to collect samples required by Part V.B.1. due to adverse climatic conditions, the discharger must submit in lieu of sampling data, a description of why samples could not be collected, including available documentation of the event. Adverse climatic conditions which may prohibit the collection of samples include weather conditions that create dangerous conditions for personnel (such as local flooding, high winds, hurricane, tornadoes, electrical storms, etc.) or otherwise make the collection of a sample impracticable (drought, etc.).

C. **Annual Report.** Each permittee shall contribute to the preparation of an annual system-wide report to be submitted by no later than six months following the period covered by the report. The ANNUAL REPORT shall cover the 12 month period beginning on the date of issuance of this permit and annually thereafter. Permittee(s) shall submit one hard copy of the ANNUAL REPORT and are highly encouraged to make use of electronic media for submittal of duplicate copies of ANNUAL REPORT information.

The preparation and submittal of a system-wide ANNUAL REPORT shall be coordinated by a *"committee."* The *"committee"* shall include a member or designated representative from each permittee covered by this permit. Each permittee shall be individually responsible for providing information on the portions of the MS4 for which they are the operator and for providing information for the system-wide report in a timely manner. Joint responsibility for the ANNUAL REPORT submission shall be limited to the following: (1) participation in preparation of the overview for the entire system; and (2) inclusion of the identity of any permittee who failed to provide input to the report. Each permittee shall sign and certify the ANNUAL REPORT in accordance with Part V.D. of this permit, and shall include a statement or resolution that the permittee's governing body or agency (or delegated representative) has reviewed or has been apprized of the content of the ANNUAL REPORT.

The ANNUAL REPORT shall be prepared in accordance with the requirements of Rule 62-624.600, F.A.C.

D. **Certification and Signature of Reports.**

All reports required by the permit and other information requested by FDEP shall be signed and certified in accordance with Rule 62-620.305, F.A.C.

E. **Reporting: Where and When to Submit.**

1. Signed copies of the ANNUAL REPORT required by Part V.C. and all other reports required herein, shall be submitted to:

Florida Department of Environmental Protection
NPDES Stormwater Section, Mail Station 2500
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

F. **Additional Notification.**

None.

G. **Retention of Records.**

The permittee(s) shall retain the latest version of the Stormwater Management Program developed in accordance with Part II of this permit in accordance with the provisions of 62-620.350, F.A.C.

PART VI. OTHER SPECIFIC CONDITIONS

A. Reopener Clause

1. This permit may be reopened and revised, or revoked and reissued, for good cause as defined in Rule 62-620.325(1)(b), F.A.C.

2. The permit may be reopened and revised during the life of the permit to:

   a. Adjust effluent limitations or monitoring requirements should future adopted total maximum daily load (TMDL), water quality studies, DEP approved changes in water quality standards, or other information show a need for a different limitation or monitoring requirement.;

   b. Address impacts on receiving water quality caused, or contributed to, by discharges from the MS4;

   c. Address changes in State or Federal statutory or regulatory requirements; or

   d. Include the addition of a new permittee who is the owner or operator of a portion of the Municipal Separate Storm Sewer System.

B. Duty to Reapply

1. The permittee shall submit an application to renew this permit at least 180 days before the expiration date of this permit, or in the fourth year annual report. Reapplication must be in accordance with Rule 62-624.420, F.A.C.

2. An application filed in accordance with subsection 1 of this section shall be considered timely and sufficient. When an application for renewal of a permit is timely and sufficient, the existing permit shall not expire until the Department has taken final action on the application for renewal or until the last day for seeking judicial review of the agency order or a later date fixed by order of the reviewing court.

3. The late submittal of a renewal application shall be considered timely and sufficient for the purpose of extending the effectiveness of the expiring permit only if it is submitted and made complete before the expiration date.

