ECONOMIC CONSIDERATIONS OF SEDIMENT QUALITY PLAN FOR ENCLOSED BAYS AND ESTUARIES IN CALIFORNIA

January 15, 2008

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Contract Number: 01-274-250-0
SAIC Project Number: 01-0833-00-0863

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Acronyms and Abbreviations

BAT	Best available technology economically achievable
BCT	Best conventional pollutant control technology
BMPs	Best management practices
BPTCP	Bay Protection and Toxic Cleanup Program
CACs	County Agricultural Commissioners
CalEPA	California Environmental Protection Agency's
Caltrans	California Department of Transportation
CCA	California Coastal Act
CCC	California Coastal Commission
CDF	California Department of Forestry
cfs	Cubic feet per second
CTR	California Toxics Rule
CSTF	Contaminated Sediments Task Force
CWA	Clean Water Act
CWC	California Water Code
CZARA	Coastal Zone Act Reauthorization Amendments of 1990
DOC	Department of Conservation
DPR	Department of Pesticide Regulation
EAD	EPA's Engineering and Analysis Division
EPA	U.S. Environmental Protection Agency
IPM	Integrated pest management
LACSD	Los Angeles County Sanitation Districts
LCP	Local costal plan
LEAs	Local Enforcement Agencies
LOE	Lines of evidence
MBNMS	Monterey Bay National Marine Sanctuary
MEP	Maximum Extent Practicable
MLOE	Multiple lines of evidence
MBNEP	Morro Bay National Estuary Program
MMs	Management measures
MS4s	Municipal separate storm sewer systems
NPDES	National Pollutant Discharge and Elimination System
OEHHA	Office of Environmental Health Hazard Assessment
OPA	Oil Pollution Act
PAHs	Polynuclear aromatic hydrocarbons
PCBs	Polychlorinated biphenyls
PCS	Permit Compliance System
Regional Water Board	Regional Water Quality Control Board
SCCWRP	Southern California Coastal Water Research Program
SFEI	San Francisco Estuary Institute
SIC	Standard Industrial Classification
SIYB	Shelter Island Yacht Basin
SMARA	Surface Mining and Reclamation Act
State Water Board	State Water Resources Control Board

SUSMP	Standard Urban Storm Water Mitigation Plan
SWMP	Storm Water Management Plans
SWPPP	Storm Water Pollution Prevention Plan
SQOs	Sediment quality objectives
THPs	Timber harvest plans
TIE	Toxicity identification evaluation
TMDL	Total Maximum Daily Load
USFS	U.S. Forest Service
WDRs	Waste discharge requirements
WWTP	Wastewater treatment plant
WWQI	Westside Water Quality Improvement

Executive Summary

The State Water Resource Control Board (State Water Board) is establishing sediment quality objectives (SQOs) and implementation procedures that apply to enclosed bays and estuaries in California (the Plan). This report provides analysis of economic factors related to the Plan.

Background

In 1989, California amended the Porter-Cologne Water Quality Control Act (Porter-Cologne) to require the State Water Board to develop SQOs as part of a comprehensive program to protect existing and future beneficial uses within enclosed bays and estuaries (Section 13393). The State Water Board is developing SQOs and an implementation policy for bays and estuaries in a phased approach due to limited availability of data for the majority of estuarine waters in the state. For enclosed bays, the State Water Board has developed the appropriate indicators with which to fully interpret the narrative objective (Phase I). However, the data needed to develop indicators for estuaries is not yet available. Thus, Phase I includes an interim approach to interpret the narrative objective in estuaries. Phase II, initiated in February 2007, will include the development of a detailed quantitative method for determining appropriate SQOs, and a final suite of indicators for interpreting the narrative objective for direct effects in estuaries (similar to the suite developed in Phase I for enclosed bays).

In establishing water quality objectives, the State Water Board considers economic factors, among others. Specifically, these economic factors include whether the objectives and alternatives under consideration are currently being attained, the methods available to achieve compliance, and the costs of those methods. The State Water Board is considering these same factors in developing the SQOs. The available compliance methods and costs depend on the types of sources that may be affected by the SQOs, which could include a variety of point and nonpoint sources.

Incremental Impact of the Plan

The incremental economic impacts of the Plan include the costs of activities above and beyond those that would be necessary in the absence of the Plan under baseline conditions, as well as the cost savings associated with actions that will no longer need to occur. Baseline conditions include current objectives and policies regulating activities and pollutant discharges that affect sediment quality (e.g., narrative Basin Plan objectives, California Toxics Rule criteria, and other policies), ongoing cleanup and remediation activities, and planned or anticipated cleanup and remediation actions that have not yet been completed [e.g., total maximum daily load development (TMDL) and implementation schedules].

Under the Plan, Regional Water Boards would list sediment as exceeding the SQOs if multiple lines of evidence (with sufficient data) indicate impairment. This requirement for additional evidence of impairment could potentially reduce the number of water bodies that would be incorrectly listed as impaired for toxic substances. Potential costs or cost savings associated with implementing the SQOs depend on the relative stringency of the objectives. **Exhibit ES-1** indicates the different incremental impacts that could occur under the Plan.

Exhibit ES-1. Incremental Impacts Associated with the Plan

Assessment Under Existing Objective	Assessment Under SQOs	
	No Sediment Impairment	**Sediment Impairment**
No Sediment Impairment	• No change in sediment quality. • Potential incremental assessment costs.	• Sediment quality improvement. • Potential incremental assessment and control costs.
Sediment Impairment	• Sediment quality remains the same as now, which may be lower than under implementation of baseline narrative objective. • Potential incremental assessment costs, but will avoid unnecessary control costs.	• Change in sediment quality if better information leads to a change in control strategies. • Potential incremental assessment costs; potential incremental costs or cost-savings depending on differences between control strategies.

Compliance with the aquatic life objective would be based on comparing coupled biological effects and chemistry data to reference site conditions. For estuaries, due to a lack of existing coupled data and known reference sites, an analysis of potential incremental impacts is not possible at this time. The State Water Board will adopt a final direct effects objective for estuaries under Phase II. Thus, it is likely that any control actions identified for compliance with the interim objective would not be implemented until it could be shown that those actions would also be required for compliance with the final objective.

For bays, the Southern California Coastal Water Research Program (SCCWRP) used the assessment matrices in the Plan to estimate compliance at sites for which available sediment monitoring data includes all three of the required sample types (toxicity, chemical exposure, and benthos community). Comparing these results to existing assessments [i.e., 303(d) listings] for the pollutants of concern in sediment, fish tissue, or the water column provides some indication of the potential incremental impacts of the Plan. This data is insufficient to determine compliance for all bays. However, for those for which data is available, the results indicate both potential incremental impairments and reduced listings, depending on the water body.

Compliance with the human health objective would be based on a human health risk assessment that utilizes OEHHA policies for fish consumption as well as other fish tissue threshold values. In the absence of the Plan, waters will continue to be listed as impaired based on exceedances of fish tissue advisory levels or criteria. Because these same levels and criteria will be used under the Plan to determine compliance with the objective there would be no incremental impacts associated with the interim human health SQO.

Monitoring and Assessment Costs

The comparison of available assessment data and existing impairments indicates that there is insufficient data to assess compliance with the SQO for a number of bays. Thus, the incremental impact of the Plan could include monitoring additional lines of evidence. Although data for some parameters may not be needed at each sampling site or for each bay, potential per sample costs may range from $3,940 to $5,810 as shown in **Exhibit ES-2**.

Exhibit ES-2. Potential Sampling Costs under the Plan

Parameter	Cost per sample
Metals suite	\$175 – \$225
Total Mercury	\$65 – \$135
PAH suite	\$400
Chlorinated pesticides	\$200 – \$575[a]
PCB congeners (not coplanar)	\$200 – \$575[a]
Sediment toxicity (acute lethal)	\$800
Sediment toxicity (sublethal)	\$800 – \$1,400
Benthic survey	\$800 – \$1,200[b]
Sediment collection on boat	\$500[c]
Total cost per sample	\$3,940 – \$5,810

Source: Chemistry cost estimates obtained from price lists used for southern California and San Francisco Bay regional monitoring programs; sediment toxicity and benthic survey costs obtained from southern California regional monitoring program and development of the Plan; sediment collection estimate from SCCWRP (2007b).
a. High estimate represents low detection limit analyses.
b. High estimate represents difficult to sort samples, such as 0.5 mm mesh screen samples in San Francisco Bay.
c. Includes the cost of the boat, crew, and any activities associated with preparing the samples for transport to the analysis laboratory (e.g., compositing and subsampling and screening of benthic samples to remove excess sediment).

The number of stations needed to assess bay sediment quality will vary based on site-specific factors. Based on between 5 and 30 samples per bay, depending on area, statewide monitoring costs to assess those bays for which existing data are insufficient (a total of 131 samples representing 20,000 acres) may range from \$516,000 to \$762,000. Costs may also be incurred for confirmatory monitoring of segments with only possibly impacted sites (no clearly or likely impacted sites).

For those sites that exceed the objectives, the next step would be a sequential approach to managing the sediments, including stressor identification. The cost of the sequential approach described in the Plan will vary depending on a number of factors, including the extent of baseline efforts and studies underway to address other impairment issues, and the number of potential stressors to the area. The State Water Board's estimate for complex TMDLs (including an implementation plan) of over \$1 million (SWRCB, 2001) provides some indication of costs that can be associated with sequential approaches to managing designated use impairments. Thus, this estimate provides an approximation of the potential magnitude of both costs and cost savings that may be associated with changes in the identification of impairments under the baseline objectives and the Plan.

There are 5 bay segments that are not on the 303(d) list for sediment related impairments for which MLOE data indicate impairment under the Plan. There are also another 3 segments not currently on the 303(d) list for which it is unclear if addressing sediment toxicity represents an incremental impact of the Plan over the existing toxicity objectives (MLOE indicate sediment toxicity; Regional Board identified sediment cleanup and remediation necessary under BPTCP). If TMDL development and implementation are needed for all eight of these segments, incremental cost could be approximately \$8 million.

There are 3 segments on the 303(d) list for sediment related impairments under the baseline for which MLOE data indicate no impairment under the Plan. Assuming that no TMDL development and implementation would be needed for these segments under the Plan, there could be a potential cost savings of $3 million. Thus, the net incremental cost associated with compliance with the Plan could be approximately $5 million ($8 million - $3 million) (or lower if such costs would be incurred in the absence of the Plan for any of the 3 sites that exhibit sediment toxicity and for which cleanup and remediation actions are necessary).

For estuaries, the State Water Board is collecting data as part of the Phase II effort to develop appropriate tools and thresholds for implementing the SQO. These data can also be used to assess compliance with the final SQO. Thus, additional monitoring may be necessary for those waters not currently being sampled as part of this effort. However, costs of these monitoring efforts cannot be estimated until the data collection effort is complete.

Clean up and Control Costs

For waters that Regional Water Boards identify as being impaired under the Plan, remediation actions and/or source controls will be needed to bring them into compliance. Many bays and estuaries are already listed for sediment impairments and, therefore, would require controls under baseline conditions. When the baseline controls are identical to the ones that would be implemented under the Plan, there is no incremental cost or cost savings associated with the Plan. When the baseline controls differ, there is potential for either incremental costs or cost-savings associated with the Plan.

Because strategies to meet current narrative objectives at many impaired sites are still in the planning stages and the overall effects of implementation strategies are unknown, estimates of incremental costs would be highly speculative. For incremental sediment remediation and/or cleanup activities to be required under the Plan, monitoring data would have to indicate biological impacts under the SQOs in areas that would not be designated for clean up under existing objectives. However, it is likely that most sites with sediment conditions that would require cleanup and remediation under the Plan would also exceed current objectives. To the extent that results differ, it is possible that the additional assessment activities under the Plan could lead to cleanup strategies that are more cost effective compared to baseline activities. In addition, based on the implementation plans for existing TMDLs, Regional Water Boards are likely to pursue source controls for ongoing sources and only require remediation activities for historical pollutants with no known, ongoing sources.

If incremental remediation activities are necessary, costs are likely to be very specific to the particular site and project. Sediment remediation and cleanup costs may range from less than $1/cy to over $1000/cy for various alternatives with different feasibility and practicality considerations (SWRCB, 1998). Preliminary estimates for dredging sediments in San Diego Bay suggest that unit costs may range from $100/cy to $200/cy, depending on the volume of sediment removed (SDRWQCB, 2007b).

For an increased source control cost associated with additional pollution controls under the Plan, the concentration of toxic pollutants in discharges would have to meet levels that are more stringent than what is needed to achieve compliance with existing objectives (e.g., since they could have to control based on the narrative sediment objectives or the CTR). Incremental costs for controls may also result from the identification of additional chemical stressors that are not included in the CTR or Basin Plans. Since many practices that may be employed under existing TMDLs are applicable for controlling the mobilization of pollutants in general, this situation is also difficult to estimate. For example, the TMDL for pesticides and PCBs in the Calleguas Creek watershed indicates that the BMPs needed to achieve the nutrient and toxicity TMDLs for the watershed would likely reduce pesticides and PCBs to necessary levels as well (LARWQCB, 2005d).

Thus, without being able to identify the particular pollutants causing biological effects, and the development of discharge concentrations needed to achieve the objectives, the needed cleanups and/or controls to achieve those concentrations are difficult to estimate. Review of existing impairments and TMDL actions for the various bays suggests that incremental impacts may be unlikely. If there are incremental impacts as a result of the Plan, controls may focus on storm water sources, marinas, and wetlands. However, some level of control for these sources would occur under the implementation plans for existing TMDLs.

For any situation in which these sources are specifically required to control toxic pollutants to levels that are lower than what would be necessary in the absence of the Plan, potential means of compliance for storm water sources include increased or additional nonstructural BMPs (e.g., institutional, education, or pollution prevention practices designed to limit generation of runoff or reduce the pollutants load of runoff); and structural controls (e.g., engineered and constructed systems designed to provide water quantity or quality control). Improving the effectiveness of nonstructural BMPs could be on the order of $26 per household (CSU Sacramento, 2005). Costs for structural controls could range from $0 to $2,500 per acre for filter strips to $3,400 per acre for wetlands in residential areas, and $4,100 per acre for infiltration basins to $19,100 per acre for sand filters in commercial areas (U.S. EPA, 1999).

For marinas and boating activities, potential means of compliance may include use of less toxic paint on boats; performing all boat maintenance activities above the waterline or in a lined channel to prevent debris from entering the water; removing boats from the water and clean in a specified location equipped to trap debris and collect wastewater; prohibiting hull scraping or any process that removes paint from the boat hull from being conducted in the water; and developing a collection system for toxic materials at harbors. For example, one marina spent $14,500 on a pollution prevention program in 1999 (MBNEP, 2000), and Carson, et al. (2002) estimated the cost of remaining life hull maintenance for 40 foot length, 11 foot width boats to range from a savings of $1,354 (new boat with nontoxic coating, good performance, and lower prices) to a cost of $6,251 (2.5 year old boat requiring stripping, fair performance, and higher prices). In addition, the cost of a unit that collects water that may contain toxic materials from boating maintenance operations so that it may be sent to the sanitary sewer could cost between $3,200 to $4,500 (Pressure Power Systems, 2007).

Wetlands controls may include aeration, channelization, revegetation, sediment removal, levees, or a combination of these practices. The extent of controls needed and the types of controls are unknown. The Central Valley Regional Water Board (2005b) provides one example of the cost of efforts underway in Anderson Marsh wetland on Cache Creek. Capital costs for controlling methylmercury export from Anderson March may range from $200,000 to $1 million, and O&M costs from $20,000 to $100,000 per year (CVRWQCB, 2005b).

For estuaries, Regional Water Boards need additional data to identify the sources that may need an incremental level of control.

1. Introduction

The State Water Resource Control Board (State Water Board) is establishing sediment quality objectives (SQOs) and implementation procedures that apply to enclosed bays and estuaries in California (the Plan). This report provides analysis of economic factors related to the Plan.

1.1 Background

In 1989, California amended the Porter-Cologne Water Quality Control Act (Porter-Cologne) to require the State Water Board to develop SQOs as part of a comprehensive program to protect existing and future beneficial uses within enclosed bays and estuaries (Section 13393). In 1991, the State Water Board prepared a work plan for the development of SQOs for enclosed bays and estuaries. This work plan included a schedule and specific tasks to develop direct effects tools that would protect benthic communities, and an element to assess the human and ecological risk in bays and estuaries from pollutants in sediments (indirect effects).

Due to significant delays, in 1999, petitioners filed a lawsuit against the State Water Board for failing, among other things, to adopt SQOs. As a result, the Superior Court ordered the State Water Board to develop SQOs for toxic pollutants as part of the Bay Protection and Toxic Cleanup Program pursuant to California Water Code (CWC) Section 13393 in accordance with a compliance schedule. The State Water Board is developing SQOs and an implementation policy for bays and estuaries in a phased approach due to limited availability of data for the majority of estuarine waters in the state.

For enclosed bays, the State Water Board has developed the appropriate indicators with which to fully interpret the narrative objectives. However, the data needed to develop indicators for estuaries is not yet available. Thus, Phase I includes an interim approach to interpret the narrative objective in estuaries. Phase II, initiated in February 2007, will develop a detailed quantitative method for determining appropriate SQOs, and a final suite of indicators for interpreting the narrative objectives for direct effects in estuaries (similar to the suite developed in Phase I for enclosed bays). Estuaries to which the final objectives will apply include, but are not limited to, the Sacramento-San Joaquin Delta as defined by Section 12220 of CWC, Suisun Bay, Carquinez Strait downstream to Carquinez Bridge, and appropriate areas of the Smith, Klamath, Mad, Eel, Noyo, and Russian Rivers.

1.2 Scope of the Economic Analysis

In establishing water quality objectives, the State Water Board considers economic factors, among others. Specifically, these economic factors include whether the objectives and alternatives under consideration are currently being attained, the methods available to achieve compliance, and the costs of those methods. The State Water Board is considering these same factors in developing the SQOs. Thus, this report addresses whether the SQOs are currently being attained, the incremental impact of the Plan on actions related to improving sediment quality, the pollution control and remediation methods available to achieve compliance the Plan, and the costs of those methods. There may also be cost savings as a result of greater accuracy in designating sediments as impacted by contaminants.

The available compliance methods and costs depend on the types of sources that may be affected by the SQOs. Potentially affected sources could include industries and municipal facilities discharging wastewater and storm water to surface waters (i.e., point sources) and nonpoint sources.

1.3 Organization of the Report

This report is organized as follows. Section 2 provides background information on factors affecting sediment quality, including sources of impairment. Section 3 describes the economic and regulatory baseline for estimating the incremental impacts of the SQOs and implementation procedures. Section 4 describes the objectives and implementation procedures. Section 5 provides estimates of the potential incremental impacts of the Plan in terms of bays that would or would not be in compliance with the objectives. Section 6 discusses potential means of compliance with the Plan and estimates of the potential costs of those methods. Section 7 provides a discussion of potential statewide costs and uncertainties of the analysis. Several appendices provide additional information related to the analysis.

2. Factors Affecting Sediment Quality

The Plan identifies a number of factors that should be considered when assessing sediment toxicity. Toxicity is determined based on the exposure of an organism to bioavailable contaminants in concert with the organism's sensitivity to the contaminant. Often, the factors affecting sediment quality are not readily identifiable. Toxicity identification evaluations (TIEs) are usually necessary to identify the specific pollutants and conditions responsible for impairments. However, there are certain classes of toxic pollutants that generally result in sediment toxicity. At a minimum, under the Plan, all samples shall be tested for the analytes identified in **Exhibit 2-1**.

Exhibit 2-1. Chemical Analytes for Characterizing Sediment Contamination

Chemical Name and Group		Chemical Name and Group	
Total Organic Carbon	General	Alpha Chlordane	Pesticide
Percent Fines	General	Gamma Chlordane	Pesticide
		Trans Nonachlor	Pesticide
Cadmium	Metal	Dieldrin	Pesticide
Copper	Metal	o,p'-DDE	Pesticide
Lead	Metal	o,p'-DDD	Pesticide
Mercury	Metal	o,p'-DDT	Pesticide
Zinc	Metal	p,p'-DDD	Pesticide
		p,p'-DDE	Pesticide
2,4'-Dichlorobiphenyl	PCB Congener	p,p'-DDT	Pesticide
2,2',5-Trichlorobiphenyl	PCB Congener		
2,4,4'-Trichlorobiphenyl	PCB Congener	Acenaphthene	PAH
2,2',3,5'-Tetrachlorobiphenyl	PCB Congener	Anthracene	PAH
2,2',5,5'-Tetrachlorobiphenyl	PCB Congener	Biphenyl Naphthalene	PAH
2,3',4,4'-Tetrachlorobiphenyl	PCB Congener	2,6-dimethylnaphthalene	PAH
2,2',4,5,5'-Pentachlorobiphenyl	PCB Congener	Fluorene	PAH
2,3,3',4,4'-Pentachlorobiphenyl	PCB Congener	1-methylnaphthalene	PAH
2,3',4,4',5-Pentachlorobiphenyl	PCB Congener	2-methylnaphthalene	PAH
2,2',3,3',4,4'-Hexachlorobiphenyl	PCB Congener	1-methylphenanthrene	PAH
2,2',3,4,4',5'-Hexachlorobiphenyl	PCB Congener	Phenanthrene	PAH
2,2',4,4',5,5'-Hexachlorobiphenyl	PCB Congener	Benzo(a)anthracene	PAH
2,2',3,3',4,4',5-Heptachlorobiphenyl	PCB Congener	Benzo(a)pyrene	PAH
2,2',3,4,4',5,5'-Heptachlorobiphenyl	PCB Congener	Benzo(e)pyrene	PAH
2,2',3,4',5,5',6-Heptachlorobiphenyl	PCB Congener	Chrysene	PAH
2,2',3,3',4,4',5,6-Octachlorobiphenyl	PCB Congener	Dibenzo(a,h)anthracene	PAH
2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl	PCB Congener	Fluoranthene	PAH
Decachlorobiphenyl	PCB Congener	Perylene	PAH
		Pyrene	PAH

Source: SWRCB (2006a).

This section describes the most common factors that affect sediment quality.

2.1 Chemical Concentrations

The State Water Board designed Phase I of the Plan, in part, to determine which sediments support a balanced, indigenous population of benthic life or do not have the potential to cause adverse human health effects and which do not. Sediments that do not support a diverse community are either toxic or have inputs and disturbances that dominate such that a healthy, balanced benthic community cannot be established. The Plan is concerned only with sediments that are impaired due to the presences of toxic pollutants that cause or have the potential to cause impacts to benthic communities or human health.

2.1.1 Metals

High loadings of metals such as cadmium, copper, lead, mercury, and zinc can result in sediment quality impairments. Heavy metals enter the water and ultimately deposit in sediments as a result of releases from both natural and anthropogenic sources. This section provides a description of those metals likely to be associated with bay sediments.

Cadmium is a trace element used in a wide variety of applications including electroplating, manufacture of pigments, storage batteries, telephone wires, photographic supplies, glass, ceramics, biocides, and stabilizer in plastics. The primary anthropogenic sources of cadmium to surface waters are metal smelters, manufacturers of alloys, paints, batteries, and plastics, agricultural runoff from the use of sludge, fertilizers, and pesticides containing cadmium, and burning of fossil fuels (LARWQCB, 2005a).

Copper is used in water and sewer pipes, brake pads, algaecides, fungicides, pesticides, and antifouling paints. Potential anthropogenic sources of copper include municipal wastewater treatment plant effluents, urban runoff, agricultural runoff, mining, smelting and refining industries, copper wire mills, coal burning industries, and iron and steel producing industries. Boats are another source of copper, especially in harbors, because antifouling paints are designed to constantly ablate or leach out (passive leaching) to reduce the attachment of fouling organisms (LARWQCB, 2005b).

Lead is primarily used in the production of lead-zinc batteries. Lead is also used in electroplating, metallurgy, construction materials, coating and dyes, electronic equipment, plastics, veterinary medicines, fuels and radiation shielding, ammunition, corrosive-liquid containers, paints, glassware, storage tank linings, solder, piping, cable sheathing, and roofing. Historically, the major source of lead to surface water was leaded gasoline. However, due to the phasing out of leaded gasoline, there has been a gradual decline of lead concentrations in the environment (LARWQCB, 2005b).

Mercury can be introduced to surface water through natural and human activities (U.S. EPA, 2000a). Mercury is found naturally in oceans and other natural waters, vegetation, volcanoes, rocks, soils, fossil fuels, and wildfires (U.S. EPA, 1997). Mercury is also used in dental amalgam, cleaning products, toiletries, batteries, thermometers, medical equipment, vehicle light switches, fluorescent lights, ceramics, and laboratory chemicals (Huber, 1997). Anthropogenic sources of mercury include mining, industrial effluent, municipal wastewater treatment plant effluent, atmospheric deposition from coal combustion, and storm water runoff. Mining, in particular, may be of greatest concern in some areas due to the combination of both historic mercury and gold mining activities.

Zinc is primarily used as a coating on iron and steel to protect against corrosion, in alloys for die-casting, in brass, in dry batteries, in roofing and exterior fittings for buildings, and in some printing processes. Zinc is released to the environment from smelting and refining activities, wood combustion, waste incineration, iron and steel production, and tire wear. Boats can also be a source of zinc to bays and harbors because zinc anodes are used to prevent corrosion (LARWQCB, 2005b).

2.1.2 Pesticides

There are a number of pesticides that contribute to the degradation of sediment quality. Many pesticides are only slightly soluble or are insoluble in water, and these pesticides generally sorb to sediments.

The use of many sediment-sorbing organochlorine pesticides has been discontinued in the United States, though some remain in use and others are manufactured strictly for export. For example, DDT, which is very insoluble and highly sorbed to the organic carbon fraction of sediment, is a pesticide that was widely used on agricultural crops to control disease-carrying insects. The United States banned uses of DDT in 1972, except for public health emergencies involving insect diseases and control of body lice. Although DDT is no longer used, it can still be found in soil particles and sediments in locations throughout the state. The primary source of DDT to surface waters is storm water runoff and soil erosion (LARWQCB, 2005a).

Toxaphene, another sediment-sorbing pesticide, was heavily used in the United States to control insect pests on cotton, other crops, and livestock, as well as to kill unwanted fish in lakes. However, the U.S. Environmental Protection Agency (EPA) banned most uses in 1982, and banned all uses in 1990 (ATSDR, 1997). Thus, like for the other banned pesticides, the major source of toxaphene to surface waters is likely storm water runoff and soil erosion.

Dieldrin (also sediment-sorbing) was widely used as a pesticide for a number of crops from the 1950s to 1970. In 1974, EPA banned all uses of dieldrin, except for termite control. Then, in 1987, EPA banned all uses (ATSDR, 2002). Because dieldrin binds tightly to soil and breaks down very slowly in soil and water, the most likely existing sources of dieldrin to surface waters are storm water runoff and soil erosion.

Unlike DDT, toxaphene, and dieldrin, endosulfan is currently used throughout the country to control insects on food and nonfood crops, and as a wood preservative (ATSDR, 2001). Endosulfan enters the environment during its manufacture and use. Because the pesticide is sprayed onto crops, it may travel long distances before it settles onto land or water. Thus, endosulfan may enter surface water through atmospheric deposition, storm water, runoff, and industrial effluents.

Similar to endosulfan, lindane is currently used as an insecticide on fruit, vegetables, and forest crops. It is also available as a prescription (lotion, cream, or shampoo) to treat head lice, body lice, and scabies. Despite continued use, lindane has not been produced in the United States since 1976 (ATSDR, 2002). Lindane may be found in municipal wastewater treatment plant effluent and agricultural runoff.

Chlordane, one of the more water soluble pesticides, was used to control insects on agricultural crops, residential lawns and gardens, and in buildings for termite control. In 1983, EPA banned all chlordane uses, except for termite control, in the United States, and banned all uses in 1988 (ATSDR, 1995). Chlordane is still manufactured in the United States for sale or use by foreign countries and persists in the environment, adhering strongly to soil particles. The major source of chlordane to surface waters is storm water runoff carrying historically deposited chlordane most likely attached to eroded sediment particles (LARWQCB, 2005b).

2.1.3 Polychlorinated Biphenyls

Polychlorinated biphenyls (PCBs) are mixtures of up to 209 individual chlorinated compounds (known as congeners) that adsorb onto sediments and thus are associated with solid particles. There are no known natural sources of PCBs. In addition, under the Toxic Substances Control Act passed in 1976, EPA prohibited the manufacture of PCBs in the United States. Prior to that time, PCBs were used in paints, as coolants and lubricants in transformers, capacitors, surface coatings, adhesives, and other electrical equipment such as fluorescent lighting fixtures and capacitors and old microscope and hydraulic oils. Historically, PCBs were introduced into the environment through discharges from industrial point sources and spills and accidental releases. Although industrial point source contributions are now controlled, nonpoint sources and storm water discharges may still be contributing to the surface water load. For example, refuse sites and abandoned facilities may still contribute PCBs to the environment (LARWQCB, 2005b).

2.1.4 Polynuclear Aromatic Hydrocarbons

Polynuclear aromatic hydrocarbons (PAHs) are a group of over 200 different chemicals primarily found naturally in coal and crude oil. Like PCBs, PAHs are typically associated with particles and adhere to sediments. PAHs are released to the environment through natural oil seeps, emissions from combustion of fossil fuels, forest fires, volcanoes, and burning of gasoline, garbage, tobacco, and other organic material. Anthropogenic sources of PAHs in surface waters include atmospheric deposition, municipal wastewater treatment plant effluents, urban storm water runoff particularly from roads, runoff from coal storage areas, effluents from wood treatment plants and other industries, oil spills, leaching from creosote pilings, and petroleum pressing (ATSDR, 1996).

2.2 Water Body and Sediment Characteristics

Aquatic organisms are exposed to sediment pollutants through transport across biological membranes either from dissolved contaminants in sediment pore water or ingestion of contaminants adhered to sediment particles (U.S. EPA, 2000b). The speciation of pollutants, especially metals, in the sediment and the way in which they behave in an aquatic environment may affect the degree of toxicity observed. The chemical partitioning characteristics of the contaminant and the nature of the sediment affects whether the contaminant is dissolved in sediment pore water or attached to sediment particles. Factors that affect bioavailability of contaminants in sediment include (U.S. EPA, 2000b):

- organic matter content
- grain size
- hydrogen ion activity (pH)

- aerobic state and sulfides concentration
- microbiological activity
- receptor
- the composition and mineralogy of the sediment itself
- degree of bioturbation or physical mixing.

Organic matter in sediments is often associated with fine particles. In general, the smaller the grain size the greater the potential for high concentrations of pollutants. Thus, sediments that contain smaller, organic particles are more likely to contain pollutants that are bioavailable to sediment ingesters—the organic matter is a food source, and the contaminant is consumed with the organic matter.

Other characteristics of sediments have a large influence on bioavailability. Low redox (anaerobic conditions) and low pH generally make metals more soluble, enhancing their bioavailability to benthic organisms through direct exposure (U.S. EPA, 2000b). Sulfides and iron oxides provide strong binding sites for metals. Fine particles provide greater surface area per unit volume, and thus, more sorption sites for pollutants. The mineralogy of sediments also has a large impact on the bioavailability and sorption of pollutants. Sand, a combination of silicon compounds, does not provide sorption sites, and even fine sand is unlikely to have high sediment concentrations of pollutants unless mixed with high amounts of organic matter.

Microbial communities control the oxidation-reduction reactions in sediments, through a series of reactions involving iron and sulfur, depending on the oxidation state. These reactions in turn affect sediment pH and buffering capacity which may ultimately control metal speciation (e.g., Cr^{+3} to Cr^{+6}) and methylation (e.g., mercury to methylmercury). These phase changes can have a profound effect on bioavailability and toxicity.

The transport and fate of suspended sediments essentially determines the transport and fate of constituents adsorbed to the sediments (USGS, 1997). Water velocity, water depth, and wave properties are important factors in determining the rate of resuspension and transport of sediments in bay systems (USGS, 1997). Resuspension can also have a large impact on the bioavailability of sediment-associated contaminants by either re-exposing organisms to contaminated particles or increasing the aqueous concentration of a contaminant through desorption from the particles within the water column (U.S. EPA, 2000b).

Within bays and estuaries, dredging and propeller wash may resuspend sediments allowing them to be transported to other sites. Resuspension is particularly a factor for the fine organic particles often associated with contaminated sediments. While dredging has the benefit of removing surface as well as deeper sediments, even with controls (such as sediment curtains), some surface sediments are released to outside the enclosure. Propeller wash is minimized within deeper channels.

Upstream of bays and estuaries, sediment is transported within channels. High water velocity, often associated with heavy rainfall, is likely to transport the greatest amounts, and the distances that the sediment is carried can be considerable. For example, much of the mercury contamination in California coastal water bodies is due to historical mining at locations that are far from the coast. As water velocities drop as fresh water meets bays (along with the tendency for particles to settle out as salinity increases), potentially contaminated sediments caused by both point and nonpoint sources can be deposited in river and stream deltas. This pollutant input often makes it difficult to determine specific sources of contamination.

3. Baseline for the Analysis

This section describes the baseline for identifying potential economic impacts of the Plan. Baseline conditions include current objectives and policies regulating activities and pollutant discharges that affect sediment quality, ongoing cleanup and remediation activities, and planned or anticipated cleanup and remediation actions that have not yet been completed [e.g., total maximum daily load development (TMDL) and implementation schedules].

3.1 Existing Objectives

Current sediment toxicity criteria for California waters are contained in the individual basin plans of the nine Regional Water Quality Control Boards. None of the Regional Water Boards have adopted numeric objectives for sediments. Rather, the Regional Water Boards rely on narrative objectives to protect and manage ambient sediment quality. The current objectives in each Basin Plan are described in **Appendix A**. The Lahontan (Region 6) and Colorado River Basin (Region 7) Regions do not contain any enclosed bays or estuaries, and thus, are not included in this analysis. (Note Phase II will include portions of Region 5 that encompass the Sacramento-San Joaquin River Delta.)

As described in Section 2, discharges of toxic pollutants can adversely affect sediment quality. The California Toxics Rule (CTR) contains criteria applicable to inland surface waters, enclosed bays, and estuaries in the state. However, Regional Water Boards may adopt more stringent criteria for specific pollutants where necessary (e.g., to meet a TMDL, site-specific objectives). **Appendix B** shows the CTR criteria, and indicates where a Regional Water Board may have more stringent criteria in its Basin Plan.

The State Water Board is also considering alternatives for adopting EPA's recommended fish tissue criterion for methylmercury (U.S. EPA, 2001), modified [following EPA (2001)] to reflect California-specific information on fish consumption. Elements of the policy may include a methylmercury fish tissue objective, a total mercury water quality objective, a methylmercury water quality objective, or some combination of these objectives (SWRCB, 2006f). The State Water Board may also adopt procedures for implementing the objectives.

In addition to the CTR and revised methylmercury criteria, the Office of Environmental Health Hazard Assessment (OEHHA) has developed draft screening values for common contaminants in sport fish that will be used to identify situations where contaminant concentrations in fish are of potential health concern and further action (e.g., additional sampling or developing consumption advisories) would be needed. These screening values are shown in **Exhibit 3-1**.

Exhibit 3-1. Screening Values for Fish Contaminants

Contaminant	Screening Value (µg/kg, wet weight)
Chlordane	200
DDT	560
Dieldrin	16
Methylmercury	80
Selenium	1,940
PCBs	20

Exhibit 3-1. Screening Values for Fish Contaminants

Contaminant	Screening Value (µg/kg, wet weight)
Toxaphene	220

Source: OEHHA (2006).

OEHHA has issued fish consumption advisories for the following bays and estuaries (OEHHA, 2007):

- San Francisco Bay and Delta Region – women beyond childbearing age and men should not eat any striped bass over 35 inches; women of childbearing age, pregnant, nursing mothers, and children should not eat more than 1 meal of fish per month and should not eat any striped bass over 27 inches or any shark.
- Richmond Harbor Channel area – no one should eat any croakers, surfperches, bullheads, gobies or shellfish because of high levels of chemicals detected.
- Tomales Bay – women of childbearing age and children (under 17 years) should not eat shark, and should not eat bat rays more than once per month, California halibut, redtail, pile, shiner surfperch, or red rock crab more than once per week, and jacksmelt more than 3 times per week; women beyond childbearing age and men shall not each brown smoothhound sharks or leopard sharks more than once per month, pacific angel sharks or bat rays more than once per week, and California halibut, redtail, pile surfperch, red rock crab more than 3 times a week.
- Los Angeles/Long Beach Harbors (especially Cabrillo Pier) – any person should never eat white croaker, and should not eat queenfish, black croaker, or surfperches more than once every two weeks.

3.2 Monitoring

Under existing objectives, policies, and programs, there are a wide range of monitoring efforts underway by Regional Water Boards, dischargers, and other organizations to characterize effluent, ambient water, sediment, and fish tissue quality. These efforts include regional and coordinated programs (**Exhibit 3-2**), as well as studies by single entities. Indeed, there are over 5,000 samples of data related to sediment quality, from 42 different agencies, for bays and estuaries in California (Weisberg and Bay, 2007).

Exhibit 3-2. Regional Monitoring Program Examples and Funding

Project/Funding	Description
CA Bay-Delta Authority Fish Mercury Project Total funding: $4,513,819	Pilot program to establish a foundation for state-of-the-science regional monitoring of mercury in the watershed.
CISNet San Pablo Bay Study Total funding: $298,224	Project to design a monitoring network that is temporally and spatially adequate to provide advance warning of the ecological impacts of natural and anthropogenic stressors.
NOAA-EMAP San Francisco Bay Study Total Funding: Variable annually since 1999	Project to provide information about sediment chemistry, toxicity, benthos, and fish tissues in areas that have not been previously sampled.
CTR Ambient Monitoring Total Funding: $120,000 annually	Project to monitor concentrations of CTR priority pollutants in San Francisco Estuary ambient waters not previously measured.
Sacramento River Watershed Program Fish Tissue Monitoring Total Funding: $27,000	Continuing program to collect, analyze and report on fish tissue contamination in the Sacramento River.

Exhibit 3-2. Regional Monitoring Program Examples and Funding

Project/Funding	Description
Indicators of Estuary Condition Total Funding: $20,000	Project to develop a set of environmental indicators of the condition of San Francisco Estuary water and sediment quality, the condition of various habitats (e.g. wetlands, key watersheds), the condition of the biological resources (e.g. mammals, birds, fish, invertebrates, plants), and threatened and endangered species, is envisioned.
Southern California Bight Pilot Project 1994 Total Funding: $2,513,000	Project to develop and demonstrate an integrated, coordinated, regional environmental monitoring program based on existing compliance monitoring programs. The program provided information about the ecological condition of the mainland shelf in the Southern California Bight, and evaluated new assessment approaches and alternative designs for compliance monitoring programs.
Southern California Bight Regional Monitoring Program (1998 and 2003) Total Funding: Not specified	Collaboration of over 60 organizations to conduct a comprehensive assessment of the ecological condition of the Southern California Bight based on three components: coastal ecology, shoreline microbiology, and water quality.

Source: SFEI. Online at: http://www.sfei.org/cmr/projects.html; SCCWRP. Online at http://www.sccwrp.org/sitemap.html#Regional.

For example, under the State Water Board's Bay Protection and Toxic Cleanup Program (BPTCP), the San Francisco Bay Regional Water Board conducted a Pilot Regional Monitoring Program (RMP) with the San Francisco Estuary Institute, and is continuing participation in the RMP, conducted a fish tissue study to identify contaminant concentrations that would trigger a fish consumption advisory in the San Francisco Bay, and conducted baywide sediment assessments to identify toxic hot spots.

In addition, under the BPTCP, each Regional Board identified toxic hot spots in their area using a two step process designed to consider three measures (toxicity testing, benthic community analysis, and chemical analysis), plus an optional bioaccumulation component (SWRCB, 2003b). The first step was a screening phase that consisted of measurements using toxicity tests, benthic community analysis, chemical tests, or bioaccumulation data to provide sufficient information to list a site as a potential toxic hot spot. A positive result in any of the tests triggered the second, confirmation step (depending on available funding) which consisted of testing the previously sampled site of concern for all three measures (SWRCB, 2003b).

Individual dischargers are also required to monitor sediment quality. As described in the fact sheet for the revised tentative order (MS4 permit) for Orange County (SDRWQCB, 2007a), the copermittees must conduct monitoring, including chemistry, toxicity, and bioassessment, and use the results to determine if impacts from urban runoff are occurring. If toxic pollutants are present in runoff, the copermittees are required to conduct a Toxicity Identification Evaluation (TIE). A TIE is a set of procedures used to identify the specific chemical or chemicals responsible for toxicity to aquatic organisms. When a TIE results in identification of a pollutant associated with urban runoff as a cause of toxicity, follow-up actions should analyze all potential sources causing toxicity, potential BMPs to eliminate or reduce the pollutants causing toxicity, and suggested monitoring to demonstrate that toxicity has been removed.

3.3 Municipal and Industrial Dischargers

Toxic pollutants in the effluents of municipal and industrial wastewater treatment facilities are currently regulated through the National Pollutant Discharge and Elimination System (NPDES) permit program. There are 79 individually permitted facilities (not including storm water) that discharge to the enclosed bays shown in Exhibit 1-1. Of these facilities, 61% are minor discharges [facilities that generally discharge less than 1 million gallons per day (mgd) and do not discharge toxic pollutants in toxic amounts]. **Exhibit 3-3** summarizes the universe of potentially affected facilities.

Exhibit 3-3. Summary of Individual NPDES Permitted Facilities Discharging to Enclosed Bays

2-Digit SIC	Standard Industrial Classification (SIC) Description	Number of Facilities	
		Majors	Minors
Mining			
14	Nonmetallic Minerals	-	1
Construction			
16	Heavy Construction	-	2
Manufacturing			
20	Food and Kindred Products	1	-
28	Chemicals and Allied Products		1
29	Petroleum and Coal Products	2	3
33	Primary Metal Industries	-	1
37	Transportation Equipment	-	14
Transportation and Public Utilities			
42	Trucking and Warehousing	-	1
44	Water Transportation	-	1
45	Transportation by Air	1	-
46	Pipelines, except Natural Gas	-	1
49	Electric, Gas, and Sanitary Services; except 4952	6	5
4952	Sewerage Services (POTWs)	19	4
Wholesale Trade			
51	Wholesale Trade – Nondurable Goods	-	7
Services			
76	Miscellaneous Repair Services	-	1
79	Amusement and Recreational Services	1	4
82	Educational Services	-	1
87	Engineering, Accounting, Research, Management, and Related Services	-	1
Public Administration			
97	National Security and International Affairs	-	3
99	Nonclassifiable Establishments	-	1
Total		31	48

'-' = none
Source: U.S. EPA (2007a).

In addition to the facilities in the exhibit, there may also be municipal and industrial facilities discharging to tributaries upstream of affected waters. These upstream facilities could be a potential source of pollutant loadings to downstream sediments.

Note that there may also be facilities covered by general permits that discharge to enclosed bays. However, EPA's Permit Compliance System (PCS) database and the State Water Board's System for Water Information Management do not contain location (e.g., latitudes and longitudes) or receiving water body information for these facilities. In addition, it is likely that most of the flows from these facilities are intermittent and small, and thus, would not likely contribute a significant pollutant load to any of the affected waters.

3.4 Storm Water Dischargers

As described in Section 2, pollutants in storm water discharges can adversely affect sediment quality. Regional Water Boards regulate most storm water discharges under general permits. General permits often require compliance with standards through an iterative approach based on storm water management plans (SWMP), rather than through the use of numeric effluent limits. In other words, permittees implement best management practices (BMPs) identified in their SWMPs. Then, if those BMPs do not result in attainment of water quality standards, Regional Water Boards would require additional practices until pollutant levels are reduced to the appropriate levels. Because Regional Water Boards use this iterative approach that increases requirements until water quality objectives are met, current levels of implementation may not reflect the maximum level of control required to meet existing standards (CSU Sacramento, 2005). The State Water Board has four existing programs for controlling pollutants in storm water runoff to surface waters: municipal, industrial, construction, and California Department of Transportation (Caltrans).

3.4.1 Municipal Discharges

The municipal program regulates storm water discharges from municipal separate storm sewer systems (MS4s). The MS4 permits require the discharger to develop and implement a SWMP, with the goal of reducing the discharge of pollutants to the maximum extent practicable (MEP). MEP is the performance standard specified in Section 402(p) of the Clean Water Act. The management programs specify the BMPs that will be used to address public education and outreach; illicit discharge detection and elimination; construction and post-construction; and good housekeeping for municipal operations. In general, medium and large municipalities are required to conduct chemical monitoring, though small municipalities are not.

There are currently 11 area-wide large MS4 permitted discharges in California that discharge, at least in part, to an enclosed bay. **Exhibit 3-4** summarizes the activities outlined in their SWMPs.

Exhibit 3-4. Permit Requirements and SWMP Activities for Large MS4s Discharging to Bays in California

MS4 Name (NPDES Number)	Affected Water Body	Permit Requirements and SWMP Activities
Alameda Countywide Clean Water Program (CAS0029831)	San Francisco Bay	• Implement copper reduction plan that includes supporting national Brake Pad Partnership, reviewing construction practices and revise practices if appropriate, street sweeping, and conducting monitoring and special studies. • Implement mercury reduction plan that includes promoting fluorescent light bulb recycling, coordinating with organizations to develop or support legislation to

Exhibit 3-4. Permit Requirements and SWMP Activities for Large MS4s Discharging to Bays in California

MS4 Name (NPDES Number)	Affected Water Body	Permit Requirements and SWMP Activities
		reduce mercury, and tracking trends in mercury concentrations in water body sediment. • Implement pesticides reduction plan that includes eliminating own use of pesticides, continuing public outreach and advertising campaign, partnering with licensed pesticide applicators to minimize environmental impacts, conducting monitoring and special studies, and participating in the insecticide registration decisions processes. • Implement PCBs reduction plan, including surveying stream sediments to assess concentrations and loadings, assessing potential for ongoing discharges, and developing a plan to reduce discharges in runoff.
City of American Canyon (CAS612007)	San Pablo Bay	• Public education/outreach: extend outreach to government officials, businesses, schools, and general public, develop storm water website, and organize community events. • Public participation: raise public awareness about storm water runoff and involve public in development and implementation of BMPs. • Illicit discharge detection and elimination: hire a hazardous materials response team outside of City staff. • Construction site runoff: adopt and enforce erosion and sediment control ordinance, develop and maintain standards for erosion and sediment control, and conduct outreach activities and site inspections. • Post construction runoff: adopt local regulations and design standards to require the implementation of BMPs, provide outreach and guidance to development community and municipal staff on source and treatment control requirements, and develop procedures for post-construction controls. • Pollution prevention/good housekeeping: street sweeping, maintain of storm drain facilities, provide litter receptacles and collection in public locations, implement BMPs and good housekeeping practices at corporation yards, maintain creeks, ditches, parks, recreation, and landscapes, hold public workshops, and developed brochures, and other outreach materials.
Contra Costa Clean Water Program (CA0029912 and CA0083313)	San Francisco Bay and Delta	• Pursue a mass emission strategy to reduce pollutant discharges from point and nonpoint sources and address accumulation of pollutants in organisms and sediments. • Improve management and control of urban runoff. • Develop BMPs to reduce pollutant loading from energy and transportation activities. • Develop and implement guidelines for site planning and BMPs. • Evaluate effectiveness of storm water pollution prevention or control measures.
City of Long Beach (CAS004003)	Long Beach Harbor and San Pedro Bay	• SWMP includes public agency activities program (e.g., trash control, street cleaning, and systems and facilities maintenance), development planning/construction program (e.g., identification and implementation of BMPs), illicit connection/discharges elimination program, and education/public information program, and annual reporting program. • Monitoring Program consists of mass emissions monitoring, multi-species toxicity testing, toxicity identification evaluations, BMP effectiveness evaluations, cooperative monitoring for the Los Angeles River and Los Cerritos Channel.
City of Stockton and County of San Joaquin	Sacramento-San Joaquin Delta	• Stockton SWMP includes extensive public outreach and education, as well as inspections of industrial sites, wet weather sampling during storms, collecting storm water and flow data, dry weather sampling 20% of outfalls every year, and complaint investigation of property or areas where complaints have been made.

Exhibit 3-4. Permit Requirements and SWMP Activities for Large MS4s Discharging to Bays in California

MS4 Name (NPDES Number)	Affected Water Body	Permit Requirements and SWMP Activities
		• The County of San Joaquin SWMP includes BMPs activities that address illicit discharges (e.g., detection, elimination, investigation, and cleanup), public outreach and education, municipal operations (e.g., sewer maintenance, pollution prevention at county facilities, landscape and pest management, and street cleaning), general industrial permit requirements, construction planning and land development, water quality plans for pesticides, pathogens, and dissolved oxygen, and monitoring.
Fairfield-Suisun Sewer District (CAS612005)	Suisun Bay and Suisun Marsh	• Key components of the URMP include industrial and commercial inspections, educational outreach to schools and the general public, monitoring municipal maintenance activities, and ensuring that local residential and commercial construction sites do not contribute to pollution in our local waterways.
Los Angeles County (CAS004001)	Los Angeles Harbor	• Implement or require the implementation of the most effective combination of BMPs for storm water/urban runoff pollution control to reduce pollutants to MEP. • Implement a public information and participation program to increase knowledge of the impacts of storm water pollution on receiving waters and potential solutions, and to change waste disposal and runoff pollution generation behavior. • Require implementation of pollutant reduction and control measures at industrial and commercial facilities, with the objective of reducing pollutants in storm water runoff; at a minimum, the permittees must track, inspect, and ensure compliance at industrial and commercial facilities that are critical sources of pollutants in storm water. • Implement a program to control runoff from construction activity. • Implement a program to minimize storm water pollution impacts from public agency activities. • Eliminate all illicit connections and illicit discharges to the storm drain system, and shall document, track, and report all such cases.
Orange County (CAS618030)	Anaheim Bay, Sunset Bay, Bolsa Bay, and Newport Bay	• Provide guidelines for implementation of integrated pest management activities, and pesticides and fertilizer BMPs. • Implement municipal activities program to provide framework and process for NPDES permittees to conduct compliance activities such as identification of maintenance procedures and BMPs to be implemented, inspections and enforcement, and assessments of program effectiveness. • Continue to implement the public education efforts already underway, participate in joint outreach efforts to ensure that a consistent message on storm water pollution prevention is brought to the public, encourage the public to report illegal dumping, and develop BMP guidance for the control of those potentially polluting activities not otherwise regulated by any agency. • Require each co-permittee to develop and implement a local implementation plan for new development/significant redevelopment areas that incorporates watershed protection/storm water quality management principles (plans will vary based on local conditions). • Develop program to implement and maintain structural and nonstructural BMPs to reduce pollutants in storm water runoff from construction sites; sediment controls should ensure that the natural quantity of sediment is not significantly changed and that contaminated sediment is prevented from reaching the watercourse. • Implement existing development program to address discharges from industrial facilities, selected commercial businesses, residential development, and common interest areas/homeowner associations.

Exhibit 3-4. Permit Requirements and SWMP Activities for Large MS4s Discharging to Bays in California

MS4 Name (NPDES Number)	Affected Water Body	Permit Requirements and SWMP Activities
		• Continue to implement a comprehensive program for detecting, responding to, investigating and eliminating these types of discharges/connections in an efficient and timely manner.
Sacramento County (CAS082597)	Sacramento-San Joaquin Delta	• Copermittees joined together to form the Sacramento Stormwater Quality Partnership (SSQP) with goals to educate and inform the public about urban runoff pollution; encourage public participation in community and clean-up events; work with industries and businesses to encourage pollution prevention; require construction activities to reduce erosion and pollution; require developing projects to include pollution controls that will continue to operate after construction is complete.
San Diego Municipal (CAS0108758)	San Diego Bay	• Select and implement BMPs to prevent erosion, construction-related materials, wastes, spills, and sediment from entering receiving waters to the MEP. • Education of public works employees to ensure knowledge of how daily work activities impact water quality and how to perform job while protecting water quality. • Implement a public information and participation program to increase knowledge of the impacts of storm water pollution on receiving waters and potential solutions, and to change waste disposal and runoff pollution generation behavior. • Develop and implement guidelines for site planning and BMPs. • Provide design guidance on effective structural and nonstructural BMPs for development sites and County capital improvement projects
San Mateo (CAS0029921)	San Francisco Bay	• Implement appropriate source control and site design measures to reduce the discharge of pollutants to the MEP. • Minimize or eliminate potential storm water pollution sources at commercial and industrial facilities through inspection and educational outreach activities. • Implement a public information and participation program to increase knowledge of the impacts of storm water pollution on receiving waters and potential solutions, and to change waste disposal and runoff pollution generation behavior. • Work closely with other public works divisions to reduce discharges of pollutants during routine maintenance activities such as street sweeping and storm drain cleaning.
Santa Clara Valley (CAS029718)	San Francisco Bay	• Implement control measures and BMPs to reduce pollutants to the MEP. • Improve management and control of urban runoff from public and private sources. • Develop BMPs to reduce pollutant loading from energy and transportation activities. • Pursue a mass emission strategy to reduce pollutant discharges from point and nonpoint sources and address accumulation of pollutants in organisms and sediments. • Develop and implement guidelines for site planning and BMPs.
Vallejo Sanitation District (CAS612006)	San Pablo Bay	• Implement control measures and BMPs to reduce pollutants to the MEP. • Improve management and control of urban runoff from public and private sources. • Develop BMPs to reduce pollutant loading from energy and transportation activities. • Pursue a mass emission strategy to reduce pollutant discharges from point and nonpoint sources and address accumulation of pollutants in organisms and sediments. • Develop and implement guidelines for site planning and BMPs.

Exhibit 3-4. Permit Requirements and SWMP Activities for Large MS4s Discharging to Bays in California

MS4 Name (NPDES Number)	Affected Water Body	Permit Requirements and SWMP Activities
Ventura County (CAS004002)		• Mark drain inlets with "no dumping" message. • Organize outreach events, training, and other education activities on storm water quality • Explain applicable storm water regulations, distribute and discuss applicable BMP/educational materials, conduct site walk-through to inspect for evidence of illicit discharges, prevention BMPs and storm water quality management education programs for employees • Implement the Storm Water Quality Urban Impact Mitigation Plan for new private development projects including residential developments, gas stations, restaurants and parking lots • Develop a technical manual that includes specifications for treatment control BMPs and structural BMPs for flow-based and volume-based water quality design criteria. • Prepare and implement Storm Water Pollution Control Plans throughout the duration of construction that identify potential pollutant sources and include the design, placement, and maintenance of appropriate BMPs. • Inspect catch basins, open drainage facilities, detention/retention basins, and concrete open channels to ensure appropriate operation and maintenance • Implement street cleaning program to reduce the discharge of pollutants to the storm water drain system • Implement the standardized protocol for application of pesticides, herbicides, and fertilizers, which includes prohibiting application during rain events, after a rain event, or when water is running offsite of the application area.

Sources: Alameda (2003); American Canyon (2005); FSSD (2007); LARWQCB (1999); LARWQCB (2001); LWA (2003); Orange County (2003); San Diego (2003); SFBRWQCB (1999); San Mateo (2003); SSQP (2007); Stockton (2007); Ventura County (2001).

In addition, there are 189 small MS4s that have submitted SWMPs to Regional Water Boards or the State Water Board for approval. However, it is not clear how many of those MS4s discharge to enclosed bays and estuaries.

3.4.2 Industrial Discharges

Under the industrial program, the State Water Board issues a general NPDES permit that regulates discharges associated with ten broad categories of industrial activities. This general permit requires the implementation of management measures that will achieve the performance standard of best available technology economically achievable (BAT) and best conventional pollutant control technology (BCT). The permit also requires that dischargers develop a Storm Water Pollution Prevention Plan (SWPPP) and a monitoring plan. Through the SWPPP, dischargers are required to identify sources of pollutants, and describe the means to manage the sources to reduce storm water pollution. For the monitoring plan, facility operators may participate in group monitoring programs to reduce costs and resources.

3.4.3 Construction

The construction program requires dischargers whose projects disturb one or more acres of soil or whose projects disturb less than one acre but are part of a larger common plan of development that in total disturbs one or more acres to obtain coverage under the a general permit for discharges of storm water associated with construction activity. The construction general permit requires the development and implementation of a SWPPP that lists BMPs the discharger will use to protect storm water runoff and the placement of those BMPs. Additionally, the SWPPP must contain a visual monitoring program; a chemical monitoring program for nonvisible pollutants to be implemented if there is a failure of BMPs; and a sediment monitoring plan if the site discharges directly to a water body impaired for sediment.

3.4.4 Caltrans

In 1996, Caltrans requested that the State Water Board consider adopting a single NPDES permit for storm water discharges from all Caltrans properties, facilities, and activities that would cover both the MS4 requirements and the statewide construction general permit requirements. The State Water Board issued the Caltrans general permit in 1999, requiring Caltrans to control pollutant discharges to the MEP for the MS4s and to the standard of BAT/BCT for construction activities through BMPs. The State Water Board also requires dischargers to implement more stringent controls, if necessary, to meet water quality standards.

3.5 Nonpoint Sources

Nonpoint source pollution, unlike pollution from industrial and sewage treatment plants, comes from many diffuse sources. Some types of nonpoint source pollution is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, depositing them into lakes, rivers, wetlands, coastal waters, and groundwater. Nonpoint source pollution may originate from several sources including agricultural operations, forestry operations, urban areas, boating and marinas, active and historical mining operations, atmospheric deposition, and wetlands. Note that, in many cases, discharges from these sources can be regulated as point sources (i.e., discernible, confined, and discrete conveyances).

In 1999, California implemented its Fifteen-Year Program Strategy for the Nonpoint Source Pollution Control Program, as delineated in the Plan for California's Nonpoint Source Pollution Control Program (NPS Program Plan). The legal foundation for the NPS Program Plan is the Clean Water Act (CWA) and the Coastal Zone Act Reauthorization Amendments of 1990 (CZARA) (SWRCB, 2000). The agencies primarily responsible for the development and implementation of the NPS Program Plan are the State Water Board, the nine Regional Water Boards, and the California Coastal Commission (CCC). Various other federal, state, and local agencies have significant roles in the implementation of the NPS Program Plan.

Federal approval and funding of the NPS Program Plan required assurance the state had legal authority to implement and enforce the plan. The state's Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program (NPS Policy) provides guidance regarding the implementation and enforcement of the NPS Program Plan. As stated in the NPS

Policy, the Porter-Cologne Act provides the legal authority of the State Water Board and Regional Water Boards to regulate nonpoint sources in California under waste discharge requirements (WDRs), conditional waivers of WDRs, or basin plan prohibitions or amendments (SWRCB, 2004c). However, all WDRs need not contain numeric effluent limits. The Regional Water Boards do not usually assign nonpoint sources numeric effluent limits; rather they primarily rely on implementation of BMPs to reduce pollution.

The NPS Program Plan specifies management measures (MMs) and the corresponding management practices or BMPs for each of six source categories. MMs should be implemented where needed by 2013 using a combination of nonregulatory activities and enforceable policies and mechanisms (SWRCB, 2003a). **Appendix C** describes the MMs for each source category applicable to sediment toxicity reductions.

3.5.1 Agriculture

Impacts from agricultural activities that may affect sediment quality include sedimentation and the runoff of pesticides. These impacts can be caused by:

- Farming activities that cause excessive erosion, resulting in sediment entering receiving waters
- Improper use and overapplication of pesticides
- Overapplication of irrigation water resulting in runoff of sediments and pesticides (SWRCB, 2006b).

Although wastewater discharges from irrigated land including storm water runoff, irrigation tailwater, and tile drainage are subject to regulation under WDRs, Regional Water Boards have historically regulated these discharges under waivers. These waivers are authorized by CWC Section 13269 which allows Regional Water Boards to waive WDRs if it is in the public interest.

Most historical waivers require that discharges not cause violations of water quality objectives; however, do not require water quality monitoring. In 1999, Senate Bill 390 amended CWC Section 13269 and required Regional Water Boards to review and renew their waivers, or replace them with WDRs. If Regional Water Boards did not reissue the waivers by January 1, 2003 they expired.

The Central Coast, Los Angeles, Central Valley, and San Diego Regional Water Boards have established conditional waivers for agricultural discharges. Central Coast Regional Water Board's group and individual waivers require monitoring focused on nutrients and toxicity. When water quality objectives are exceeded or toxicity is detected, the waiver requires follow up monitoring under the regional monitoring and reporting program. The waiver also requires 15 hours of training in farm water quality management, and development of farm water quality management plans that address, at a minimum, irrigation management, nutrient management, pesticide management, and erosion control; and begin implementing management practices identified in their plans (CCRWQCB, 2006a). To date, 1577 farming operations have enrolled in the conditional waiver program, representing approximately 380,000 irrigated acres (87% of the estimated irrigated acres in the region) (CCRWQCB, 2006b).

The Los Angeles Regional Water Board's conditional waiver requires dischargers to monitor for physical parameters, nutrients, and pesticides twice during wet weather and twice during dry weather conditions. Individual dischargers are to monitor surface water at the end of the property and group dischargers are to monitor surface water and watershed-wide receiving waters. If Basin Plan or CTR objectives or TMDL allocations are not attained, the waiver requires that the discharger submit a Corrective Action Plan that identifies time-specific management modifications. In addition, dischargers are required to take 8 hours of training in farm water quality management (LARWQCB, 2005c).

Central Valley Regional Water Board emphasizes group participation as part of its conditional waiver for agricultural growers. Under the group waiver, growers must implement management practices, as necessary, to improve and protect water quality and to achieve compliance with applicable water quality standards. If there is more than one exceedance of a standard in three years, growers must develop and submit a management plan to the Regional Water Board, unless the Executive Officer determines that the exceedance is not likely to be remedied or addressed by a management plan.

The San Diego Regional Water Board adopted a conditional waiver for agricultural and nursery operations on October 10, 2007. The waiver requires that these dischargers implement BMPs to minimize or eliminate the discharge of pollutants and form or join a monitoring group by December 31, 2010. Operators must also prevent the direct or indirect discharge of products used in operations (e.g., pesticides) into surface waters (SDRWQCB, 2007b).

The Santa Ana Regional Water Board is in the process of developing a conditional waiver for discharges from irrigated agricultural lands. While the North Coast and San Francisco Bay Regional Water Boards have no immediate plans to adopt waivers for agricultural discharges, they may do so in the future in the context of TMDLs.

In conjunction with conditional waivers, Regional Water Boards regulate agricultural discharges from cropland under nonpoint source programs that rely on BMPs to protect water quality. For example, the State Water Board and the CCC oversee agricultural control programs, with assistance from the Department of Pesticide Regulation (DPR) for pesticide pollution and the Department of Water Resources for irrigation water management (SWRCB, 2006b).

The pesticide management measure (MM 1D) is likely to have the greatest impact on sediment toxicity. This MM reduces contamination of surface water and ground water from pesticides through:

- development and adoption of reduced risk pest management strategies (including reductions in pesticide use)
- evaluation of pest, crop, and field factors
- use of Integrated Pest Management (IPM)
- consideration of environmental impacts when choosing pesticides for use
- calibration of equipment
- use of antibackflow devices (SWRCB, 2006b).

IPM is a key component of pest control. IPM strategies include evaluating pest problems in relation to cropping history and previous pest control measures, and applying pesticides only when an economic benefit will be achieved. Pesticides should be selected based on their effectiveness to control target pests and their potential environmental impacts such as persistence, toxicity, and leaching potential (SWRCB, 2006b).

There are many planned, on-going, and completed activities related to management of pesticides. However, as reported in the most recent NPS Program Plan progress report (SWRCB, 2004a), efforts to improve water quality impaired by agriculture activities are highly challenging because of the different perspectives that exist between the regulatory community and the agricultural community.

As of 2003, the SWRCB (2004a) reports the following progress:

- 16 watershed working groups are actively developing farm water quality plans, with 19 new groups being formed
- Of the over 90 farmers that attended a Farm Water Quality Course, half have developed comprehensive water quality plans for more than 10,700 acres of irrigated crops
- Over 750 farmers have attended 35 workshops designed to train farmers in specific conservation practices.

3.5.2 Forestry

Timber harvesting and associated activities can result in the discharge of chemical pollutants and petroleum products, in addition to other conventional pollutants. Chemical pollutants and metals can be discharged through runoff and drift. Potential sources of chemical runoff include roads that have been treated with oils or other dust suppressing materials and herbicide applications.

Forest chemical management focuses on reducing pesticides that are occasionally used for pest management to reduce mortality of desired tree species, and improve forest production. Pesticide use on state or private forestry land is regulated by DPR. However, a large proportion of California's forested lands are owned or regulated by the federal government (SWQCB, 2004a) in which pesticide use is controlled by the USDA Forest Service Region 5.

In addition to the NPS Program Plan MMs, forestry activities are also controlled through WDR and conditional waivers. Recently, Regional Water Boards have adopted waivers for timber harvesting activities, provided that the activities comply with the general conditions listed in each waiver, including compliance with applicable requirements contained in each Region's basin plans.

The DPR regulates the sale and use of pesticides and, through county agricultural commissioners (CACs), enforces laws pertaining to pesticide use. CACs inspect pesticide applications to forests and ensure that applications do not violate pesticide laws and regulations. Landowners must also submit timber harvest plans (THPs) to the California Department of Forestry (CDF) outlining what timber will be harvested, how it will be harvested, and the steps that will be taken to prevent damage to the environment. CDF will only approve those THPs that comply with all applicable federal and state laws.

The Forest Practices Act provides a conditional exemption from WDRs for timber operations (article 1. section 4514.3). The Forest Practice Rules establish responsible forest resource management practices which serve the demand for timber and other forest products, while giving consideration to the public's need for watershed protection, fisheries, and wildlife and recreational opportunities.

3.5.3 Urban Runoff

Pollutants found in runoff from urban areas include, among others, sediments, heavy metals, petroleum hydrocarbons, and plastics. As population densities increase, pollutant loadings generated from human activities also increase. Most urban runoff enters surface waters without undergoing treatment.

The control of urban nonpoint pollution requires the use of two primary strategies: preventing pollutant loadings from entering waters and reducing the impact of unavoidable loadings. The major opportunities to control nonpoint loadings occur during the following three stages of development: (1) the siting and design phase, (2) the construction phase, and (3) the post-development phase. Before development occurs, land in a watershed is available for a number of pollution prevention and treatment options, such as setbacks, buffers, or open space requirements, as well as wet ponds or constructed urban runoff wetlands that can provide treatment of the inevitable runoff and associated pollutants. In addition, siting requirements and restrictions and other land use ordinances, which can be highly effective, are more easily implemented during this period. After development occurs, these options may no longer be practicable or cost-effective.

Urban runoff is addressed primarily through the NPDES program, although the State Water Board NPS Program Plan applies where runoff is not regulated as a permitted point source. The NPDES program supersedes the State Water Board and Regional Water Board NPS Program in the areas where there is overlap. NPDES permits require implementation of BMPs, which may or may not be similar to the MMs in the NPS Program.

In 1976, the State Legislature enacted the California Coastal Act (CCA) to provide for the conservation and planned development of the State's coastline. The CCA directs each of the 73 coastal cities and counties to prepare, for review and certification by the CCC, a local coastal plan (LCP) consisting of land use plans, zoning ordinances, zoning district maps, and, other implementation actions. The CCC also works with local governments to incorporate urban MMs and MPs into their respective LCPs. Certified LCPs are important tools for implementing urban runoff MMs and MPs that prevent, reduce or treat polluted runoff from proposed developments. Storm water programs can become more effective because of local planning and permitting decisions throughout the State.

3.5.4 Marina and Recreational Boating

Poorly planned or managed boating and related activities (e.g., marinas and boat maintenance areas) may threaten the health of aquatic systems and pose other environmental hazards. There are nearly 1 million registered boats and approximately 650 marinas in California (SWRCB, 2004a). Boats repairs, fouling and corrosion control, and sanding, scraping, painting, varnishing and fiberglassing boats can result in pollutants such as metals, solvents, hydrocarbons and other contaminants entering surface waters (Hunt and Doll, 2007). For example, as mentioned in Section 2.1.1, copper and zinc are often found in marina sediments due to the leaching of antifoulant paints.

Note that commercial and military ports are subject to storm water NPDES permits regulating industrial and construction activities. Commercial ports are also required to submit a port master plan to the CCC. The master plan must include an estimate of the effect of development on habitat areas and the marine environment, a review of existing water quality, habitat areas, and quantitative and qualitative biological inventories, and proposals to minimize and mitigate any substantial adverse impact. In addition, the state has the opportunity to ensure that appropriate pollution prevention and control measures are in place at all military ports.

There are many planned, on-going, and completed activities related to nonpoint source pollution in marinas. The primary focus of these activities is to prevent discharges of waste oil, sewage, petroleum, solid waste, and toxic pollutants from surface runoff, improper boat cleaning/maintenance activities, lack of disposal facilities, or improper maintenance of facilities at marinas (SWRCB, 2006b). For example, the compliance schedule for the Dissolved Copper in Shelter Island Yacht Basin (SIYB), San Diego Bay TMDL consists of a 17-year staged schedule period. The first stage consists of an initial 2-year orientation period. The subsequent 15-year reduction period will achieve the incremental copper load reductions by requiring all new boats entering SIYB to have nontoxic or less toxic coatings, and through replacement of copper coatings on all existing boats with a nontoxic or less toxic coating at the next time routine hull stripping is scheduled (SDRWQCB, 2005).

The state is also relying on education and outreach efforts aimed at marina owners and operators, and the boating public, to provide information on pollution problems and management practices that can be implemented to prevent or control improper disposal of pollutants into surface waters (SWRCB, 2006b). For example, the Boating Clean and Green Campaign provides statewide boater education and technical assistance program, conducted by the CCC in partnership with the California Department of Boating and Waterways, to promote environmentally sound boating practices. Issues addressed through the Campaign include vessel cleaning and maintenance, handling and disposal oil and fuel, handling and disposal of hazardous materials, and proper disposal of trash and gray water. A California Clean Marina Toolkit is available to assist marine operators in identifying clean marina practices and resources that will help to implement these practices (CCC, 2004).

The Federal Oil Pollution Act (OPA) is a comprehensive prevention, response, liability, and compensation regime for dealing with vessel- and facility-generated discharges of oil or hazardous substances. Under the OPA, any hazardous waste spill from a vessel must be reported by the owner of the vessel, and vessel owners are responsible for any costs of a resulting environmental cleanup and any damage claims that might result from the spill. Marinas are responsible for any oil contamination resulting from their facilities, including dumping or spilling of oil or oil-based paint and the use of chemically treated agents. The California Department of Fish and Game's Office of Spill Prevention and Response enforces the laws designed to prevent spills, dispatches units to respond to spills, and investigates spills.

3.5.5 Abandoned and Inactive Mines

The State Water Board and Regional Water Boards have identified approximately 40 mines that cause serious water quality problems resulting from acid mine drainage and acute mercury loading (SWRCB, 2000). Although all mines may not be significant polluters individually, cumulatively mines may contribute to chronic toxicity due to increased metals loadings. Additionally, drainage structures and sluices associated with abandoned hydraulic gold mines are a potential source of mercury to surface waters. Mercury from abandoned mines poses a serious potential threat to coastal waters because mercury transported from these sites may bioaccumulate in fish.

The NPS Program Plan does not contain management measures for abandoned mines, and there is no specific, comprehensive program at either the state or federal level for cleaning up abandoned and inactive mines other than coal. Rather, abandoned and inactive mine cleanup is carried out under a variety of state, federal, and local programs. Regional Water Boards may issue WDRs to the most serious sites. The federal Superfund Program addresses only the most extreme pollution sites, such as Iron Mountain Mine. Federal land management agencies have specific, marginally funded programs for cleaning up abandoned mines on federal land, but most projects address safety hazards rather than water quality. California's Title 27 Program regulates discharges of wastes to land, and can be used to pursue mine cleanups.

Enforcement actions, however, are costly and have not been effective because responsible parties are difficult to locate, and current property owners either do not have, or will not spend money, to cleanup their sites. The main barrier to a comprehensive program for abandoned mines is liability (SWRCB, 2003a). Under the federal CWA, a third party can sue an agency or private party that performs abatement actions at an abandoned mine if the discharge from the mine continues to violate the CWA.

In June 2000, the California Department of Conservation (DOC) inventoried the number of abandoned mine sites and features located in the state. DOC estimates that of the 47,084 historic and inactive mine sites in the state, approximately 11% (5,200) present an environmental hazard. The most common hazards include heavy metals from acid rock drainage and methylmercury from mercury contaminated sediments. DOC (2000) indicates that some bays have been or could be impacted by acid rock drainage and mercury from abandoned mines.

As a land-managing agency, the U.S. Forest Service (USFS) also has an abandoned mine reclamation program. The program includes an inventory of abandoned mines and locations, environmental and/or resource problems present, rehabilitation measures required, and potential sources of funding. The USFS has worked with various Regional Water Boards on numerous occasions in the rehabilitation of mine sites. Restoration funding comes from USFS funds, the Comprehensive Environmental Response and Compensation Liability Act, and Resource Conservation and Recovery Act sources. All lands disturbed by mineral activities must be reclaimed to a condition consistent with resource management plans, including air and water quality requirements (SWQBC, 2000; SWQBC 2003a).

All active mining projects must comply with the federal Surface Mining and Reclamation Act (SMARA). The goal of SMARA is to have mined lands reclaimed to a beneficial end use. Local Enforcement Agencies (LEAs), usually counties, implement SMARA. The DOC's Office of Mine Reclamation provides technical support to LEAs but has limited enforcement authority.

Mining projects that could impair water quality or beneficial uses may also be subject to NPDES permits or conditions under the CWA section 401 Water Quality Certification Program.

3.5.6 Atmospheric Deposition

Atmospheric deposition may be a potential nonpoint source to bays through either direct or indirect deposition. Indirect deposition reflects the process by which metals and other pollutants such as PAHs deposited on the land surface are washed off during storm events and enter surface water through storm water runoff (LARWQCB, 2005a). For example, Sabin, et al. (2005) concluded that atmospheric deposition potentially accounts for as much as 57–100% of the total trace metal loads in storm water within Los Angeles. In LARWQCB (2005a) and LARWQCB (2005b) loadings associated with indirect atmospheric deposition are included in the storm water waste load allocations. Therefore, nonpoint source pollution from atmospheric deposition is not directly addressed, but indirectly addressed through storm water management. Typically, direct deposition accounts for a very small fraction of nonpoint source pollution (for example, see LARWQCB, 2005a and LARWQCB, 2005b).

3.5.7 Wetlands

Seasonally and permanently flooded wetlands are sites for methylmercury production due to the presence of sulfate-reducing bacteria in wetland environments (CVRWQCB, 2005a). Wetlands can be significant sources of methylmercury production; for example, the Central Valley Regional Water Board (2005c) estimated that 21,000 acres of wetland in the Sacramento-San Joaquin River Delta produce about 16% of the annual methylmercury load to the watershed. A complicating issue is that wetland restoration efforts are ongoing because wetlands provide important services for ecosystems and human communities.

Management practices to reduce methylmercury discharge could include aeration, changing the stream channel, revegetation, sediment removal, and levees. Some of these practices may be applied upstream to reduce inorganic mercury in water flowing into the wetland, thus reducing methylmercury formation. Other practices may reduce the downstream transport of methylmercury formed in the wetland (CVRWQCB, 2005b).

3.6 Existing Impaired Waters

Under the CWA, Section 303(d), states are required to develop a list of water quality limited segments, establish priority rankings for the segments, and develop action plans, or TMDLs, to improve water quality. The State Water Board's existing 303(d) Listing Policy (SWRCB, 2004) indicates that a water segment will be listed as impaired if the sediments exhibit statistically significant toxicity based on a binomial distribution of the sampling data and exceedances. That is, if the number of measured toxicity exceedances supports rejection of the null hypothesis as presented in **Exhibit 3-5**, the Regional Water Board will list the segment as impaired.

Exhibit 3-5. Minimum Number of Measured Exceedances for 303(d) Listing in California

Sample Size	Number of Exceedances (Equal or Greater Than) for Listing[1]
2 – 24	2[a]
25 – 36	3
37 – 47	4
48 – 59	5
60 – 71	6
72 – 82	7
83 – 94	8
95 – 106	9
107 – 117	10
118 – 129	11

Source: SWRCB (2004b).
1. Null Hypothesis: Actual exceedance proportion < 3%.
a. Application of the binomial test requires a minimum sample size of 16. The number of exceedances required using the binomial test at a sample size of 16 is extended to smaller sample sizes.

The policy indicates that a segment should be listed if the observed toxicity is associated with a pollutant or pollutants, or for toxicity alone. If the pollutant causing or contributing to the toxicity is identified, the pollutant should be added to the 303(d) list as well. Appropriate reference and control measures must be included in the toxicity testing. Reference conditions may include a response less than 90% of the minimum significant difference for each specific test organism. Acceptable methods include, but are not limited to, those listed in water quality control plans, the methods used by Surface Water Ambient Monitoring Program, the Southern California Bight Projects of the Southern California Coastal Water Research Project, American Society for Testing and Materials, U.S. EPA, the Regional Monitoring Program of the San Francisco Estuary Institute, and the Bay Protection and Toxic Cleanup Program (BPTCP) (SWRCB, 2004b).

Association of pollutant concentrations with toxic or other biological effects should be determined by one of the following (SWRCB, 2004b):

- Sediment quality guidelines are exceeded using the binomial distribution; in addition, using rank correlation, the observed effects are correlated with measurements of chemical concentration in sediments
- An evaluation of equilibrium partitioning or other type of toxicological response that identifies the pollutant that may cause the observed impact; comparison to reference conditions within a watershed or ecoregion may be used to establish sediment impacts
- Development of an evaluation (such as a TIE) that identifies the pollutant that contributes to or caused the observed impact.

Exhibit 3-6 shows existing impairments for bays and estuaries by region.

Exhibit 3-6. 2006 303(d) Listings for Bays in California

Water Body	2006 303(d) List[1]
Region 1	
Humboldt Bay	Tissue: PCBs
Region 2	
Tomales Bay	Tissue: mercury
San Francisco Bay, Richardson Bay	Water: chlordane, dieldrin, DDT Tissue: PCBs, mercury
San Francisco Bay, San Pablo Bay	Water: chlordane, dieldrin, DDT Tissue: PCBs, mercury
San Francisco Bay, Central Basin	Sediment: mercury, PAHs Water: chlordane, dieldrin, DDT Tissue: mercury, PCBs,
San Francisco Bay, Oakland Inner Harbors	Sediment: copper, lead, mercury, zinc, PCBs, PAHs, chlordane, dieldrin, sediment toxicity Water: chlordane, dieldrin, DDT Tissue: mercury, PCBs,
San Francisco Bay, San Leandro Bay	Sediment: lead, mercury, zinc, PAH, pesticides Water: chlordane, dieldrin Tissue: mercury
San Francisco Bay, Lower Basin	Sediment: mercury Water: mercury, chlordane, dieldrin, DDT Tissue: mercury, PCBs,
San Francisco Bay, South Basin	Sediment: mercury Water: mercury, chlordane, dieldrin, DDT Tissue: mercury, PCBs
Carquinez Strait	Water: chlordane, DDT, dieldrin Tissue: mercury, PCBs
Castro Cove, Richmond	Sediment: dieldrin, mercury, PAHs
Islais Creek	Sediment: chlordane, dieldrin, PAHs, sediment toxicity
Mission Creek	Sediment: chlordane, dieldrin, lead, mercury, PCBs, silver, zinc Water: PAHs
Sacramento-San Joaquin Delta	Water: chlordane, DDT, dieldrin, nickel Tissue: mercury, PCBs
Region 3	
Moss Landing Harbor	Water: pesticides
Monterey Harbor	Water: metals
Carpineteria Marsh	Water: priority organics
Elkhorn Slough	Water: pesticides
Goleta Slough/Estuary	Water: priority organics
Moro Cojo Slough	Water: pesticides
Old Salinas River Estuary	Water: pesticides
Salinas River Lagoon (North)	Water: pesticides
Region 4	
Ventura Harbor	Tissue: PCBs, DDT
Channel Islands Harbor	Sediment: lead, zinc
Port Hueneme Harbor	Tissue: PCBs, DDT

Exhibit 3-6. 2006 303(d) Listings for Bays in California

Water Body	2006 303(d) List[1]
Marina del Rey – Back Basins	Sediment: copper, lead, zinc, PCBs, chlordane, DDT, sediment toxicity Tissue: PCBs, chlordane, dieldrin, DDT
Los Angeles Harbor Consolidated Slip	Sediment: cadmium, copper, lead, mercury, zinc, chlordane, sediment toxicity, benthic community effects Water: dieldrin Tissue: chlordane, DDT, pesticides
Los Angeles Fish Harbor	Sediment: copper, lead, mercury, zinc, chlordane, PAH, sediment toxicity Water: PCBs, DDT
Los Angeles Harbor - Cabrillo Beach	Sediment: copper Tissue: PCBs, DDT
Los Cerritos Channel	Sediment: chlordane Water: copper, lead, zinc
Long Beach Inner/Outer Harbor	Sediment: sediment toxicity, benthic community effects Water: chlordane, DDT
San Pedro Bay Near/Offshore Zones	Sediment: copper, zinc, PAH, DDT, chlordane, sediment toxicity Tissue: PCBs, DDT
Calleguas Creek Reach 1 (Mugu Lagoon)	Water: copper, mercury, nickel
Dominguez Channel Estuary	Sediment: PAHs, chlordane, DDT, PCBs, zinc, benthic community effects Tissue: DDT, dieldrin, lead, PCBs
Los Angeles River Estuary	Sediment: chlordane, DDT, lead, PCBs, zinc, sediment toxicity
Malibu Lagoon	Benthic community effects
Santa Clara River Estuary	Water: toxaphene
Region 5	
Sacramento-San Joaquin Delta (all areas)	Water: group A pesticides Tissue: DDT, mercury
Sacramento-San Joaquin Delta (Stockton Ship Channel)	Water group A pesticides Tissue: DDT, PCBs, mercury
Region 8	
Anaheim Bay	Sediment: sediment toxicity Tissue: PCBs, dieldrin
Huntington Harbor	Sediment: lead, chlordane, sediment toxicity Water: copper Tissue: PCBs
Bolsa Bay	Water: Copper
Newport Bay, Upper	Sediment: sediment toxicity Water: copper, PCBs, chlordane, DDT, metals
Newport Bay, Lower	Sediment: sediment toxicity Water: copper, PCBs, chlordane, DDT
Rhine Channel	Sediment: sediment toxicity Water: copper, lead, mercury, zinc, PCB
Region 9	
Mission Bay	Water: lead
San Diego Bay	Tissue: PCBs

Exhibit 3-6. 2006 303(d) Listings for Bays in California

Water Body	2006 303(d) List[1]
San Diego Bay, Shoreline 32nd St Naval Station	Sediment: sediment toxicity, benthic community effects
San Diego Bay, Shoreline Downtown Anchorage	Sediment: sediment toxicity, benthic community effects
San Diego Bay, Shoreline Near Chollas Creek	Sediment: sediment toxicity, benthic community effects
San Diego Bay, Shoreline near Coronado Bridge	Sediment: sediment toxicity, benthic community effects
San Diego Bay, Shoreline near Switzer Creek	Water: PAH, chlordane
San Diego Bay, Shoreline North of 24th St Marine Terminal	Sediment: sediment toxicity, benthic community effects
San Diego Bay, Shoreline Seventh Street Channel	Sediment: sediment toxicity, benthic community effects
San Diego Bay, Shoreline Vicinity of B St./Broadway Piers	Sediment: sediment toxicity, benthic community effects
San Diego Bay, Shoreline at Coronado Cays	Water: copper
San Diego Bay, Shoreline at Glorietta Bay	Water: copper
San Diego Bay, Shoreline, at Harbor Island (East Basin)	Water: copper
San Diego Bay, Shoreline, at Harbor Island (West Basin)	Water: copper
San Diego Bay, Shoreline, at Marriott Marina	Water: copper
San Diego Bay, Shoreline, between Sampson and 28th St.	Water: copper, mercury, zinc, PAH, PCBs
San Diego Bay, Shoreline, Chula Vista Marina	Water: copper
San Diego Bay, Shoreline, near sub base	Sediment: sediment toxicity, benthic community effects
Tijuana River Estuary	Water: lead, nickel, pesticides

Source: SWRCB (2006c; 2006d), U.S. EPA (2007b; 2003).
1. Assumed water to be the impaired medium where there is no indication.

There are also a number of sediment quality-related 303(d) listings for waters upstream of affected bays and estuaries (see SWRCB, 2006c). Impaired sediments can be carried downstream and settle into bays and estuaries, contributing to existing impairments or causing new impairments.

Under the existing listing policy, Regional Water Boards may remove waters from the 303(d) list, or delist, if sediment toxicity or associated sediment quality guidelines are no longer exceeded. Regional Water Boards can delist waters if, using the binomial distribution, the number of measured exceedances supports rejection of the null hypothesis as presented in **Exhibit 3-7**. Note that at least 28 samples are necessary to use the binomial distribution to support a delisting.

Exhibit 3-7. Minimum Number of Measured Exceedances for 303(d) Delisting in California[1]

Sample Size	Number of Exceedances (Equal or Greater Than) for Listing[1]
28 – 36	2
37 – 47	3
48 – 59	4
60 – 71	5
72 – 82	6
83 – 94	7
95 – 106	8
107 – 117	9
118 – 129	10

Exhibit 3-7. Minimum Number of Measured Exceedances for 303(d) Delisting in California[1]

Sample Size	Number of Exceedances (Equal or Greater Than) for Listing[1]

Source: SWRCB (2004b).
1. Null Hypothesis: Actual exceedance proportion > 18%. Alternate Hypothesis: Actual proportion < 3 % of the samples
The minimum effect size is 15%.

For sample sizes greater than 129, the maximum number of measured exceedances allowed is based on the following Microsoft Excel functions:

α = BINOMDIST(k, n, 0.18, TRUE)
β = BINOMDIST(n-k-1, n, 1 – 0.03, TRUE)

where,
α and β < 0.10
|α - β| is minimized.
n = the number of samples
k = maximum number of measured exceedances allowed
0.03 = acceptable exceedance proportion
0.18 = unacceptable exceedance proportion.

Waters may also be removed from the list if objectives or standards are revised and the site or water meets the revised standards.

3.7 Sediment Cleanup and Remediation Activities

There are a number of sediment cleanup and remediation programs and activities planned or currently underway in California.

3.7.1 Bay Protection and Toxic Cleanup Program

The State Water Board established the Bay Protection and Toxic Cleanup Program (BPTCP) to implement the requirements of Chapter 5.6 of the CWC. Section 13394 of Chapter 5.6 requires the State Water Board and the Regional Water Boards to develop a Consolidated Toxic Hot Spots Cleanup Plan (Consolidated Plan). The Consolidated Plan identifies and ranks known toxic hot spots based on a two-step process using three lines of evidence, and presents descriptions of toxic hot spots, actions necessary to remediate sites, the benefits of remediation, and a range of remediation costs. The plan is applicable to any point and nonpoint source discharges that the Regional Water Boards reasonably determine to contribute to or cause the pollution at toxic hot spots.

The Consolidation Plan requires Regional Water Boards to implement the remediation action to the extent that responsible parties can be identified, and funds are available and allocated for this purpose. When the Regional Water Boards cannot identify a responsible party, the Consolidation Plan indicates that they are to seek funding from available sources to remediate the site.

The Regional Water Boards determine the ranking of each known toxic hot spot based on the five general criteria specified in the Consolidation Plan as shown in **Exhibit 3-8**.

Exhibit 3-8. Toxic Hot Spot Ranking Criteria

Criteria Category	High	Moderate	Low
Human Health Impacts	Human health advisory for consumption of nonmigratory aquatic life from the site	Tissue residues in aquatic organisms exceed FDA/DHS action level or U.S. EPA screening levels	None
Aquatic Life Impacts[1]	Hits in any two biological measures if associated with high chemistry	Hit in one of the measures associated with high chemistry	High sediment or water chemistry
Water Quality Objectives	Objectives exceeded regularly	Objectives occasionally exceeded	Objectives infrequently exceeded
Areal Extent of Hot Spot	More than 10 acres	1 to 10 acres	Less than 1 acre
Natural Remediation Potential	Unlikely to improve without intervention	May or may not improve without intervention	Likely to improve without intervention

Source: SWRCB (2003b).
1. Site ranking are based on an analysis of the sediment chemistry, sediment toxicity, biological field assessments (including benthic community analysis), water toxicity, TIEs, and bioaccumulation.

Appendix D provides additional information on the enclosed bays listed as known toxic hot spots in the Consolidated Plan, including ranking and reason for listing. **Exhibit 3-9** provides a summary of the remedial actions and estimated costs for the high priority toxic hot spots. Note that several of the remedial actions identified by the State and Regional Water Boards only characterize the problem at a hot spot. Thus, the costs identified for those actions do not include all actions necessary to fully remediate the toxic hot spot. Additional funds would be required for remediation after characterization studies are complete.