PART VII. General Conditions

1. The terms, conditions, requirements, limitations and restrictions set forth in this permit are binding and enforceable pursuant to Chapter 403, Florida Statutes. Any permit noncompliance constitutes a violation of Chapter 403, Florida Statutes, and is grounds for enforcement action, permit termination, permit revocation and reissuance, or permit revision. *[62-620.610(1), F.A.C]*

2. This permit is valid only for the specific processes and operations applied for and indicated in the approved drawings or exhibits. Any unauthorized deviation from the approved drawings, exhibits, specifications or conditions of this permit constitutes grounds for revocation and enforcement action by the Department. *[62-620.610(2), F.A.C.]*

3. As provided in Subsection 403.087(6), F.S., the issuance of this permit does not convey any vested rights or any exclusive privileges. Neither does it authorize any injury to public or private property or any invasion of personal rights, nor authorize any infringements of federal, state, or local laws or regulations. This permit is not a waiver of or approval of any other Department permit or authorization that may be required for other aspects of the total project which are not addressed in this permit. *[62-620.610(3), F.A.C.]*

4. This permit conveys no title to land or water, does not constitute state recognition or acknowledgment of title, and does not constitute authority for the use of submerged lands unless herein provided and the necessary title or leasehold interests have been obtained from the State. Only the Trustees of the Internal Improvement Trust Fund may express State opinion as to title. *[62-620.610(4), F.A.C.]*

5. This permit does not relieve the permittee(s) from liability and penalties for harm or injury to human health or welfare, animal or plant life, or property caused by the construction or operation of this permitted source; nor does it allow the permittee(s) to cause pollution in contravention of Florida Statutes and Department rules, unless specifically authorized by an order from the Department. The permittee(s) shall take all reasonable steps to minimize or prevent any discharge, reuse of reclaimed water, or residuals use or disposal in violation of this permit which has a reasonable likelihood of adversely affecting human health or the environment. It shall not be a defense for a permittee(s) in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit. *[62-620.610(5), F.A.C.]*

6. If the permittee(s) wishes to continue an activity regulated by this permit after its expiration date, the permittee(s) shall apply for and obtain a new permit. *[62-620.610(6), F.A.C.]*

7. This permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by the permittee(s) for a permit revision, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not stay any permit condition. *[62-620.610(8), F.A.C.]*

8. The permittee(s), by accepting this permit, specifically agrees to allow authorized Department personnel, including an authorized representative of the Department and authorized EPA personnel, when applicable, upon presentation of credentials or other documents as may be required by law, and at reasonable times, depending upon the nature of the concern being investigated, to:
   a. Enter upon the permittee(s)'s premises where a regulated facility, system, or activity is located or conducted, or where records shall be kept under the conditions of this permit;
   b. Have access to and copy any records that shall be kept under the conditions of this permit;
   c. Inspect the facilities, equipment, practices, or operations regulated or required under this permit; and
   d. Sample or monitor any substances or parameters at any location necessary to assure compliance with this permit or Department rules. *[62-620.610(9), F.A.C.]*

9. In accepting this permit, the permittee(s) understands and agrees that all records, notes, monitoring data, and other information relating to the construction or operation of this permitted source which are submitted

to the Department may be used by the Department as evidence in any enforcement case involving the permitted source arising under the Florida Statutes or Department rules, except as such use is proscribed by Section 403.111, Florida Statutes, or Rule 62-620.302, F.A.C. Such evidence shall only be used to the extent that it is consistent with the Florida Rules of Civil Procedure and applicable evidentiary rules. [62-*620.610(10), F.A.C.]*.

10. When requested by the Department, the permittee(s) shall within a reasonable time provide any information required by law which is needed to determine whether there is cause for revising, revoking and reissuing, or terminating this permit, or to determine compliance with the permit. The permittee(s) shall also provide to the Department upon request copies of records required by this permit to be kept. If the permittee(s) becomes aware of relevant facts that were not submitted or were incorrect in the permit application or in any report to the Department, such facts or information shall be promptly submitted or corrections promptly reported to the Department. *[62-620.610(11), F.A.C.]*

11. The permittee(s), in accepting this permit, agrees to pay the applicable regulatory program and surveillance fees in accordance with Rule 62-4.052, F.A.C. *[62-620.610(13), F.A.C.]*

12. This permit is transferable only upon Department approval in accordance with Rule 62-624.700, F.A.C. The permittee(s) shall be liable for any noncompliance of the permitted activity until the transfer is approved by the Department. *[62-620.610(14), F.A.C.]*

13. The permittee(s) shall give the Department written notice at least 60 days before inactivation or abandonment of a wastewater facility and shall specify what steps will be taken to safeguard public health and safety during and following inactivation or abandonment. *[62-620.610(15), F.A.C.]*