Exhibit 3-9. Summary of Actions and Costs to Address High Priority Known Toxic Hot Spots

Site	Source	Remedial Actions and Estimated Costs to Remediate Site
Delta Estuary, Cache Creek	• Exports from Placer gold mining regions of the Sierra Nevada • Mercury mining in the Coast Range • Resuspension of estuarine sediment • Effluent from municipal and industrial discharges to surface waters.	Studies to develop mercury control strategy: • Fish eating bird & egg studies plus OEHHA coordination: $335,000 • Mercury monitoring in Cache Creek/year (multi year): $1,120,000 • Mine remediation feasibility studies: $150,000 • Estuarine mercury monitoring studies (multi year): $1,500,000
Delta Estuary, Entire Delta	• Application of diazinon as a dormant orchard spray in the agricultural areas of the Central Valley	• Regional Water Board implementation oversight: $400,000 FY 2002-2003 • Costs to other entities to oversee: $200,000 FY 2003-2004 • Costs to growers: $180,000-$600,000/yr • Implementation of practices: $0-$300,000/yr • Regulatory compliance: $3-$164/acre • Continued practices development: $1,000-$4,060/grower/yr

Exhibit 3-9. Summary of Actions and Costs to Address High Priority Known Toxic Hot Spots

Site	Source	Remedial Actions and Estimated Costs to Remediate Site
		• Monitoring: $100,000 (Delta only) to $1million/yr.
Delta Estuary, Morrison Creek, Mosher, 5-Mile, Mormon Slough, and Calaveras River	• Urban runoff	• Rainfall contribution evaluation: $50,000/ yr for 3 years • Monitoring costs for urban dischargers: $50,000/yr in urban creeks • Continued practices evaluation: $50,000 to $100,000 for cities annually • Implementation of practices: No additional cost • Regulatory agency oversight: $20,000/yr • Develop TMDL: $50,000/yr until 2005 • Develop Basin Plan amendment (if needed): $50,000/yr for 2 years.
Delta Estuary, Ulatis Creek, Paradise Cut, French Camp, and Duck Slough	• Agricultural use	• Develop Basin Plan proposal: $100,000 FY 2002-2003 • R5 Implementation oversight: $100,000 FY 2003-2004 • Costs to other entities to oversee: $540,000 - $1.8 million/yr • Costs to growers: $0-$300,000/yr • Implementation of practices: $2,695-$27,555/grower • Regulatory compliance: $555 - $8,200/grower/yr • Continued practices development: $100,000 - $1million/ yr • Monitoring: $100,000/yr in Delta only.
Humboldt Bay, Eureka Waterfront H Street	• Scrap metal facility including disassembly, incineration, and crushing of autos • Storage of metals, batteries, radiators, metal reclamation from electrical transformers and miscellaneous refuse	• Removal of polluted soils and capping of site: $500,000 - $5,000,000, based on a $500/ton cost for hauling and tipping fees at a hazardous waste disposal site
Los Angeles/ Inner Harbor, Dominguez Channel/ Consolidated Slip	• Historical discharges of DDTs, PCBs, metals • Nonpoint sources such as spills, vessel discharges, anti fouling paints, and storm drains • Waste streams from refineries	• Dredging and offsite disposal of polluted sediments: $1,000,000 - $5,000,000 • Treatment of polluted sediments: $5,000,000 - $50,000,000
Los Angeles Outer Harbor, Cabrillo Pier	• Historical discharge of DDTs, PCBs • Discharge of wastewater effluent from Terminal Island Wastewater Treatment Plant (WWTP) • Nonpoint sources including ship spills, industrial facilities, and storm water runoff	• Dredging and offsite disposal of polluted sediments: $500,000 - $5,000,000 • Capping: $500,000 - $1,000,000 • Treatment of polluted sediments: $2,500,000 - $50,000,000
Lower Newport Bay, Rhine	• Boat yard operations	Dredging and off-site removal • Sediment removal: $231,800

Exhibit 3-9. Summary of Actions and Costs to Address High Priority Known Toxic Hot Spots

Site	Source	Remedial Actions and Estimated Costs to Remediate Site
Channel		• Offsite transport: $4,600,000 • Disposal in a Class I facility: $5,750,000
Moss Landing Harbor and Tributaries	• Past and present agricultural activities • River and stream maintenance activities • Ship maintenance • Urban runoff	• Regional Water Board Program Management: $925,000 (over 5 yrs) • Control of harbor pollutants: $348,334 • Urban runoff action plan: $1,052,750 • Agricultural BMPs: $6,790,000 • Monitoring: $678,000
Mugu Lagoon east arm, Main Lagoon, western arm Calleguas Creek Tidal Prism	• Agricultural runoff, nonpoint source runoff	• In situ treatment of polluted sediment: $72,500,000 • Dredging and removal of polluted sediments: $1,000,000 - $5,000,000
San Diego Bay, Seventh St. Channel Naval Station	• Industrial activities • Pesticides from lawns, streets and buildings • Runoff from pest control operations • Atmospheric deposition	• Dredging and upland disposal: $3,384,800 - $7,405,200 • Dredging and contained aquatic disposal: $145,520 - $275,880
San Francisco Bay, Castro Cove	• Refinery operations	• Site investigation and feasibility study: $2,000,000 • Dredging with upland disposal and capping: $1,000,000 - $20,000,000, based on the size of the contaminated area ranging from 10 to 100 acres, and a depth of 3 feet • Regional Water Board staff cost: $200,000
San Francisco Bay, Entire Bay	• Mercury mining runoff and use in placer and hydraulic gold mining operations • Historic industrial use of PCBs	• Cleanup New Almaden Mine: $10,000,000 • Point Potrero cleanup: $800,000-3,000,000 • TMDLs adoption and mercury strategy: $10,000,000 - $20,000,000 • Watershed investigations to identify sources: $4,000,000/5 yrs • Regional Monitoring Plan studies: $75,000/yr; $150,000/2 yrs; then $50,000/yr • Public education on source control and product substitution: $50,000
San Francisco Bay, Islais Creek	• Storm water or urban runoff entering directly or through combined sewer overflows • Sheet runoff or past discharge from auto dismantlers and metal recycling facilities Deposition of air emissions from I-280	• Site investigation and feasibility study: $1,000,000 • Remediation including dredging with follow-up monitoring: $800,000 - $5,200,000 • Changing operation or increase storage and treatment capacity of the current system: $75,000,000 • Regional Water Board staff costs: $100,000 - $200,000
San Francisco Bay, Mission Creek	• Historic sources • Storm water entering directly or through infrequent combined sewer overflows • Deposition of air emissions from I-280	• Site investigation and feasibility study: $1,000,000 • Remediation including dredging/capping or off site disposal and follow-up monitoring:

Exhibit 3-9. Summary of Actions and Costs to Address High Priority Known Toxic Hot Spots

Site	Source	Remedial Actions and Estimated Costs to Remediate Site
		$800,000 - $1,800,000 • Increase storage and structural changes: $75,000,000 • Regional Water Board staff costs: $100,000-$200,000
San Francisco Bay, Peyton Slough	• Historical industrial activity associated with the creation of cinder/slag piles	• Dredging and disposal of 12,000 cubic yards of sediments, and a 3 foot cap on the entire slough: $400,000 - $1,200,000, depending on the method for cleanup, and other potential activities such as building a subsurface cutoff wall or cap on sidewall along the slough to control groundwater discharge • Follow-up monitoring: $5,000 - $10,000 per yr • Regional Water Board staff costs: $10,000 - $50,000
San Francisco Bay, Point Potrero/ Richmond Harbor	• Historical ship building and scrapping operations • Metal scrap recycling operations	Recommendations: • Sheetpile bulkhead, capping, and institutional controls: $792,000 • Rock Dike bulkhead capping and institutional controls: $1,344,000 • Excavation and off-site disposal: $3,010,000 • Excavation reuse or disposal on site: $881,000 • Regional Water Board costs: $30,000/3yrs
San Francisco Bay, Stege Marsh	• Oxidation of pyrite cinders in the presence of sulfides produced during industrial process Urban runoff • Upland industrial facilities	• Site investigation and feasibility study and remediation option: $1,500,000 to $10,000,000 • Regional Water Board costs: $100,000-$200,000
Santa Monica Bay, Palos Verdes Shelf	• Historical wastewater discharges from manufacturing operations • Wastewater treatment plant discharges	Remedial Action Options • Capping 7.6 sq. km with 45 cm isolation cap: $44,000,000 - $67,000,000 • Capping 7.6 sq. km with 15 cm isolation cap: $18,000,000 - $30,000,000 • Capping most polluted area 4.9 sq. km with 15 cm. isolation cap: $13,000,000 - $19,000,000

Source: SWRCB (2003b). Year dollars not specified.

3.7.2 TMDLs

As part of a TMDL, Regional Water Boards identify potential implementation strategies and estimate the cost of implementation. However, Porter-Cologne prohibits Regional Water Boards from prescribing the exact method of achieving compliance with the targets. Thus, there is no requirement to follow the proposed strategies as long as the allowable loadings are not exceeded.

Although sources are not required to follow the proposed strategies, the recommendations provide an idea of the types of activities that could be necessary for compliance with baseline standards.

Permit writers may also translate the waste load allocations into BMPs, based on BMP performance data. However, the permit writers must provide adequate justification and documentation to demonstrate that specified practices will achieve the numeric waste load allocations.

Exhibit 3-10 summarizes the targets, load allocations, and implementation plans for sediment-related TMDLs completed for enclosed bays and estuaries in the state.

Exhibit 3-10. Summary of Toxic Pollutant TMDLs for Bays and Estuaries

Water Body	Numeric Targets	Load Allocations	Implementation
Ballona Creek Estuary Toxics TMDL (LARWQCB, 2005a)	Sediment: Chlordane = 0.5 µg/kg; DDT = 1.58 µg/kg; PCBs = 22.7 µg/kg; PAHs = 4,022 µg/kg; Cadmium = 1.2 mg/kg; Copper = 34 mg/kg; Lead = 46.7 mg/kg; Silver = 1.0 mg/kg; Zinc = 15 mg/kg	Direct Air: Chlordane = 0.02 g/yr; DDT = 0.1 g/yr; PCBs = 1.0 g/yr; PAHs = 170 g/yr; Cadmium = 0.05 kg/yr; Copper = 1.4 kg/yr; Lead = 2 kg/yr; Silver = 0.04 kg/yr; Zinc = 6 kg/yr Open Space: Chlordane = 0.02 g/yr; DDT = 0.1 g/yr; PCBs = 1.0 g/yr; PAHs = 160 g/yr; Cadmium = 0.05 kg/yr; Copper = 1.4 kg/yr; Lead = 2 kg/yr; Silver = 0.04 kg/yr; Zinc = 6 kg/yr General Construction SW: Chlordane = 0.1 g/yr; DDT = 0.31 g/yr; PCBs = 4 g/yr; PAHs = 800 g/yr; Cadmium = 0.23 kg/yr; Copper = 6.6 kg/yr; Lead = 9.1 kg/yr; Silver = 0.2 kg/yr; Zinc = 29 kg/yr General Industrial SW: Chlordane = 0.02 g/yr; DDT = 0.08 g/yr; PCBs = 1.0 g/yr; PAHs = 200 g/yr; Cadmium = 0.06 kg/yr; Copper = 1.7 kg/yr; Lead = 2.3 kg/yr; Silver = 0.05 kg/yr; Zinc = 7 kg/yr Caltrans: Chlordane = 0.05 g/yr; DDT = 0.15 g/yr; PCBs = 2 g/yr; PAHs = 400 g/yr; Cadmium = 0.11 kg/yr; Copper = 3.2 kg/yr; Lead = 4.4 kg/yr; Silver = 0.09 kg/yr; Zinc = 14 kg/yr MS4s: Chlordane = 3.34 g/yr; DDT = 10.56 g/yr; PCBs =	Potential implementation strategies: • Implement nonstructural BMPs such as better sediment control at construction sites and improved street cleaning by upgrading to vacuum type sweepers for 30% of urbanized watershed • Install structural BMPs at critical points in the storm water conveyance system for 40% of urbanized watershed: 50% infiltration trenches and 50% sand filters. • The Regional Water Board assumed that the remaining 30% of urbanized land will be controlled through Los Angeles County's Integrated Resources Plan that aims to increase the amount of wet-weather urban runoff that can be captured and beneficially used. The Regional Water Board estimated that implementation of an adaptive management approach could costs from about $245 million to $335 million.

Exhibit 3-10. Summary of Toxic Pollutant TMDLs for Bays and Estuaries

Water Body	Numeric Targets	Load Allocations	Implementation
		152 g/yr; PAHs = 26,900 g/yr; Cadmium = 8.0 kg/yr; Copper = 227.3 kg/yr; Lead = 312.3 kg/yr; Silver = 6.69 kg/yr; Zinc = 1,003 kg/yr	
Cache Creek Mercury TMDL (part of Delta watershed) (CVRWQCB, 2004a; 2004b; 2005b)	Fish Tissue: Methylmercury trophic level 3 fish = 0.12 mg/kg Methylmercury trophic level 4 fish = 0.23 mg/kg	Mercury Allocations: Bear Creek mines = 5% of existing Hg loads (Rathburn, Petray North and South, and Rathburn-Petray); Harley Gulch mines = 5% of existing Hg loads (Abbott and Turkey Run); Sulphur Creek = 30% of existing Hg loads (geothermal springs, erosion of undisturbed soil, mines, contaminated streambeds, and atmospheric deposition) Methylmercury Allocations: Cache Creek at Yolo = 66 g MeHg/yr; Settling Basin = 34.7 g MeHg/yr; Bear Creek at gauge = 3.2 g MeHg/yr	Implementation options include: • Public outreach regarding the levels of safe fish consumption and monitoring • Remediation of inactive mines • Control of erosion in mercury-enriched upland areas and in floodplains downstream of the mines and in the lower watershed, • Conducting feasibility studies and evaluating possible remediation at the Harley Gulch delta • Identifying sites and projects to remediate or remove floodplain sediments containing mercury and implement feasible projects • Addressing methylmercury reductions through studies of sources and possible controls in Bear Creek and Anderson Marsh, controlling inputs from new impoundments, wetlands restoration projects, or geothermal spring development. The Regional Water Board estimated capital costs of $14 million and O&M of $700,000 per year.
Calleguas Creek Watershed Metals and Selenium TMDL[a] (LARWQCB, 2006)	Dry Weather Water: Dissolved Copper = 3.1 × WER**; Dissolved Nickel = 8.2 μg/L; Total Mercury = 0.051 μg/L Wet Weather Water: Dissolved Copper = 4.8 × WER**; Dissolved Nickel = 74 μg/L; Total Mercury = 0.051 μg/L Sediment: Copper = 34,000 μg/kg; Nickel = 20,900 μg/kg Fish Tissue: Methylmercury = 0.3 mg/kg (human health); Methylmercury Trophic Level 3 <50 mm = 0.03 mg/kg; Methylmercury Trophic Level 3 50-150 mm = 0.05 mg/kg; Methylmercury Trophic Level 3 150-350 mm = 0.1 mg/kg	Suspended Sediments: Mercury = 80% reduction below background concentrations **Average Dry Weather (<86th Percentile Flow)** Agriculture: Copper = 0.12 × WER** - 0.02 lbs/day; Nickel = 0.26 lbs/day Open Space: Copper = 0.08 lbs/day; Nickel = 0.42 lbs/day NPDES Dischargers: Copper Monthly Average = 3.7 × WER** μg/L; Nickel Monthly Average = 8.2 μg/L; Mercury = 0.051 μg/L **Wet Weather** Agriculture: Copper = (0.00017 × $flow^2$ × 0.01 × flow – 0.05) × WER** - 0.02 lbs/day; Nickel = 0.014 × flow + 0.42 × flow lbs/day Open Space: Copper =	Implementation options include: • Establish group concentration-based effluent limits for NPDES dischargers • Implement BMPs for nonpoint sources consistent with the Nonpoint Source Plan and Conditional Waiver Program.

Exhibit 3-10. Summary of Toxic Pollutant TMDLs for Bays and Estuaries

Water Body	Numeric Targets	Load Allocations	Implementation
	Bird Egg: Mercury = 0.5 mg/kg	0.0000537 × flow^2 + 0.00321 × flow lbs/day; Nickel = 0.014 × flow + 0.42 × flow lbs/day NPDES Dischargers: Copper Daily Maximum = 5.8 × WER** µg/L; Nickel Daily Maximum = 74 µg/L; Mercury = 0.051 µg/L	
Calleguas Creek Watershed OC Pesticides and PCBs TMDL[a] (LARWQCB, 2005e)	Sediment: Chlordane = 0.5 µg/kg; DDT = 1 µg/kg; Dieldrin = 20 ng/kg; PCBs = 23 µg/kg Water: Chlordane = 4 ng/L; DDT = 1 ng/L; Dieldrin = 1.9 ng/L; PCBs = 30 ng/L; Toxaphene = 0.2 ng/L Fish Tissue: Chlordane = 0.83 µg/kg; DDT = 32 µg/kg; Dieldrin = 0.65 µg/kg; PCBs = 5.3 µg/kg; Toxaphene = 9.8 µg/kg	Storm Water Permits: Chlordane = 3.3 ng/g; DDT = 0.3 ng/g; Dieldrin = 4.3 ng/g; PCBs = 180 ng/g; Toxaphene = 360 ng/g Minor Point Sources Daily Maximum: Chlordane = 1.2 ng/L; DDT = 1.2 ng/L; Dieldrin = 0.28 ng/L; PCBs = 0.33 ng/L; Toxaphene = 0.34 ng/L Minor Point Sources Average Monthly: Chlordane = 0.59 ng/L; DDT = 0.59 ng/L; Dieldrin = 0.14 ng/L; PCBs = 0.17 ng/L; Toxaphene = 0.16 ng/L	Implementation options include: • Establish group concentration-based effluent limits for NPDES dischargers • Implement BMPs for nonpoint sources consistent with the Nonpoint Source Plan and Conditional Waiver Program. • Develop Agricultural Water Quality Management Plans and implement agricultural BMPs based on results of BMP effectiveness studies • Develop agricultural education program to inform growers of the recommended BMPs and the Management Plan.
Delta Waterways Methylmercury TMDL (CVRWQCB, 2005a)	Fish Tissue: Methylmercury for largemouth bass = 0.28 mg/kg	Methylmercury Allocations: Central Delta = current load; Marsh Creek = 1.8 g MeHg/yr; Mokelumne-Cosumnes Rivers = 44 g MeHg/yr; Sacramento River = 1,341 g MeHg/yr; San Joaquin = 178 g MeHg/yr; West Delta = current load; Yolo Bypass = 234 g MeHg/yr Total Mercury Allocations: All mercury sources to delta = 174,000 g Hg/yr	Draft implementation options include: • Improve trapping efficiency in Cache Creek Settling Basin • Require that dredged spoil with average concentrations greater than 0.2 mg/kg be placed on or above the 100-year flood plain • Require mercury concentration of fine grain material in top 6-cm of newly exposed sediment to have an average concentration less than the surface material before dredging or be less than 0.2 mg/kg dry weight • Cap NPDES discharger loads at 2005 levels • Implement P2 at facilities with increasing loads • Allow facilities that show maintaining cap is technically impractical or excessively expensive to participate in offsets program • Implement studies to enable reduction of methylmercury in Delta waters.
Marina del Rey Toxics TMDL (LARWQCB, 2005b)	Sediment: Chlordane = 0.5 µg/kg; PCBs = 22.7 µg/kg; Copper = 34 mg/kg; Lead = 46.7 mg/kg; Zinc = 150 mg/kg Water Quality: PCBs =	Atmospheric Deposition: Chlordane = 0.002 g/yr; PCBs = 0.079 g/yr; Copper = 0.12 kg/yr; Lead = 0.16 kg/yr Zinc = 0.52 kg/yr General Construction SW:	Potential implementation strategies: • Implement nonstructural BMPs such as better sediment control at construction sites and improved street cleaning by upgrading to vacuum type sweepers for 30% of urbanized watershed

Exhibit 3-10. Summary of Toxic Pollutant TMDLs for Bays and Estuaries

Water Body	Numeric Targets	Load Allocations	Implementation
	0.17 ng/L (interim); PCBs = 30 ng/L (final) Fish Tissue: PCBs = 5.3 µg/Kg	Chlordane = 0.0005 g/yr; PCBs = 0.0219 g/yr; Copper = 0.033 kg/yr; Lead = 0.045 kg/yr; Zinc = 0.144 kg/yr General Industrial SW: Chlordane = 0.0001 g/yr; PCBs = 0.029 g/yr; Copper = 0.004 kg/yr; Lead = 0.006 kg/yr; Zinc = 0.018 kg/yr Caltrans: Chlordane = 0.0003 g/yr; PCBs = 0.015 g/yr; Copper = 0.022 kg/yr; Lead = 0.030 kg/yr; Zinc = 0.096 kg/yr MS4s: Chlordane = 0.03 g/yr; PCBs = 1.34 g/yr; Copper = 2.01 kg/yr; Lead = 2.75 kg/yr; Zinc = 8.85 kg/yr	• Install structural BMPs at critical points in the storm water conveyance system for 70% of urbanized watershed: 50% infiltration trenches and 50% sand filters. The Regional Water Board estimated structural storm water BMP implementation costs to range from about \$5.5 million to \$7.6 million.
Upper and Lower Newport Bay (including Rhine Channel) Metals TMDL (U.S. EPA Region 9, 2002; Anchor Environmental, 2005)	Sediment Quality: Cadmium: 0.67 mg/kg; Copper: 18.7 mg/kg; Lead: 30.2 mg/kg; Zinc: 124 mg/kg; Mercury = 0.13 mg/kg; Chromium = 52 mg/kg Acute Water Quality: Cadmium: 42 µg/L; Copper: 4.8 µg/L; Lead: 210 µg/L; Zinc: 90 µg/L Chronic Water Quality: Cadmium: 9.3 µg/L; Copper: 3.1 µg/L; Lead: 8.1 µg/L; Zinc: 81 µg/L Fish Tissue: Mercury = 0.3 mg/kg; Chromium = 0.2 mg/kg	Urban runoff: Cadmium = 9,589 lb/yr; Copper = 3,043 lb/yr; Lead = 17,638 lb/yr; Zinc = 174,057 lb/yr; Mercury = 17.1 g/yr; Chromium = 5.66 kg/yr Caltrans: Cadmium = 1,185 lb/yr; Copper = 423 lb/yr; Lead = 2,171 lb/yr; Zinc = 22,866 lb/yr; Mercury = 2.7 g/yr; Chromium = 0.89 kg/yr Other NPDES Permittees: Cadmium = 596 lb/yr; Copper = 190 lb/yr; Lead = 1,154 lb/yr; Zinc = 17,160 lb/yr; Mercury = 2.7 g/yr; Chromium = 0.89 kg/yr Agriculture: Copper = 215 lb/yr; Zinc = 114 lb/yr; Mercury = 0 g/yr; Chromium = 0.89 kg/yr Boats: Copper = 4,542 lb/yr; Zinc = 1,056 lb/yr Air Deposition: Cadmium = 4 lb/yr; Copper = 101 lb/yr; Lead = 68 lb/yr; Zinc = 606 lb/yr Open Space and Existing Sediments: Cadmium = 428 lb/yr; Copper = 803 lb/yr; Lead = 678 lb/yr; Zinc = 11,414 lb/yr; Mercury = 67.5 g/yr; Chromium = 22.3 kg/yr	RWQCB is considering the following options for the Rhine Channel (in Lower Newport Bay): • Dredge sediment and dewater prior to transporting to an approved off-site upland disposal facility (\$11 million to \$17 million) • Dredge sediment and place within an off-site nearshore confined disposal facility (\$7.5 million) • Dredge sediment and dispose of within a confined aquatic disposal area excavated near channel mouth (\$12.6 million). First option shown is preferred option.

Exhibit 3-10. Summary of Toxic Pollutant TMDLs for Bays and Estuaries

Water Body	Numeric Targets	Load Allocations	Implementation
Upper and Lower Newport Bay Organochlorine Compounds TMDL (SARWQCB, 2006)	Sediment Quality: Chlordane = 2.26 µg/kg; DDT = 3.89 µg/kg; PCBs = 21.5 µg/kg Fish Tissue: Chlordane = 30 µg/kg; DDT = 50 µg/kg; PCBs = 20 µg/kg Water Quality: Chlordane = 0.59 ng/L; DDT = 0.59 ng/L; PCBs = 0.17 ng/L	Urban runoff*: Chlordane = 41.1 g/yr; DDT = 70.9 g/yr; PCBs = 107.9 g/yr Caltrans*: Chlordane = 12.6 g/yr; DDT = 21.6 g/yr; PCBs = 33 g/yr Construction*: Chlordane = 32 g/yr; DDT = 55.2 g/yr; PCBs = 83.9 g/yr Commercial Nurseries: Chlordane = 4.5 g/yr; DDT = 7.9 g/yr; PCBs = 12 g/yr Agriculture*: Chlordane = 9.5 g/yr; DDT = 9.9 g/yr; PCBs = 17.8 g/yr Open Space: Chlordane = 10.4 g/yr; DDT = 17.8 g/yr; PCBs = 27 g/yr Channels and Streams: Chlordane = 2.3 g/yr; DDT = 4.0 g/yr; PCBs = 6.0 g/yr Existing Sediments and Air Deposition*: Chlordane = 5.7 g/yr; DDT = 9.9 g/yr; PCBs = 15 g/yr	The Regional Water Board recommends the following implementation actions: • Review and revise existing NPDES permits to incorporate wasteload allocations (WLAs), compliance schedules, and monitoring program requirements. • Require agricultural operators to identify and implement monitoring program to assess pollutant discharges from their facilities, and to identify and implement a BMP program. • Identify parties responsible for open space areas, and implement a monitoring program to assess the discharges. • Implement appropriate BMPs and sampling plans for construction activities. • MS4s shall implement additional/enhanced BMPs to ensure pollutant reductions. • Evaluate feasibility and mechanisms to fund future dredging operations. • Develop a work plan to meet TMDL implementation requirements. • Revise regional monitoring program to evaluate effectiveness of actions and programs. • Conduct special studies to review and revise TMDLs.
San Diego Bay, Shelter Island Yacht Club Dissolved Copper TMDL (SDRWQCB, 2005)	Acute Water Quality: 4.8 µg/L Chronic Water Quality: 3.1 µg/L	Passive Leaching: 375 kg Cu/yr Hull Cleaning: 72 kg Cu/yr Urban Runoff: 30 kg Cu/yr Background: 30 kg Cu/yr Direct Atmospheric Deposition: 3 kg Cu/yr Existing Sediment: 0 kg Cu/yr	The Regional Water Board recommends the following implementation actions: • Coordinate with governmental agencies over the use of copper-based antifouling paints to protect water quality from the adverse effects of copper-based antifouling paints • Regulate discharges of copper through WDRs, waivers of WDRs, or adoption of waste discharge prohibitions • Amend MS4 permit to require that discharges of copper not exceed 30 mg/kg.
San Francisco Bay Mercury TMDL (SFBRWQCB, 2004a)	Sediment Quality: 0.2 mg Hg/kg Fish Tissue: 0.2 mg Hg/kg Wildlife, Birds Egg: 0.5 mg Hg/kg	Bed erosion: 220 kg Hg/yr (53% reduction) Central Valley watershed: 330 kg Hg/yr (24% reduction) Urban storm water runoff: 82 kg Hg/yr (48% reduction) Guadalupe River watershed: 2 kg Hg/yr (98% reduction) Atmospheric deposition: 27 kg Hg/yr (current load) Nonurban storm water runoff: 25 kg Hg/yr (current load) Wastewater: 20 kg Hg/yr (current load; 17 kg Hg/yr	The proposed implementation plan identified actions for each source except bed erosion and nonurban storm water runoff because more information is needed. • Central Valley watershed: developing TMDL to meet allocation; actions likely to include mine remediation and sediment capture • Urban storm water runoff: comply with NPDES permits and implement pollution prevention (P2) • Guadalupe R. watershed: developing TMDL to meet allocation; actions likely to include mining waste removal and slope stabilization • Atmospheric deposition: no mandated action

Exhibit 3-10. Summary of Toxic Pollutant TMDLs for Bays and Estuaries

Water Body	Numeric Targets	Load Allocations	Implementation
		municipal; 3 kg Hg/yr industrial)	• Wastewater: capped at current loads.
San Francisco Bay PCBs TMDL (SFBRWQCB, 2004b)	Sediment Quality: 2.5 µg PCBs/kg Fish Tissue: 22 ng PCBs/g	Atmospheric Deposition: -7 kg PCBs/yr Central Valley Delta: 32 kg/yr Wastewater Discharges: 2.3 kg/yr Urban Runoff: 2 kg/yr Dredged Material: 1.4 kg/yr In-Bay PCBs Hot Spots: Not quantified	The Regional Water Board recommends the following implementation actions: • Develop a watershed-wide NPDES permit for all point source dischargers that caps current loads • Implement source control programs for point source dischargers • Require petroleum refineries to evaluate the significance of PCB air emissions to load to bay • Cleanup of hotspots on land, storm drains, and vicinity of storm drain outfalls • Capture, detention, and treatment of highly contaminated runoff (where cleanup is not effective) • Implementation of urban runoff management practices and controls that remove PCBs • Implementation and attainment of the Long Term Management Strategy in-Bay disposal goals • Remediate PCBs contaminated sediments according to site-specific clean-up plans.

*Includes Upper and Lower Newport Bay allocations.

** The WER has a default value of 1.0 unless the Regional Water Board approves a site-specific WER. The Regional Water Board is reviewing a WER study for Mugu Lagoon (Reach 1), and if approved, the Regional Water Board will modify the TMDL targets in accordance with all legal and regulatory requirements.

a. Only includes pollutants from Exhibit 2-1 and allocations for Mugu Lagoon/Calleguas Creek Reach 1.

3.7.3 Cleanup and Abatement Orders

Regional Water Boards have issued a number of existing cleanup and abatement orders for bays and estuaries to improve sediment quality and reduce toxicity. Under these orders, dischargers or companies are required to cleanup contaminated sediments, soils, or groundwater to background levels, or if background levels are not technologically or economically feasible, to a level determined by the Regional Water Board. For example, the San Diego Regional Water Board is proposing a tentative cleanup order for the contaminated sediments in the San Diego Bay between Sampson Street extension and the mouth of Chollas Creek. The Regional Water Board has proposed a cleanup level that the responsible parties will be required to achieve.

3.7.4 Contaminated Sediment Task Force

In 1997, the governor signed Senate Bill 673 into law, requiring the California Coastal Commission and the Los Angeles Regional Water Board to establish a multi-agency Contaminated Sediments Task Force (CSTF) to assist in the preparation of a long-term management strategy for dredging and disposal of contaminated sediments in the Los Angeles area. The resulting long-term management strategy includes, among other recommendations, a component focused on the reduction of contaminants at their source (CSTF, 2005). The next steps involve implementing the plan. The CSTF Management Committee meets on a quarterly basis to address a number of issues, including continuing refinement of management tools (e.g., BMP toolbox, water quality monitoring, and sediment quality guidelines) (CSTF, 2005).

4. Description of the Plan

This section describes the applicability of the regulation, and the SQOs, implementation procedures, and monitoring requirements.

4.1 Applicability

The Sediment Quality Plan for Enclosed Bays and Estuaries [the Plan; SWRCB (2006)] applies to:

- Enclosed bays[1] and estuaries[2]
- Surficial sediments that have been deposited or emplaced below the intertidal zone, not to sediments characterized by less than 5% fines or substrates composed of gravels, cobbles, or consolidated rock.

The Plan is not applicable to ocean waters including Monterey Bay, Santa Monica Bay, or inland surface waters, and does not govern dredge material suitability determinations or the management of active, designated, or permitted aquatic dredged material disposal or placement sites.

4.2 Sediment Quality Objectives

The Plan protects estuarine and marine habitat and rare and endangered species beneficial uses, and commercial and sport fishing, aquaculture, and shellfish harvesting beneficial uses by protecting benthic aquatic life and human health, respectively:

- Aquatic Life – Benthic Community Protection: Pollutants in sediments shall not be present in quantities that, alone or in combination, are toxic to benthic communities in bays and estuaries implemented using the integration of multiple lines of evidence (MLOE) as described in Section V of the Plan.
- Human Health: Pollutants shall not be present in sediments at levels that bioaccumulate in aquatic life to levels that are harmful to human health.

4.3 Implementation Procedures

The Plan specifies procedures for implementing the narrative SQOs, including determining compliance, NPDES permitting procedures, and monitoring requirements.

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[1] Enclosed Bays are indentations along the coast which enclose an area of oceanic water within distinct headlands or harbor works. Enclosed bays include all bays where the narrowest distance between headlands or outermost harbor works is less than 75% of the greatest dimension of the enclosed portion of the bay (SWRCB, 2006a).

[2] Estuaries and coastal lagoons are waters at the mouths of streams that serve as mixing zones for fresh and ocean waters during a major portion of the year. Mouths of streams that are temporarily separated from the ocean by sandbars are considered estuaries. Estuarine waters generally extend from a bay or the open ocean to the upstream limit of tidal action, but may extend seaward if significant mixing of fresh and salt water occurs in open coastal waters (SWRCB, 2006a).

4.3.1 Assessing Compliance with the SQOs

The Plan outlines procedures for assessing compliance with the aquatic life SQOs for bays and estuaries and the human health SQO.

Aquatic Life – Benthic Community Protection for Bays

The Plan requires that MLOE be used to assess compliance with the aquatic life SQO (i.e., the condition of benthic communities and the potential for exposure to toxic pollutants in sediments): sediment toxicity, as measured by determining short-term survival and appropriate sublethal effects on specified groups of organisms; benthic community condition, as measured by determining the benthic response index, index of benthic integrity, the relative benthic index, and the river invertebrate prediction and classification system for species present; and sediment chemistry, as measured by determining the north and south chemical category score (nCCS, sCCS) and the California Pmax based on concentrations of specified chemicals in sediments (at a minimum all samples shall be tested for the analytes identified in Exhibit 2-1).

To assess compliance with the aquatic life SQO, each line of evidence is first evaluated and classified into a response category (no, low, moderate, or high effect) that reflects a change in the level of certainty that an adverse response is present or in the severity of effect. Next, the results for the lines of evidence (LOE) are combined to assess biological effect or chemical exposure at a site. The severity of biological effect is determined from the benthos and toxicity test results, where benthos is given greater weight for determining effects. Evidence of chemical exposure, or the potential that effects are chemically mediated, is determined from the sediment chemistry and toxicity test results. Note that benthos is not used to assess chemical exposure because benthic disturbance can be caused by nontoxic-related factors, such as grain size, temperature, and recruitment.

The framework for assessing the MLOE classifies each site into one of six categories of impact as described in **Exhibit 4-1**.

Exhibit 4-1. Sediment Quality Assessment Categories

Assessment Category	Description
Unimpacted	• Confident that any sediment contamination present at the site is not causing significant adverse direct impacts to aquatic life. • Sediment conditions support a benthic community composition that is similar to that attained in reference areas representing the best available conditions in the region. • High agreement among the LOE is present.
Likely Unimpacted	• Sediment contamination present at the site is not expected to cause significant adverse direct impacts to aquatic life. • Some disagreement among the LOE is present, which indicates uncertainty in the classification.
Possibly Impacted	• Sediment contamination present at the site may be causing significant adverse direct impacts to aquatic life, but these impacts may be moderate or variable in nature. • The LOE may agree in indicating a minor level of effect, or there may be substantial disagreement among the LOE.

Exhibit 4-1. Sediment Quality Assessment Categories

Assessment Category	Description
Likely Impacted	• Confidence that sediment contamination present at the site is causing significant adverse direct impacts to aquatic life. • There may be disagreement among the LOE, but the evidence for a contaminant-related impact is persuasive.
Clearly Impacted	• Confidence that sediment contamination present at the site is causing severe adverse direct impacts to aquatic life.
Inconclusive	• Unable to classify the site. • Extreme disagreement among the LOE indicate that either the data are suspect or that additional information is needed before a classification can be made.

Source: SWRCB (2006a).

The above categories are based on the presence and magnitude of biological effects and chemical exposure. **Exhibit 4-2** provides the station assessment categories for all possible MLOE combinations under the Plan.

Exhibit 4-2. MLOE Combinations for Each Assessment Category

Chemistry exposure	Benthic disturbance	Toxicity	Assessment Category
Minimal	Reference	Nontoxic	Unimpacted
Minimal	Reference	Low	Unimpacted
Minimal	Reference	Moderate	Unimpacted
Minimal	Reference	High	Inconclusive
Minimal	Low	Nontoxic	Unimpacted
Minimal	Low	Low	Likely unimpacted
Minimal	Low	Moderate	Likely unimpacted
Minimal	Low	High	Possibly impacted
Minimal	Moderate	Nontoxic	Likely unimpacted
Minimal	Moderate	Low	Likely unimpacted
Minimal	Moderate	Moderate	Possibly impacted
Minimal	Moderate	High	Likely impacted
Minimal	High	Nontoxic	Likely unimpacted
Minimal	High	Low	Inconclusive
Minimal	High	Moderate	Possibly impacted
Minimal	High	High	Likely impacted
Low	Reference	Nontoxic	Unimpacted
Low	Reference	Low	Unimpacted
Low	Reference	Moderate	Likely unimpacted
Low	Reference	High	Possibly impacted
Low	Low	Nontoxic	Unimpacted
Low	Low	Low	Likely unimpacted
Low	Low	Moderate	Possibly impacted
Low	Low	High	Possibly impacted
Low	Moderate	Nontoxic	Likely unimpacted
Low	Moderate	Low	Possibly impacted
Low	Moderate	Moderate	Likely impacted
Low	Moderate	High	Likely impacted
Low	High	Nontoxic	Likely unimpacted
Low	High	Low	Possibly impacted

Exhibit 4-2. MLOE Combinations for Each Assessment Category

Chemistry exposure	Benthic disturbance	Toxicity	Assessment Category
Low	High	Moderate	Likely impacted
Low	High	High	Likely impacted
Moderate	Reference	Nontoxic	Unimpacted
Moderate	Reference	Low	Likely unimpacted
Moderate	Reference	Moderate	Likely unimpacted
Moderate	Reference	High	Possibly impacted
Moderate	Low	Nontoxic	Unimpacted
Moderate	Low	Low	Possibly impacted
Moderate	Low	Moderate	Possibly impacted
Moderate	Low	High	Possibly impacted
Moderate	Moderate	Nontoxic	Possibly impacted
Moderate	Moderate	Low	Likely impacted
Moderate	Moderate	Moderate	Likely impacted
Moderate	Moderate	High	Likely impacted
Moderate	High	Nontoxic	Possibly impacted
Moderate	High	Low	Likely impacted
Moderate	High	Moderate	Likely impacted
Moderate	High	High	Likely impacted
High	Reference	Nontoxic	Likely unimpacted
High	Reference	Low	Likely unimpacted
High	Reference	Moderate	Inconclusive
High	Reference	High	Likely impacted
High	Low	Nontoxic	Likely unimpacted
High	Low	Low	Possibly impacted
High	Low	Moderate	Likely impacted
High	Low	High	Likely impacted
High	Moderate	Nontoxic	Likely impacted
High	Moderate	Low	Likely impacted
High	Moderate	Moderate	Clearly impacted
High	Moderate	High	Clearly impacted
High	High	Nontoxic	Likely impacted
High	High	Low	Likely impacted
High	High	Moderate	Clearly impacted
High	High	High	Clearly impacted

The Plan specifies that sites with unimpacted and likely unimpacted sediments achieve the SQO, whereas sites with clearly impacted, likely impacted, and possibly impacted sediments exceed the SQO. In addition, a Regional Water Board shall designate the possibly impacted category as meeting the protective condition if studies demonstrate that the combination of effects and exposure measures are not responding to toxic pollutants in sediments and that other factors are causing these responses within a specific reach segment or water body. In this situation, the Regional and State Board will only consider the likely impacted and clearly impacted categories as degraded when making a determination on receiving water limits or impaired water bodies.

Aquatic Life – Benthic Community Protection for Estuaries

Compliance assessment for estuaries should be based on the same tools described above for enclosed bays. That is, MLOE should be used, there must be evidence of both elevated chemical exposure and biological effects, and the categorization of each LOE should be based on numeric values or a statistical comparison. However, the categorization of each LOE will be based on a reference condition rather than an established index or score. Reference sites should be located in an area uninfluenced by the dischargers or pollutants of concern, and should be representative of other habitat characteristics of the assessment area (e.g., salinity, grain size).

Sites are classified in only two impact categories:

- Unimpacted – no conclusive evidence of both high pollutant exposure and high biological effects present at the site; evidence of chemical exposure and biological effects may be within natural variability or measurement error
- Impacted – confident that sediment contamination present at the site is causing adverse direct impacts to aquatic life.

Human Health Protection

Compliance with the human health narrative sediment quality objective will be assessed based on a human health risk assessment in accordance with the California Environmental Protection Agency's (CalEPA) OEHHA policies for fish consumption and risk assessment, CalEPA's DTSC Risk Assessment, and U.S. EPA Human Health Risk Assessment policies.

4.3.2 NPDES Permits

SQOs will be implemented as receiving water limits in NPDES permits where a Regional Water Board believes there is potential for the discharge to be causing or contributing to an exceedance of an applicable SQO, based on the results of stressor identification studies. Targeted monitoring designs shall be applied to those permittees that are required to meet receiving water limits.

If a single discharger is found to be responsible for discharging a pollutant resulting in the exceedance of an SQO, the Regional Water Board shall require the discharger to take all necessary and appropriate steps to address the exceedance, including but not limited to, reducing the pollutant loading to the sediment. When multiple sources are present in the water body, the Regional Water Board shall require the sources to take all necessary and appropriate steps to address exceedance of the SQO. If appropriate, the Regional Water Board may adopt a TMDL to ensure attainment of the sediment objective.

4.3.3 303(d) Listings

To determine impairments for 303(d) listing purposes, the Regional Water Boards will use the state's existing listing policy (described in Section 3.6). Clearly impacted, likely impacted, and possibly impacted categories will be considered exceedances; if the number of exceedances supports rejection of the null hypothesis (as presented in Exhibit 3-5), the Regional Water Board will list the segment as impaired. Regional Water Boards should make every effort to use spatially representative stations in their assessment of compliance with the SQOs.

4.4 Monitoring Requirements

The Plan directs Regional Water Boards to require permittees that discharge toxic or priority pollutants that may accumulate in sediments at levels that will cause, have the reasonable potential to cause, or contribute to an exceedance of applicable SQOs, to monitor sediments at intervals not less than once per permit cycle, prior to the issuance or re-issuance of a permit. However, a Regional Water Board may choose to exempt low volume discharges that have no significant adverse impact on sediment quality from this monitoring requirement.

Monitoring may be performed by individual permittees, a regional or water body monitoring coalition, or both. To achieve maximum efficiency and economy of resources, the State Water Board encourages the regulated community in coordination with the Regional Water Boards to establish water body-monitoring coalitions that would enable the sharing of technical resources, trained personal, and associated costs and create an integrated sediment-monitoring program within each major water body. Sediment monitoring programs shall be designed to ensure that the aggregate stations are spatially representative of the sediment within the water body.

Where water bodies or segments contain possibly impacted and no clearly or likely impacted sites, confirmatory monitoring shall be conducted to determine whether the results are a response to toxic pollutants in sediments or other factors. If MLOE or confirmatory monitoring results indicate that sediments fail to meet the narrative SQOs, the Plan requires a sequential approach to manage the sediment appropriately. The sequential approach consists of development and implementation of a work plan (i.e., stressor identification) to seek confirmation and characterization of pollutant-related impacts, pollutant identification, and source identification. The Plan directs Regional Water Boards to prioritize segments or reaches with the highest percentage of sites designated as clearly impacted and likely impacted for stressor identification.

Exceedance of the direct effects SQO at a site indicates that pollutants in the sediment are the cause, but does not identify the specific contaminants responsible or rule out confounding factors (e.g., physical disturbance). Physical alterations such as reduced salinity, impacts from dredging, very fine or course grain size, and propeller wash from passing ships may produce a condition in the benthic community similar to that caused by toxic pollutants. If impacts to a site are purely due to physical disturbance, the LOE characteristics will likely show a degraded benthic community with little or no toxicity and low chemical concentrations. Other nontoxic pollutant related stressors include elevated levels of total organic carbon, nutrients and pathogens. Chemical and microbiological analysis will be necessary to determine if these constituents are present. The LOE characteristics for this type of stressor would likely be a degraded benthic community with possibly an indication of toxicity, and low chemical concentrations.

To further assess a site that is impacted by toxic pollutants, the Plan allows for several studies to be considered and evaluated in the work plan for the confirmation effort:

- Evaluate the spatial extent of the area of concern
- Examination of body burden data from animals exposed to the site's sediment to indicate if pollutants are being accumulated and to what degree

- Application of chemical specific mechanistic benchmarks to interpret sediment chemistry concentrations
- Examination of chemistry and biology data from the site to determine if there is a correlation between the two lines of evidence
- Gather alternate biological effects data such as bioaccumulation experiments and pore water toxicity or chemical analysis
- Conduct other investigations commonly be performed as part of a Phase I TIE.

If there is compelling evidence that the SQO exceedances contributing to a receiving water limit exceedance are not due to toxic pollutants, then the Plan indicates that the assessment area shall be designated as having achieved the receiving water limit.

Pollutant identification studies to identify the cause of the observed effects may be based on the following:

- **Statistical methods**: Correlations between individual chemicals and biological endpoints (toxicity and benthic community).
- **Gradient analysis:** Comparisons between samples taken at various distances from a chemical hotspot determine patterns in chemical concentrations and biological responses.
- **Toxicity Identification Evaluation (TIE)**: Sediment samples are manipulated chemically or physically to remove classes of chemicals or render them biologically unavailable. Following the manipulations, biological tests determine if toxicity has been removed. TIEs should be conducted at a limited number of stations, and preferably those with strong biological effects.
- **Bioavailability**: Chemical and toxicological measurements on pore water may determine the availability of sediment contaminants. Measurement of acid volatile sulfides and extracted metals analysis determine if sufficient sulfides are present to bind metals. Solid phase microextraction (SPME) or laboratory desorption experiments can be used to identify which organics are available to animals.
- **Verification**: Compare body burden measurements on animals exposed to the sediment to established toxicity thresholds. Spike sediments with the suspected chemicals to verify that they are toxic at the concentrations observed in the field. Alternately, transplant unaffected animals to suspected sites for in-situ toxicity and bioaccumulation testing.

To address sources identification and management actions, the Plan requires:

- Determining if sources are ongoing or legacy
- Determining the number and nature of ongoing sources
- If a single discharger is found to be responsible for discharging the stressor pollutant at a loading rate that is significant, requiring the discharger to take all necessary and appropriate steps to address exceedances, including but not limited to reducing the pollutant loading into the sediment
- When multiple sources are present in the water body and the stressor pollutant is discharged at a loading rate that is significant, requiring the sources to take all necessary and appropriate steps to address exceedances, including adopting a TMDL, if appropriate.

5. Incremental Impact of the Plan

This section discusses the potential incremental impacts of the SQOs and implementation procedures for affected bays and estuaries, and provides estimates of these impacts associated with the aquatic life (benthic community protection) SQO based on an initial assessment of available monitoring data for bays performed for the State Water Board by the Southern California Coastal Water Research Program (SCCWRP) in 2007.

5.1 Identifying Incremental Impacts

As discussed in Section 3, there are many existing policies, procedures, and initiatives affecting sediments that are impairing beneficial uses of bays and estuaries. The assessment, pollution control, and sediment cleanups identified in Section 3 would continue in the absence of the Plan. Thus, the purpose of this analysis is to identify the potential change in the nature and extent of these activities that is likely to occur under the Plan.

All Regional Water Boards currently have narrative objectives for toxic substances, toxicity, pesticides, bioaccumulation, or a combination of these categories. Although these narrative objectives are subject to interpretation and are implemented according to each Regional Water Board's policy, any water body could potentially be listed because of impaired biota, bioaccumulation in biota, sediment toxicity, or high concentrations of toxic substances (especially pesticides) in sediments or fish tissue.

Depending on each Regional Water Board's implementation policy, a water body could be listed based on only one of the narrative objective categories. Thus, there is potential for erroneous listings. Impaired biota, for example, might not be due to the effects of toxic substances, but to other factors such as sedimentation or reduced dissolved oxygen. Sediments might be toxic to test organisms, but not be toxic to the species indigenous to the area. Similarly, there may be high concentrations of toxic substances in sediments that are not bioavailable. Under any of these circumstances, a water body could be listed for toxic substances when, in fact, toxic substances are not the cause of impairment.

In comparison, under the Plan, Regional Water Boards would list sediment as exceeding the objectives only if multiple lines of evidence (with sufficient data) indicate impairment. This requirement for additional evidence of impairment could potentially reduce the number of water bodies that would be incorrectly listed as impaired for toxic substances. Potential costs or cost savings associated with implementing the SQOs depends on the relative stringency of the objectives.

The lines of evidence, tools for assessing impairment, stressor thresholds, and thus, potential costs vary for the aquatic life SQO for bays, the aquatic life SQO for estuaries, and the human health SQO. However, the possible outcomes based on a comparison of existing objectives and implementation of the Plan are similar. **Exhibit 5-1** indicates the possible outcomes.

Exhibit 5-1. Incremental Impacts Associated with the Plan

Assessment Under Existing Objective	Assessment Under SQOs: No Sediment Impairment	Assessment Under SQOs: Sediment Impairment
No Sediment Impairment	• No change in sediment quality. • Potential incremental assessment costs.	• Sediment quality improvement. • Potential incremental assessment and control costs.
Sediment Impairment	• Sediment quality remains the same, which may be lower than under implementation of baseline narrative objective. • Potential incremental assessment costs, but will avoid unnecessary control costs.	• Change in sediment quality if better data lead to change in control strategies. • Potential incremental assessment costs; potential incremental costs or cost-savings depending on differences in control strategies.

5.2 Compliance Assessment

Under the Plan, compliance with the interim aquatic life objective for estuaries would be based on comparing coupled biological effects and chemistry data to reference site conditions. Due to a lack of existing coupled data and known reference sites, an analysis of potential incremental impacts is not possible at this time. The State Water Board will adopt final direct effects objectives for estuaries under Phase II. Thus, it is likely that any control actions identified for compliance with the interim objectives would not be implemented until it could be shown that those actions would also be required for compliance with final objectives, especially given that compliance with the interim objective is only based on two assessment categories rather than six.

Compliance with the interim human health objectives under the Plan would be based on a human health risk assessment that utilizes OEHHA policies for fish consumption as well as other fish tissue threshold values. In the absence of the Plan, waters will continue to be listed as impaired based on exceedances of fish tissue advisory levels or criteria. Because these same levels and criteria will be used under the Plan to determine compliance with the objectives there would be no incremental impacts associated with the interim human health SQO.

There are sufficient data available to estimate the incremental impacts associated with compliance the aquatic life SQO for bays. Using existing sediment monitoring assessment data for stations for which all three LOE (toxicity, chemical exposure, and benthos community) are available, SCCWRP assessed the results according the framework provided in the Plan and described in Section 4. SCCWRP compiled the data from diverse sources which includes both targeted and randomly located stations sampled over a 10-year period. **Exhibits 5-2 to 5-13** provide the results for these stations, compared to existing listings for the pollutants of concern in sediment, fish tissue, or the water column. (Water column listings for the pollutants of concern are relevant to evaluation of the impacts of the Plan since most of the pollutants of concern are insoluble, and are likely to eventually settle or attach to sediments; fish tissue listings also may be due to contaminated sediments. Thus, control measures and activities necessary for compliance with fish tissue and water quality objectives could also potentially result in compliance with the SQO.)

Exhibit 5-2. 2006 303(d) List for Toxics and Potential Characterization under the Plan, Region 1: Crescent City Harbor and Humboldt Bay

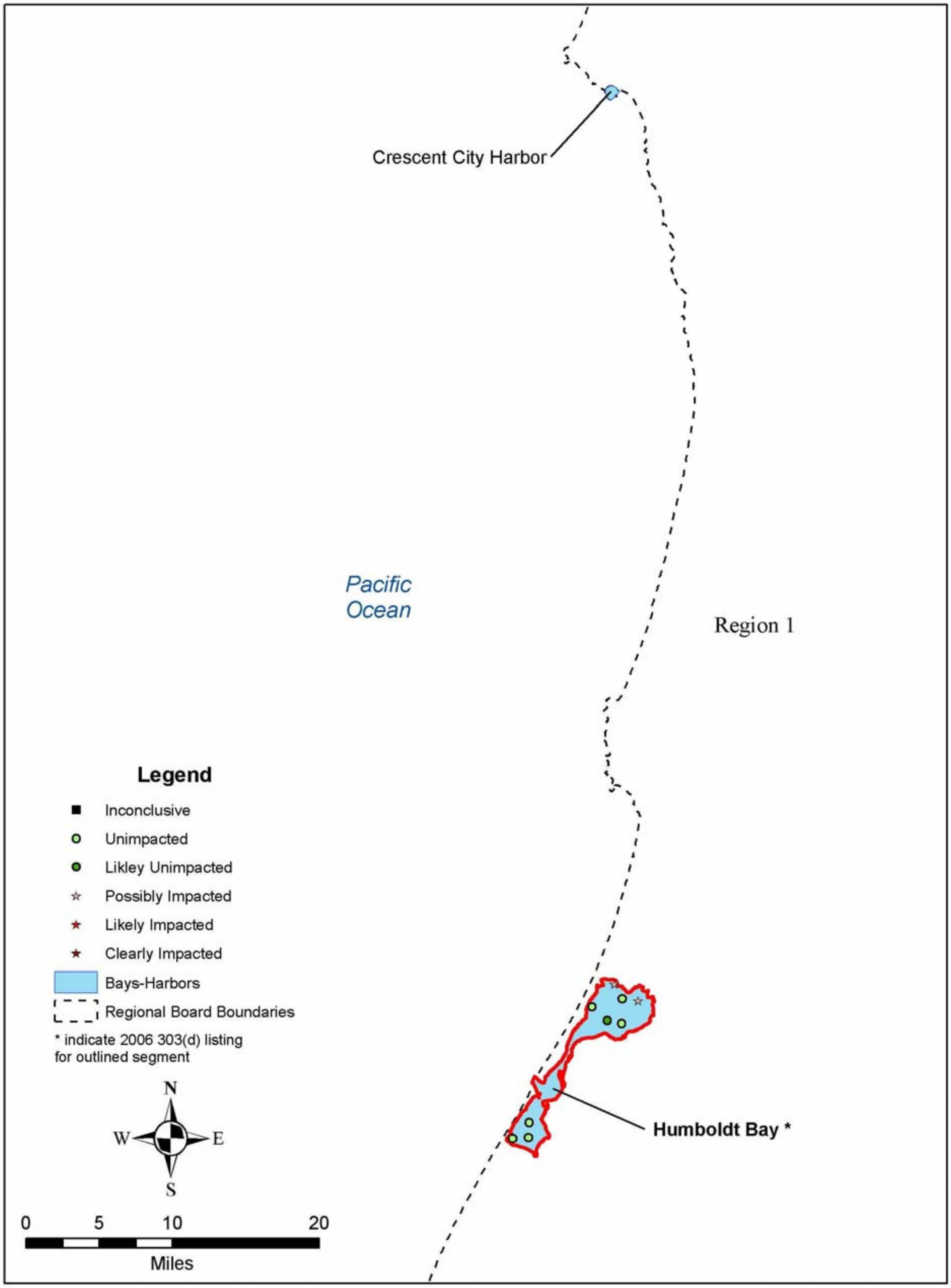


Exhibit 5-3. 2006 303(d) List for Toxics and Potential Characterization under the Plan, Region 1, Bodega Harbor

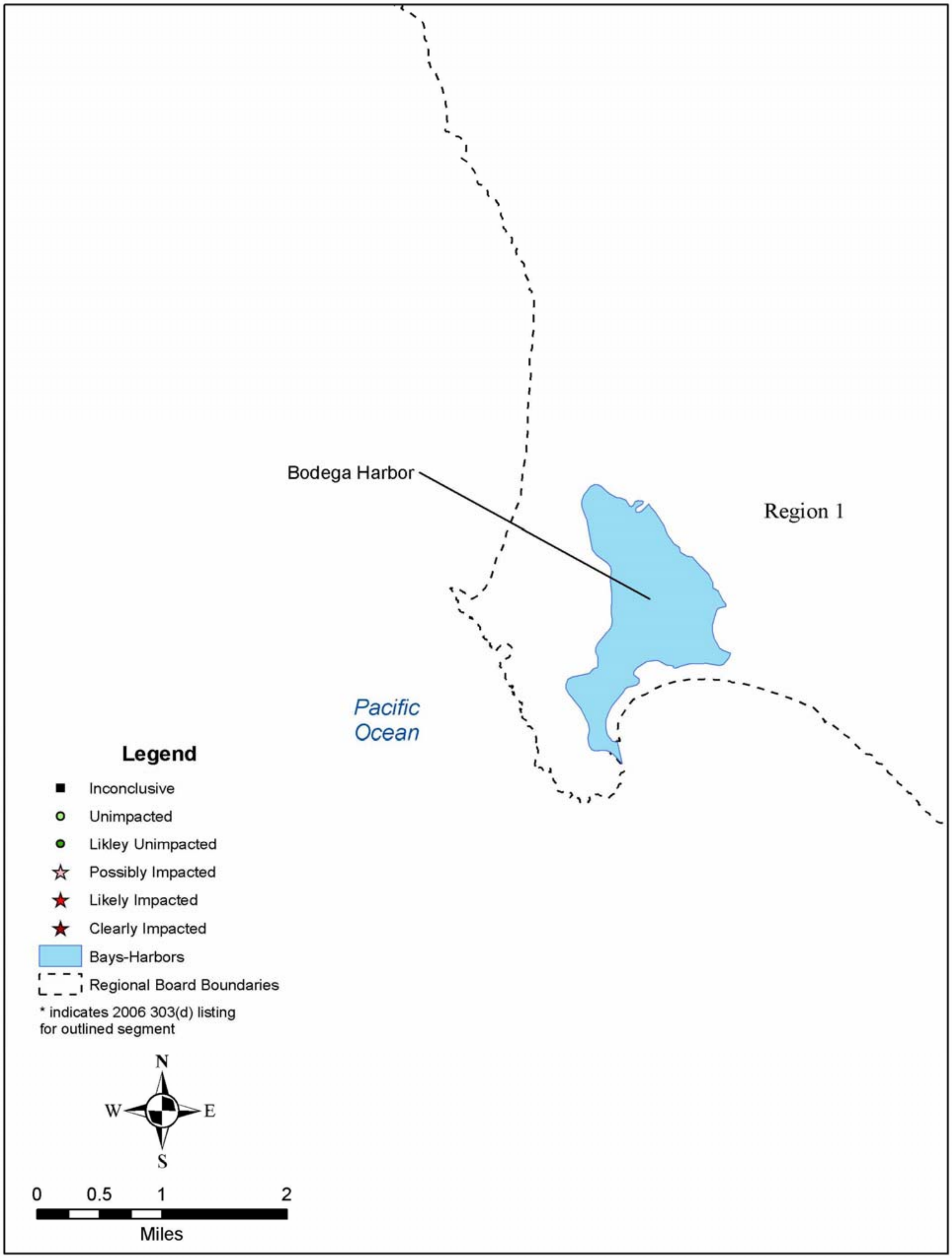


Exhibit 5-4. 2006 303(d) List for Toxics and Potential Characterization under the Plan, Region 2

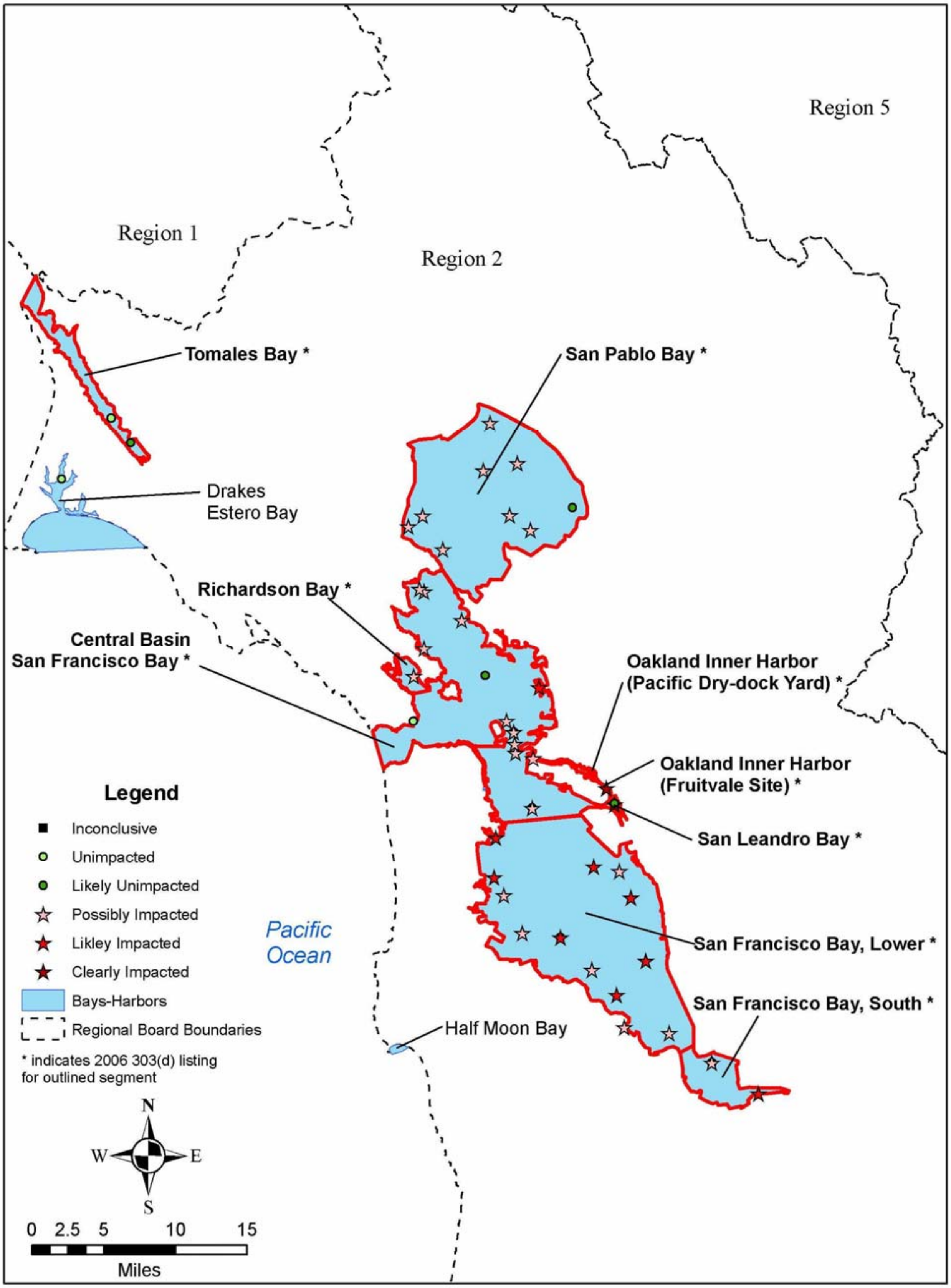


Exhibit 5-5. 2006 303(d) List for Toxics and Potential Characterization under the Plan, Region 3: Moss Landing Harbor and Monterey Harbor

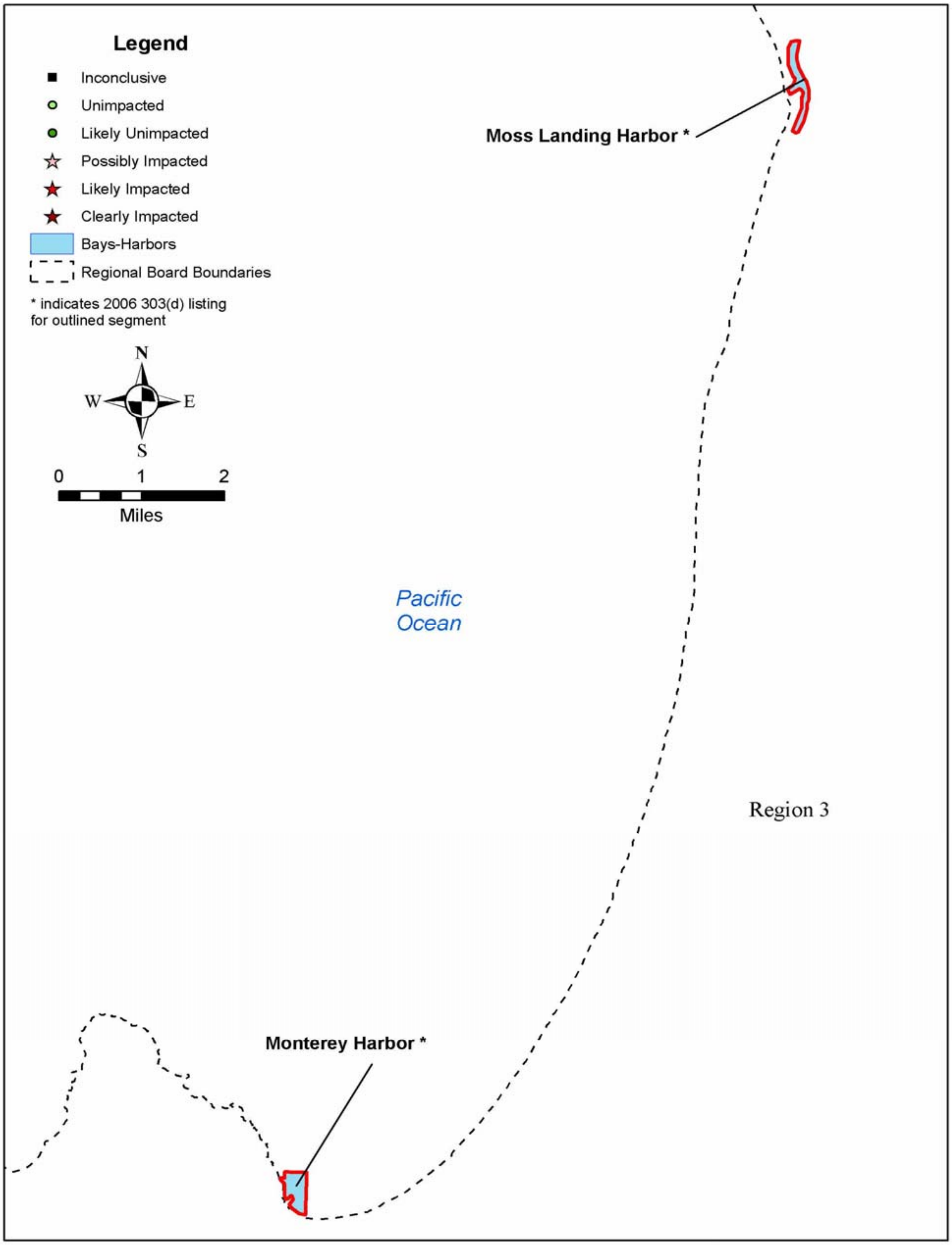


Exhibit 5-6. 2006 303(d) List for Toxics and Potential Characterization under the Plan, Region 3: Morro Bay

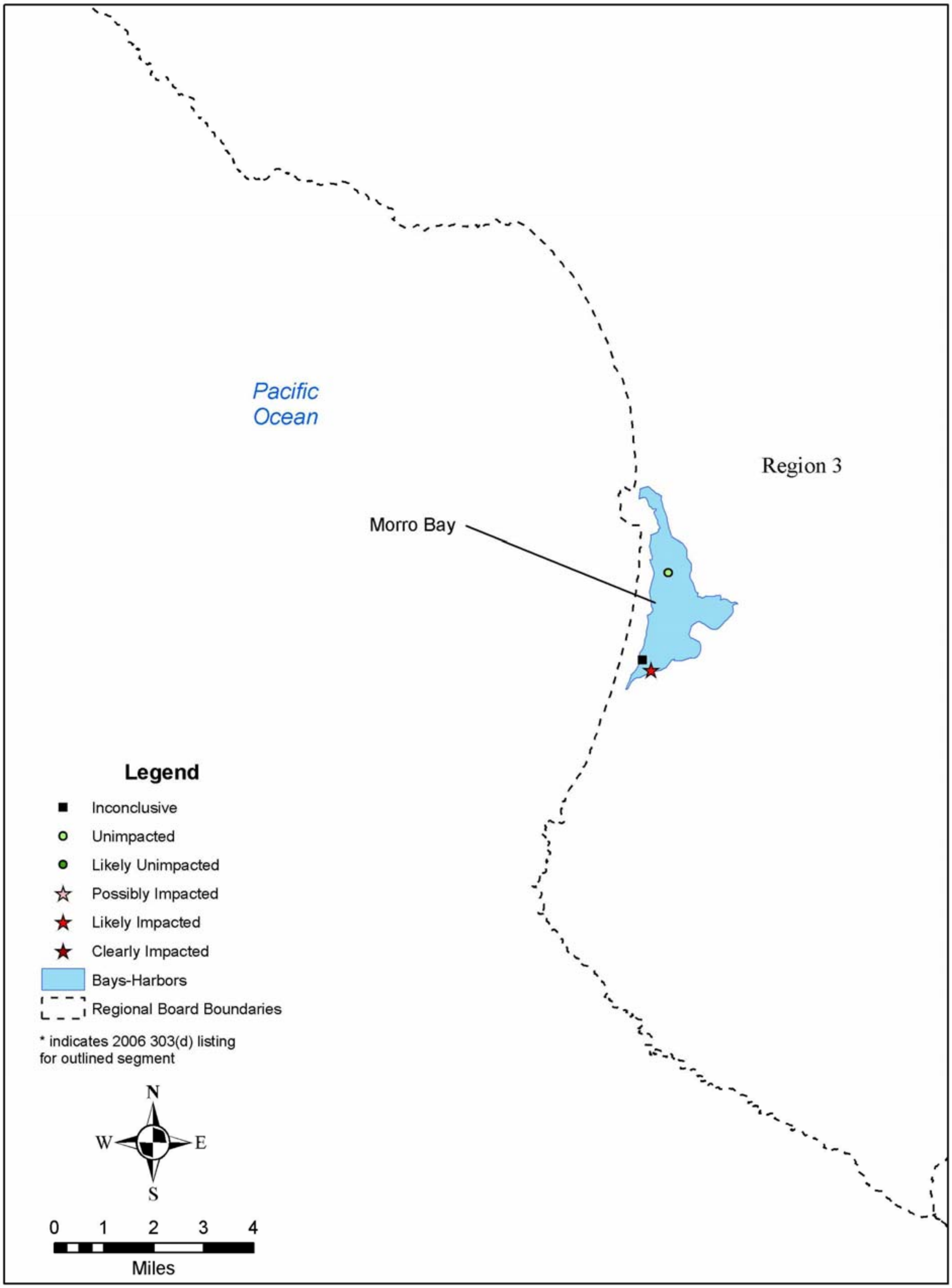


Exhibit 5-7. 2006 303(d) List for Toxics and Potential Characterization under the Plan, Region 3: Santa Barbara Harbor

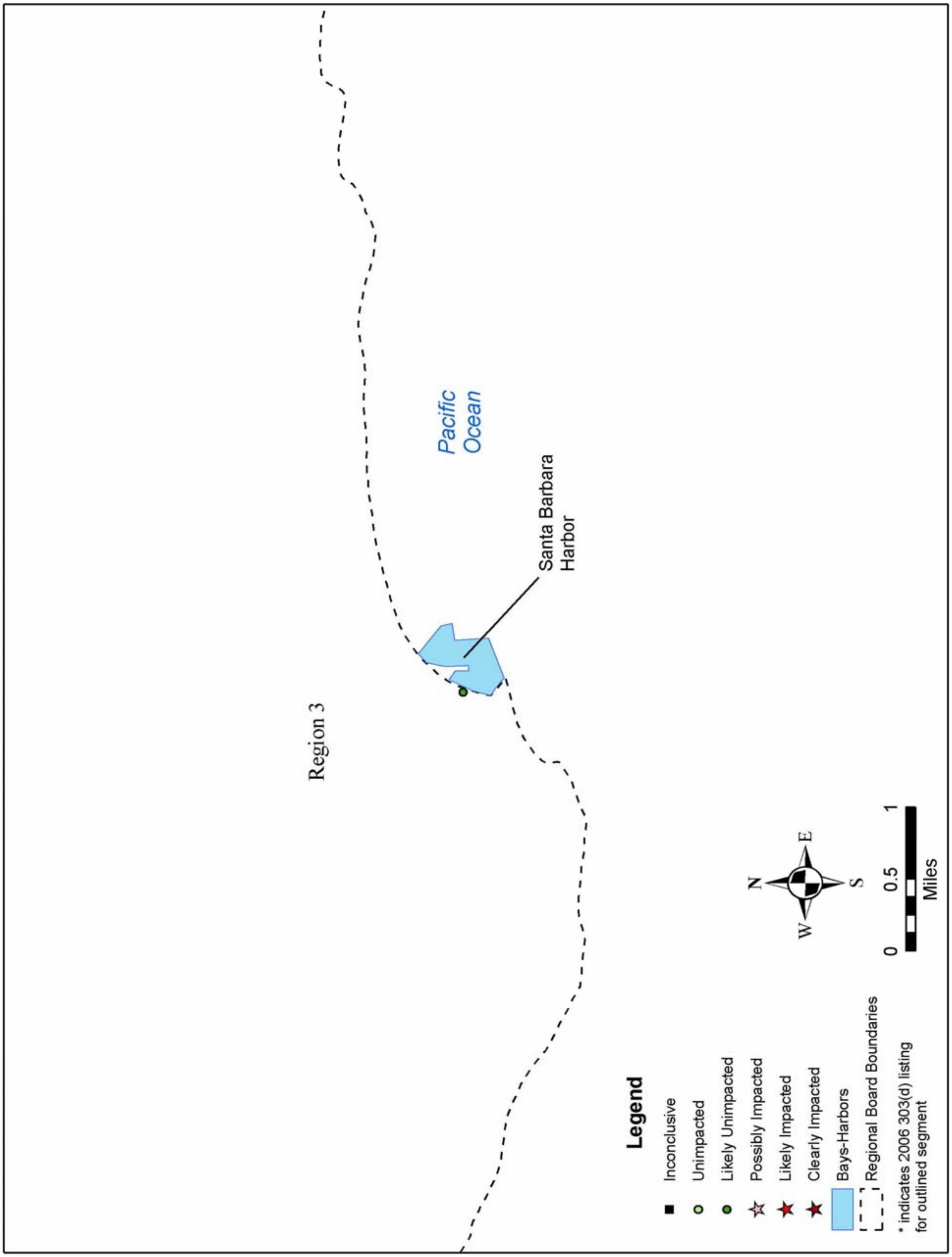


Exhibit 5-8. 2006 303(d) List for Toxics and Potential Characterization under the Plan, Region 4: Ventura Harbor, Channel Islands Harbor, Port Hueneme Harbor

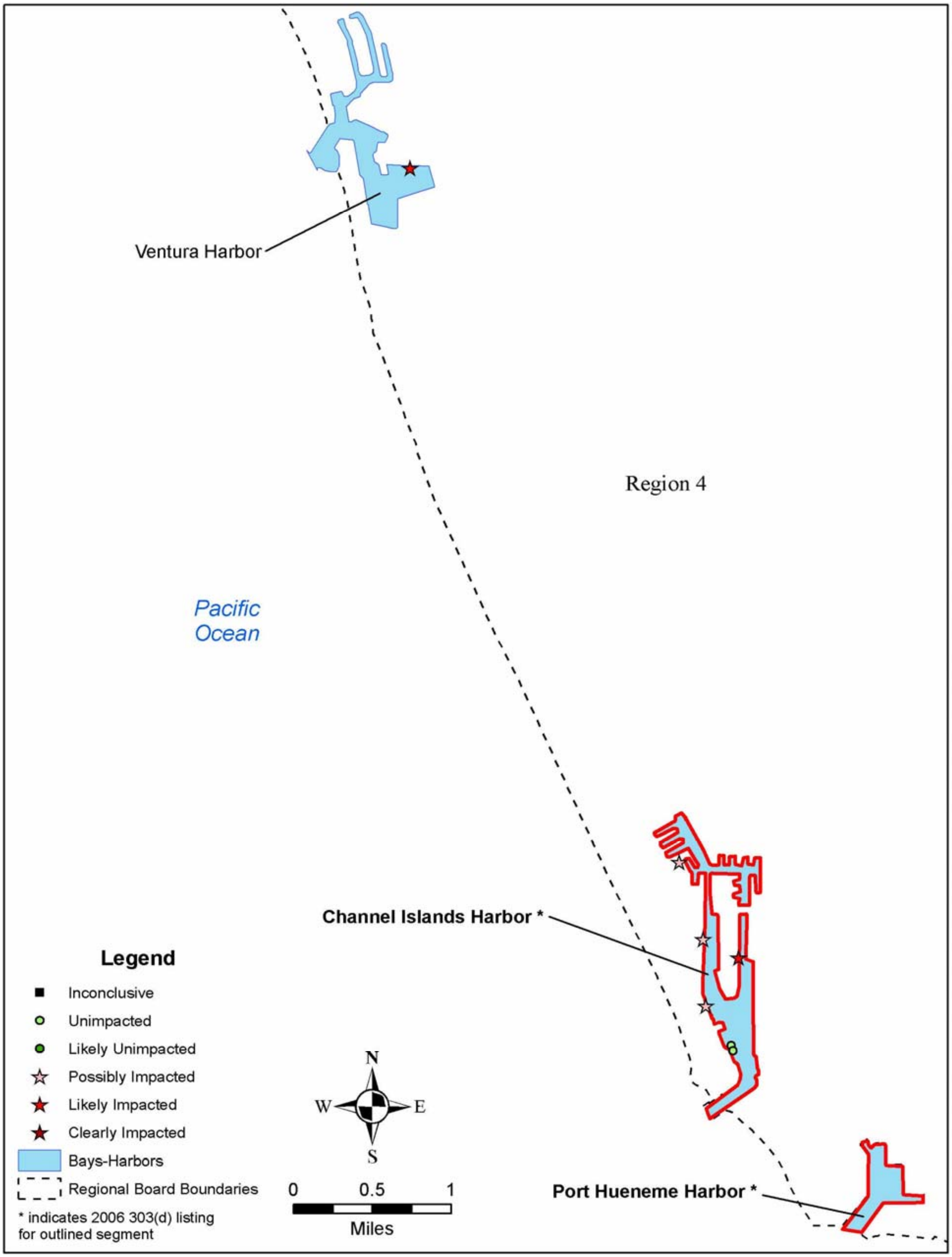


Exhibit 5-9. 2006 303(d) List for Toxics and Potential Characterization under the Plan, Region 4: Marina del Rey and King Harbor

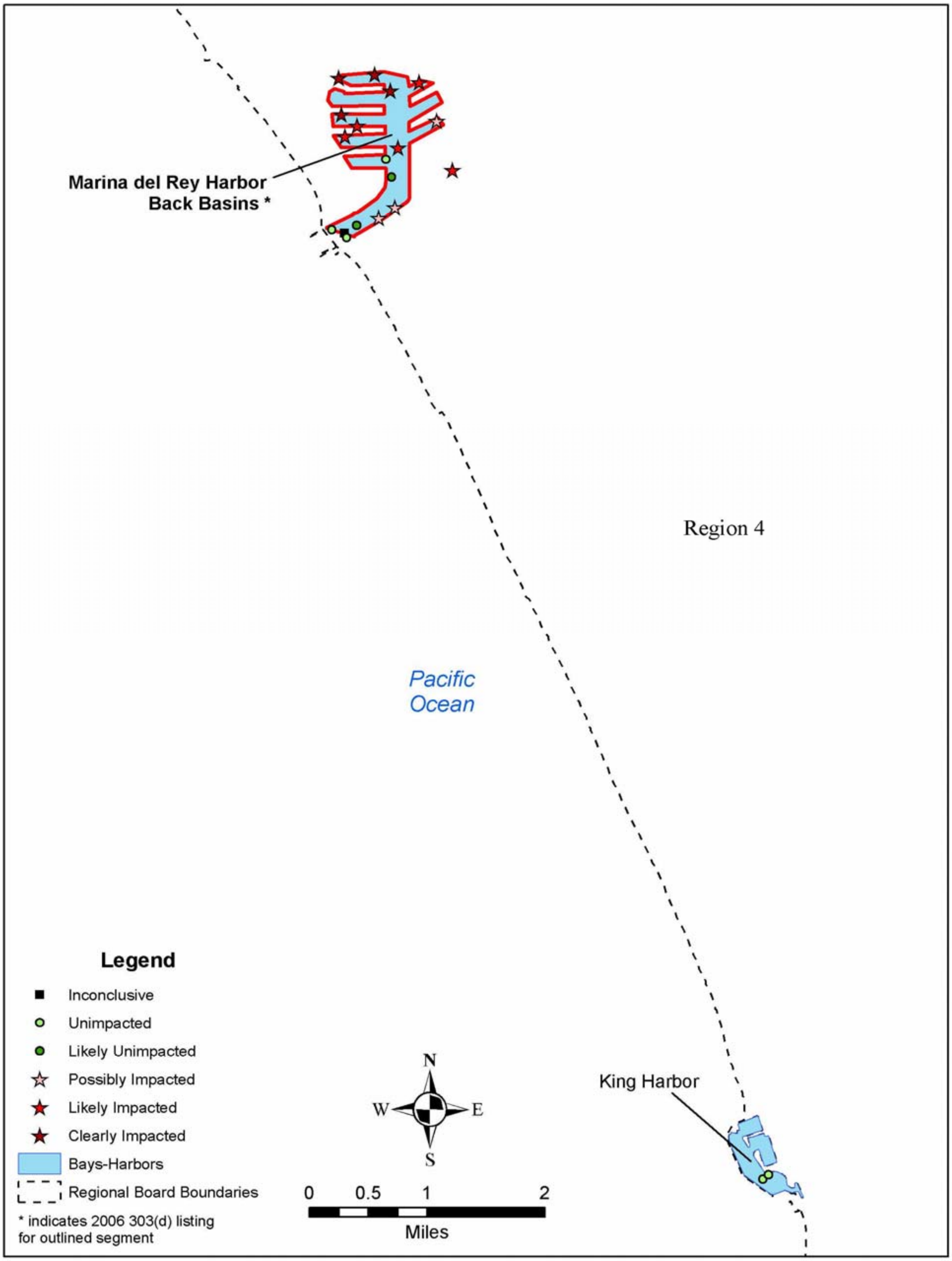


Exhibit 5-10. 2006 303(d) List for Toxics and Potential Characterization under the Plan, Region 4: Los Angeles/Long Beach Harbor

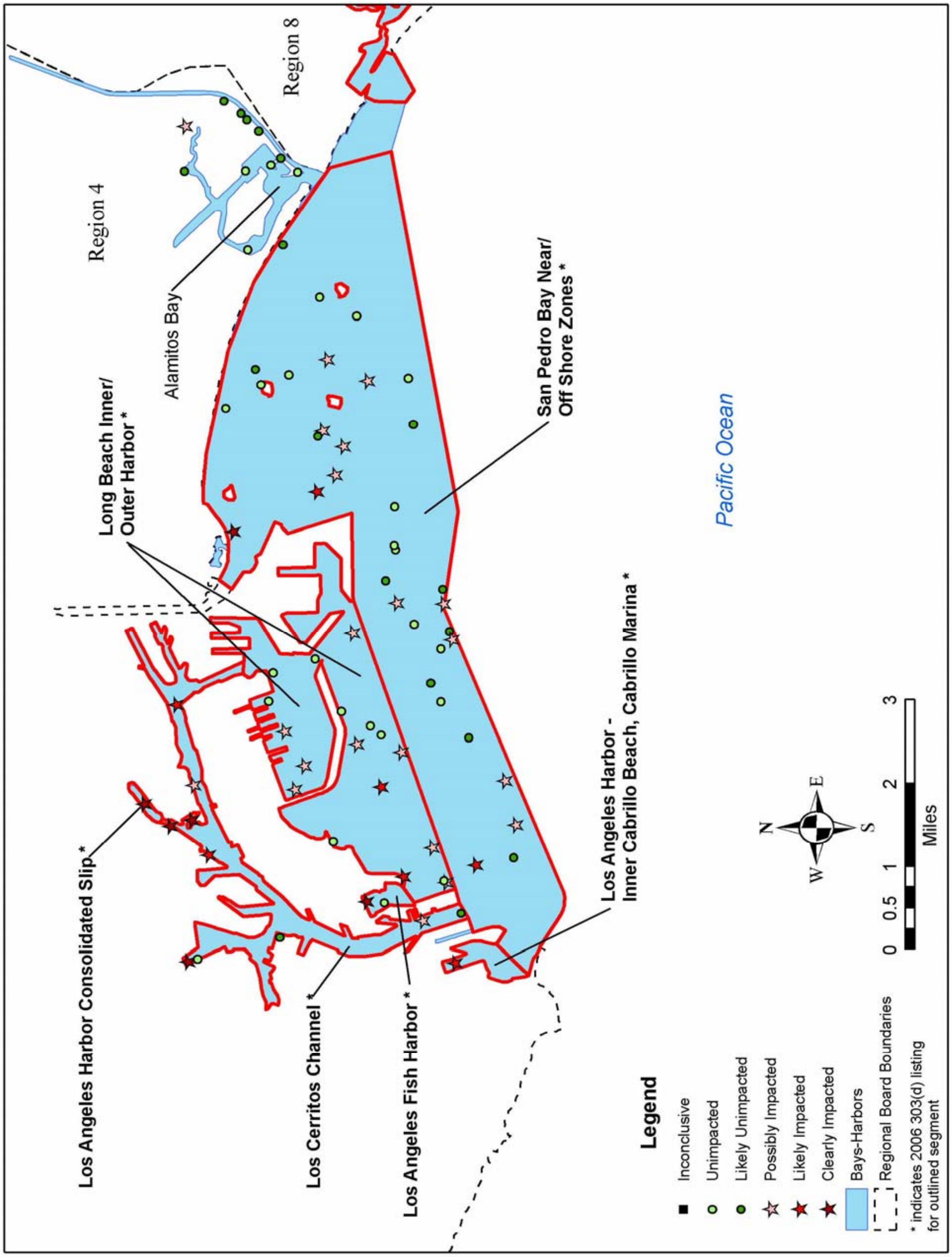


Exhibit 5-11. 2006 303(d) List for Toxics and Potential Characterization under the Plan, Region 8: Anaheim Bay, Huntington Harbor, Bolsa Bay

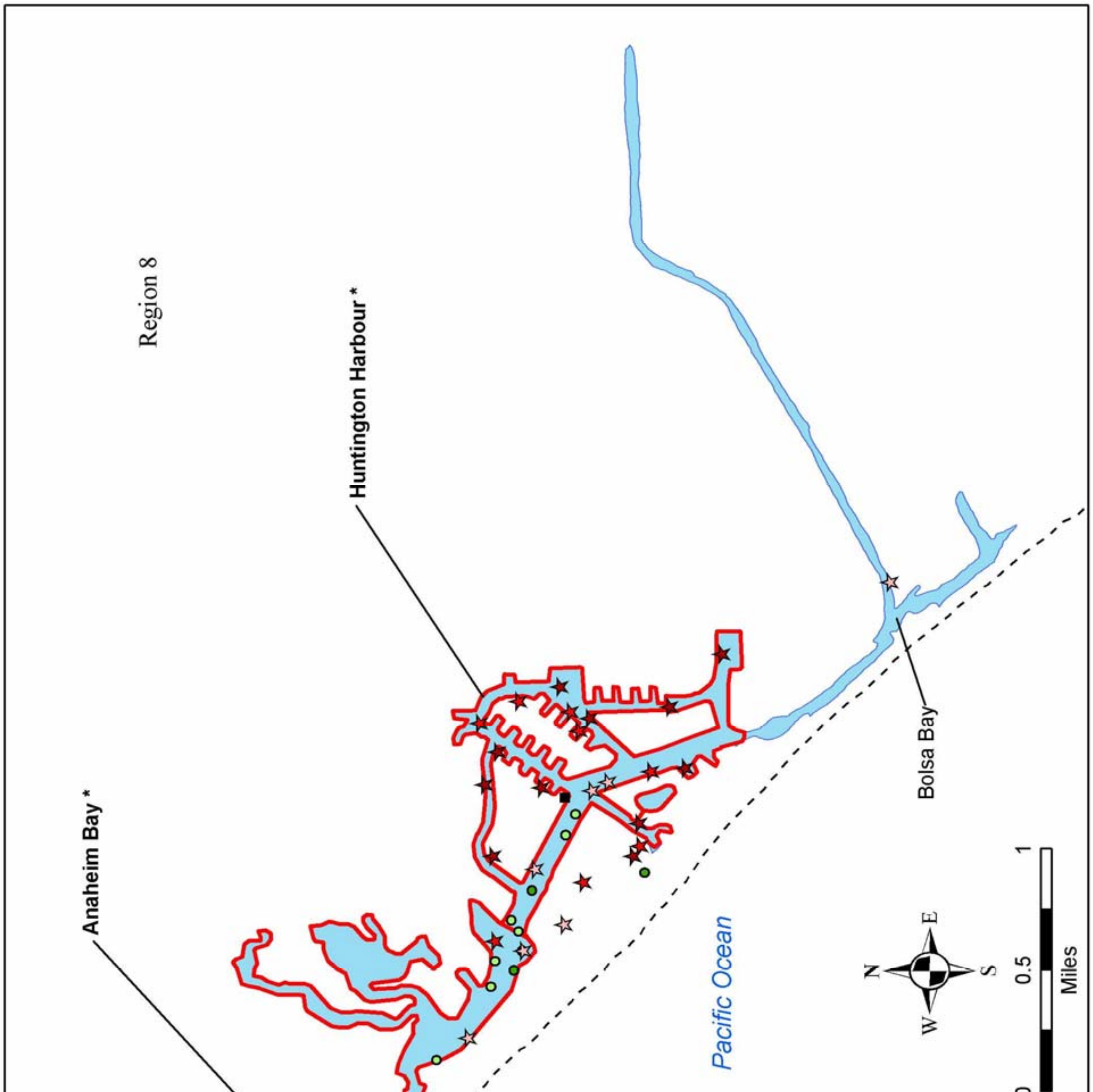


Exhibit 5-12. 2006 303(d) List for Toxics and Potential Characterization under the Plan, Region 8: Newport Bay