14. Sampling and monitoring data shall be collected and analyzed in accordance with Rule 62-4.246, Chapter 62-160 and 62-601, F.A.C. and 40 CFR 136, as appropriate.
    a. Monitoring results shall be reported at the intervals specified elsewhere in this permit and shall be reported on a Discharge Monitoring Report (DMR), DEP Form 62-620.910(10).
    b. If the permittee(s) monitors any contaminate more frequently than required by the permit, using Department approved test procedures, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the DMR.
    c. Calculations for all limitations which require averaging of measurements shall use an arithmetic mean unless otherwise specified in this permit.
    d. Any laboratory test required by this permit for domestic wastewater facilities shall be performed by a laboratory that has been certified by the Department of Health and Rehabilitative Services (DHRS) under Chapter 10D41, F.A.C., to perform the test. In domestic wastewater facilities, on-site tests for dissolved oxygen, pH, and total chlorine residual shall be performed by a laboratory certified test for those parameters or under the direction of an operator certified under Chapter 61E12-41, F.A.C.
    e. Under Chapter 62-160, F.A.C., sample collection shall be performed by following the protocols outlined in "DER Standard Operating Procedures for Laboratory Operations and Sample Collection Activities" (DER-QA-001/92). Alternatively, sample collection may be performed by an organization who has an approved Comprehensive Quality Assurance Plan (CompQAP) on file with the Department. The CompQAP shall be approved for collection of samples from the required matrices and for the required tests. *[62-620.610(18), F.A.C.]*

15. Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule detailed elsewhere in this permit shall be submitted no later than 14 days following each schedule date. *[62-620.610(19), F.A.C.]*

16. The permittee(s) shall report to the Department any noncompliance which may endanger health or the environment. Any information shall be provided orally with 24 hours from the time the permittee(s) becomes aware of the circumstances. A written submission shall also be provided within 5 days of the time

the permittee(s) becomes aware of the circumstances. The written submission shall contain a description of the noncompliance and its cause; the period of noncompliance including exact dates and time, and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent recurrence of the noncompliance.

a. The following shall be included as information which must be reported within 24 hours under this condition:
   1) Any unanticipated bypass which causes any reclaimed water or the effluent to exceed any permit limitation or results in an unpermitted discharge,
   2) Any upset which causes any reclaimed water or the effluent to exceed any limitation in the permit,
   3) Violation of a maximum daily discharge limitation for any of the pollutants specifically listed in the permit for such notice, and
   4) Any unauthorized discharge to surface or ground waters.

b. If the oral report has been received within 24 hours, the noncompliance has been corrected, and the noncompliance did not endanger health or the environment, the Department shall waive the written report.

PART VIII. PERMIT REVISION

A. **Termination of Coverage for a Single Permittee**

Permit coverage may be terminated, in accordance with the provisions of Rule 62-624.300(4) and Rule 62-620.345, F.A.C., for a single permittee without terminating coverage for other permittee(s).

B. **Revision of Permit Conditions**

The permit may be revised in accordance with Rule 62-620.325, F.A.C. Modifications to the Stormwater Management Program do not require revision to the permit and can be authorized pursuant to Part II.G., of this permit.

PART IX. DEFINITIONS

Where terms are used in this permit, definitions found in Rule 62-624.200 and Rule 62-620.200, F.A.C. shall apply. Other definitions used in this permit are provided below:

A. "Best Management Practices" ("BMPs") means schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters. BMPs also include treatment requirements, operating procedures, and practices to control facility site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

B. "Discharge" for the purpose of this permit, unless indicated otherwise, refers to discharges from the Municipal Separate Storm Sewer System (MS4).

C. "Flow-weighted composite sample" means a composite sample consisting of a mixture of aliquots collected at a constant time interval, where the volume of each aliquot is proportional to the flow rate of the discharge at the time of sampling.

D. "Illicit connection" means any man-made conveyance connecting a non-stormwater discharge directly to a municipal separate storm sewer system.

E. "Storm Sewer", unless otherwise indicated, refers to a municipal separate storm sewer.

F. "Stormwater" means stormwater runoff, snowmelt runoff, surface runoff and drainage.

G. "Time-weighted composite" means a composite sample consisting of a mixture of equal volume aliquots collected at a constant time interval.

Executed in Tallahassee, Florida.

STATE OF FLORIDA DEPARTMENT OF
ENVIRONMENTAL PROTECTION

Mimi Drew
Director
Division of Water Resource Management

DATE: ____________________

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