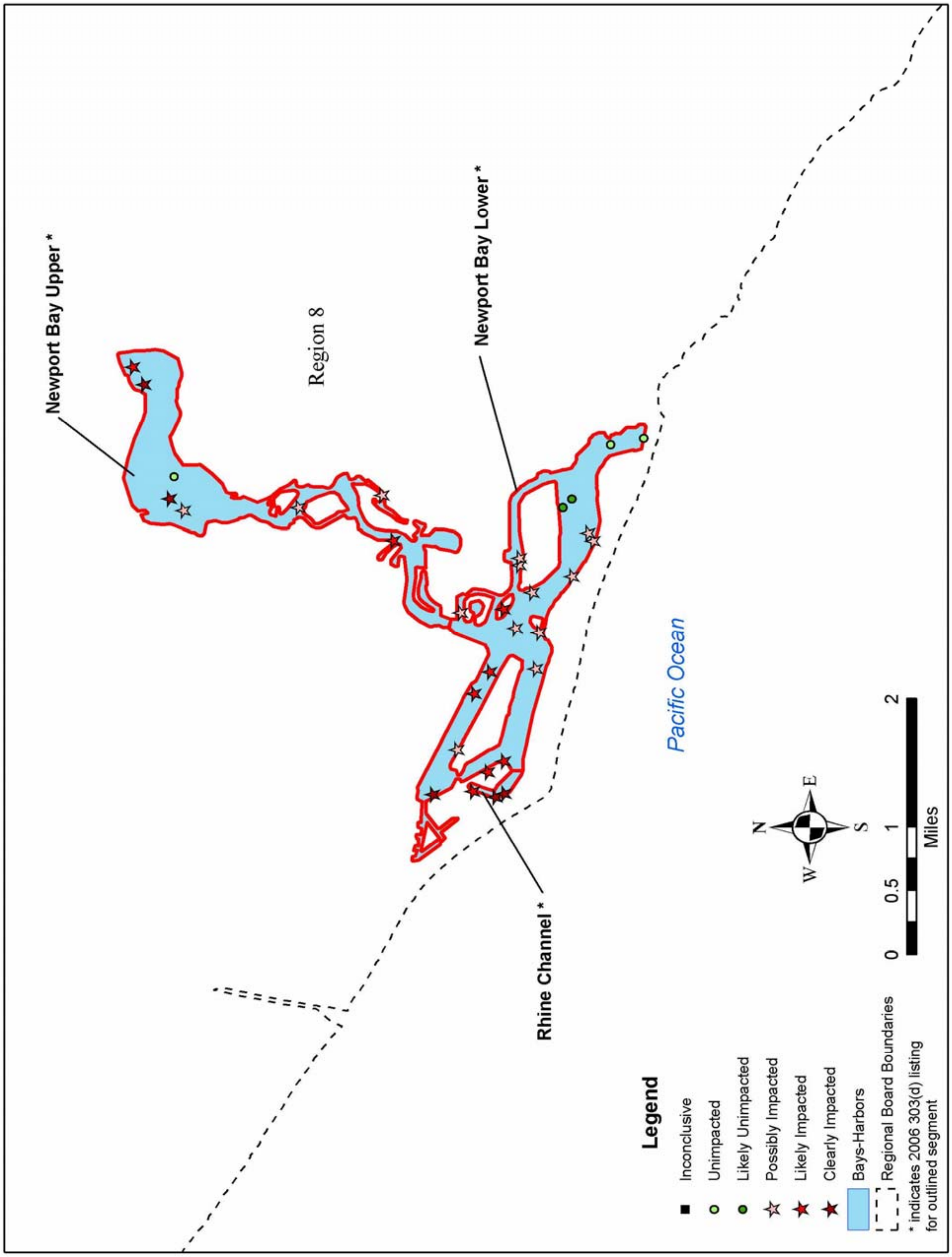


Exhibit 5-13. 2006 303(d) List for Toxics and Potential Characterization under the Plan, Region 9: Dana Point Harbor

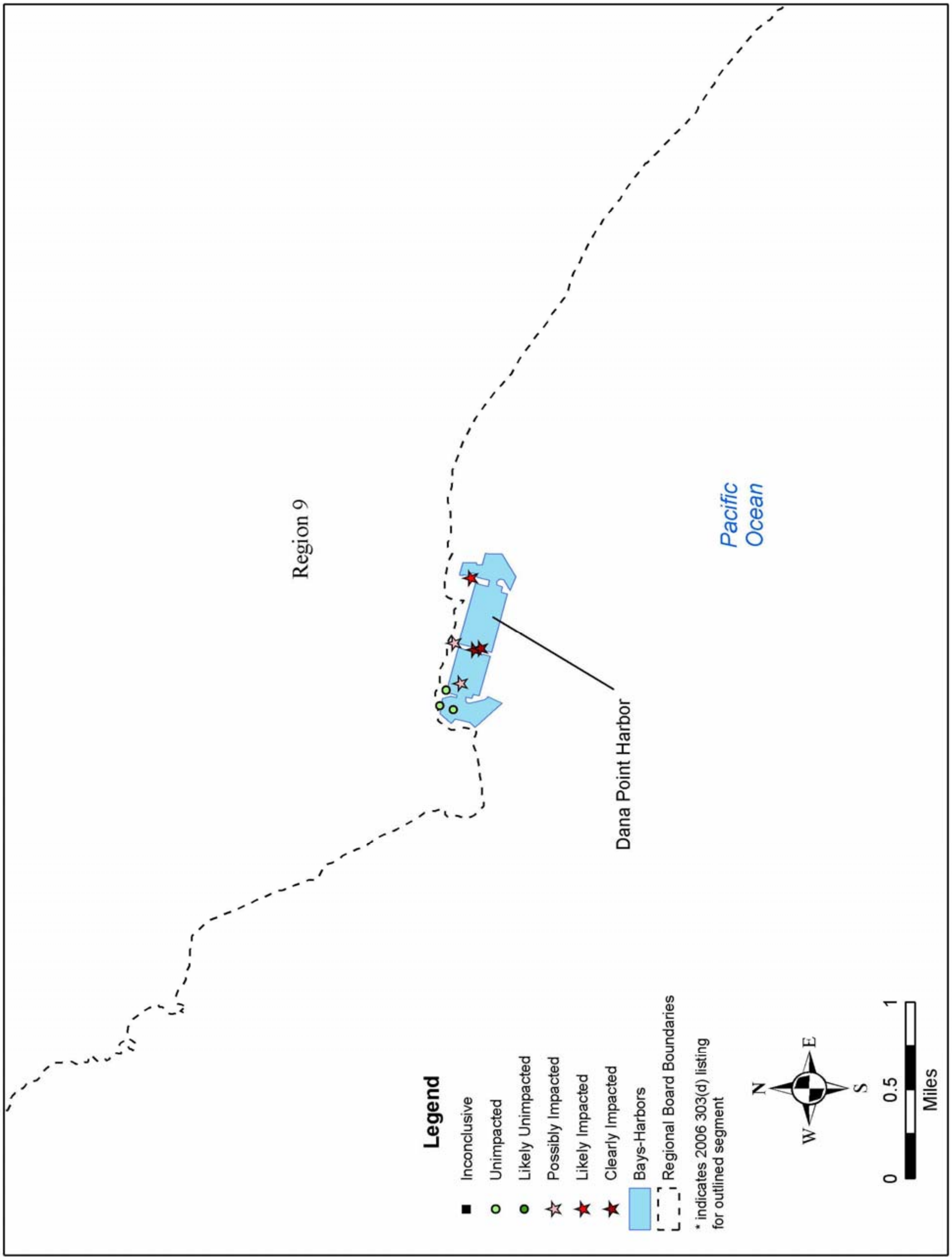


Exhibit 5-14. 2006 303(d) List for Toxics and Potential Characterization under the Plan, Region 9: Oceanside Harbor

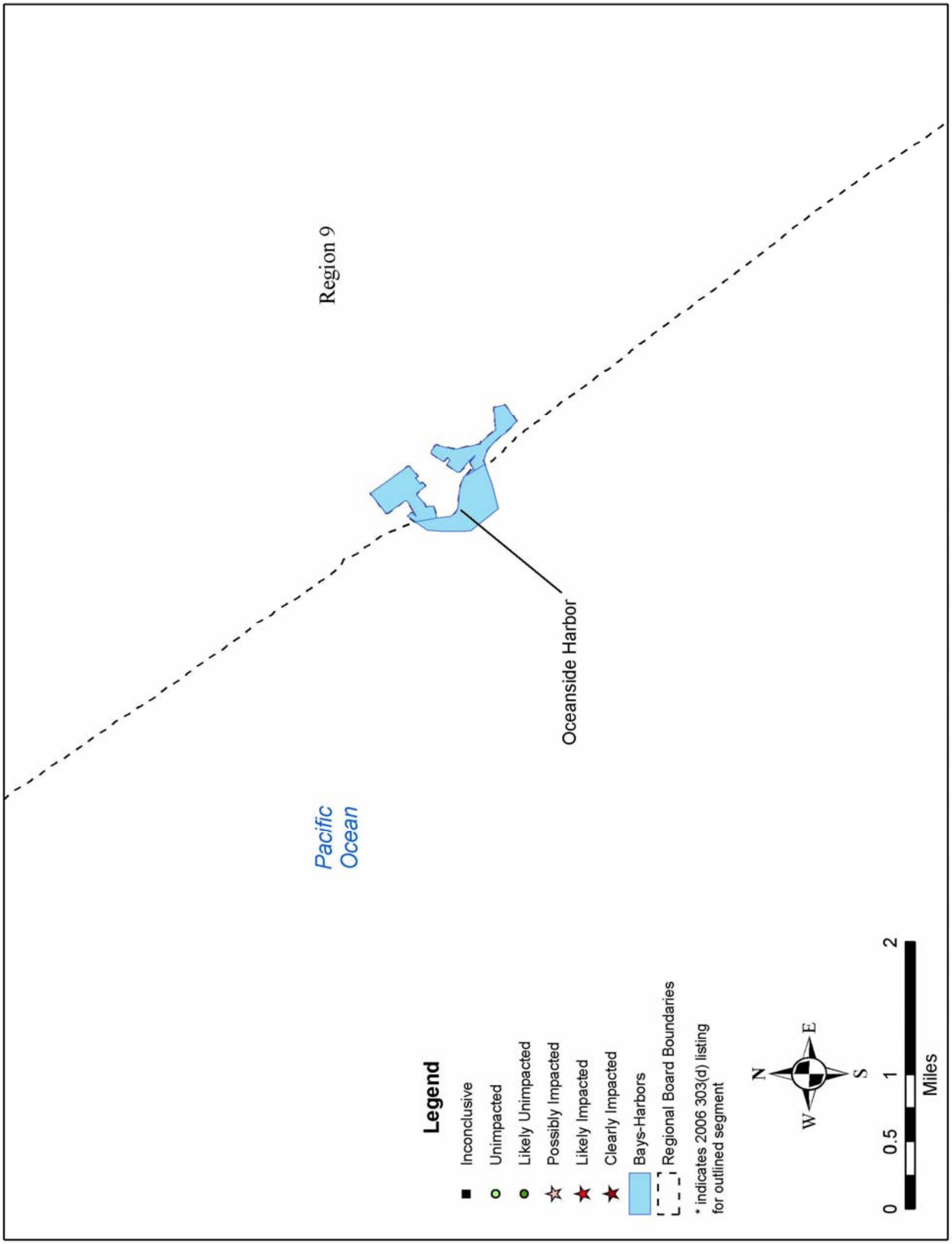


Exhibit 5-15. 2006 303(d) List for Toxics and Potential Characterization under the Plan, Region 9: Mission Bay

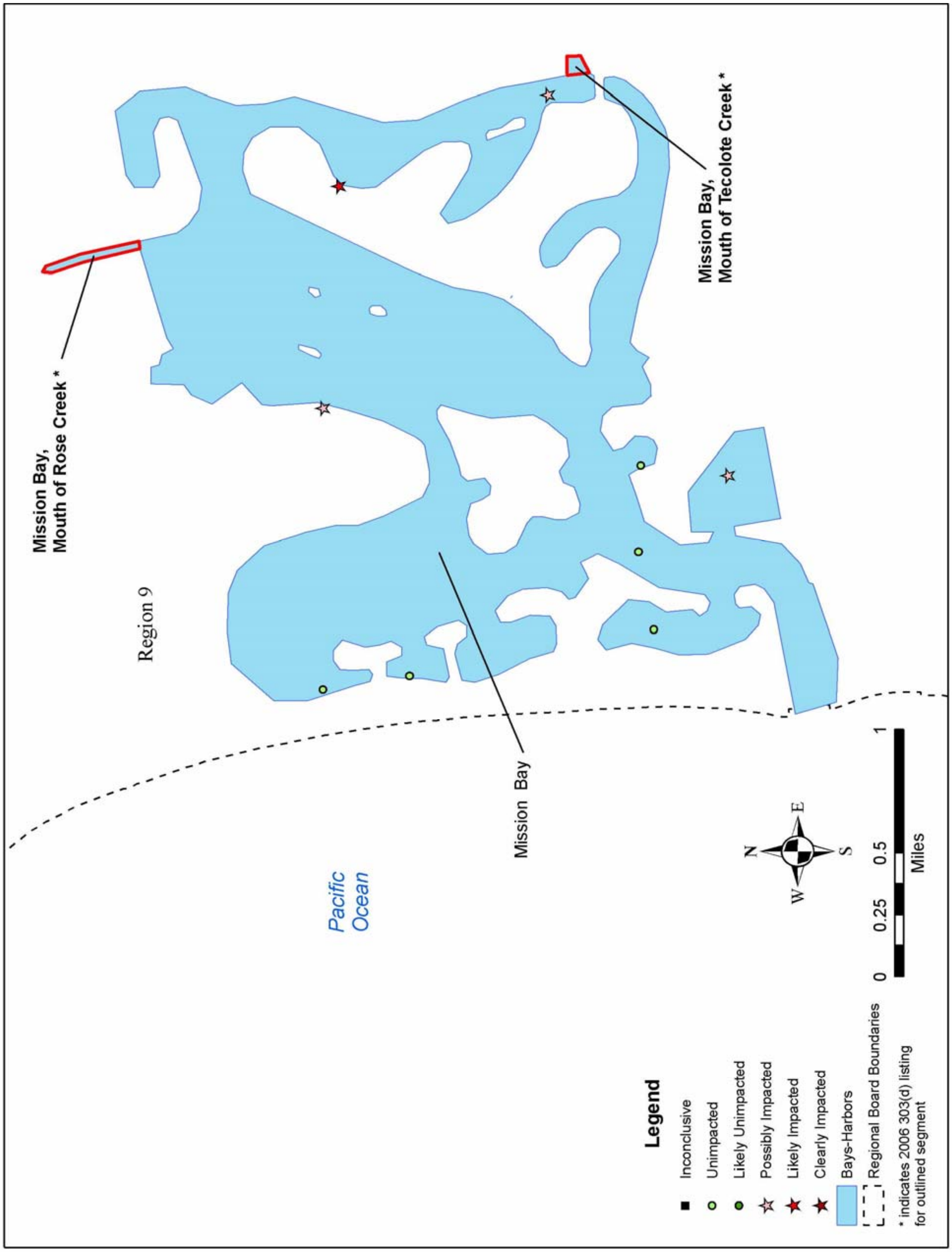


Exhibit 5-16. 2006 303(d) List for Toxics and Potential Characterization under the Plan, Region 9: North Half of San Diego Bay

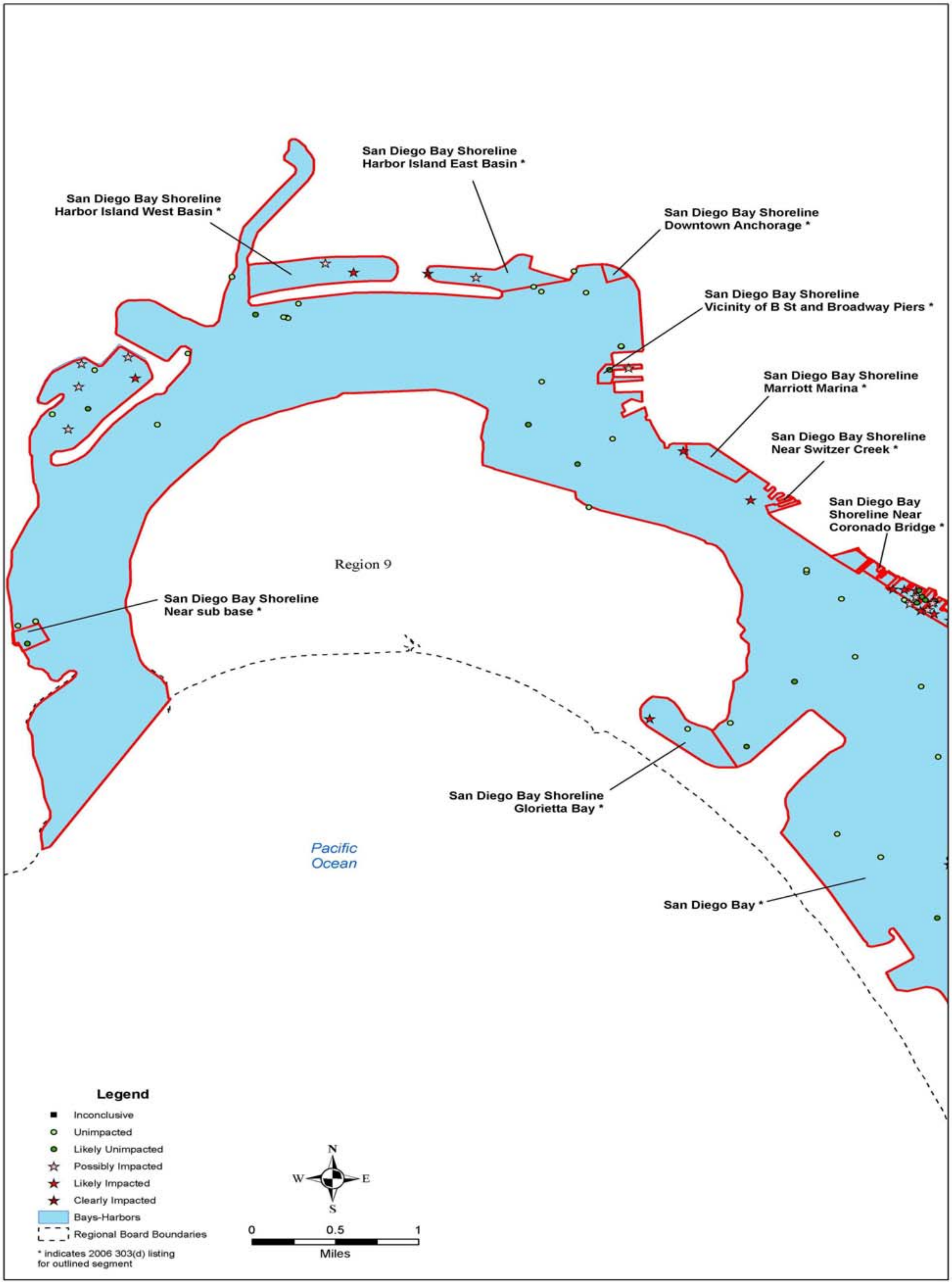
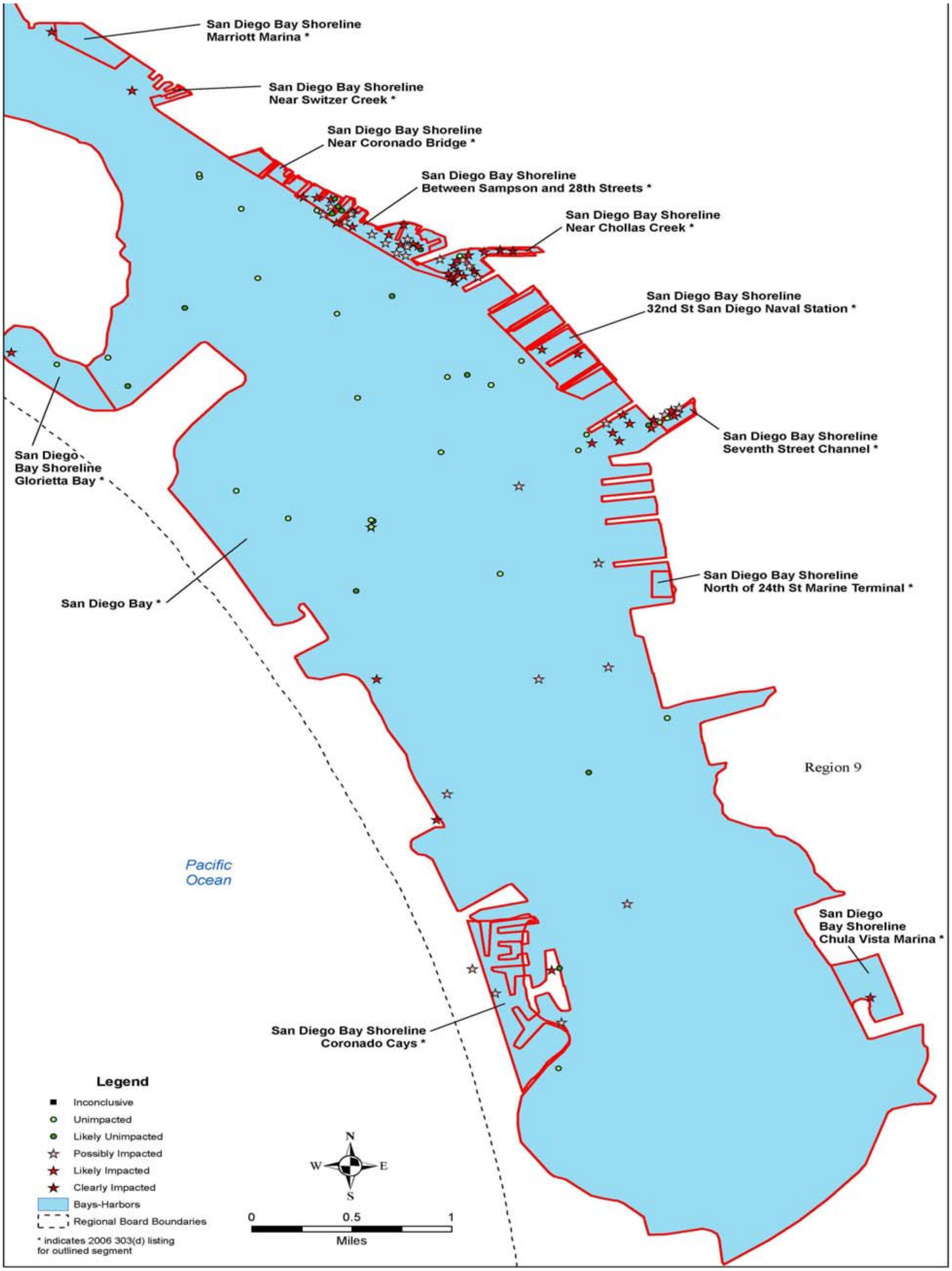


Exhibit 5-17. 2006 303(d) List for Toxics and Potential Characterization under the Plan, Region 9: South Portion of San Diego Bay



5.2.1 Crescent City Harbor (Region 1)

Crescent City Harbor is not on the 2006 303(d) list as impaired for any toxic pollutants. In addition, there are no data available for all three MLOE (sediment toxicity, chemical concentrations, and benthic community impacts) at a single location from which to assess impairment under the Plan. Thus, the incremental impacts of the Plan include monitoring costs and possibly a stressor assessment study (if monitoring data indicate impairment).

5.2.2 Humboldt Bay (Region 1)

Humboldt Bay is on the 2006 303(d) list as impaired for PCBs in fish tissue. In addition, the bay's Eureka Waterfront at H Street is listed as a high priority known toxic hot spot for lead, silver, antimony, zinc, methoxychlor, and PAHs due to a nearby scrap metal facility that disassembles, incinerates, and crushes autos and storage of metals, batteries, radiators, metal reclamation from electrical transformers and miscellaneous refuse (SWRCB, 2003b). Thus, a TMDL for sources of PCBs, and potential cleanup actions and controls on sources of the pollutants in sediments would be needed in the absence of the Plan. Note however that the Eureka Waterfront at H Street toxic hot spot is not located near the possibly impacted monitoring sites. Therefore, it is unlikely that cleanup of this hot spot will have a significant impact on sediment toxicity levels elsewhere in the bay.

Exhibit 5-18 shows the MLOE assessment data for the bay.

Exhibit 5-18. Summary of MLOE Assessment Data, Humboldt Bay

Water Body Name	Inconclusive	Unimpacted	Likely Unimpacted	Possibly Impacted	Likely Impacted	Clearly Impacted
Humboldt Bay	0	6	1	2	0	0

Source: SCCWRP (2007a).

Based on the existing 303(d) listing policy, because 2 of the 9 assessment results fall into an impacted category (i.e., exceedances), Humboldt Bay could meet the listing criteria for the SQO under the Plan. However, under the Plan, because there are no likely or clearly impacted results, confirmatory monitoring would be needed prior to stressor assessment to determine whether the effects and exposure measures are a response to toxic pollutants in sediments or other factors. Thus, incremental impacts of the Plan include confirmatory monitoring.

As mentioned above Humboldt Bay is already listed for PCBs in fish tissue. Thus, if the confirmatory monitoring and subsequent source assessment evaluations indicate that the SQO exceedances are a result of high PCB levels, no additional controls would be necessary for compliance with the Plan. If the evaluations indicate that other toxic pollutants are the cause of the exceedances, other management actions in addition to those needed for controlling PCBs may be necessary. For example, as described in Section 2, common sources of sediment toxicity to bays include storm water runoff from urban and contaminated areas, industrial and municipal effluents, agricultural runoff, active and abandoned mines, marinas and boating activities, and atmospheric deposition. Thus, controls on these sources could be needed to reduce sediment toxicity.

There are 5 individually permitted point source facilities discharging to Humboldt Bay (3 majors and 2 minors). One of these facilities, the Arcata WWTP, is located in the northern portion of the bay near the impacted monitoring stations (the other 4 facilities are located in the southern, unimpacted portion of the bay). Effluent data for this facility from EPA's PCS database indicate that 112 priority pollutants are nondetect in the effluent, and that the detected values for arsenic, chromium, lead, mercury, nickel, zinc, and toluene are below applicable water quality criteria. Only effluent values for cyanide and dichlorobromomethane exceed the applicable CTR criteria. However, both of these pollutants are not known to cause sediment toxicity because they do not sorb to sediments, and evaporate easily from water.

The primary land use types surrounding northern Humboldt Bay (in the vicinity of the impacted monitoring stations) are wetlands/herbaceous, agriculture, and urban. The wetland land cover is made up of the Arcata Marsh and Wildlife Sanctuary (AMWS), which was constructed for recreation, wildlife habitat, education, and wastewater treatment. Constructed wetlands are usually built as a means of reducing pollution. However, in some cases, constructed wetlands may actually increase the bioavailability of certain pollutants such as mercury (e.g., conversion to methylmercury), resulting in increases in pollutant fish tissue concentrations and toxicity. If source evaluation monitoring indicates that sediment toxicity is the result of increased methylmercury production, management practices such as aeration, revegetation, or sediment removal could be implemented to reduce methylmercury discharge (CVRWQCB, 2005b).

Sediment toxicity could also be the result of pesticides from agricultural runoff. However, most of the agricultural land in the northern part of the bay is surrounded by wetlands. Wetlands have been shown to remove a number of toxic pollutants, including pesticides from agricultural runoff water (Shulz and Peall, 2000). The pollutants are either oxidized in the water column and precipitated in sediments or absorbed and complexed with organic material in sediments (U.S. EPA, 2000c). Because wetland sediments are not transported into the bay, it is unlikely that agricultural activities would be contributing to sediment toxicity.

Lastly, urban runoff or storm water may contribute toxic pollutants such as metals and organochloride compounds to the bay. The City of Arcata's SWMP outlines activities to be conducted from October 2003 to July 2008. Under the SWMP, Arcata is currently implementing the following BMPs:

- Education and outreach to inform the public on the impacts of storm water on the bay
- Public involvement/participation through community meetings, volunteer cleanups, and a water quality hotline
- Illicit discharge detection and elimination enforced through the storm water ordinance that provides the City with a mechanism to enforce water quality standards
- Construction site runoff control enforced through regular site inspections, staff training, and construction workshops
- Post-construction storm water management in new development and redevelopment (e.g., reducing impervious surfaces associated with new development by 10% by 2006
- Pollution prevention/good housekeeping for municipal operations including evaluating alternative equipment and sweeping schedules to optimize pollutant removal, determining schedule for cleaning out storm drain system as part of routine maintenance, and implementing a pesticide control management plan.

If confirmatory monitoring and subsequent stressor assessment studies indicate a need for sediment toxicity controls, these BMPs may or may not be sufficient for reducing sediment toxicity levels.

5.2.3 Bodega Harbor (Region 1)

Bodega Harbor is not on the 2006 303(d) list as impaired for any toxic pollutants. However, Porto Bodega Marina is a moderate priority toxic hot spot for copper, lead, mercury, zinc, TBT, DDT, PCBs, and PAHs, and Mason's Marina is a moderate priority hot spot for cadmium, copper, TBT, and PAHs (SWRCB, 2003b). The Regional Water Board indicates that additional information is necessary to determine the areal extent of the contamination and the need for cleanup or mitigation at these sites. These sites are listed as toxic hot spots due to bioassay toxicity, and are therefore currently exceeding the Regional Water Board's narrative toxicity objective that requires all waters to be free of toxic substances in concentrations which are toxic to, or which produce detrimental physiological responses in, human, plant, animal, or aquatic life. Thus, cleanup and/or source control efforts would be needed for compliance with existing objectives in the absence of the Plan.

There are no data available for all three MLOE (sediment toxicity, chemical concentrations, and benthic community impacts) at a single location from which to assess impairment under the Plan. Thus, the incremental impacts of the Plan include monitoring costs. However, given the presence of two known toxic hot spots it is likely that monitoring data will indicate impairment under the Plan. If monitoring indicates that the sediment meets the listing criteria for the SQO, TIEs and source assessment studies would also be necessary to determine the pollutants and sources causing the exceedances.

There may or may not be an incremental level of control beyond those needed for compliance with existing standards needed to comply with the SQO.

5.2.4 Tomales Bay (Region 2)

Tomales Bay is on the 2006 303(d) list as impaired for mercury in fish tissue. Thus, the Regional Water Board would have to address this impairment in the absence of the Plan.

However, the available MLOE assessment data shown in **Exhibit 5-19** indicates that the water body would not meet the listing criteria for the SQO. Thus, it is unlikely that costs would be incurred as a result of the Plan.

Exhibit 5-19. Summary of MLOE Assessment Data, Tomales Bay

Water Body Name	Inconclusive	Unimpacted	Likely Unimpacted	Possibly Impacted	Likely Impacted	Clearly Impacted
Tomales Bay	0	1	1	0	0	0

Source: SCCWRP (2007a).

5.2.5 Drakes Estero Bay (Region 2)

Drakes Estero Bay is not currently listed on the 2006 303(d) list as impaired for any toxic pollutants, and there is only one data point available from which to assess impairment under the Plan. Although the limited data indicates that the water body is unimpacted, the 303(d) listing policy requires additional assessment data. Thus, the incremental impacts of the Plan include monitoring costs and possibly a stressor assessment study (if monitoring data indicate impairment).

5.2.6 San Francisco Bay (Region 2)

San Francisco Bay (Richardson Bay, San Pablo Bay, Central, Lower, and South Basins, Oakland Inner Harbors, and San Leandro Bay) is on the 2006 303(d) list for a number of toxic pollutants in sediments, fish tissue, and the water column (see Exhibit 3-6).

The bay is also listed as a high priority toxic hot spot for mercury, PCBs, dieldrin, chlordane, DDT, and dioxin due to mercury mining runoff, mercury use in placer and hydraulic gold mining operations, and historic industrial use of PCBs.

Exhibit 5-20 shows the MLOE assessment data for the segments of the bay.

Exhibit 5-20. Summary of MLOE Assessment Data, San Francisco Bay

Water Body Name	Inconclusive	Unimpacted	Likely Unimpacted	Possibly Impacted	Likely Impacted	Clearly Impacted
Richardson Bay	0	0	0	1	0	0
San Pablo Bay	0	3	6	8	0	0
Lower Basin	0	0	3	12	15	0
South Basin	0	2	1	6	2	0
Central Basin	0	8	10	17	2	0
Oakland Inner Harbors	0	0	0	3	0	1
San Leandro Bay	0	0	1	0	0	1

Source: SCCWRP (2007a).

Based on the existing 303(d) listing policy, Richardson Bay, San Pablo Bay, the Lower, South, and Central Basins, and the Oakland Inner Harbors would also meet the listing criteria for the SQO (note there is only one data point available for Richardson Bay and the 303(d) list policy requires additional data to assess impairment).

These water body sections are covered under San Francisco Bay's PCBs and mercury TMDLs. In addition, in the absence of the Plan, the Regional Water Board would need to develop TMDLs to address the additional existing 303(d) listings for these waters. Therefore, once controls for the completed and future TMDLs (e.g., see Exhibit 3-10 for implementation actions) and hot spot cleanups (e.g., see Exhibit 3-9 for cleanup actions) are implemented, it is likely that number of SQO exceedances will also be reduced. Thus, incremental impacts and costs associated with the Plan are not likely for these sections. In comparison, given the large number of pollutants for which the Oakland Inner Harbors are listed as impaired for sediments, conducting TIEs and source assessment studies may result in long term cost savings due to more focused TMDLs and cost-effective implementation of controls.

Based on the existing 303(d) listing policy, San Leandro Bay would not be considered impaired for sediment toxicity under the Plan because only one of the two assessment results falls into an impacted category (i.e., exceedance). Thus, no incremental costs would be incurred. Note, however, that one of the two results is listed as clearly impacted. Thus, the potential exists for additional monitoring data to indicate sediment toxicity and the need for a stressor assessment study to determine the cause of the toxicity. San Leandro Bay is covered under San Francisco Bay's PCBs and mercury TMDLs. Also, in the absence of the Plan, the Regional Water Board would need to develop TMDLs for the existing impairments for lead, zinc, PAHs, and pesticides in the sediment, and chlordane and dieldrin in fish tissue. Therefore, even if additional monitoring data indicate sediment toxicity, implementation of controls to reduce PCBs and mercury (see Exhibit 3-10 for implementation actions) as well as controls necessary for compliance with future TMDLs is likely to also reduce sediment toxicity levels. Thus incremental impacts and costs associated with the Plan are not likely. In comparison, given the large number of pollutants for which the water body is listed as impaired for sediments, conducting TIEs and source assessment studies could possibly result in long term cost savings due to more focused TMDLs and cost-effective implementation of controls.

5.2.7 Half Moon Bay (Region 2)

Half Moon Bay is not on the 2006 303(d) list as impaired for any toxic pollutants. In addition, there are no data available for all three MLOE (sediment toxicity, chemical concentrations, and benthic community impacts) at a single location from which to assess impairment under the Plan. Thus, the incremental impacts of the Plan include monitoring costs and possibly a stressor assessment study (if monitoring data indicate impairment).

5.2.8 Moss Landing Harbor (Region 3)

Moss Landing Harbor is on the 2006 303(d) list for pesticides in the water column. The Moss Landing Harbor and its tributaries are also listed as a high ranking known toxic hot spot for pesticides, PCBs, nickel, chromium, and tributyltin as a result of past and present agricultural activities, river and stream maintenance activities, ship maintenance, and urban runoff.

There are no data available for all three MLOE (sediment toxicity, chemical concentrations, and benthic community impacts) at a single location from which to assess impairment under the Plan. Thus, the incremental impacts of the Plan include monitoring costs. However, given that the harbor is listed as a known toxic hotspot, additional monitoring is likely to indicate exceedance of the SQO. If monitoring indicates impairment, TIEs and source assessment studies would also be necessary to determine the pollutants and sources causing the exceedances.

As described in Section 2, common sources of sediment toxicity to bays include storm water runoff from urban and contaminated areas, industrial and municipal effluents, agricultural runoff, active and abandoned mines, marinas and boating activities, and atmospheric deposition. The primary land uses surrounding the harbor are urban and agriculture. In addition, EPA's PCS database indicates that the two major individually permitted point source facilities that discharge in the vicinity of Moss Landing Harbor actually discharge to the Pacific Ocean. Thus, storm water runoff, agricultural runoff, and marinas and boating activities may contribute toxic pollutants to the harbor's sediments.

The Regional Water Board identified the following remedial actions and associated costs for cleanup of the Moss Landing Harbor hot spot (SWRCB, 2003b):

- Program management: $925,000 (over 5 yrs)
- Control of harbor pollutants: $348,334
- Urban runoff action plan: $1,052,750
- Agricultural BMPs: $6,790,000
- Monitoring: $678,000

These actions target main sources of sediment pollutants (e.g., marinas, urban runoff, and agriculture). Therefore, it is unlikely that incremental costs would be incurred under the Plan.

5.2.9 Monterey Harbor (Region 3)

Monterey Harbor is on the 2006 303(d) list as impaired for metals in the water column. The Monterey Harbor is also listed as a moderate priority toxic hot spot for PAHs, copper, zinc, toxaphene, PCBs, and tributyltin. Thus, a TMDL for sources of metals, and potential cleanup actions and controls on sources of the pollutants in sediments would be needed in the absence of the Plan.

There are no data available for all three MLOE (sediment toxicity, chemical concentrations, and benthic community impacts) at a single location from which to assess impairment under the Plan. Thus, the incremental impacts of the Plan include monitoring costs. Under the Plan, pollutant identification studies are also likely to be required, since the presence of a toxic hot spot suggests that the sediments may be impaired. However, if identification of the pollutants causing exceedance of the SQO narrows the focus of the cleanup efforts associated with the moderate priority hot spot, then there may be cost savings as a result of the studies required under the Plan.

Information from the Marina del Rey TMDL (described in Exhibit 3-10) and Section 2.1 suggests that boating activities, storm water, and agricultural runoff are the main sources of toxic pollutants in harbor sediments. Section 2.1 also indicates that the most common sources of metals to the water column include industrial point source dischargers, abandoned and active mines, urban runoff, agricultural runoff, boats, and atmospheric deposition. There are no municipal or industrial point source dischargers to the harbor according to location data in EPA's PCS database. In addition, the harbor is surrounded by urban parkland and residential and commercial properties, and houses a marina that provides 413 slips and 6 end ties for larger boats (Monterey Harbor, 2007). These sources would likely need controls to address baseline impairment conditions; additional study would be required to identify whether additional sources or more stringent source control would be required under the Plan.

For example, the City of Monterey currently has a SWMP, as well as a storm water ordinance that requires any dischargers of storm water to ensure compliance with water quality standards including the narrative toxicity objective. However, the Harbor is not complying with water quality standards for metals (impaired for metals on 2006 303(d) list) or the narrative toxicity objective (listed as a known toxic hotspot). To date, only nonstructural BMPs have been implemented to control storm water dischargers. Exhibit 3-10 indicates that additional nonstructural BMPs or structural controls for storm water may be required to meet future TMDLs. Thus, it is uncertain whether some level of incremental control for storm water would be needed beyond what would be needed for compliance with existing standards.

In addition to existing storm water controls, the harbor also has a program for implementation of BMPs for marina and boating activities. Under a Memorandum of Agreement, the Monterey Bay National Marine Sanctuary (MBNMS) developed a Water Quality Protection Program (WQPP) that included the following activities for marinas and boating:

- Develop a public education and outreach program to communicate to boaters the environmental and economic impacts of polluting activities and simple pollution prevention methods
- Develop a regional technical training program on pollution prevention for harbor and boatyard staff
- Facilitate the collection of contaminated bilge water and waste oil by construction and operation of pump out and waste handling sites, and distribution of oil-absorbent pads
- Promote the use of containment methods to reduce waste runoff from boatyards and emissions from paint stripping
- Encourage the use of less toxic paint on boats and improvements in underwater hull cleanings to prevent heavy scraping
- Coordinate regulatory agencies to develop a pick-up system for toxic materials at harbors.

If these activities are not sufficient for compliance with existing objectives, additional BMPs may be necessary. There may or may not be yet another incremental level of control needed to comply with the SQO.

5.2.10 Morro Bay (Region 3)

Morro Bay is not on the 2006 303(d) list as impaired for any toxic pollutants.

Exhibit 5-21 shows the MLOE assessment data for the bay.

Exhibit 5-21. Summary of MLOE Assessment Data, Morro Bay

Water Body Name	Inconclusive	Unimpacted	Likely Unimpacted	Possibly Impacted	Likely Impacted	Clearly Impacted
Morro Bay	1	1	0	0	1	0

Source: SCCWRP (2007a).

Based on the existing 303(d) listing policy, Morro Bay would not be listed as impaired for the SQO because only one of the two assessment results (the one inconclusive result is not included) falls into an impacted category (i.e., exceedance). Thus, no incremental costs would be incurred. Note, however, that one of the two results is listed as likely impacted. Thus, the potential exists for additional monitoring data to indicate exceedances of the SQO. If additional data indicate exceedances, a stressor assessment study could also be necessary.

As described in Section 2, common sources of sediment toxicity to bays include storm water runoff from urban and contaminated areas, industrial and municipal effluents, agricultural runoff, active and abandoned mines, marinas and boating activities, and atmospheric deposition. The Morro Bay National Estuary Program (MBNEP) has already begun addressing these sources of heavy metals and toxic pollutants through its Comprehensive Conservation and Management Plan (CCMP). MBNEP (2000) identified several action plans and associated costs that address the sources of toxic pollutants to the bay, including:

- Reduce drainage problems by acquiring detention and retention areas ($2 million – $4 million)
- Implement urban storm water BMPs based on assessment of pollutant loadings (costs will vary based on BMPs implemented; range from $10,000 – $200,000 per year)
- Remediate inactive/abandoned mines and reduce heavy metals and sediment loadings ($100,000 – $350,000 per mine)
- Implement marina BMPs including encouraging use of less toxic paints and management of boat cleaning operations ($20,000 – $40,000 per year)
- Support development and design for environmentally friendly boat haulouts and maintenance facilities for large vessels ($2 million)
- Establish a network of easily accessible hazardous waste facilities, including bayside locations ($125,000 upfront and $5,000 per year to maintain).

The MBNEP outlined an implementation plan and identified the agencies that should be involved in the implementation for each action. These actions should reduce sediment toxicity. Thus, even if additional monitoring data indicates exceedance of the SQO, there may not be any incremental control costs (i.e., over and above those identified by the MBNEP) needed for compliance.

5.2.11 Santa Barbara Harbor (Region 3)

Santa Barbara Harbor is not on the 2006 303(d) list as impaired for any toxic pollutants, and there is only one data point available from which to assess exceedance of the SQO. Although the limited data indicates that the water body is likely unimpacted, the 303(d) listing policy requires additional assessment data. Thus, the incremental impacts of the Plan include monitoring costs and possibly a stressor assessment study (if monitoring data indicate impairment).

5.2.12 Ventura Harbor (Region 4)

Ventura Harbor is on the 2006 303(d) list for PCBs and DDT in fish tissue. Thus, the Regional Water Board would have to address these impairments in the absence of the Plan.

There is only one data point available from which to assess exceedances of the SQO. Although the limited data indicates that the water body is likely impacted, the 303(d) listing policy requires additional assessment data. If monitoring indicates that the water body meets the listing criteria for the SQO, stressor identification studies would also be necessary to determine the pollutants and sources causing the exceedances.

Ventura Harbor is already listed impaired for PCBs and DDT in fish tissue. As described in Section 2.1.1., the main anthropogenic sources of PCBs and DDT include runoff from abandoned industrial facilities and refuse sites, storm water runoff, and soil erosion. The main land uses surrounding Ventura Harbor are urban and agriculture. Thus, sources of PCBs and DDT to the harbor could include storm water runoff and soil erosion from nearby agricultural lands. In the absence of the Plan, the Regional Water Board would likely develop and implement a TMDL that targets those sources to reduce the PCBs and DDT loadings to the harbor. Thus, if stressor identification studies for Ventura Harbor indicate that PCBs and DDT are causing the sediment toxicity, there will be no incremental impacts associated with the Plan.

However, if pollutants other than PCBs and DDT are causing impairment based on the SQO, additional controls, above those that would be needed under the PCBs and DDT TMDLs, may or may not be needed for compliance with the Plan. For example, Section 2.1 suggests that municipal and industrial point source dischargers, agricultural runoff and irrigation return flows, marinas and boating activities, and storm water runoff are potential source of the pollutants of concern.

EPA's PCS database indicates that there is one individually permitted point source discharger to the harbor: Ventura Port District. The facility is permitted to discharge up to 100 gallons/day of boat washdown water to the Ventura Marina after it has been sent to a clarifier. The facility's 2003 fact sheet indicates that the facility may be discharging copper and zinc at levels that could exceed existing water quality objectives. This assessment is based on limited data, and the permit only requires the facility to monitor monthly. If the additional data show that the facility has reasonable potential to cause or contribute to an exceedance of existing standards, the facility would receive effluent limits and be required to reduce concentrations to below those limits. Thus, in the absence of the Plan, some additional level of control may be needed at this facility for compliance with existing standards. It is uncertain whether the facility would be required to achieve effluent concentrations for copper and zinc below the existing criteria for compliance with the Plan.

Soil erosion and runoff may be controlled under the TMDLs for PCBs and DDT in the absence of the Plan. However, pollutants other than PCBs and DDT could enter the harbor from irrigation runoff, and could require additional controls. The Los Angeles Regional Water Board has issued a conditional waiver of WDR for farm lands. The waiver requires dischargers to submit a Corrective Action Plan that identifies time-specific management modifications whenever Basin Plan or CTR objectives or TMDL allocations are not attained. Given the narrative pesticides, bioaccumulation, and toxicity objectives in the Basin Plan, additional controls could be needed to control agricultural inputs in the absence of the Plan. Thus, once farmers near Ventura Harbor implement controls for compliance with the existing waiver, it is unlikely that additional controls would be necessary under the Plan.

Because marinas and boating activities are potential sources of toxic pollutants to harbor sediment and PCBs and DDT (existing impairments) are not associated with boating, it is possible that some incremental level of control could be necessary for compliance with the Plan.

5.2.13 Channel Islands Harbor (Region 4)

Channel Islands Harbor is on the 2006 303(d) list for lead and zinc in sediment. Thus, the Regional Water Board would have to address these impairments in the absence of the Plan.

Exhibit 5-22 shows the MLOE assessment data for the harbor.

Exhibit 5-22. Summary of MLOE Assessment Data, Channel Islands Harbor

Water Body Name	Inconclusive	Unimpacted	Likely Unimpacted	Possibly Impacted	Likely Impacted	Clearly Impacted
Channel Islands Harbor	0	2	0	3	1	0

Source: SCCWRP (2007a).

Based on the existing 303(d) listing policy, because 4 of the 6 assessment results fall into an impacted category (i.e., exceedances), Channel Islands Harbor would meet the listing criteria for the SQO. TIEs and source assessment studies would be necessary to determine the pollutants and sources causing the exceedances.

The harbor sediment is already known to be impaired for lead and zinc. If these pollutants also cause exceedance of the SQO, there are not likely to be incremental control costs as a result of the Plan. However, if pollutants other than lead and zinc are the problem, some incremental level of control may be needed.

Information from the Marina del Rey TMDL (described in Exhibit 3-10) and Section 2.1 suggests that boating activities, storm water, and agricultural runoff are the main sources of toxic pollutants in harbor sediments. Section 2.1 also indicates that the most common sources of metals to the water column include industrial point source dischargers, abandoned and active mines, urban runoff, agricultural runoff, boats, and atmospheric deposition. There are no individually permitted point source facilities that discharge to the harbor according to EPA's PCS database. The only land uses surrounding the harbor are urban and agriculture. Thus, potential sources of pollution could include storm water runoff, runoff from nearby farms, and marina and boating activities.

The Ventura County SWMP (2001) outlines a number of activities planned or being implemented for compliance with its storm water permit, as described in Exhibit 3-4. In the absence of the Plan, BMPs above and beyond those currently identified in the SWMP may be needed to address the existing impairments. It is uncertain whether these controls would result in compliance with the SQO if the existing impairments are not causing sediment toxicity. Therefore, incremental controls and costs may or may not be necessary under the Plan.

The Los Angeles Regional Water Board adopted a conditional waiver of WDR for farm lands. The waiver requires all farmers to submit a Corrective Action Plan that identifies time-specific management modifications whenever Basin Plan or CTR objectives or TMDL allocations are not attained. The Los Angeles Regional Water Board Basin Plan contains three narrative standards that require all waters to be maintained free of toxic substances that produce detrimental physiological responses in, human, plant, animal, or aquatic life, prohibits pesticides from being present in concentrations that adversely affect beneficial uses or increase concentrations found in bottom sediments or aquatic life, and prohibits toxic pollutants from being present at levels that bioaccumulate in aquatic life to levels which are harmful to aquatic life or human health. Thus, once farmers near Channel Islands Harbor implement controls for compliance with the existing waiver, it is unlikely that additional controls would be necessary under the Plan.

The Ventura County Harbor Department plans to rehabilitate and reconstruct several marina areas in the Channel Islands Harbor. As part of this effort, the CCC is requiring that the following BMPs be implemented to ensure that the long term waterborne berthing of boats at the marina is managed in a manner that protects water quality (CCC, 2007):

- Maintenance shall be performed above the waterline so that no debris falls into the water
- In-water boat cleaning shall be by hand and minimize the discharge of soaps, paints, and debris
- Where feasible, remove boats from the water and perform cleaning at a location where debris can be captured and disposed of properly
- Detergents and cleaning products used for washing boats shall be phosphate-free and biodegradable, and amounts used shall be kept to a minimum
- Detergents containing ammonia, sodium hypochlorite, chlorinated solvents, petroleum distillates or lye shall not be used
- In-the-water hull scraping or any process that occurs underwater to remove paint from the boat hull shall be prohibited
- Boat repair and maintenance shall only occur in clearly marked designated work areas
- All boaters shall regularly inspect and maintain engines, seals, gaskets, lines and hoses in order to prevent oil and fuel spills.

If these activities are not sufficient for compliance with existing standards, additional BMPs may be necessary. It is uncertain whether these controls would result in compliance with the SQO as well if the existing impairments are not causing sediment toxicity. Therefore, incremental controls may or may not be necessary under the Plan.

5.2.14 Port Hueneme (Region 4)

Port Hueneme is on the 2006 303(d) list for PCBs and DDT in fish tissue. Thus, the Regional Water Board would have to address these impairments in the absence of the Plan.

There are no data available for all three MLOE (sediment toxicity, chemical concentrations, and benthic community impacts) at a single location from which to assess impairment under the Plan. Thus, the incremental impacts of the Plan include monitoring costs. If monitoring indicates that water body would meet the listing criteria for the SQO, TIEs and source assessment studies would also be necessary to determine the pollutants and sources causing the exceedances.

Information from the Marina del Rey TMDL (described in Exhibit 3-10) and Section 2.1 suggests that boating activities, storm water, and agricultural runoff are the main sources of toxic pollutants in harbor sediments. Section 2.1 also indicates that the most common sources of PCBs and DDT to the water column include storm water runoff and soil erosion because they are legacy pollutants no longer in use or manufactured in the United States. The harbor coastline is completely surrounded by urban areas. Thus, boating activities and urban runoff may be sources of the pollutants.

Port Hueneme is currently covered under the Ventura County MS4 NPDES permit that requires implementation of BMPs to the maximum extent practicable. However, given the fish tissue impairments (PCBs and DDT) and narrative toxicity objective (there shall be no increase in pesticide concentrations found in bottom sediments or aquatic life and toxic pollutants shall not be present at levels that will bioaccumulate in aquatic life to levels which are harmful to aquatic life or human health), additional controls could be necessary for compliance with existing standards.

There is insufficient information to determine whether there would be any incremental costs (or cost savings) to storm water or other sources as a result of the Plan.

5.2.15 Marina del Rey (Region 4)

Marina del Rey is on the 2006 303(d) list for copper, lead, zinc, PCBs, chlordane, and DDT in sediment, sediment toxicity, and PCBs, chlordane, dieldrin, and DDT in fish tissue. The marina is also listed as a moderate priority toxic hot spot for DDT, PCBs, copper, mercury, nickel, lead, zinc, and chlordane. The Regional Water Board completed a TMDL for Marina del Rey for copper, lead, zinc, and chlordane in sediments and PCBs in fish tissue. Chlordane, DDT, and dieldrin in fish tissue are not included in the TMDL because more recent data shows these pollutants to be below screening values.

Exhibit 5-23 shows the MLOE assessment data for the bay.

Exhibit 5-23. Summary of MLOE Assessment Data, Marina del Rey

Water Body Name	Inconclusive	Unimpacted	Likely Unimpacted	Possibly Impacted	Likely Impacted	Clearly Impacted
Marina del Rey	1	3	2	3	5	4

Source: SCCWRP (2007a).

Based on the existing 303(d) listing policy, because 12 of the 17 assessment results (inconclusive results are not included in the impairment assessment) fall into an impacted category (i.e., exceedances), Marina del Rey would be listed as impaired under the Plan.

In the Marina Del Rey TMDL, the Regional Water Board identifies storm water runoff and marina activities as the main sources of pollution. The Regional Water Board recommends implementing nonstructural BMPs for 30% of urbanized watershed and structural controls for 70% of urbanized watershed (50% infiltration trenches and 50% sand filters). Because there was insufficient information available to quantify the metals loading to the sediment from boat discharges, the Regional Water Board did not assigned load allocations to marina activities, and instead required a study to estimate copper partitioning between the water column and sediment. The Regional Water Board intends to reconsider the TMDL six years after the effective date to reevaluate the waste load allocations and the implementation schedule based on the additional data obtained from special studies. One such study requires five agencies (Los Angeles Department of Beaches and Harbors, Los Angeles Department of Public Works, Caltrans, City of

Los Angeles, and City of Culver City) to conduct a characterization study to evaluate the sediment contamination problem in the harbor, including a sampling and analysis plan to assess the extent of sediment contamination in the harbor (e.g., characterize the areal extent of contamination, collect coring samples to determine the thickness of any contaminated sediment layer at appropriate locations, and collect three lines of evidence at each sampling station). Based on the results of these studies, implementation of additional controls may be needed to meet the TMDL.

Achieving the load allocations in the existing TMDL for Marina del Rey may also result in compliance under the Plan.

5.2.16 King Harbor (Region 4)

King Harbor is not on the 2006 303(d) list as impaired for any toxic pollutants. In addition, the MLOE assessment data shown in **Exhibit 5-24** indicates that the water body would not exceed the SQO.

Exhibit 5-24. Summary of MLOE Assessment Data, King Harbor

Water Body Name	Inconclusive	Unimpacted	Likely Unimpacted	Possibly Impacted	Likely Impacted	Clearly Impacted
King Harbor	0	2	0	0	0	0

Source: SCCWRP (2007a).

Thus, there is no indication that incremental costs (or cost savings) would be incurred under the Plan.

5.2.17 Alamitos Bay (Region 4)

Alamitos Bay is not on the 2006 303(d) list as impaired for any toxic pollutants. In addition, the MLOE assessment data shown in **Exhibit 5-25** indicates that the water body would not exceed the SQO.

Exhibit 5-25. Summary of MLOE Assessment Data, Alamitos Bay

Water Body Name	Inconclusive	Unimpacted	Likely Unimpacted	Possibly Impacted	Likely Impacted	Clearly Impacted
Alamitos Bay	0	4	6	1	0	0

Source: SCCWRP (2007a).

Thus, there is no indication that incremental costs (or cost savings) would be incurred under the Plan.

5.2.18 Los Angeles and Long Beach Harbors (Region 4)

The Los Angeles and Long Beach Harbor areas (Consolidated Slip, Los Angeles Fish Harbor, Cabrillo Beach, Los Cerritos Channel, Long Beach Inner and Outer Harbors, and San Pedro Bay Near/Offshore Zone) are on the 2006 303(d) list for a number of toxic pollutants in sediments, fish tissue, and the water column (see Exhibit 3-6).

In addition, a number of sites are also listed as high priority toxic hot spots (SWRCB, 2003b):

- Consolidated Slip – DDT, PCBs, PAHs, cadmium, copper, lead, mercury, zinc, dieldrin, and chlordane due to historical discharges of DDTs, PCBs, and metals; nonpoint sources such as spills, vessel discharges, anti-fouling paints, and storm drains, and waste streams from refineries
- Cabrillo Beach Pier – DDT, PCBs, PAHs, cadmium, copper, lead, mercury, zinc, dieldrin, and chlordane due to historical discharge of DDT and PCBs, discharge of wastewater effluent from Terminal Island WWTP, and nonpoint sources including ship spills, industrial facilities, and storm water runoff.

For both of these hot spots, there is only 1 data point available from which to assess compliance with the Plan, and the 303(d) listing policy requires at least 2 data points. Note, however that the limited data indicates that the areas could be exceeding the SQO.

Most of the contaminants in the Consolidated Slip enter through the Dominguez Channel which drains the highly urbanized area west of the Los Angeles River carrying with it urban runoff and nonprocess industrial waste discharges (SWRCB, 2003b). The Consolidated Slip is the only remaining toxic hot spot in the Los Angeles Harbor (Port of Los Angeles, 2007). The Port of Los Angeles is currently working with the Regional Water Board to clean up the sediments, and is considering the following remedial actions (SWRCB, 2003b):

- Dredging and offsite disposal of polluted sediments: $1,000,000 - $5,000,000
- Treatment of polluted sediments: $5,000,000 - $50,000,000.

However, although these actions could eliminate the hot spot, they would not prevent future contamination from existing sources. Therefore, in 2005, the Port of Los Angeles began a $1.5 million water quality modeling study focused on storm water contamination from the Dominguez Channel. The Port of Los Angeles also joined the Dominguez Watershed Task force, which established a plan to curtail contaminated runoff from entering harbor waters. Los Angeles County and the City of Long Beach both have SWMPs that focus on implementation of nonstructural BMPs.

As part of the Main Channel Deepening Project, the U.S. Army Corps of Engineers and the Port of Los Angeles expanded the Cabrillo Shallow Water Habitat area to cover much of the area with available uncontaminated sediments, effectively capping a portion of the area. The Port of Los Angeles is also undertaking additional efforts to address sources of impairment other than the existing sediments for Cabrillo Beach (CCC, 2005). In addition, the Los Angeles County and the City of Long Beach both have SWMPs that focus on implementation of nonstructural BMPs. These efforts should prevent future contamination from existing sources.

In addition to the current activities for these two hot spots, the Regional Water Board has begun developing the Dominguez Channel and the Los Angeles and Long Beach Harbors toxic and metals TMDL to address the existing pollutant concentrations in sediments, sediment toxicity, and benthic community effects. Therefore, once this TMDL is complete and controls are implemented, it is likely that sediment toxicity levels will be reduced to the levels necessary for compliance with the Plan. Thus, incremental impacts and costs associated with the Plan are not likely for the Consolidated Slip and Cabrillo Beach.

Exhibit 5-26 shows the MLOE assessment data for each of the areas in the harbors with more than one data point.

Exhibit 5-26. Summary of MLOE Assessment Data, Los Angeles and Long Beach Harbors

Water Body Name	Inconclusive	Unimpacted	Likely Unimpacted	Possibly Impacted	Likely Impacted	Clearly Impacted
Los Angeles Fish Harbor	0	1	0	0	0	1
Los Cerritos Channel	0	1	2	2	2	3
Long Beach Harbors	0	8	0	8	2	0
San Pedro Bay Near/Offshore	0	12	10	10	2	1

Source: SCCWRP (2007a).

Based on the existing 303(d) listing policy, Los Cerritos Channel (Main Channel), Long Beach Inner and Outer Harbors, and San Pedro Bay Near/Offshore Zone would be considered impaired under the Plan.

All of these areas will be covered under the Dominguez Channel and the Los Angeles and Long Beach Harbors toxic and metals TMDL. The Regional Water Board will likely conduct pollutant and source identification studies as part of the TMDL to determine the specific pollutants and sources of the impairments. Under the Plan, these studies would be performed prior to TMDL development. Either way, once the TMDL is complete and controls are implemented, it is likely that sediment toxicity levels will be reduced to the levels necessary for compliance with the Plan. Thus, incremental impacts and costs associated with the Plan are not likely.

The Los Angeles Fish Harbor would not be considered impaired for sediment toxicity under the Plan because only one of the two assessment results falls into an impacted category (i.e., exceedance). Thus, no incremental costs would be incurred. However, because one of the two results is listed as clearly impacted, the potential exists for additional monitoring data to indicate sediment toxicity. The Fish Harbor will be covered under the Dominguez Channel and the Los Angeles and Long Beach Harbors toxic and metals TMDL. Therefore, once this TMDL is complete and controls are implemented, it is likely that sediment toxicity levels will be reduced to the levels necessary for compliance with the Plan. Thus, incremental impacts and costs associated with the Plan are not likely.

In comparison, given that there are a number of different segments currently listed as impaired for several pollutants in various media, and that the cause of the sediment toxicity in some of those areas has not yet been identified, conducting TIEs and source assessment studies could possibly result in long term cost savings due to a more focused TMDL and cost-effective implementation of controls.

5.2.19 Anaheim Bay (Region 8)

Anaheim Bay is on the 2006 303(d) list for sediment toxicity and PCBs and dieldrin in fish tissue. Anaheim Bay Naval Reserve is also listed as a moderate priority toxic hot spot for chlordane and DDE. Thus, a TMDL for sources of sediment toxicity and PCBs and dieldrin in fish tissue, and potential cleanup actions and controls on sources of the pollutants in sediments would be needed in the absence of the Plan.

Exhibit 5-27 shows the MLOE assessment data for the bay.

Exhibit 5-27. Summary of MLOE Assessment Data, Anaheim Bay

Water Body Name	Inconclusive	Unimpacted	Likely Unimpacted	Possibly Impacted	Likely Impacted	Clearly Impacted
Anaheim Bay	0	30	1	4	1	0

Source: SCCWRP (2007a).

Based on the existing 303(d) listing policy, because 5 of the 36 assessment results fall into an impacted category (i.e., exceedances), Anaheim Bay would meet the listing criteria for the SQO.

The bay is already listed as being impaired due to sediment toxicity. In the absence of the Plan, the Regional Water Board would likely conduct additional monitoring as part of the TMDL process to determine the specific pollutants and sources of the toxicity. Based on the results of this monitoring, the Regional Water Board would develop and implement a TMDL to remedy the sediment toxicity problem in Anaheim Bay. Under the Plan, this source assessment monitoring would be done prior to TMDL development. Either way, the Regional Water Board would require that the controls needed to reduce sediment toxicity be implemented as part of the TMDL. Thus, the Plan could actually result in no incremental impacts, or long term cost savings due to a more focused TMDL and cost-effective implementation of controls.

5.2.20 Huntington Harbor (Region 8)

Huntington Harbor is on the 2006 303(d) list for sediment toxicity, lead, and chlordane in sediment, copper in water, and PCBs in fish tissue. The upper reach of the harbor is also listed as a low priority toxic hot spot for chlordane, DDE, and chlorpyrifos. Thus, a TMDL for sources of pollutants in sediment and fish tissue, and potential cleanup actions and controls on sources of the pollutants in sediments would be needed in the absence of the Plan.

Exhibit 5-28 shows the MLOE assessment data for the harbor.

Exhibit 5-28. Summary of MLOE Assessment Data, Huntington Harbor

Water Body Name	Inconclusive	Unimpacted	Likely Unimpacted	Possibly Impacted	Likely Impacted	Clearly Impacted
Huntington Harbor	1	4	2	4	7	11

Source: SCCWRP (2007a).

Based on the existing 303(d) listing policy, because 22 of the 29 assessment results (the one inconclusive result is not included in the assessment analysis) fall into an impacted category (i.e., exceedances), Huntington Harbor would meet the listing criteria for the SQO.

The harbor sediment is already known to be impaired for lead, and chlordane, as well as toxicity. In the absence of the Plan, the Regional Water Board would likely conduct additional monitoring as part of the TMDL process to confirm lead, and chlordane as the cause of the sediment toxicity, or to determine other pollutants and sources of the toxicity. Based on the results of this monitoring, the Regional Water Board would develop and implement a TMDL to address the sediment toxicity problem in Huntington Harbor. Under the Plan, this source assessment monitoring would be done prior to TMDL development. Either way, the Regional Water Board would require that the controls needed to reduce sediment toxicity be implemented as part of the TMDL. Thus, the Plan could actually result in no incremental impacts, or long term cost savings due to a more focused TMDL and cost-effective implementation of controls.

5.2.21 Bolsa Bay (Region 8)

Bolsa Bay is on the 2006 303(d) list for copper in water. Thus, the Regional Water Board would have to address these impairments in the absence of the Plan.

There is only one data point available (upstream of the bay) from which to assess sediment toxicity under the Plan. Although the limited data indicates that the water body is possibly impacted, the 303(d) listing policy requires additional assessment data. Thus, the incremental impacts of the Plan include monitoring costs. If monitoring indicates that the water body would meet the listing criteria of the SQO, TIEs and source assessment studies would also be necessary to determine the pollutants and sources causing the exceedances.

Bolsa Bay is already listed for copper in water. As described in Section 2.1.1., the main anthropogenic sources of copper include municipal wastewater treatment plant effluents, urban storm water runoff, agricultural runoff, mining, industrial effluents, and boats. The main land uses surrounding Bolsa Bay are urban and herbaceous, and EPA's PCS database indicates that there are no individually permitted point source dischargers to the bay. Therefore, urban storm water and boats are the most likely sources of copper to Bolsa Bay. In the absence of the Plan, the Regional Water Board would likely develop and implement a TMDL that targets those sources to reduce the copper loading to the Bay. Thus, if the source assessment studies for Bolsa Bay indicate that copper is causing the sediment toxicity, there will be no incremental impacts associated with the Plan.

However, if copper is not the cause of the impairment, additional controls, above those that would be needed under the copper TMDL, may or may not be needed for compliance with the Plan.

5.2.22 Newport Bay (Region 8)

The Upper, Lower, and Rhine Channel sections of Newport Bay are on the 2006 303(d) list for the following pollutants:

- Upper Newport Bay – sediment toxicity and copper, PCBs, chlordane, DDT, and metals

- Lower Newport Bay – sediment toxicity and copper, PCBs, chlordane, and DDT
- Rhine Channel – sediment toxicity and copper, lead, mercury, zinc, and PCBs

Also, the Upper Newport Bay Narrows and Newport Island in the Lower Newport Bay are listed as moderate priority toxic hot spots for chlordane, zinc and DDE, and copper, lead, mercury, zinc, chlordane, DDE, PCBs, and tributyltin, respectively.

Exhibit 5-29 shows the MLOE assessment data for the bay segments.

Exhibit 5-29. Summary of MLOE Assessment Data, Newport Bay

Water Body Name	Inconclusive	Unimpacted	Likely Unimpacted	Possibly Impacted	Likely Impacted	Clearly Impacted
Upper Bay	0	1	0	3	2	2
Lower Bay	0	2	2	11	5	1
Rhine Channel	0	0	0	0	2	1

Source: SCCWRP (2007a).

Based on the existing 303(d) listing policy, all the sections of Newport Bay would meet the listing criteria for the SQO.

The Regional Water Board has already developed TMDLs for metals (cadmium, copper, lead, zinc, mercury, and chromium) and organochlorine compounds (chlordane, DDT, and PCBs) for Newport Bay. As part of these TMDLs, the Regional Water Board is considering dredging contaminated sediment in the Rhine Channel, in addition to the following implementation actions:

- Review and revise existing NPDES permits to incorporate WLAs, compliance schedules, and monitoring program requirements
- Require agricultural operators to identify and implement monitoring program to assess pollutant discharges from their facilities, and to identify and implement a BMP program
- Identify parties responsible for open space areas, and implement a monitoring program to assess the discharges
- Implement appropriate BMPs and sampling plans for construction activities
- Require MS4s to implement additional/enhanced BMPs to ensure pollutant reductions
- Evaluate feasibility and mechanisms to fund future dredging operations
- Develop a work plan to meet TMDL implementation requirements
- Revise regional monitoring program to evaluate effectiveness of actions and programs
- Conduct special studies to review and revise TMDLs.

These actions should be sufficient for compliance under the Plan. Thus, incremental costs are unlikely.

5.2.23 Dana Point Harbor (Region 9)

Dana Point Harbor is not on the 2006 303(d) list as impaired for any toxic pollutants.

Exhibit 5-30 shows the MLOE assessment data for the harbor.

Exhibit 5-30. Summary of MLOE Assessment Data, Dana Point Harbor

Water Body Name	Inconclusive	Unimpacted	Likely Unimpacted	Possibly Impacted	Likely Impacted	Clearly Impacted
Dana Point Harbor	0	3	0	2	1	2

Source: SCCWRP (2007a).

Based on the existing 303(d) listing policy, because 5 of the 8 assessment results fall into an impacted category (i.e., exceedances), Dana Point Harbor would meet the listing criteria for the SQO. Therefore, TIEs and source assessment studies would be needed to determine the specific pollutants and sources contributing to the exceedances.

Information from the Marina del Rey TMDL (described in Exhibit 3-10) and Section 2.1 suggests that boating activities, storm water, and agricultural runoff are the likely sources of toxic pollutants in harbor sediments. EPA's PCS database indicates that there is one individually permitted point source facility discharging to the Dana Point Harbor: Dana Point Shipyard. The NPDES permit for the shipyard indicates that the facility has two outfalls. One outfall discharges storm water, including the first flush (i.e., first tenth of an inch of rainfall), without treatment from the vessel storage area at the north end of the complex. Industrial activity is prohibited in this section of the facility. All industrial processes are performed on the southern end of the facility, including hydrowashing, chemical storage, mechanical work, and painting and sanding. All process water and first flush storm water are sent to South Orange County Wastewater Authority. Only during extreme storm events would storm water, beyond the first flush, be discharged to the harbor. The permit also prohibits the discharge from causing the concentration of any priority pollutant from increasing to levels that would degrade indigenous biota. Thus, compliance with the existing permit should ensure that the discharger would not contribute to exceedance of the SQO.

The Dana Point Harbor is completely surrounded by urbanized land. Thus, urban runoff and marina activities could be sources of toxic pollutants to the harbor. The City of Dana Point developed the Standard Urban Storm Water Mitigation Plan (SUSMP) to address post construction urban runoff and storm water pollution from all new development and significant redevelopment projects. The plan requires all priority new development and significant redevelopment projects to:

- Incorporate and implement all source control BMPs (routine structural and nonstructural) unless not applicable to the project
- Consider and implement site design BMPs where applicable and feasible
- Implement treatment control BMPs.

The City's SUSMP indicates that combination of the various types of BMPs must adequately address all identified pollutants of concern, including metals, pesticides, and organic compounds (Dana Point, 2003). Thus, the existing storm water program already regulates storm water discharges with both structural and nonstructural BMPs. Therefore, additional controls for storm water beyond what is already required for compliance with existing regulations would not likely be needed under the Plan.

The location of the clearly and likely impacted monitoring stations suggests that marina and boating activities may be contributing to the exceedance of the SQO. Thus, implementation of BMPs may be needed for compliance with the Plan.

5.2.24 Mission Bay (Region 9)

Mission Bay is on the 2006 303(d) list for lead in water. However, this listing is only applicable to the area at the mouth of Tecolote Creek and the area at the mouth of Rose Creek.

Exhibit 5-31 shows the MLOE assessment data for the bay.

Exhibit 5-31. Summary of MLOE Assessment Data, Mission Bay

Water Body Name	Inconclusive	Unimpacted	Likely Unimpacted	Possibly Impacted	Likely Impacted	Clearly Impacted
Mission Bay	0	5	0	3	1	0

Source: SCCWRP (2007a).

Based on the existing 303(d) listing policy, because 4 of the 9 assessment results fall into an impacted category (i.e., exceedances), Mission Bay would meet the listing criteria for the SQO. However, as shown in Exhibit 5-15 the data points are spread throughout the water body, making it difficult to determine the extent of the impairment, if any. Thus, additional monitoring data may be needed to assess impairment under the Plan.

As described in Section 2, common sources of sediment toxicity to bays include storm water runoff from urban and contaminated areas, industrial and municipal effluents, agricultural runoff, active and abandoned mines, marinas and boating activities, and atmospheric deposition. Mission Bay is completely surrounded by urbanized areas, and EPA's PCS database indicates that there are two facilities that discharge to Mission Bay: SeaWorld San Diego and Driscoll Boat Maintenance. Therefore, municipal and industrial dischargers and storm water runoff may be contributing to exceedances of the SQO.

SeaWorld is permitted to discharge up to 9.36 mgd of wastewater from exhibit pools, pool draining and cleaning operations, runoff from landscape irrigation, facility wash down water, and storm water through two outfalls. Prior to discharge, the facility wastewater combines with storm water, some of which is filtered due to high solids content. The combined effluent is chlorinated, and velocities are reduced to induce settling prior to discharge to Mission Bay. The facility's fact sheet indicates that during large storms and after the treatment system is at full capacity, storm water bypasses chlorination and settling, and is discharged directly to Mission Bay. However, it is unlikely that this bypassed storm water is contributing to exceedances of the SQO because the first flush, which contains most of the pollutants, is being treated, and only the excess rain water is being directly discharged. Therefore, it is unlikely that this facility would need to implement additional treatment controls for compliance under the Plan.

The Driscoll Boat Maintenance facility discharges excess storm water to Mission Bay. Storm water runoff from the docks, piers, travel lifts, in-yard boat repair areas, and buildings may contain toxic pollutants. Therefore, the facility discharges storm water and process water to the sanitary sewer after clarification, settling, and filtration. Only storm water flows exceeding the

20,500 gallon capacity of the holding tanks are discharged to Mission Bay. Thus, it is unlikely that the storm water is contributing to exceedances of the SQO, and the facility should not incur control costs under the Plan.

As mentioned above, storm water runoff could also be a source of sediment pollution in Mission Bay. The City of San Diego has a comprehensive storm water pollution prevention program that is designed to eliminate or minimize the discharge of pollutants to the storm water drain system and receiving waters. The City's urban runoff management program plan identifies BMPs that address sources of pollutants from airports, buildings, landfills, stadium, household hazardous waste transfer facility, landscape and recreational facilities, wastewater collection and operations, parking facilities, streets, vehicle maintenance/equipment yards, water systems, solid waste services, nonemergency fire fighting, industrial and commercial uses, residential uses, and planning and development activities. All of the potential pollutant sources and applicable BMPs have not yet been identified and implemented. Continued implementation of this program should result in reductions in sediment toxicity related to storm water runoff. However, until that time, there is uncertainty as to whether those controls would result in compliance under the Plan. Therefore, there may be some level of incremental controls needed for compliance with the Plan.

5.2.25 San Diego Bay (Region 9)

San Diego Bay is on the 2006 303(d) list for PCBs in water. There are also smaller areas in the Bay on the list for a number of toxic pollutants in sediments, fish tissue, and the water column (see Exhibit 3-6). In addition, several areas are also known toxic hot spots (SWRCB, 2003b):

- Shoreline Seventh Street Channel – high priority for chlordane, DDT, PAHs and total chemistry due to industrial activities, pesticides from lawns, streets and buildings, runoff from pest control operations, and atmospheric deposition
- Shoreline Near Chollas Creek – moderate priority for chlordane and total chemistry
- Shoreline Vicinity of B St./Broadway Piers – moderate priority for PAHs and total chemistry
- Shoreline, between Sampson and 28th St. – moderate priority for PCBs, antimony, copper, and total chemistry
- Shoreline near Switzer Creek – moderate priority for chlordane, lindane, DDT, and total chemistry.

Thus, the Regional Water Board would need to address these existing impairments and hot spots in absence of the Plan.

There are no data available for all three MLOE (sediment toxicity, chemical concentrations, and benthic community impacts) at a single location from which to assess impairment under the Plan for the Downtown Anchorage shoreline, north of the 24th Street Marine Terminal, the shoreline near Switzer Creek, and Marriott Marina; there is only one data point for the Chula Vista Marina and the Naval Submarine Base. Thus, the incremental impacts of the Plan include monitoring costs for these areas. However, because these areas are currently impaired for pollutants that settle into sediments, it is possible that additional data could indicate exceedance of the SQO.

Exhibit 5-32 shows the MLOE assessment data for the remaining bay areas.

Exhibit 5-32. Summary of MLOE Assessment Data, San Diego Bay

Water Body Name	Inconclusive	Unimpacted	Likely Unimpacted	Possibly Impacted	Likely Impacted	Clearly Impacted
Entire Bay[1]	0	51	23	38	38	17
32nd St Naval Station	0	0	0	0	2	0
Near Chollas Creek	0	1	0	4	8	11
Near Coronado Bridge	0	0	1	1	3	0
Seventh Street Channel	0	3	1	6	9	4
Vicinity B St./Broadway Piers	0	0	1	1	0	0
Sampson and 28th St.	0	0	5	9	6	1
Coronado Cays	0	1	1	3	1	0
Glorietta Bay	0	1	0	0	1	0
Harbor Island (East Basin)	0	0	0	1	0	1
Harbor Island (West Basin)	0	0	0	1	1	0

Source: SCCWRP (2007a).
1. Represents data for entire bay; data for individual areas included in totals.

Based on the existing 303(d) listing policy, all the areas in the above exhibit except Glorietta Bay and the vicinity of B Street and Broadway Piers would meet the listing criteria for the SQO. Glorietta Bay and the vicinity of B Street and Broadway Piers would not be listed for the SQO because only one of the two assessment results falls into an impacted category (i.e., exceedance). Thus, no incremental costs would be incurred. Note that because one of the two results is listed as impacted, the potential exists for additional monitoring data to indicate sediment toxicity.

In the absence of the Plan, the Downtown Anchorage, 24th Street Marine Terminal, Naval Submarine Base, Seventh Street Channel, Chollas Creek, Switzer Creek, B Street/Broadway Piers, 32nd Street Naval Station, and Coronado Bridge areas would be covered under ongoing, planned, or future TMDLs aimed at reducing sediment toxicity and benthic community effects. TIEs and source assessment studies would be conducted as part of these TMDLs. Under the Plan, these studies would be performed prior to TMDL development. Thus, the Plan could either result in no incremental impacts over those that would be incurred in the absence of the Plan, or in long term cost savings due to more focused TMDLs and cost-effective implementation of controls for these areas of the bay.

The San Diego Regional Water Board has issued a tentative cleanup and abatement order for the area between Sampson and 28th Streets in the San Diego Bay. The order requires National Steel and Shipbuilding Company, Southwest Marine, City of San Diego (MS4), Marine Construction and Design Company and Campbell Industries, Chevron, British Petroleum, San Diego Gas and Electric, and the U.S. Navy to lower concentrations of arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, zinc, tributyltin, benzo(a)pyrene, and PCBs to five times background levels. The Regional Water Board estimated that cleanup to this level through dredging would cost approximately $96 million, and would be the most economically feasible option. Therefore, it is unlikely that additional controls would be necessary for compliance with the SQO.

EPA (1993) indicates that copper is the most common pollutant found at toxic levels in marinas nationwide. The copper TMDLs that the Regional Water Board would develop and implement for the Marriott Marina, Chula Vista Marina, Coronado Cays, Glorietta Bay, and Harbor Island (East and West) areas would affect any copper in sediments. However, there is uncertainty as to whether the controls needed under these TMDLs would results in compliance with the Plan. Therefore, there may or may not be some level of incremental controls needed for compliance with the SQO for these areas. For example, controls likely to be implemented to reduce copper from boating activities and marinas (e.g., switching to less toxic hull paint, removing boats from water for maintenance activities, and education and outreach) could also reduce the levels of other toxic pollutants associated with boating.

Under these copper TMDLs, storm water may also be targeted. San Diego County is covered by a MS4 general storm water permit which requires each copermittee to develop a SWMP that eliminates or minimizes the discharge of pollutants to the storm water drain system and receiving waters. Many of these SWMPs focus on implementation of nonstructural BMPs, however some include structural controls. Thus, it is possible that additional controls could be needed for compliance with existing standards. It is uncertain whether incremental controls beyond those needed for compliance with existing standards would be needed for compliance under the Plan.

As shown in Exhibits 5-16 and 5-17, areas in the northwestern and southern portions of the bay also meet the listing criteria for the SQO. The northwestern portion of the bay is covered under the Shelter Island Yacht Club dissolved copper TMDL which focuses on controls on marina and boating activities to reduce the copper load to the bay. TIEs and source assessment studies may be necessary to determine if copper is the only cause of the SQO exceedances. After these studies are complete, some level of incremental controls may or may not be needed for compliance with the SQO.

In the absence of the Plan, the southern portion of the bay would also be covered under a TMDL to address PCBs. Based on completed TMDLs for PCBs (Exhibit 3-10) and information in Section 2.1, sources of PCBs could include municipal and industrial point source dischargers, storm water, agricultural runoff, and air deposition. Control strategies likely to be implemented could include:

- Capping current loads for municipal and industrial point source dischargers
- Implement source control programs for municipal and industrial point source dischargers
- Cleanup of hotspots on land, storm drains, and vicinity of storm drain outfalls or treatment of contaminated runoff
- Implementation BMPs that remove PCBs
- Remediate contaminated sediments.

TIEs and source assessment studies may be necessary to determine if PCBs are the cause of the SQO exceedances. After these studies are complete, some additional level of incremental controls may or may not be needed for potential sources of toxic pollutants in sediments (e.g., storm water, municipal and industrial facilities, marinas and boating activities, and agricultural runoff) for compliance with the SQO. For examples, the majority of the south bay is surrounded by urbanized land. Thus, storm water may be a source of pollutants. Thus, because many of the SWMPs in the area focus on implementation of nonstructural BMPs, it is possible that some incremental level of controls could be needed for compliance under the Plan.

5.3 Summary of Results

Exhibit 5-33 summarizes the possible actions necessary for compliance with baseline objectives and the Plan and any potential incremental impacts for each bay described in the sections above.

Exhibit 5-33. Incremental Impacts Summary

Water Body	303(d) Listed for Sediment Quality?	Actions under Existing Regulatory Framework	Exceeds SQO?	Actions Under the Plan	Potential Incremental Impact
Region 1					
Crescent City Harbor	No	• Monitoring existing objectives.	Insufficient data	• Monitoring additional LOE.	• Monitoring additional LOE to assess sediment quality.[1]
Humboldt Bay	No	• Monitoring MLOE. • Cleanup of toxic hot spots of lead, silver, antimony, zinc, methoxychlor, and PAHs under BPTCP. • TMDL for PCBs in fish tissue.	Uncertain	• Confirmatory monitoring (MLOE) of possibly impacted sites.	• Additional MLOE monitoring. • Unclear whether confirmatory monitoring will indicate an impairment and whether assessment and controls beyond those needed under the baseline would be needed.
Bodega Harbor	No	• Monitoring existing objectives • Cleanup of toxic hot spots of cadmium, copper, lead, mercury, zinc, TBT, DDT, PCBs, and PAHs under BPTDP.	Insufficient data	• Monitoring additional LOE.	• Monitoring additional LOE to assess sediment quality.[1]
Region 2					
Tomales Bay	No	• Monitoring MLOE. • TMDL for mercury in fish tissue.	No (limited data)	• Possibly none.	• Possibly none.
Drakes Estero Bay	No	• Monitoring existing objectives.	Insufficient data	• Monitoring additional LOE.	• Monitoring additional LOE to assess sediment quality.[1]
San Francisco Bay, Richardson Bay	No	• Monitoring existing objectives. • Cleanup of toxic hot spots of mercury, PCBs, dieldrin, chlordane, DDT, and dioxin under BPTCP. • TMDLs for chlordane, dieldrin, and DDT in water and PCBs and mercury in fish tissue.	Insufficient data	• Monitoring additional LOE.	• Monitoring additional LOE to assess sediment quality.[1]

Exhibit 5-33. Incremental Impacts Summary

Water Body	303(d) Listed for Sediment Quality?	Actions under Existing Regulatory Framework	Exceeds SQO?	Actions Under the Plan	Potential Incremental Impact
San Francisco Bay, San Pablo Bay	No	• Monitoring MLOE. • Cleanup of toxic hot spots of mercury, PCBs, dieldrin, chlordane, DDT, and dioxin under BPTCP. • TMDLs for chlordane, dieldrin, and DDT in water and PCBs and mercury in fish tissue.	Yes	• Stressor identification (work plan to confirm and characterize pollutant-related impacts, pollutant identification, and source identification; adopt TMDL if appropriate).	• Unclear if addressing sediment toxicity represents an incremental impact of the Plan over existing objectives (MLOE indicate sediment toxicity; Regional Board identified sediment cleanup and remediation necessary under BPTCP). • Assessment and controls beyond those needed under the baseline may or may not be needed.
San Francisco Bay, Central Basin	Yes	• Monitoring MLOE. • Cleanup of hot spots of mercury, PCBs, dieldrin, chlordane, DDT, and dioxin under BPTCP. • TMDLs for mercury and PAHs in sediment; chlordane, dieldrin, and DDT in water; and PCBs and mercury in fish tissue.	Yes	• Stressor identification (work plan to confirm and characterize pollutant-related impacts, pollutant identification, and source identification; adopt TMDL if appropriate).	• Potential for no impact if assessment, cleanup, and controls under baseline would result in compliance with the Plan, or cost savings due to better targeted TMDLs.
San Francisco Bay, Oakland Inner Harbors	Yes	• Monitoring MLOE. • Cleanup of hot spots of mercury, PCBs, dieldrin, chlordane, DDT, and dioxin under BPTCP. • TMDLs for sediment toxicity; copper, lead, mercury, zinc, PCBs, PAHs, chlordane, and dieldrin in sediment; chlordane, dieldrin, and DDT in water; and mercury and PCBs in fish tissue.	Yes	• Stressor identification (work plan to confirm and characterize pollutant-related impacts, pollutant identification, and source identification; adopt TMDL if appropriate).	• Potential for no impact if assessment, cleanup, and controls under baseline would result in compliance with the Plan, or cost savings due to better targeted TMDLs.

Exhibit 5-33. Incremental Impacts Summary

Water Body	303(d) Listed for Sediment Quality?	Actions under Existing Regulatory Framework	Exceeds SQO?	Actions Under the Plan	Potential Incremental Impact
San Francisco Bay, San Leandro Bay	Yes	• Monitoring MLOE. • Cleanup of hot spots of mercury, PCBs, dieldrin, chlordane, DDT, and dioxin under BPTCP. • TMDLs for lead, mercury, zinc, PAH, and pesticides in sediment; chlordane and dieldrin in water, and mercury in fish tissue.	No (limited data)	• Possibly none.	• Potential cost savings for TMDL development and implementation.
San Francisco Bay, Lower Basin	Yes	• Monitoring MLOE. • Cleanup of toxic hot spots of mercury, PCBs, dieldrin, chlordane, DDT, and dioxin under BPTCP. • TMDLs for mercury in sediment; mercury, chlordane, dieldrin, and DDT in water; and mercury and PCBs in fish tissue.	Yes	• Stressor identification (work plan to confirm and characterize pollutant-related impacts, pollutant identification, and source identification; adopt TMDL if appropriate).	• Potential for no impact if assessment, cleanup, and controls under baseline would result in compliance with the Plan, or cost savings due to better targeted TMDLs.
San Francisco Bay, South Basin	Yes	• Monitoring MLOE. • Cleanup of toxic hot spots of mercury, PCBs, dieldrin, chlordane, DDT, and dioxin under BPTCP. • TMDLs for mercury in sediment; mercury, chlordane, dieldrin, and DDT in water; and mercury and PCBs in fish tissue.	Yes	• Stressor identification (work plan to confirm and characterize pollutant-related impacts, pollutant identification, and source identification; adopt TMDL if appropriate).	• Potential for no impact if assessment, cleanup, and controls under baseline would result in compliance with the Plan, or cost savings due to better targeted TMDLs.
Half Moon Bay	No	• Monitoring existing objectives.	Insufficient data	• Monitoring additional LOE.	• Monitoring additional LOE to assess sediment quality.[1]

Exhibit 5-33. Incremental Impacts Summary

Water Body	303(d) Listed for Sediment Quality?	Actions under Existing Regulatory Framework	Exceeds SQO?	Actions Under the Plan	Potential Incremental Impact
Region 3					
Moss Landing Harbor	No	• Monitoring existing objectives. • Cleanup of toxic hot spots of pesticides, PCBs, nickel, chromium, and tributyltin under BPTCP. • TMDLs for pesticides in water.	Insufficient data	• Monitoring additional LOE.	• Monitoring additional LOE to assess sediment quality.[1]
Monterey Harbor	Yes	• Monitoring existing objectives. • Cleanup of toxic hot spots of PAHs, copper, zinc, toxaphene, PCBs, and tributyltin under BPTCP. • TMDLs for metals in water. • Harbor water quality protection program under Monterey Bay National Marine Sanctuary.	Insufficient data	• Monitoring additional LOE.	• Monitoring additional LOE to assess sediment quality.[1] • Potential cost savings (better targeted TMDL).
Morro Bay	No	• Monitoring MLOE. • Comprehensive Conservation and Management Plan to address sources of heavy metals and toxic pollutants.	No	• None.	• None.
Santa Barbara Harbor	No	• Monitoring of existing objectives.	Insufficient data	• Monitoring additional LOE.	• Monitoring additional LOE to assess sediment quality.[1]
Region 4					
Ventura Harbor	No	• Monitoring of existing objectives. • TMDLs for PCBs and DDT in fish tissue. • Monitoring MLOE.	Insufficient data	• Monitoring additional LOE.	• Monitoring additional LOE to assess sediment quality.[1]
Channel Islands Harbor	Yes	• Monitoring MLOE. • TMDLs for lead and zinc in sediment.	Yes	• Stressor identification (work plan to confirm and characterize pollutant-related impacts, pollutant identification, and source identification; adopt TMDL, if appropriate).	• Potential for no impact if assessment, cleanup, and controls under baseline would result in compliance with the Plan, or cost savings due to better targeted TMDLs.

Exhibit 5-33. Incremental Impacts Summary

Water Body	303(d) Listed for Sediment Quality?	Actions under Existing Regulatory Framework	Exceeds SQO?	Actions Under the Plan	Potential Incremental Impact
Port Hueneme Harbor	No	• TMDLs for PCBs and DDT in fish tissue. • Monitoring of existing objectives	Insufficient data	• Monitoring additional LOE	• Monitoring additional LOE to assess sediment quality.[1]
Marina del Rey Harbor - Back Basins	Yes	• Monitoring MLOE. • Cleanup of toxic hot spots of DDT, PCBs, copper, mercury, nickel, lead, zinc, and chlordane under BPTCP. • TMDLs for sediment toxicity; copper, lead, zinc, PCBs, chlordane, and DDT in sediment; and PCBs, chlordane, dieldrin, and DDT in fish tissue. • Wasteload allocations for storm water under TMDL (BMPs).	Yes	• Stressor identification (work plan to confirm and characterize pollutant-related impacts, pollutant identification, and source identification; adopt TMDL, if appropriate).	• Potential for no impact if assessment, cleanup, and controls under baseline would result in compliance with the Plan, or cost savings due to better targeted TMDLs.
King Harbor	No	• Monitoring MLOE.	No (limited data)	• Possibly none.	• Possibly none.
Alamitos Bay	No	• Monitoring MLOE.	No	• None.	• None.
Los Angeles Harbor Consolidated Slip	Yes	• Monitoring existing objectives. • Cleanup of hot spots of DDT, PCBs, PAHs, cadmium, copper, lead, mercury, zinc, dieldrin, and chlordane under BPTCP. • TMDLs for sediment toxicity; benthic community effects; cadmium, copper, lead, mercury, zinc, and chlordane in sediment; dieldrin in water; and chlordane, DDT, and pesticides in fish tissue.	Insufficient data	• Monitoring additional LOE.	• Monitoring additional LOE to assess sediment quality.[1] • Potential cost savings (better targeted TMDL).

Exhibit 5-33. Incremental Impacts Summary

Water Body	303(d) Listed for Sediment Quality?	Actions under Existing Regulatory Framework	Exceeds SQO?	Actions Under the Plan	Potential Incremental Impact
Los Angeles Fish Harbor	Yes	• Monitoring MLOE. • TMDLs for sediment toxicity; copper, lead, mercury, zinc, chlordane, and PAHs in sediment; and PCBs and DDT in water.	No (limited data)	• Possibly none.	• Potential cost savings for TMDL development and implementation.
Los Angeles Harbor - Cabrillo Beach	Yes	• Monitoring existing objectives. • Cleanup of toxic hot spots of DDT, PCBs, PAHs, cadmium, copper, lead, mercury, zinc, dieldrin, and chlordane under BPTCP. • TMDLs for copper in sediment and PCBs and DDT in fish tissue.	Insufficient data	• Monitoring additional LOE.	• Monitoring additional LOE to assess sediment quality.[1] • Potential cost savings (better targeted TMDL).
Los Cerritos Channel	Yes	• Monitoring MLOE. • TMDLs for chlordane in sediment and copper, lead, and zinc in water.	Yes	• Stressor identification (work plan to confirm and characterize pollutant-related impacts, pollutant identification, and source identification; adopt TMDL if appropriate).	• Potential for no impact if assessment, cleanup, and controls under baseline would result in compliance with the Plan, or cost savings due to better targeted TMDLs.
Long Beach Inner/Outer Harbor	Yes	• Monitoring MLOE. • TMDLs for sediment toxicity; benthic community effects; and chlordane and DDT in water.	Yes	• Stressor identification (work plan to confirm and characterize pollutant-related impacts, pollutant identification, and source identification; adopt TMDL if appropriate).	• Potential for no impact if assessment, cleanup, and controls under baseline would result in compliance with the Plan, or cost savings due to better targeted TMDLs.
San Pedro Bay Near/Offshore Zones	Yes	• Monitoring MLOE. • TMDLs for sediment toxicity; copper, zinc, PAH, DDT, and chlordane in sediment; and PCBs and DDT in fish tissue.	Yes	• Stressor identification (work plan to confirm and characterize pollutant-related impacts, pollutant identification, and source identification; adopt TMDL if appropriate).	• Potential for no impact if assessment, cleanup, and controls under baseline would result in compliance with the Plan, or cost savings due to better targeted TMDLs.
Region 8					

Exhibit 5-33. Incremental Impacts Summary

Water Body	303(d) Listed for Sediment Quality?	Actions under Existing Regulatory Framework	Exceeds SQO?	Actions Under the Plan	Potential Incremental Impact
Anaheim Bay	Yes	• Monitoring MLOE. • Cleanup of toxic hot spots of chlordane and DDE under BPTCP. • TMDLs for sediment toxicity and PCBs and dieldrin in fish tissue.	Yes	• Stressor identification (work plan to confirm and characterize pollutant-related impacts, pollutant identification, and source identification; adopt TMDL if appropriate.	• Potential for no impact if assessment, cleanup, and controls under baseline would result in compliance with the Plan, or cost savings due to better targeted TMDLs.
Huntington Harbor	Yes	• Monitoring MLOE. • TMDLs for sediment toxicity; lead and chlordane in sediment; copper in water; and PCBs in fish tissue.	Yes	• Stressor identification (work plan to confirm and characterize pollutant-related impacts, pollutant identification, and source identification; adopt TMDL if appropriate).	• Potential for no impact if assessment, cleanup, and controls under baseline would result in compliance with the Plan, or cost savings due to better targeted TMDLs.
Bolsa Bay	No	• TMDLs for copper in water. • Monitoring of existing objectives.	Insufficient data	• Monitoring MLOE.	• Monitoring additional LOE to assess sediment quality.[1]
Newport Bay, Upper	Yes	• Monitoring MLOE. • Cleanup of toxic hot spots of chlordane, zinc and DDE under BPTCP. • TMDLs for sediment toxicity and copper, PCBs, chlordane, DDT, and metals in water.	Yes	• Stressor identification (work plan to confirm and characterize pollutant-related impacts, pollutant identification, and source identification; adopt TMDL if appropriate).	• Potential for no impact if assessment, cleanup, and controls under baseline would result in compliance with the Plan, or cost savings due to better targeted TMDLs.
Newport Bay, Lower	Yes	• Monitoring MLOE. • Cleanup of toxic hot spots of copper, lead, mercury, zinc, chlordane, DDE, PCBs, and tributyltin under BPTCP. • TMDLs for sediment toxicity and copper, PCBs, chlordane, and DDT in water.	Yes	• Stressor identification (work plan to confirm and characterize pollutant-related impacts, pollutant identification, and source identification; adopt TMDL if appropriate).	• Potential for no impact if assessment, cleanup, and controls under baseline would result in compliance with the Plan, or cost savings due to better targeted TMDLs.

Exhibit 5-33. Incremental Impacts Summary

Water Body	303(d) Listed for Sediment Quality?	Actions under Existing Regulatory Framework	Exceeds SQO?	Actions Under the Plan	Potential Incremental Impact
Rhine Channel	Yes	• Monitoring MLOE. • TMDLs for sediment toxicity and copper, lead, mercury, zinc, and PCBs in water.	Yes	• Stressor identification (work plan to confirm and characterize pollutant-related impacts, pollutant identification, and source identification; adopt TMDL if appropriate).	• Potential for no impact if assessment, cleanup, and controls under baseline would result in compliance with the Plan, or cost savings due to better targeted TMDLs.
Region 9					
Dana Point Harbor	No	• Monitoring MLOE.	Yes	• Stressor identification (work plan to confirm and characterize pollutant-related impacts, pollutant identification, and source identification; adopt TMDL if appropriate).	• Stressor identification. • Controls beyond those needed under the baseline may or may not be needed.
Mission Bay	No	• Monitoring MLOE. • TMDLs for lead in water (in limited area)	Yes	• Stressor identification (work plan to confirm and characterize pollutant-related impacts, pollutant identification, and source identification; adopt TMDL if appropriate).	• Possible monitoring additional LOE to assess sediment quality.[1] • Stressor identification. • Controls beyond those needed under the baseline may or may not be needed.
San Diego Bay, Shoreline 32nd St Naval Station	Yes	• Monitoring MLOE. • TMDL for sediment toxicity and benthic community effects.	Yes	• Stressor identification (work plan to confirm and characterize pollutant-related impacts, pollutant identification, and source identification; adopt TMDL if appropriate).	• Potential for no impact if assessment, cleanup, and controls under baseline would result in compliance with the Plan, or cost savings due to better targeted TMDLs.
San Diego Bay, Shoreline Downtown Anchorage	Yes	• Monitoring of existing objectives. • TMDL for sediment toxicity and benthic community effects.	Insufficient data	• Monitoring MLOE.	• Monitoring additional LOE to assess sediment quality.[1] • Potential cost savings (better targeted TMDL).

Exhibit 5-33. Incremental Impacts Summary

Water Body	303(d) Listed for Sediment Quality?	Actions under Existing Regulatory Framework	Exceeds SQO?	Actions Under the Plan	Potential Incremental Impact
San Diego Bay, Shoreline Near Chollas Creek	Yes	• Monitoring MLOE. • Cleanup of toxic hot spots of chlordane and total chemistry under BPTCP. • TMDL for sediment toxicity and benthic community effects	Yes	• Stressor identification (work plan to confirm and characterize pollutant-related impacts, pollutant identification, and source identification; adopt TMDL if appropriate).	• Potential for no impact if assessment, cleanup, and controls under baseline would result in compliance with the Plan, or cost savings due to better targeted TMDLs.
San Diego Bay, Shoreline near Coronado Bridge	Yes	• Monitoring MLOE. • TMDL for sediment toxicity and benthic community effects	Yes	• Stressor identification (work plan to confirm and characterize pollutant-related impacts, pollutant identification, and source identification; adopt TMDL if appropriate).	• Potential for no impact if assessment, cleanup, and controls under baseline would result in compliance with the Plan, or cost savings due to better targeted TMDLs.
San Diego Bay, Shoreline near Switzer Creek	No	• Monitoring of existing objectives. • Cleanup of toxic hot spots of chlordane, lindane, DDT, and total chemistry under BPTCP. • TMDLs for PAHs and chlordane in water.	Insufficient data	• Monitoring MLOE.	• Monitoring additional LOE to assess sediment quality.[1]
San Diego Bay, Shoreline North of 24th St Marine Terminal	Yes	• Monitoring of existing objectives. • TMDL for sediment toxicity and benthic community effects.	Insufficient data	• Monitoring MLOE.	• Monitoring additional LOE to assess sediment quality.[1] • Potential cost savings (better targeted TMDL).
San Diego Bay, Shoreline Seventh St Channel	Yes	• Monitoring MLOE. • Cleanup of toxic hot spots of chlordane, DDT, PAHs and total chemistry under BPTCP. • TMDL for sediment toxicity and benthic community effects	Yes	• Stressor identification (work plan to confirm and characterize pollutant-related impacts, pollutant identification, and source identification; adopt TMDL if appropriate).	• Potential for no impact if assessment, cleanup, and controls under baseline would result in compliance with the Plan, or cost savings due to better targeted TMDLs.
San Diego Bay, Shoreline Vicinity of B St/Broadway Piers	Yes	• Monitoring MLOE. • Cleanup of toxic hot spot for PAHs and total chemistry under BPTCP. • TMDL for sediment toxicity and benthic community effects	No (limited data)	• Possible none.	• Potential cost savings for TMDL development and implementation.

Exhibit 5-33. Incremental Impacts Summary

Water Body	303(d) Listed for Sediment Quality?	Actions under Existing Regulatory Framework	Exceeds SQO?	Actions Under the Plan	Potential Incremental Impact
San Diego Bay, Shoreline at Coronado Cays	No	• Monitoring MLOE. • TMDL for copper in water.	Yes	• Stressor identification (work plan to confirm and characterize pollutant-related impacts, pollutant identification, and source identification; adopt TMDL if appropriate).	• Stressor identification. • Controls beyond those needed under the baseline may or may not be needed.
San Diego Bay, Shoreline at Glorietta Bay	No	• Monitoring MLOE. • TMDL for copper in water.	No (limited data)	• Possibly none.	• Possibly none.
San Diego Bay, Shoreline, at Harbor Island (East Basin)	No	• Monitoring MLOE. • TMDL for copper in water.	Yes	• Stressor identification (work plan to confirm and characterize pollutant-related impacts, pollutant identification, and source identification; adopt TMDL if appropriate).	• Stressor identification. • Controls beyond those needed under the baseline may or may not be needed.
San Diego Bay, Shoreline, at Harbor Island (West Basin)	No	• Monitoring MLOE. • TMDL for copper in water.	Yes	• Stressor identification (work plan to confirm and characterize pollutant-related impacts, pollutant identification, and source identification; adopt TMDL if appropriate).	• Stressor identification. • Controls beyond those needed under the baseline may or may not be needed.
San Diego Bay, Shoreline, at Marriott Marina	No	• Monitoring existing objectives. • TMDL for copper in water.	Insufficient data	• Monitoring additional LOE.	• Monitoring additional LOE to assess sediment quality.[1]
San Diego Bay, Shoreline, between Sampson and 28th St	No	• Monitoring MLOE. • Cleanup of toxic hot spots of PCBs, antimony, copper, and total chemistry under BPTCP. • TMDLs for copper, mercury, zinc, PAHs, and PCBs in water.	Yes	• Stressor identification (work plan to confirm and characterize pollutant-related impacts, pollutant identification, and source identification; adopt TMDL if appropriate).	• Unclear if addressing sediment toxicity represents an incremental impact of the Plan over existing toxicity objective (MLOE indicate sediment toxicity; Regional Board identified sediment cleanup and remediation necessary under BPTCP). • Assessment and controls beyond those needed under the baseline may or may not be needed.
San Diego Bay, Shoreline, Chula Vista Marina	No	• Monitoring existing objectives. • TMDL for copper in water.	Insufficient data	• Monitoring additional LOE.	• Monitoring additional LOE to assess sediment quality.[1]

Exhibit 5-33. Incremental Impacts Summary

Water Body	303(d) Listed for Sediment Quality?	Actions under Existing Regulatory Framework	Exceeds SQO?	Actions Under the Plan	Potential Incremental Impact
San Diego Bay, Shoreline, near submarine base	Yes	• Monitoring existing objectives. • TMDL for sediment toxicity and benthic community effects.	Insufficient data	• Monitoring additional LOE.	• Monitoring additional LOE to assess sediment quality.[1] • Potential cost savings (better targeted TMDL).
Rest of San Diego Bay	No	• Monitoring MLOE. • TMDL for PCBs in fish tissue. • Implementation of Shelter Island Yacht Club dissolved copper TMDL.	Yes	• Stressor identification (work plan to confirm and characterize pollutant-related impacts, pollutant identification, and source identification; adopt TMDL if appropriate).	• Stressor identification. • Controls beyond those needed under the baseline may or may not be needed.

1. Monitoring of additional LOE to assess compliance with the SQO may represent an incremental impact of the Plan. However, as noted, MLOE are already being collected at a number of bays and estuaries to evaluate sediment toxicity and as part of TMDLs for sites exceeding baseline objectives, even in the absence of the Plan.

6. Methods of Compliance and Potential Costs

This section identifies potential means of compliance with the Plan, and the potential costs of those measures.

6.1 Monitoring and Stressor Identification

As discussed in Section 3, there are extensive monitoring and assessment activities supporting the baseline regulatory framework. Indeed, as a result of these baseline efforts, MLOE data are available for 11 of the bays addressed by the Plan. Absent the Plan, these activities will continue, and additional efforts will be undertaken (e.g., as Regional Boards assess compliance with existing objectives for sediment toxicity, and address sites currently impaired for sediment toxicity). That is, data is needed to determine whether sediments are in compliance with existing narrative objectives for sediment toxicity. Similarly, in instances in which sediments exceed baseline objectives for sediment toxicity, assessment of the causes and sources will be needed in order to identify means of compliance with the objectives. These activities, which can include developing a work plan/project management, collecting additional data, conducting toxicity identification evaluations (TIEs), surface water modeling, and other analysis, may be conducted as part of developing a TMDL (SCCWRP, 2005; Parsons, et al., 2002, as cited in WSPA, 2007).

The incremental impact of the Plan could include monitoring of additional lines of evidence or additional confirmatory monitoring for possibly impacted sites to assess compliance with the SQOs. However, as noted, MLOE are already being collected at a number of bays and estuaries, and this monitoring standard could be pursued to assess compliance or as part of a TMDL for impaired sites even in the absence of the Plan. The incremental impact of the Plan could also include the stressor identification efforts identified in the Plan, including developing a work plan to seek confirmation and characterization of pollutant-related impacts, pollutant identification, and source identification for sites that exceed the SQOs. However, similar efforts could be pursued if the sediments are listed under the existing objectives (SCCWRP, 2005; Parsons, et al., 2002, as cited in WSPA, 2007). Further, for those sites not currently listed for sediment toxicity, if MLOE would indicate sediment toxicity under the Plan, Regional Boards could determine that the narrative objective is exceeded in the future even in the absence of the Plan, triggering assessment activities. Thus, the extent to which the need for the particular stressor identification actions identified in the Plan represent new requirements that would not be undertaken in the absence of the Plan is uncertain.

The incremental impact of the Plan could also include a reduction in stressor identification efforts for sites currently listed as impaired for sediment toxicity that would not be listed under the Plan.

6.1.1 Bays

Exhibit 5-33 indicates that there is insufficient data to assess compliance with the SQO for a number of bays. The Plan requires three lines of evidence to identify impaired sediments: chemical concentrations, sediment toxicity, and benthic community condition. **Exhibit 6-1** provides laboratory prices for the analyses potentially required under the Plan. Although data for some parameters may not be needed at each sampling site or for each bay, potential sampling costs per sample may be in the range of $3,940 to $5,810.

Exhibit 6-1. Potential Sampling Costs under the Plan

Parameter	Cost per sample
Metals suite	$175 – $225
Total Mercury	$65 – $135
PAH suite	$400
Chlorinated pesticides	$200 – $575[a]
PCB congeners (not coplanar)	$200 – $575[a]
Sediment toxicity (acute lethal)	$800
Sediment toxicity (sublethal)	$800 – $1,400
Benthic survey	$800 – $1,200[b]
Sediment collection on boat	$500[c]
Total cost per sample	$3,940 – $5,810

Source: Chemistry cost estimates obtained from price lists used for southern California and San Francisco Bay regional monitoring programs; sediment toxicity and benthic survey costs obtained from southern California regional monitoring program and development of the Plan; sediment collection estimate from SCCWRP (2007b).
a. High estimate represents low detection limit analyses.
b. High estimate represents difficult to sort samples, such as 0.5 mm mesh screen samples in San Francisco Bay.
c. Includes the cost of the boat, crew, and any activities associated with preparing the samples for transport to the analysis laboratory (e.g., compositing and subsampling and screening of benthic samples to remove excess sediment).

Sample collection costs may vary based on factors such as water depth, sediment characteristics (may cause unsuccessful grabs that need to be repeated), and distance between stations.

The number of stations from which data should be collected will vary based on water body-specific factors including:

- area
- tidal flow and/or direction of predominant currents
- historic and or legacy conditions in the vicinity of the water body
- nearby land and marine uses or actions
- beneficial uses
- potential receptors of concern
- changes in grain size, salinity, water depth, and organic matter
- other sources or discharges in the immediate vicinity of the water body.

Exhibit 6-2 shows the minimum number of samples for different size bays, assuming that sediment conditions are relatively homogeneous. These estimates reflect a goal of providing a spatially-based measure of sediment condition with a level of precision similar to that used in regional monitoring programs throughout California. Different numbers of stations may be required for targeted or focused studies.

Exhibit 6-2. Potential Number of Samples to Assess Compliance

Bay Size (acres)	Number of Samples/Stations
<500	5
500-5000	12
>5000	30

Exhibit 6-2. Potential Number of Samples to Assess Compliance

Bay Size (acres)	Number of Samples/Stations

Source: SCCWRP (2007b).

Exhibit 6-3 shows a range of potential costs to obtain data for the bays for which no or insufficient data are available for assessing SQO compliance. These estimates represent the product of the potential number of samples (Exhibit 6-2) and the cost per sample of $3,940 to $5,810.

Exhibit 6-3. Potential Incremental Sediment Quality Monitoring Costs

Water Body	Size (Acres)	Number of Samples	Total Monitoring Costs (Low)[1]	Total Monitoring Costs (High)[2]
Region 1				
Crescent City Harbor	374	5	$19,700	$29,100
Bodega Bay	822	12	$47,300	$69,700
Region 2				
Drakes Estero Bay	12,780	30	$118,200	$174,300
San Francisco Bay, Richardson Bay	2,439	12	$47,300	$69,700
Half Moon Bay	355	5	$19,700	$29,100
Region 3				
Moss Landing Harbor	79	5	$19,700	$29,100
Monterey Harbor	76	5	$19,700	$29,100
Santa Barbara Harbor	266	5	$19,700	$29,100
Region 4				
Ventura Harbor	179	5	$19,700	$29,100
Port Hueneme Harbor	65	5	$19,700	$29,100
King Harbor	105	5	$19,700	$29,100
Los Angeles Harbor Consolidated Slip	36	5	$19,700	$29,100
Los Angeles Harbor - Cabrillo Beach	156	5	$19,700	$29,100
Region 8				
Bolsa Bay	116	5	$19,700	$29,100
Region 9				
Mission Bay	2,032	12	$47,300	$69,700
San Diego Bay, Shoreline, at Marriott Marina	32	5	$19,700	$29,100
San Diego Bay, Shoreline, Chula Vista Marina	49	5	$19,700	$29,100
Total	19,961	131	$516,200	$761,700

Detail may not add to total due to rounding.
1. Equals the number of samples times the low estimate of cost per sample ($3,940).
2. Equals the number of samples times the high estimate of cost per sample ($5,810).

In addition to the need for monitoring MLOE for segments with no or insufficient data, confirmatory monitoring would also be required in instances where existing data indicate possibly impacted sites with no clearly or likely impacted results. Exhibit 5-33 indicates that confirmatory monitoring would be needed for Humboldt Bay for two stations. Thus, confirmatory monitoring costs could range from $7,900 to $11,600 ($3,940 × 2 to $5,810 × 2).

Exhibit 5-33 also indicates that some bays that are not currently on the 303(d) list for sediment toxicity would exceed the SQO under the Plan. As noted above, if MLOE indicate sediment toxicity, it is possible that Regional Boards could identify these sites as impaired under the baseline narrative objectives even in the absence of the Plan (e.g., as shown in Exhibit 5-33, some areas containing toxic hot spots needing cleanup and remediation under the BPTCP are not currently listed for sediment toxicity). Under the Plan, the next step would be a sequential approach to manage the sediment appropriately, including developing and implementing a work plan to confirm and characterize pollutant-related impacts, identify pollutants, and identify sources and management actions (including adopting a TMDL, if appropriate).

The cost of the sequential approach described in the Plan will vary depending on a number of factors, including the extent of baseline efforts and studies underway to address other impairment issues, and the number of potential stressors to the area. The State Water Board's estimate for complex TMDLs (including an implementation plan) of over $1 million (SWRCB, 2001) provides some indication of costs that can be associated with sequential approaches to managing designated use impairments. Thus, this estimate provides an approximation of the potential magnitude of both costs and cost savings that may be associated with changes in the identification of impairments under the baseline objectives and the Plan.

As shown in Exhibit 5-33, there are 5 bay segments that are not on the 303(d) list for sediment related impairments for which MLOE data indicate impairment under the Plan. There are also another 3 segments not currently on the 303(d) list for which it is unclear if addressing sediment toxicity represents an incremental impact of the Plan over the existing toxicity objectives (MLOE indicate sediment toxicity; Regional Board identified sediment cleanup and remediation necessary under BPTCP). If TMDL development and implementation are needed for all 8 of these segments, incremental cost could be approximately $8 million.

Exhibit 5-33 also indicates that there are 3 segments on the 303(d) list for sediment related impairments under the baseline for which MLOE data indicate no impairment under the Plan. Assuming that no TMDL development and implementation would be needed for these segments under the Plan, there could be a potential cost savings of $3 million. Thus, the net incremental cost associated with compliance with the Plan could be approximately $5 million ($8 million - $3 million) (or lower if such costs would be incurred in the absence of the Plan for any of the 3 sites that exhibit sediment toxicity and for which cleanup and remediation actions are necessary). **Appendix E** provides additional available information related to components of the sequential management process.

6.1.2 Estuaries

As part of the Phase II effort, the State Water Board is collecting the data from estuaries throughout the state necessary to develop appropriate tools and thresholds for implementing the SQO for estuaries. These data can also be used to assess compliance with the final SQO. Thus, additional monitoring may be necessary for those waters not currently being sampled as part of this effort. However, costs of these monitoring efforts cannot be estimated until the data collection effort is complete to avoid double counting the sampling efforts already underway.

6.2 Controls

For waters that Regional Water Boards identify as being impaired under the Plan, remediation actions and/or source controls will be needed to bring them into compliance. Many bays and estuaries are already listed for sediment impairments and, therefore, would require controls under baseline conditions. When the baseline controls are identical to the ones that would be implemented under the Plan, there is no incremental cost or cost savings associated with the Plan. When the baseline controls differ, there is potential for either incremental costs or cost-savings associated with the Plan.

Several factors prevent meaningful estimates of incremental control costs or cost savings at this stage. First, the sediment impairment outcomes for some bays and all estuaries are uncertain because of missing assessment data. Second, the assessment data available for identifying the sites that might exceed a SQO for one or more toxic substances are not sufficient to identify specific changes in controls because the data do not identify the likely contamination sources. Third, strategies to meet current narrative objectives at many impaired sites are still in the planning stages and, therefore, necessary baseline information is missing. For waters where impairment status changes because of the Plan (either from impaired to not impaired for sediment toxicity or vice versa), the net effect may be incremental costs or cost savings, but missing information on pollutants and source contribution still prevents cost estimation.

For an increased source control cost associated with additional pollution controls under the Plan, the concentration of toxic pollutants in discharges would have to meet levels that are more stringent than what is needed to achieve compliance with existing objectives (e.g., since they could have to control based on the narrative sediment objectives or the CTR). Incremental costs for controls may also result from the identification of additional chemical stressors that are not included in the CTR or Basin Plans. Since many practices that may be employed under existing TMDLs are applicable for controlling the mobilization of pollutants in general, this situation is also difficult to estimate. For example, the TMDL for pesticides and PCBs in the Calleguas Creek watershed indicates that the BMPs needed to achieve the nutrient and toxicity TMDLs for the watershed would likely reduce pesticides and PCBs to necessary levels as well (LARWQCB, 2005d).

Thus, without being able to identify the particular pollutants causing biological effects, and the development of discharge concentrations needed to achieve the objectives, the needed controls to achieve those concentrations are difficult to estimate. Review of existing impairments and TMDL actions for the various bays identified in Section 5 suggests that incremental impacts may be unlikely. If there are incremental impacts as a result of the Plan, source controls may focus on storm water sources, marinas, and wetlands. However, some level of control for these sources would occur under the implementation plans for existing TMDLs (Exhibit 3-10). The following sections discuss these issues; Appendix E provides additional information on unit costs.

6.2.1 Municipal and Industrial Facilities

Regional Water Boards regulate municipal and industrial wastewater treatment facilities through the NPDES permit program. If these dischargers have potential to cause or contribute to an exceedance of water quality standards contained in Basin Plans, the CTR, or any other applicable policy, permit writers assign effluent limits. Regional Water Boards may also adopt more stringent criteria for specific pollutants where necessary (e.g., to meet a TMDL, site-specific objectives). If the Plan requires municipal and industrial dischargers to reduce pollutant concentrations to levels below those required by existing standards, it is likely that these facilities would implement source control to eliminate the pollutant from entering their treatment plant or industrial process, or pursue regulatory relief (e.g., a variance), rather than install costly end-of-pipe treatment. However, it is uncertain whether such a situation would arise under the Plan.

6.2.2 Agriculture

Regional Water Boards regulate farmers primarily through the conditional WDR waivers that require compliance with water quality standards. Regional Water Boards may also require farmers to meet more stringent criteria for specific pollutants where necessary (e.g., to meet a TMDL, site-specific objectives). All of the affected Regional Water Boards have narrative objectives that specifically prohibit the discharge of pesticides and/or toxic pollutants that cause detrimental effects in aquatic life or to animals and humans. Thus, even in the absence of the Plan, farmers would be prohibited from causing or contributing to biological impacts.

For example, the Central Valley Regional Water Board developed a cleanup plan for the entire Sacramento-San Joaquin Delta to address high diazinon levels from dormant orchard spray. In the cleanup plan the Regional Water Board identified several management actions for controlling the release of pesticides into surface waters and set a time schedule for completion and implementation of TMDLs for the Sacramento River, San Joaquin River, and the Delta. The Regional Water Board adopted all of these TMDLs by May 2007. In both the cleanup plan and TMDLs, the Regional Water Board identified possible management actions for reducing the concentration of diazinon in surface waters (CVRWQCB, 2005c; 2006; 2007; SWRCB, 2003b):

- Pest management practices – use of alternatives to diazinon and chlorpyrifos
- Pesticide application practices –improved sprayer technologies, more frequent calibration of sprayer equipment, use of aerial drift retardants, improved mixing and loading procedures, and other practices that would result in reduced application rates or mitigation of off-site pesticide movement
- Vegetation management practices – used to increase infiltration and/or decrease runoff (e.g., planting cover crops, buffer strips, or allowing native vegetation to grow in places that would reduce runoff rates)
- Water management practices – improvements in water infiltration and runoff control include better irrigation efficiency and distribution uniformity, increased use of soil moisture monitoring tools, increased use of tailwater return systems, and vegetated drainage ditches.

6.2.3 Storm Water

An incremental level of control for storm water sources (e.g., need to implement new practices, increase the frequency of existing practices, or install structural controls that might not be required under existing objectives) may or may not be necessary for compliance with the Plan. For any situation in which storm water sources are specifically required to control toxic pollutants to levels that are lower than what would be necessary in the absence of the Plan, potential means of compliance include:

- increased or additional nonstructural BMPs – institutional, education, or pollution prevention practices designed to limit generation of runoff or reduce the pollutants load of runoff
- structural controls – engineered and constructed systems designed to provide water quantity or quality control.

The following sections provide general discussion of the types of activities and associated costs that may be affected by changes in control strategies attributable to the Plan.

Nonstructural BMPs

Nonstructural BMPs can be very effective in controlling pollution generation at the source, which in turn can reduce or eliminate the need for costly end-of-pipe treatment or structural controls. Most municipal SWMPs primarily implement nonstructural BMPs to meet existing permit requirements. It is possible that additional or increased efforts for certain nonstructural BMPs could be used for compliance with the Plan. Examples include expanding an existing outreach and education program to a larger or new target audience, refocusing source control efforts on pollutants and sources of concern (e.g., pesticide/herbicide use or integrated pest management program), increasing program compliance efforts, and increasing frequency, duration, or efficiency of maintenance practices such as street sweeping.

Although nonstructural practices play an invaluable role in protecting surface water, costs and effectiveness are not easily quantified, primarily because there are no design standards for these practices (SWRCB, 2006d) and because many have been education-oriented with high up-front costs to develop outreach materials. For example, the State Water Board's Erase the Waste campaign is a public education program that works to reduce storm water pollution and improve the environment of coastal and inland communities. The State Water Board launched the campaign in Los Angeles County in August 2003 as a 2-year, $5 million outreach campaign (SWRCB, 2004d). However, the materials produced are now available statewide (SWRCB, 2006d). Thus, expanding the program to other regions would not be as costly as starting a similar program from scratch.

A recent survey of California municipalities reports a mean annual cost of $26 per household for nonstructural SWMP measures including: public education and outreach, illicit discharge detection and elimination, construction site storm water runoff control, post construction storm water management in new development and redevelopment, and pollution prevention and good housekeeping for municipal operations such as street sweeping (CSU Sacramento, 2005). Incremental costs to improve the effectiveness of these measures may have a similar order of magnitude, although actual costs will vary depending on the baseline program, the incremental activities, municipality size, and degree of coordination with other municipalities. Appendix E provides additional examples of nonstructural BMP cost estimates.

Structural Controls

There are a variety of structural means to control the quantity and quality of storm water runoff including infiltration systems, detention systems, retention systems, constructed wetlands, filtration systems, and vegetated systems. The cost for any particular structure depends on the type of control, the quantity of water treated, and site-specific factors such as land cost. Incremental costs or cost-savings associated with the plan cannot be estimated without information on differences, if any, in structural control strategies between baseline and Plan conditions. Appendix E provides examples of cost estimates for individual structures.

6.2.4 Marinas and Boating Activities

Control measures that address toxic pollutants from marinas and boating activities include:

- Use of biocide-free paint on boats or more frequent boat hull cleaning to prevent leaching of toxic paints
- Performing above waterline boat maintenance activities in a lined channel to prevent debris from entering the water
- Performing below waterline boat maintenance on land in area with runoff (and dust) controls
- Developing a collection system for toxic materials at harbors.

Although water quality controls for marinas are less common than controls for urban storm water, Exhibit 3-10 indicates that they may be included in baseline strategies for impaired sites. However, there may also be incremental costs or cost savings at these sites under the Plan. Sites that are not exceeding current objectives, but would be exceeding the SQO could incur incremental control costs if boating activities contribute to sediment toxicity. Conversely, there may be cost savings for sites exceeding current standards that are not exceeding the SQO.

Incremental costs or cost savings will depend on the pollutants of concern, the types of activities undertaken, and in some cases the number of boats affected. Appendix E provides examples of the types of activities that may be included in incremental costs (or cost savings if baseline activities are not necessary).

6.2.5 Wetlands

Incremental wetland controls may or may not be necessary to achieve compliance with the SQO. Potential means of compliance include: aeration, channelization, revegetation, sediment removal, levees, or a combination of these practices.

In the case of Humboldt Bay, incremental controls may be needed to control methylmercury production to levels that are lower than what would be necessary in the absence of the Plan. The extent of controls needed and the types of controls are unknown. One example of efforts underway elsewhere is the Anderson Marsh wetland on Cache Creek. This wetland is located within a 1,000-acre park that also includes oak woodlands and riparian areas. Various management practices mentioned above may be applied upstream to reduce inorganic mercury in water flowing into the wetland, thus reducing methylmercury formation, and other practices may reduce the downstream transport of methylmercury formed in the wetland. The Central Valley Regional Water Board (2005b) provides capital cost estimates for controlling methylmercury export from Anderson March ranging from $200,000 to $1 million, and O&M costs ranging from $20,000 to $100,000 per year.

6.3 Cleanup and Remediation Activities

As shown in Exhibit 5-33, there is uncertainty as to whether incremental cleanup and remediation activities will be required as a result of the Plan. In addition, based on the implementation plans for existing TMDLs, Regional Water Boards are likely to pursue source controls for ongoing sources and only require remediation activities for historical pollutants with no known, ongoing sources. However, for any situation in which cleanup or remediation would be required that would not be conducted in the absence of the Plan, costs will depend on the technical feasibility of different strategies (e.g., capping, removal and disposal, removal and treatment and disposal), the proximity of source material (for capping) or to appropriate treatment and disposal facilities, whether disposal facilities exist or whether new facilities must be built, as well as other factors. Costs for any sediment remediation actions necessary as a result of the Plan could be similar to those estimated by the Regional Water Board for hot spot cleanup shown in Exhibit 3-9. Appendix E provides additional discussion regarding potential costs.

7. Analysis of Statewide Costs

This section provides a summary of the economic considerations of the Plan, and discusses the key sources of uncertainty in the analysis.

7.1 Sediment Quality and Costs in the Absence of the Plan

There are currently 64 segments of bays and estuaries on the State's 2006 303(d) list, including 31 listings for sediment quality, and 38 sites identified as known toxic hot spots under the State Water Board's BPTCP. These conditions require substantial resources to be spent over the next decades for monitoring, assessment, TMDL development, pollution controls, and sediment cleanup and remediation. These resources include an estimated $87.6 million to $1.03 billion for cleanup and remediation of toxic hot spots that are of high priority (SWRCB, 2003b).

All Regional Water Boards currently have narrative objectives for toxic substances, toxicity, pesticides, bioaccumulation, or a combination of these categories. Although these narrative objectives are subject to interpretation and are implemented according to each Regional Water Board's policy, any water body could potentially be listed because of impaired biota, bioaccumulation in biota, sediment toxicity, or high concentrations of toxic substances (especially pesticides) in sediments. There is uncertainty regarding whether the TMDLs developed or under development for listed waters would result in restoring beneficial uses. Indeed, TMDLs are often phased, such that evaluation of early actions can result in changes or redirection of future actions. Thus, additional costs could be incurred in the future in order to eliminate sediment toxicity in bays and estuaries.

7.2 Sediment Quality and Costs under the Plan

The Plan provides statewide narrative objectives for sediment quality, and an increased data requirement for assessing sediment quality using three LOE: sediment toxicity, benthic community condition, and sediment chemistry. Evaluation of existing monitoring data suggests that there may be insufficient data to assess compliance in a number of areas. Specifically, for the segment delineations found on the 2006 303(d) list for bays there is insufficient data for approximately 16 of these segments, and no data for estuaries. As discussed in Section 6.1, monitoring costs to obtain the necessary data to assess compliance may include approximately $516,000 to $762,000 for the bay sites. Monitoring costs for estuaries cannot be estimated until the State Water Board's Phase II program is complete.

There are two possible outcomes under the Plan with respect to 303(d) listings and toxic hot spot identification that result in costs or cost-savings:

- Data indicate impairment where none was identified previously
- Data reclassify sediments thought to be impaired as unimpaired.

Thus, there is the potential to either incur or reduce costs under the Plan.

Under the Plan, if sediments exceed the SQOs, the next step would be a sequential approach to manage the sediment appropriately, including developing and implementing a work plan to confirm and characterize pollutant-related impacts, identify pollutants, and identify sources and management actions (including adopting a TMDL, if appropriate). Thus, there could be incremental TMDL costs for sites that are classified as unimpaired under current criteria, but impaired under the Plan. Based on existing monitoring data for segment delineations found on the 2006 303(d) list for bays (Exhibit 3-6), 8 sites may fall in this category. Incremental TMDL development costs will depend on the type and extent of sediment impairment, the number and type of contaminant sources, and other water quality conditions. However, the State Water Board (1999) estimates that a complex TMDL could cost over $1 million.

Using this estimate, incremental TMDL cost for bays could be over $8 million. Conversely, there may be incremental cost savings for sites that are currently classified as impaired, but found to not be impaired for sediment toxicity under the Plan. There are 3 bays on the current 303(d) list for sediment toxicity related impairments that do not exceed the aquatic life SQO. Thus, if no TMDL development and implementation are needed for these segments under the Plan, there could be a potential cost savings of $3 million, resulting in net incremental cost associated with compliance with the Plan of approximately $5 million ($8 million - $3 million). The extent of cost savings depends on the status of TMDL development, and the portion of costs attributable to sediment allocations.

The control strategies implemented to address sediment impairments identified under the SQOs may differ from baseline control strategies. Where the control strategies associated with the Plan are more extensive than the baseline controls, there are incremental costs. Conversely, where control strategies do not need to be as stringent, there are cost savings. Because the impairment status of most sites is not expected to change under the Plan, there are few instances of unambiguous incremental costs or cost savings.

These same considerations apply to incremental cleanup and remediation activities under the Plan. It is likely that most sites with sediment conditions that would require cleanup and remediation under the Plan would also exceed current objectives. To the extent that results differ, it is possible that the additional assessment activities under the Plan could lead to cleanup strategies that are more cost effective compared to baseline activities. In addition, based on the implementation plans for existing TMDLs, Regional Water Boards are likely to pursue source controls for ongoing sources and only require remediation activities for historical pollutants with no known, ongoing sources. If incremental remediation activities are necessary, costs are likely to be very specific to the particular site and project.

7.3 Uncertainties

As noted above, several data limitations prevent estimating incremental control costs or cost savings. There are additional sources of uncertainty regarding baseline conditions that affect the evaluation of the incremental economic impacts of the narrative SQOs. Existing TMDLs and hot spot cleanup and remediation actions have yet to be implemented, and the sediment quality that would result without the Plan is unknown. Baseline control scenarios are relevant because many practices can reduce loadings for a wide variety of pollutants. For example, the TMDL for pesticides and PCBs in the Calleguas Creek watershed indicates that the BMPs needed to achieve the nutrient and toxicity TMDLs for the watershed would likely reduce pesticides and PCBs to necessary levels as well (LARWQCB, 2005d). Thus, controls to address existing impairments (for water or sediment) could alter the assessment of compliance with the objectives.

Assessment data gaps also introduce uncertainty to the economic analysis of achieving compliance with the Plan. These gaps limit assessment classification under the Plan for almost 20 of the 54 bay sites and all of the estuaries. Many of these locations are already classified as impaired under current narrative criteria, but may or may not be considered to be exceeding the objectives under the Plan.

How the Regional Water Boards will ultimately implement the Plan is also highly uncertain. It is possible that stressor assessment and pollution controls could be required to address clearly impacted results at the station level, even if the data as a whole do not support 303(d) listing. Such an approach would increase the incremental impacts of the policy in the short term, but could result in long term cost savings by avoiding the need for more costly cleanup and remediation activities that could be required by waiting until the sediments are impaired before reducing levels of toxic pollutants.

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Appendix A. Current Sediment Quality Objectives

This Appendix lists the current Regional Water Board Basin Plan objectives that relate to sediment quality.

North Coast Regional Water Board (Region 1)

- Toxicity – All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life. Compliance with this objective will be determined by use of indicator organisms, analyses of species diversity, population density, growth anomalies, bioassays of appropriate duration, or other appropriate methods as specified by the Regional Water Board.
- Pesticides – No individual pesticide or combination of pesticides shall be present in concentrations that adversely affect beneficial uses. There shall be no bioaccumulation of pesticide concentrations found in bottom sediments or aquatic life.

San Francisco Bay Regional Water Board (Region 2)

- Bioaccumulation – Many pollutants can accumulate on particles, in sediment, or bioaccumulate in fish and other aquatic organisms. Controllable water quality factors shall not cause a detrimental increase in concentrations of toxic substances found in bottom sediments or aquatic life. Effects on aquatic organisms, wildlife, and human health will be considered.
- Toxicity – All waters shall be maintained free of toxic substances in concentrations that are lethal to or that produce other detrimental responses in aquatic organisms. Detrimental responses include, but are not limited to, decreased growth rate and decreased reproductive success of resident or indicator species. There shall be no acute toxicity in ambient waters. There shall be no chronic toxicity in ambient waters.
- The health and life history characteristics of aquatic organisms in waters affected by controllable water quality factors shall not differ significantly from those for the same waters in areas unaffected by controllable water quality factors.

Central Coast Regional Water Board (Region 3)

- Toxicity – All waters shall be maintained free of toxic substances in concentrations which are toxic to, or which produce detrimental physiological responses in, human, plant, animal, or aquatic life. Compliance with this objective will be determined by use of indicator organisms, analyses of species diversity, population density, growth anomalies, toxicity bioassays of appropriate duration, or other appropriate methods as specified by the Regional Water Board.
- Pesticides – No individual pesticide or combination of pesticides shall reach concentrations that adversely affect beneficial uses. There shall be no increase in pesticide concentrations found in bottom sediments or aquatic life.

Los Angeles Regional Water Board (Region 4)

- Pesticides – No individual pesticide or combination of pesticides shall be present in concentrations that adversely affect beneficial uses. There shall be no increase in pesticide concentrations found in bottom sediments or aquatic life.
- Bioaccumulation – Toxic pollutants shall not be present at levels that will bioaccumulate in aquatic life to levels which are harmful to aquatic life or human health.
- Toxicity – All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life. Compliance with this objective will be determined by use of indicator organisms, analyses of species diversity, population density, growth anomalies, bioassays of appropriate duration, or other appropriate methods as specified by the Regional Water Board.

Central Valley Regional Water Board (Region 5)

- No individual pesticide or combination of pesticides shall be present in concentrations that adversely affect beneficial uses; discharges shall not result in pesticide concentrations in bottom sediments or aquatic life that adversely affect beneficial uses; total identifiable persistent chlorinated hydrocarbon pesticides shall not be present in the water column at concentrations detectable within the accuracy of analytical methods approved by EPA or the Executive Officer; and pesticide concentrations shall not exceed the lowest levels technically and economically achievable.
- All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life. This objective applies regardless of whether the toxicity is caused by a single substance or the interactive effect of multiple substances. Compliance with this objective will be determined by analyses of indicator organisms, species diversity, population density, growth anomalies, and biotoxicity tests of appropriate duration or other methods as specified by the Regional Water Board.

Santa Ana Regional Water Board (Region 8)

- Toxic Substances – Toxic substances shall not be discharged at levels that will bioaccumulate in aquatic resources to levels which are harmful to human health. The concentrations of toxic substances in the water column, sediments or biota shall not adversely affect beneficial uses.

San Diego Regional Water Board (Region 9)

- Pesticides – No individual pesticide or combination of pesticides shall be present in the water column, sediments or biota at concentrations that adversely affect beneficial uses. Pesticides shall not be present at levels which will bioaccumulate in aquatic organisms to levels which are harmful to human health, wildlife, or aquatic organisms.
- Toxicity – All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life. Compliance with this objective will be determined by use of indicator

organisms, analyses of species diversity, population density, growth anomalies, bioassays of appropriate duration, or other appropriate methods as specified by the Regional Water Board.

Appendix B. Current Water Quality Objectives

This Appendix lists the current water quality objectives for toxic pollutants under the California Toxics Rule (CTR).

Exhibit B-1. CTR Priority Toxic Pollutant Criteria (concentrations in µg/L)

Pollutant	Freshwater		Saltwater		Human Health For consumption of:	
	Acute	Chronic	Acute	Chronic	Water & Organisms	Organisms Only
Antimony					14	4300
Arsenic	340	150	69	36		
Beryllium						
Cadmium [2]	4.3	2.2	42	9.3		
Chromium (III)	550	180				
Chromium (VI)	16	11	1100	50		
Copper	13	139.0	4.8	3.1	1300	
Lead	65	652.5	210	8.1		
Mercury					0.05	0.051
Nickel	470	47052	74	8.2	610	4600
Selenium		5.0	290	71		
Silver	3.4	3.4	1.9			
Thallium					1.7	6.3
Zinc [2]	120	120	90	81		
Cyanide	22	5.2	1	1	700	220,000
Asbestos					7,000,000 fibers/L	
2,3,7,8-TCDD (dioxin)					0.000000013	0.000000014
Acrolein					320	780
Acrylonitrile					0.059	0.66
Benzene					1.2	71
Bromoform					4.3	360
Carbon Tetrachloride					0.25	4.4
Chlorobenzene					680	21,000
Chlorodibromomethane					0.401	34
Chloroethane						
2-Chloroethylvinyl Ether						
Chloroform						
Dichlorobromomethane					0.56	46
1,1-Dichloroethane						
1,2-Dichloroethane					0.38	99
1,1-Dichloroethylene					0.057	3.2
1,2-Dichloropropane					0.52	39
1,3-Dichloropropylene					10	1,700
Ethylbenzene					3,100	29,000
Methyl Bromide					48	4,000
Methyl Chloride						
Methylene Chloride					4.7	1,600

Exhibit B-1. CTR Priority Toxic Pollutant Criteria (concentrations in µg/L)

Pollutant	Freshwater		Saltwater		Human Health For consumption of:	
	Acute	Chronic	Acute	Chronic	Water & Organisms	Organisms Only
1,1,2,2-Tetrachlorethane					0.17	11
Tetrachloroethylene					0.8	8.85
Toluene					6,800	200,000
1,2-Trans-Dichloroethylene					700	140,000
1,1,1-Trichloroethane						
1,1,2-Trichloroethane					0.60	42
Trichloroethylene					2.7	81
Vinyl Chloride					2	525
2-Chlorophenol					120	400
2,4-Dichlorophenol					93	790
2,4-Dimehtylphenol					540	2,300
2-Methyl-4,6-Dinitrophenol					13.4	765
2,4-Dinitrophenol					70	14,000
2-Nitrophenol						
4-Nirtophenol						
3-Methyl-4-Chlorophenol						
Pentachlorophenol					0.28	8.2
Phenol					21,000	4,600,000
2,4,6-Trichlorophenol					2.1	6.5
Acenaphthene					1,200	2,700
Acenaphthylene						
Anthracene					9,600	110,000
Benzidine					0.00012	0.00054
Benzo(a)Anthracene					0.0044	0.049
Benzo(a)Pyrene					0.0044	0.049
Benzo(b)Fluoranthene					0.0044	0.049
Benzo(ghi)Perylene						
Benzo(k)Fluoranthene					0.0044	0.049
Bis(2-Chloroethoxy)Methane						
Bis(2-Chloroethyl)Ether					0.031	1.4
Bis(2-Chloroisopropyl)Ether					1,400	170,000
Bis(2-Ethylhexyl)Phthalate					1.8	5.9
4-Bromophenyl Phenyl Ether						
Butylbenzyl Phthalate					3,000	5,200
2-Chloronaphthalene					1,700	4,300
4-Chlorophenyl Phenyl Ether						
Chrysene					0.0044	0.049
Dibenzo(a,h)Anthracene					0.0044	0.049
1,2 Dichlorobenzene					2,700	17,000
1,3 Dichlorobenzene					400	2,600
1,4 Dichlorobenzene					400	2,600
3,3'-Dichlorobenzidine					0.04	0.077
Diethyl Phthalate					23,000	120,000
Dimethyl Phthalate					313,000	2,900,000

Exhibit B-1. CTR Priority Toxic Pollutant Criteria (concentrations in µg/L)

Pollutant	Freshwater		Saltwater		Human Health For consumption of:	
	Acute	Chronic	Acute	Chronic	Water & Organisms	Organisms Only
Di-n-Butyl Phthalate					2,700	12,000
2,4-Dinitrotoluene					0.11	9.1
2,6- Dinitrotoluene						
Di-n-Octyl Phthalate						
1,2-Diphenylhydrazine					0.040	0.54
Fluoroanthene					300	370
Fluorene					1,300	14,000
Hexachlorobenzene					0.00075	0.00077
Hexachlorobutadiene					0.44	50
Hexachlorocyclopentadiene					240	17,000
Hexachloroethane					1.9	8.9
Indeno(1,2,3-cd) Pyrene					0.0044	0.049
Isophorone					8.4	600
Naphthalene						
Nitrobenzene					17	1,900
N-Nitrosodimethylamine					0.00069	8.1
N-Nitrosodi-n-Propylamine					0.005	1.4
N-Nitrosodiphenylamine					5.0	16
Phenanthrene						
Pyrene					960	11,000
1,2,4-Trichlorobenzene						
Aldrin	3		1.3		0.00013	0.00014
Alpha-BHC					0.0039	0.013
Beta-BHC					0.014	0.046
Gamma-BHC	0.95		0.16		0.019	0.063
Delta-BHC	2.4					
Chlordane [1]	1.1	0.0043	0.09	0.004	0.00057	0.00059
4,4'-DDT		0.001	0.13	0.001	0.00059	0.00059
4,4'-DDE					0.00059	0.00059
4,4'-DDD	0.24				0.00083	0.00084
Dieldrin	0.22	0.056	0.71	0.0019	0.00014	0.00014
Alpha-Endosulfan	0.22	0.056	0.034	0.0087	110	240
Beta-Endosulfan		0.056	0.034	0.0087	110	240
Endosulfan Sulfate					110	240
Endrin	0.086	0.036	0.037	0.0023	0.76	0.81
Endrin Aldehyde	0.52				0.76	0.81
Heptachlor	0.52	0.0038	0.053	0.0036	0.00021	0.00021
Heptachlor Epoxide		0.0038	0.053	0.0036	0.00010	0.00011
Polychlorinated biphenyls (PCBs)	0.73	0.014		0.03	0.00017	0.00017
Toxaphene		0.0002	0.21	0.0002	0.00073	0.00075

Exhibit B-1. CTR Priority Toxic Pollutant Criteria (concentrations in µg/L)

Pollutant	Freshwater		Saltwater		Human Health For consumption of:	
	Acute	Chronic	Acute	Chronic	Water & Organisms	Organisms Only

1. Regions 1, 4, and 9 have municipal water supply use maximum contaminant level criterion for chlordane = 0.1 µg/L.
2. The maximum dissolved cadmium criterion for the Sacramento River and its tributaries above State Hwy 32 Bridge at Hamilton City in Region 5 is 0.22 µg/L; the maximum dissolved zinc criterion for Sacramento River from Keswick Dam to the I Street Bridge at City of Sacramento; American River from Folsom Dam to the Sacramento River; Folsom Lake (50); and the Sacramento-San Joaquin Delta is 0.1 mg/L.
3. Region 2 has aquatic life criteria for mercury: saltwater 4-day average = 0.025 µg/L; saltwater 1-hr average = 2.1 µg/L; freshwater 4-day average = 0.025 µg/L; freshwater 1-hr average = 2.4 µg/L. Region 3 has aquatic life criteria for mercury: freshwater average = 0.05 µg/L; freshwater maximum = 0.2 µg/L; marine habitats average = 0.05 µg/L; marine habitats maximum = 0.1 µg/L.

Appendix C. Nonpoint Source Plan Management Measures

This appendix provides a description of the management measures (MMs) applicable to sediment toxicity control from California's Nonpoint Source Management Program Plan.

There are five MMs in the NPS Program Plan relevant to sediment toxicity control for agriculture **(Exhibit C-1)**.

Exhibit C-1. Agricultural Management Measures

MM Code	Agriculture MM Title	Description
1A	Erosion and Sediment Control	Where erosion and sedimentation from agricultural lands affects coastal waters and/or water bodies listed as impaired by sediment, landowners must design and install or apply a combination of practices to reduce solids and associated pollutants in runoff during all but the larger storms. Alternatively, landowners may apply the erosion component of a Resource Management System as defined in the U.S. Department of Agriculture Natural Resources Conservation Service Field Office Technical Guide.
1D	Pesticide Management	Implementation will occur through cooperation with the Department of Pesticide Regulation by development and adoption of reduced risk management strategies (including reductions in pesticide use); evaluation of pest, crop, and field factors; use of Integrated Pest Management (IPM); consideration of environmental impacts in choice of pesticides; calibration of equipment; and use of anti-backflow devices. IPM strategies are key and include evaluating pest problems in relation to cropping history and previous pest control measures, and applying pesticides only when an economic benefit will be achieved. Pesticides should be selected based on their effectiveness to control target pests and environmental impacts such as their persistence, toxicity, and leaching potential.
1F	Irrigation Water Management	Irrigation water would be applied uniformly based on an accurate measurement of crop water needs and the volume of irrigation water applied, considering limitations raised by such issues as water rights, pollutant concentrations, water delivery restrictions, salt control, wetland, water supply, and frost/freeze temperature management. Additional precautions would apply when chemicals are applied through irrigation.
1G	Education/Outreach	Implement pollution prevention and education programs such as: activities that cause erosion and loss of sediment on agricultural land; activities that cause discharge from confined animal facilities (excluding Concentrated Animal Feeding Operations) to surface water; activities that cause excess delivery of nutrients and/or leaching of nutrients; activities that cause contamination of surface water and ground water from pesticides; grazing activities that cause physical disturbance to sensitive areas and the discharge of sediment, animal waste, nutrients, and chemicals to surface and ground waters; irrigation activities that cause nonpoint source pollution of surface waters.

Source: SWRCB (2000).

There are 11 MMs that address the various forestry operations and practices (**Exhibit C-2**). The Forest Practice Rules (FPRs) also closely reflect these silvicultural MMs.

Exhibit C-2. Forestry Management Measures

MM Code	Code Forestry MM Title	Description
2A	Pre-Harvest Planning	Silvicultural activities should be planned to reduce potential delivery of pollutants to surface waters by addressing the timing, location, and design of harvesting and road construction; site preparation; identification of sensitive or high-erosion risk areas; and the potential for cumulative water quality impacts.
2B	Streamside Management Areas (SMAs)	Protect against soil disturbance and reduce sediment and nutrient delivery to waters from upland activities. Intended to safeguard vegetated buffer areas along surface waters to protect the water quality of adjacent streams.
2C	Road construction/Reconstruction	Road construction/reconstruction should be conducted so as to reduce sediment generation and delivery by following preharvest plan layouts and designs for road systems, incorporating adequate drainage structures, properly installing stream crossings, avoiding road construction in SMAs, removing debris from streams, and stabilizing areas of disturbed soil such as road fills.
2D	Road Management	Management of roads to prevent sedimentation, minimize erosion, maintain stability, and reduce the risk that drainage structures and stream crossings will fail or become less effective. Implementation includes inspections and maintenance actions to prevent erosion of road surfaces and to ensure the effectiveness of stream-crossing structures. Also address appropriate methods for closing roads that are no longer in use.
2E	Timber Harvesting	Addresses skid trail location and drainage, management of debris and petroleum, and proper harvesting in SMAs. Timber harvesting practices that protect water quality and soil productivity also have economic benefits by reducing the length of roads and skid trails, reducing equipment and road maintenance costs, and providing better road protection.
2F	Site Preparation and Forest Regeneration	Impacts of mechanical site preparation and regeneration operations—particularly in areas that have steep slopes or highly erodible soils, or where the site is located in close proximity to a water body—can be reduced by confining runoff onsite. This measure addresses keeping slash material out of drainage ways, operating machinery on contours, timing of activities, and protecting ground cover in ephemeral drainage areas and SMAs. Careful regeneration of harvested forestlands is important in protecting water quality from disturbed soils.
2H	Revegetation of Disturbed Areas	Addresses the rapid revegetation of areas disturbed during timber harvesting and road construction—particularly areas within harvest units or road systems where mineral soil is exposed or agitated (e.g., road cuts, fill slopes, landing surfaces, cable corridors, or skid trails) with special priority for SMAs and steep slopes near drainage ways.
2I	Forest Chemical Management	Application of pesticides, fertilizers, and other chemicals used in forest management should not lead to surface water contamination. Pesticides must be properly mixed, transported, loaded, and applied, and their containers disposed of properly. Fertilizers must also be properly handled and applied since they also may be toxic depending on concentration and exposure. Includes applications by skilled workers according to label instructions, careful prescription of the type and

Exhibit C-2. Forestry Management Measures

MM Code	Code Forestry MM Title	Description
		amount of chemical to be applied, use of buffer areas for surface waters to prevent direct application or deposition, and spill contingency planning.
2J	Wetlands Forest Management	Forested wetlands provide many beneficial water quality functions and provide habitat for aquatic life. Activities in wetland forests should be conducted to protect the aquatic functions of forested wetlands.
2K	Postharvest Evaluation	Incorporate postharvest monitoring, including (a) implementation monitoring to determine whether the operation was conducted according to specifications, and (b) effectiveness monitoring after at least one winter period to determine whether the specified operation prevented or minimized discharges.
2L	Education/Outreach	Implement pollution prevention and education programs to reduce NPS pollutants generated by applicable silvicultural activities.

Source: SWRCB (2000).

California's 15 urban MMs (**Exhibit C-3**) are organized to parallel the land use development process to address the prevention and treatment of pollution during all phases of urbanization; this strategy relies primarily on pollution prevention or source reduction practices.

Exhibit C-3. Urban Management Measures

MM Code	Urban MM Title	Description
3.1A	Developing Areas – Watershed Protection	Encourage land use and development planning on a watershed scale that takes into consideration sensitive areas that, by being protected, will maintain or improve water quality.
3.1B	Developing Areas – Site Development	Aims to protect areas that provide important water quality benefits and limit land disturbance.
3.1C	Developing Areas – New Development	Addresses increased pollutant loads associated with developed lands, and the hydrologic alterations resulting from development that affects runoff volume and timing. Developers can use innovative site planning techniques or incorporate runoff management practices to reduce the hydrologic impact of development on receiving waters.
3.2A	Construction Sites – Construction Site Erosion and Sediment Control	Aims to reduce erosion through implementation of erosion and sediment control practices.
3.2B	Construction Sites – Chemical Control	Implement a chemical control plan to: limit application, generation, and migration of toxic substances; ensure proper storage and disposal of toxic materials; and apply nutrients to establish and maintain vegetation.
3.3A	Existing Development	Includes the implementation of nonstructural controls to reduce pollutant loads and volume of storm water runoff.
3.4A	On-site Disposal Systems (OSDS) – New OSDSs	Includes comprehensive planning by the regulatory authority, including measures to protect sensitive areas, such as nutrient-limited waters and shellfish harvest areas. Measures might include prohibitions, setbacks, or requirements for the use of innovative treatment systems to effect greater treatment of sewage. Also includes performance-based requirements for the siting, design, and installation of systems, and inspection of newly installed systems.

Exhibit C-3. Urban Management Measures

MM Code	Urban MM Title	Description
3.4B	On-site Disposal Systems (OSDS) – Operating OSDSs	Addresses the programmatic aspects of OWTS management to ensure that systems that are installed as designed are inspected and maintained regularly to prevent failures. Public education about proper sewage treatment system use and maintenance is an important part of this measure, as is development and enforcement of policies to prevent or minimize the impacts of OWTS failures.
3.5A	Transportation Development – Planning, Siting, and Developing Roads and Highways	Aims to protect areas that provide important water quality benefits and limit land disturbance.
3.5B	Transportation Development – Bridges	Aims to design bridges to minimize damage to riparian or wetland habitats and treating runoff from bridge decks before it is allowed to enter watercourses. Bridge maintenance activities should be conducted using containment practices to prevent pollutants from entering the water or riparian habitat below. Restoration of damaged riparian or instream habitats should be done after bridge construction, maintenance, and demolition.
3.5C	Transportation Development – Construction Projects	Implement a chemical control plan to: limit application, generation, and migration of toxic substances; ensure proper storage and disposal of toxic materials; and apply nutrients to establish and maintain vegetation.
3.5D	Transportation Development – Chemical Control	Implement a chemical control plan to: limit application, generation, and migration of toxic substances; ensure proper storage and disposal of toxic materials; and apply nutrients to establish and maintain vegetation.
3.5E	Transportation Development – Operation and Maintenance	Incorporate pollution prevention procedures into the operation and maintenance of roads, highways, and bridges to reduce pollutant loadings to surface waters.
3.5F	Transportation Development – Road, Highway, and Bridge Runoff Systems	Acknowledges the fact that roads built in the past may not have the same level of runoff control and treatment that is expected today, and these older roads may be contributing to pollution problems in receiving waters. Municipalities responsible for road and bridge rights-of-way should undertake an assessment of the roads' and bridges' contribution to surface waters and identify opportunities for installing new treatment practices. Based on water quality priorities and the availability of staff and funding resources, a schedule should be devised to implement these practices.
3.6A	Education/Outreach – Pollution Prevention: General Sources	Used to reduce the amount of pollutants generated or allowed to be exposed to runoff.

Source: SWRCB (2000).

There are 16 MMs to address marina and boating sources of nonpoint pollution (**Exhibit C-4**). Effective implementation of these MMs can ensure appropriate operation and maintenance practices and encourage the development and use of effective pollution control and education efforts. The MMs cover the following operations and facilities:

- Any facility that contains 10 or more slips, piers where 10 or more boats may tie up, or any facility where a boat for hire is docked
- Any residential or planned community marina with 10 or more slips
- Any mooring field where 10 or more boats are moored
- Public or commercial boat ramps
- Boat maintenance or repair yards on or adjacent to the water (typically, boat yards are separate entities from marinas and are regulated under NPDES storm water permits).

Exhibit C-4. Marinas and Boating Management Measures

MM Code	Marinas MM Title	Description
4.1A	Assessment, Siting and Design – Marina Flushing	Provides for maximum flushing and circulation of surface waters through marina siting and designs. These practices can reduce the potential for water stagnation, maintain biological productivity, and reduce the potential for toxic accumulation in bottom sediment.
4.1D	Assessment, Siting and Design – Shoreline Stabilization	Use of vegetative stabilization methods is preferred over the use of structural stabilization methods where shoreline erosion is a pollution problem.
4.1E	Assessment, Siting and Design – Storm Water runoff	Involves implementing runoff control strategies to remove at least 80 percent of suspended solids from storm water runoff coming from boat maintenance areas (some boat yards may conform to this provision through NPDES permits).
4.1F	Assessment, Siting and Design – Fueling Station Design	Requires that fueling stations be located and designed to contain accidental fuel spills in a limited area, and that fuel containment equipment and spill contingency plans be provided to ensure quick spill response.
4.1H	Assessment, Siting and Design – Waste Management Facilities	Requires that facilities be installed at new and expanding marinas where needed for the proper recycling or disposal of solid wastes (e.g., oil filters, lead acid batteries, used absorbent pads, spent zinc anodes, and fish waste as applicable) and liquid materials (e.g., fuel, oil, solvents, antifreeze, and paints).
4.2A	Operation and Maintenance – Solid Waste Control	Involves properly disposing of solid wastes produced by the operation, cleaning, maintenance, and repair of boats to limit entry of these wastes to surface waters.
4.2C	Operation and Maintenance – Liquid Material Control	Promotes sound fish waste management through a combination of fish cleaning restrictions, education, and proper disposal.
4.2D	Operation and Maintenance – Petroleum Control	Requires provision and maintenance of the appropriate storage, transfer, containment, and disposal facilities for liquid materials commonly used in boat maintenance, as well as encouraging the recycling of these materials.
4.2E	Operation and Maintenance – Boat Cleaning and Maintenance	Aimed at reducing the amount of fuel and oil that leaks from fuel tanks and tank air vents during the refueling and operation of boats.
4.2G	Operation and Maintenance – Boat Operation	Involves prevention of turbidity and physical destruction of shallow-water habitat resulting from boat wakes and prop wash.

Exhibit C-4. Marinas and Boating Management Measures

MM Code	Marinas MM Title	Description
4.3A	Education and Outreach – Public Education	Requires that public education, outreach, and training programs be instituted to prevent and control improper disposal of pollutants into State waters.

Source: SWRCB (2000).

Appendix D. Toxic Hot Spots for Bays

This appendix provides additional information on the enclosed bays listed as known toxic hot spots in the Consolidated Plan. **Exhibit D-1** summarizes the information in the Consolidation Plan for bays.

Exhibit D-1. Enclosed Bays Listed as Known Toxic Hot Spots

Rank	Site Identification	Reason for Listing	
		Definition trigger	Pollutants
High	Delta Estuary, Cache Creek watershed including Clear lake	Human health impacts	Mercury
High	Delta Estuary	Aquatic life impacts	Diazinon
High	Delta Estuary - Morrison Creek, Mosher Slough, 5 Mile Slough, Mormon Slough & Calaveras River	Aquatic life impacts	Diazinon & Chlorpyrifos
High	Delta Estuary - Ulatis Creek, Paradise Cut, French Camp & Duck Slough	Aquatic life impacts	Chlorpyrifos
High	Humboldt Bay Eureka Waterfront H Street	Bioassay toxicity	Lead, Silver, Antimony, Zinc, Methoxychlor, PAHs
High	Los Angeles Inner Harbor Dominguez Channel, Consolidated Slip	Human health, aquatic life impacts	DDT, PCBs, PAH, Cadmium, Copper, Lead, Mercury, Zinc, Dieldrin, Chlordane
High	Los Angeles Outer Harbor Cabrillo Pier	Human health, aquatic life impacts	DDT, PCBs, Copper
High	Lower Newport Bay Rhine Channel	Sediment toxicity, exceeds objectives	Arsenic, Copper, Lead, Mercury, Zinc, DDE, PCB, TBT
High	Moss Landing Harbor and Tributaries	Sediment chemistry, toxicity, bioaccumulation, and exceedances of NAS and FDA guidelines	Pesticides, PCBs, Nickel, Chromium, TBT
High	Mugu Lagoon/ Calleguas Creek tidal prism, Eastern Arm, Main Lagoon, Western Arm	Aquatic life impacts	DDT, PCBs, metals, Chlordane, Chlorpyrifos
High	San Diego Bay Seventh St. Channel Paleta Creek, Naval Station	Sediment toxicity and benthic community impacts	Chlordane, DDT, PAHs and Total Chemistry[2]
High	San Francisco Bay Castro Cove	Aquatic life impacts	Mercury, Selenium, PAHs, Dieldrin
High	San Francisco Bay Entire Bay	Human health impacts	Mercury, PCBs, Dieldrin, Chlordane, DDT, Dioxin Site listing was based on Mercury and PCB health advisory
High	San Francisco Bay Islais Creek	Aquatic life impacts	PCBs, chlordane, dieldrin, endosulfan sulfate, PAHs, anthropogenically enriched H_2S and NH_3

Exhibit D-1. Enclosed Bays Listed as Known Toxic Hot Spots

Rank	Site Identification	Reason for Listing	
		Definition trigger	Pollutants
High	San Francisco Bay Mission Creek	Aquatic life impacts	Silver, Chromium, Copper Mercury, Lead, Zinc, Chlordane, Chlorpyrifos, Dieldrin, Mirex, PCBs, PAHs, anthropogenically enriched H_2S and NH_3
High	San Francisco Bay Peyton Slough	Aquatic life impacts	Silver, Cadmium, Copper, Selenium, Zinc, PCBs, Chlordane, ppDDE, Pyrene
High	San Francisco Bay Point Potrero/ Richmond Harbor	Human health	Mercury, PCBs, Copper, Lead, Zinc
High	San Francisco Bay Stege Marsh	Aquatic life impacts	Arsenic, Copper, Mercury, Selenium, Zinc, chlordane, dieldrin, ppDDE, dacthal, endosulfan, endosulfan sulfate, dichlorobenzophenone, heptachlor epoxide, hexachlorobenzene, mirex, oxidiazon, toxaphene and PCBs
Moderate	Anaheim Bay, Naval Reserve	Sediment toxicity	Chlordane, DDE
Moderate	Ballona Creek Entrance Channel	Sediment toxicity	DDT, zinc, lead, Chlordane, dieldrin, chlorpyrifos
Moderate	Bodega Bay-10006 Mason's Marina	Bioassay toxicity	Cadmium, Copper, TBT, PAH
Moderate	Bodega Bay-10028 Porto Bodega Marina	Bioassay toxicity	Copper, lead, Mercury, Zinc, TBT, DDT, PCB, PAH
Moderate	Delta Estuary Delta	Aquatic life impacts	Chlordane, Dieldrin, Lindane, Heptachlor, Total PCBs, PAH & DDT
Moderate	Delta Estuary Delta	Human health impacts	Chlordane, Dieldrin, Total DDT, PCBs, Endosulfan, Toxaphene
Moderate	Los Angeles River Estuary	Sediment toxicity	DDT, PAH, Chlordane
Moderate	Upper Newport Bay Narrows	Sediment toxicity, exceeds water quality objectives	Chlordane, Zinc, DDE
Moderate	Lower Newport Bay Newport Island	Exceeds water quality objectives	Copper, Lead, Mercury, Zinc, Chlordane, DDE, PCB, TBT
Moderate	Marina del Rey	Sediment toxicity	DDT, PCB, Copper, Mercury, Nickel, Lead, Zinc, Chlordane
Moderate	Monterey Harbor	Aquatic life impacts, sediment toxicity	PAHs, Cu, Zn, Toxaphene, PCBs, Tributyltin
Moderate	San Diego Bay Between "B" Street & Broadway Piers	Benthic community impacts	PAHs, Total Chemistry
Moderate	San Diego Bay Central Bay Switzer Creek	Sediment toxicity	Chlordane, Lindane, DDT, Total Chemistry
Moderate	San Diego Bay Chollas Creek	Benthic community impacts	Chlordane, Total Chemistry

Exhibit D-1. Enclosed Bays Listed as Known Toxic Hot Spots

Rank	Site Identification	Reason for Listing	
		Definition trigger	Pollutants
Moderate	San Diego Bay Foot of Evans & Sampson Streets	Benthic Community Impacts	PCBs, Antimony, Copper, Total Chemistry
Moderate	San Francisco Bay Central Basin, San Francisco Bay	Aquatic life impacts	Mercury, PAHs
Moderate	San Francisco Bay Fruitvale (area in front of storm drain)	Aquatic life impacts	Chlordane, PCBs
Moderate	San Francisco Bay Oakland Estuary. Pacific Drydock #1 (in front of storm drain)	Aquatic life impacts	Copper, Lead, Mercury, Zinc, TBT, ppDDE, PCBs, PAHs, Chlorpyrifos, Chlordane, Dieldrin, Mirex
Moderate	San Francisco Bay, San Leandro Bay	Aquatic life impacts	Mercury, Lead, Selenium, Zinc, PCBs, PAHs, DDT, pesticides
Low	Huntington Harbor Upper Reach	Sediment toxicity	Chlordane, DDE, Chlorpyrifos

Source: SWRCB (2003b).

Appendix E. Control Costs

This appendix provides a description of the types of the control costs that might be incurred as incremental costs of the Plan should entities need to implement controls that would not be necessary in the absence of the Plan.

E.1 Stressor Identification

Under the Plan, once a Regional Board identifies a water body or segment as exceeding the SQO, the next step would be a sequential approach to manage the sediment appropriately, including developing and implementing a work plan to confirm and characterize pollutant-related impacts, identify pollutants, and identify sources and management actions (including adopting a TMDL, if appropriate). A toxicity identification evaluation (TIE) study is one tool that can be used for identifying pollutants and sources. When properly executed, TIE studies help identify classes of stressors that cause toxicity to aquatic life, facilitating evaluation of the need for remediation and controls, and when required, the development of appropriate, cost-effective remedial alternatives and controls (SAIC, 2003).

TIEs can also be used to confirm that the cause of toxicity is related to the presence of toxic pollutants. The U.S. Navy initiated a TIE demonstration study that used sediment pore water from the Hunter's Point Shipyard in San Francisco Bay as part of a demonstration for the U.S. Navy Engineering Field Activity Northeast (SAIC, 2002). The study was designed to illustrate the applicability of TIEs in resolving the sources of toxicity and assist with management of contaminated sediments. The Navy intended to use this Phase I TIE study to identify sources and the magnitude of toxicity associated with contaminants at the site, and to characterize the extent to which confounding factors (e.g., ammonia) are potentially involved in the toxic response (SAIC, 2002). Phase II and III TIE studies are used to specifically define and confirm the contaminants causing the toxicity from the class of contaminants determined during the Phase I study.

However, since a TIE study can be costly, the benefits of obtaining specific results may need to be weighed against the cost of controls that target all contaminants and address a variety of water quality concerns in the context of comprehensive watershed management. Furthermore, a TIE may not be warranted if the contaminated area of concern is small, if minimal toxicity is observed, or if there is a clear link between a point source of contamination and observed adverse effects (SAIC, 2003).

The design, and thus the costs of a stressor assessment study are site-specific, and vary based on the degree of coordination with other studies, the number of toxic samples that are identified for testing, and the number and type of toxicity tests to be performed. Unit cost estimates for TIEs may also vary based on what is included (e.g., the need to arrange for a vessel and support, study design and approval) and who is providing them (e.g., costs for universities and governmental agencies are unlikely to reflect the full cost of labor, including wages, benefits, and overhead). There are no estimates of the cost of TIEs conducted as part of recent TMDLs for sediment quality listings in California. SCCWRP estimates that the intensive laboratory study part of a Phase I TIE would range from approximately $3,000 to $9,000 per sample (SCCWRP, 2007b).

Nautilus (2007) estimates that a Phase I TIE can cost between $5,000 to $7,000 per sample, including labor and materials for sample fractionation, bioassay procedures, all associated quality assurance and quality control, data analysis, interpretation, reporting, and discussions with regulatory agencies, as needed. The estimate does not include pollutant-specific chemical analyses that may be necessary depending on the analytes in question (Nautilus, 2007).

It is more difficult to provide estimates for Phase II and III TIE studies because they are designed based on the results of the Phase I study, and are largely dependent on the class of contaminants identified as causing the toxicity. Nautilus (2007) estimates that costs for Phase II identification studies are typically in the range of $9,000 to $12,000 per sample. Costs for Phase III studies are highly variable because they depend on both the results of Phase I and II studies.

A TIE study could be necessary at sites that would be impaired under the listing policy defined in the Plan (SWRCB, 2006a). The number of samples for a TIE study could be less than or equal to the number of samples taken for assessment monitoring. However, there are no specific requirements in the Plan, and there is uncertainty regarding the strategies that will be employed by implementing agencies. For example, confirmatory monitoring may result in a need for conducting TIEs only at those sites determined to be clearly and likely impacted and not possibly impacted sites.

The Plan does not specify the number of TIE studies needed for stressor identification, as this number is likely to vary depending on factors such as water body size and contamination patterns. Between 2 and 5 different stations could be needed in proportion to the size of the water body (SCCWRP, 2007b). **Exhibit E-1** shows the potential number of sites by bay size assuming that the same stressors are present through the water body.

Exhibit E-1. Potential Number of Stressor Identification Stations

Bay Size (acres)	Number of Stressor Identification Stations
<500	2
500-5000	3
>5000	5

E.2 Storm Water Nonstructural BMPs

Street sweeping programs are often among the more costly nonstructural BMPs, accounting for approximately 11% to 64% of SWMP costs incurred by municipalities responding to a recent survey (CSU Sacramento, 2005). More intensive sweeping could include incremental costs for equipment purchase and operation. The effectiveness of street sweeping depends on the type and operation of the equipment, sweeping frequency and number of passes, and climate (FHWA, 2002). Thus, increasing the frequency of sweeping or changing the type of sweeper used may result in decreases in pollutant loads.

California State University (CSU) Sacramento conducted a storm water cost survey for the State Water Board to document costs incurred by select municipalities in implementing SWMPs as part of their MS4 NPDES permits. **Exhibit E-2** shows street sweeping costs for several California municipalities, with costs ranging from $12 to $61 per curb mile. Incremental costs for more extensive sweeping would depend on a municipality’s current sweeping practices and the extent of the increase needed to reduce toxic loadings (e.g., the incremental curb miles and whether new sweepers need to be purchased).

Exhibit E-2. Examples of Street Sweeping Costs

Municipality	Street Sweeping Costs ($)	Annual Curb Miles Swept	Cost Per Curb Mile Swept ($/curb mile)	Estimated Annual Frequency
Fremont	$1,915,000	31,405	$61	12
Sacramento	$1,322,748	26,450	$50	12
Encinitas	$117,962	5,832	$20	12
Corona	$414,215	20,877	$20	26
Fresno-Clovis	$2,193,296	142,411	$15	12
Santa Clarita	$557,443	46,800	$12	50

Source: CSU Sacramento (2005).
1. Costs are in 2002/2003 fiscal year dollars.

Most municipalities use mechanical/brush model sweepers (Minton, 2007). These models are generally only half as effective as vacuum sweepers with respect to pollutant loading reduction. Vacuum sweepers are much more effective at removing fine sediments, silts and clays where much of the pollution resides. There are two types of vacuum sweepers: wet and dry. The dry vacuum sweepers remove a greater percentage of small particulates and sediments than the wet vacuum sweepers. Thus, depending on the load reductions needed, switching to either a wet or dry vacuum sweeper could increase pollutant load reductions to surface waters.

Conventional mechanical sweepers cost approximately $69,000 (1995 dollars), whereas wet vacuum sweepers cost around $127,000 (1995 dollars) (FHWA, 2002). The useful life span of these sweepers is between 4 and 7 years, and the operating cost associated with these sweepers is about $70 per hour (1996 dollars) (FHWA, 2002). The capital cost of vacuum-assisted dry sweepers is on the order of $170,000 (1996 dollars) with a projected useful life span of about 8 years, and operating costs of approximately $35 per hour (1996 dollars) (FHWA, 2002).

E.2 Storm Water Structural Controls

There are a variety of structural means to control the quantity and quality of storm water runoff including infiltration systems, detention systems, retention systems, constructed wetlands, filtration systems, and vegetated systems.

Infiltration systems capture runoff and infiltrate it into the ground. These systems provide both water quality and quantity control. Typically, these systems are designed for water to infiltrate into the ground relatively rapidly (from a few hours up to 72 hours). The primary drawback of these systems is that they are not appropriate in areas where groundwater is used as a drinking water source. Additional constraints include identifying sites with appropriate soils and risk of failure due to clogging. **Exhibit E-3** summarizes the different types of infiltration systems.

Exhibit E-3. Summary of Storm Water Infiltration Systems

System Type	Description
Infiltration Basin	• Large capacity of infiltration systems. • Basins should be designed to drain within 72 hours in order to prevent mosquito breeding and possible odor. • Removes pollutant and helps restore or maintain predevelopment hydrology.
Porous Pavement Systems	• Include porous asphalt, porous concrete, modular perforated concrete block, cobble pavers with porous joints or gaps or reinforced/stabilized turf. • Only effective in areas not exposed to high volumes of traffic, heavy equipment, and high amounts of sediments in runoff. • Appropriate for driveways/streets in residential areas and parking areas in commercial areas.
Infiltration Trenches and Wells	• Typically designed to capture only a small volume of water (appropriate to capture first flush of a runoff event).

Source: U.S. EPA (1999).

Detention systems capture runoff and temporarily retain it for later release. Detention systems do not retain a significant permanent pool of water between runoff events. These systems provide quantity and quality control; however, resuspension of particulate matter often occurs. **Exhibit E-4** summarizes the different types of detention systems.

Exhibit E-4. Summary of Storm Water Detention Systems

System Type	Description
Detention Basin	• Primary purpose is quantity control. • Typically designed to empty within 24 hours of a runoff event. • Limited quality control through gravity setting of suspended solids. • Earthen basins achieve high levels of quality control by allowing some infiltration (however, ground water is then a risk of contamination).
Underground Vaults, Pipes, and Tanks	• Same primary purpose as basins – storage to limit downstream effects due to high peak flow rates. • Limit quality control.

Source: U.S. EPA (1999).

Retention systems capture runoff and retain it until it is displaced by the next runoff event. Retention systems maintain a significant permanent pool volume of water between runoff events. The most common retention system is a retention pond (wet pond). The primary pollutant removal mechanism is sedimentation. These systems can also benefit from added biological and biochemical pollutant removal mechanisms provided by aquatic plants and microorganisms. Compared to detention systems, resuspension is less likely due to the presence of a permanent pool of water. The primary constraint to these systems is the need for a perennial flow to sustain the permanent pool. Furthermore, these systems typically require more land than other controls (U.S. EPA, 1999).

Constructed wetland systems are similar to retention and detention systems, except that a major portion of the water surface area (for pond systems) or bottom (for meadow-type systems) contains wetland vegetation. These systems can be effective in both quantity and quality control, but, as with natural wetlands, are relatively delicate and require a water balance to sustain the aquatic vegetation. Sedimentation can especially reduce the effectiveness of the system.

Pollutant removal in wetlands can occur through a number of mechanisms including sedimentation, filtration, volatilization, adsorption, absorption, microbial decomposition, and plant uptake. Pretreatment of runoff may be necessary for these systems (U.S. EPA, 1999).

Filtration systems use some combination of a granular filtration media such as sand, soil, organic material, and carbon, or a membrane to remove constituents found in runoff. These systems are primarily used for quality control. Filters are commonly used to treat runoff from small sites such as parking lots and small developments, in areas with high pollution potential such as industrial areas, or in highly urbanized areas where land availability or costs preclude the use of other controls. Often these systems are designed to treat only the first half inch to inch of runoff. These systems do not require large areas of land and can be placed under parking lots or large buildings (U.S. EPA, 1999). **Exhibit E-5** summarizes the different types of filtration systems.

Exhibit E-5. Summary of Storm Water Filtration Systems

System Type	Description
Surface Sand Filter	• Most common system is the Austin sand filter. • Runoff first enters a sedimentation basin where coarse particles are removed by gravity settling. • The filter bed consists of sand with a gravel and perforated pipe under-drain system to capture the treated water.
Underground Vault Sand Filter	• Common systems are the D.C. sand filter and the Delaware sand filter. • Basic design premise is the same as the surface sand filter.
Biofiltration/Bioretention Systems	• Designed to mimic the functions of a natural forest ecosystem for treating storm water runoff. • Variation of surface sand filter where sand filtration media is replaced with a planted soil bed. • Pollutants are removed by a number of processes including adsorption, filtration, volatilization, ion exchange, and decomposition.

Source: U.S. EPA (1999).

Vegetated systems (biofilters) such as swales and filter strips are designed to convey and treat either shallow flow (swales) or sheetflow (filter strips) runoff. Open channel vegetated systems are alternatives to the traditional curb-and-gutter and storm sewer conveyance systems. By conveying storm water runoff in vegetated systems treatment, storage, and infiltration can be provided prior to discharge to the storm sewer system (U.S. EPA, 1999). **Exhibit E-6** summarizes the different types of vegetated systems.

Exhibit E-6. Summary of Storm Water Vegetated Systems

System Type	Description
Grass Filter Strips	• Densely vegetated, uniformly graded areas that intercept sheet runoff from impervious surfaces such as parking lots, highways, and rooftops. • Designed to trip sediments, to partially infiltrate runoff, and to reduce the velocity of the runoff. • Frequently used as a pretreatment system prior to storm water being treated by BMPs such as filters or bioretention systems.

Exhibit E-6. Summary of Storm Water Vegetated Systems

System Type	Description
Vegetated Swales	• Broad, shallow channels with a dense stand of vegetation covering the side slopes and channel bottom. • Designed to slowly convey storm water runoff, and in the process trap pollutants, promote infiltration, and reduce flow velocities. • Swales can be either wet or dry.

Source: U.S. EPA (1999).

The performance of BMPs can vary considerably based on differences in the design criteria and performance standards. Factors that influence performance and design include size of the drainage area, the level of watershed imperviousness, duration and volume of runoff, and the land use of contributing drainage areas. Ranges for pollutant removal for various controls are summarized in **Exhibit E-7**.

Exhibit E-7. Potential Pollutant Removal Efficiencies for Structural Storm Water Controls

BMP Type	Suspended Solids	Metals
Infiltration Basin[1]	50% - 80%	50% - 80%
Infiltration Trenches[1]	50% - 80%	50% - 80%
Porous Pavement[1]	65% - 100%	65% - 100%
Detention Basins	30% - 65%	15% - 45%
Retention Basins	50% - 80%	50% - 80%
Constructed Wetlands	50% - 80%	50% - 80%
Surface Sand Filters[2]	50% - 80%	50% - 80%
Other Media Filters[2]	65% - 100%	50% - 80%
Vegetated Filter Strips	50% - 80%	30% - 65%
Grassed Swales	30% - 65%	15% - 45%

Source: U.S. EPA (1999); Caltrans (2004).

1. Removal is considered to be 100% when the water is infiltrated and not discharged to surface waters.
2. Filters must be placed off-line to assure continued functioning; only provide treatment based on a design storm.

The cost of constructing storm water controls depends on site conditions and drainage area. Furthermore, there are often economics of scale, making it difficult to develop a unit construction cost. As described below, U.S. EPA (1999) and the Caltrans (2001) provide cost estimates for various controls.

EPA's Engineering and Analysis Division (EAD) reviewed and summarized the available information related to expected costs of storm water controls (U.S. EPA, 1999). EAD identified only three studies that systematically evaluated the construction costs associated with structural controls since 1985. EAD used these studies to develop construction costs for specified drainage size and percent impervious cover (**Exhibit E-8**).

Exhibit E-8. Estimated Costs of Storm Water Controls in the U.S.

BMP Type	Typical Construction Cost ($/Control)	Drainage Size (Acre)	Approximate Unit Cost ($/acre)
35% Impervious Cover (Residential)			
Retention Basin	$136,500	50	$2,730
Wetland	$170,500	50	$3,410

Exhibit E-8. Estimated Costs of Storm Water Controls in the U.S.

BMP Type	Typical Construction Cost ($/Control)	Drainage Size (Acre)	Approximate Unit Cost ($/acre)
Grass Swale	$5,000	5	$1,000
Filter Strip	$0-$12,500	5	$0-$2,500
65% Impervious Cover (Commercial)			
Infiltration Trench	$61,500	5	$12,300
Infiltration Basin	$20,500	5	$4,100
Sand Filter[1]	$47,500-$95,500	5	$9,500-$19,100
Bioretention	$82,000	5	$16,400

Source: U.S. EPA (1999); escalated from 1997 dollars to 2007 dollars using the Environmental News Record (ENR) Construction Cost Index (CCI) and round to the near $500.
1. Range accounts for design variations.

In addition to capital costs, additional costs include design, contingency, and permitting costs; land costs; and operation and maintenance (O&M) costs. EPA (1999) estimated that the design, contingency, and permitting costs equal approximately 25%-32% of the base construction costs. Land costs are extremely variable. For example, it may be the case that little or no land acquisition is needed for the storm water control resulting in low or zero additional costs. However, if land acquisition is needed for the construction of a storm water control, the cost could potentially outweigh the design and construction costs combined.

EPA (1999) indicates that most studies estimate O&M costs as a fraction of base construction costs. O&M costs vary across controls and may also vary based on site and region specific parameters. Potential O&M costs are presented in **Exhibit E-9**.

Exhibit E-9. Potential Annual O&M Costs for Storm Water Controls

Control Type	Percent of Construction Cost
Infiltration Basin	1%-10%
Infiltration Trenches	5%-20%
Detention Basins	<1%
Retention Basins	3%-6%
Constructed Wetlands	2%-6%
Surface Sand Filters	11%-13%
Bioretention	5%-7%
Vegetated Filter Strips	$320/acre (maintained)
Grassed Swales	5%-7%

Source: U.S. EPA (1999).

Caltrans conducted a storm water control retrofit pilot program to acquire experience in the installation and operation of a wide range of structural controls and to evaluate the performance and costs of these devices (Caltrans, 2004). As part of this program, Caltrans compared the construction costs incurred during the program to costs collected from several other transportation departments and jurisdictions (Caltrans, 2001). Caltrans obtained cost data from the following entities: Maryland State Highway Administration, Texas Department of Transportation, City of Austin (Texas), King County (Washington), Florida Department of Environmental Quality, Maryland and Virginia BMP data collected by the Center for Watershed

Protection, and City of Santa Monica (California). **Exhibit E-10** presents Caltrans' unit cost estimates for these municipalities.

Exhibit E-10. Storm Water Control Cost Summary (2007$)[1]

Control Type	Number of Projects	Approximate Unit Cost ($/acre)			
		Median	Average	Max	Min
Detention Basin	23	$4,901	$6,983	$32,336	$470
Retention Basin (Wet Pond)	23	$8,287	$13,122	$55,883	$1,625
Wetland	25	$4,807	$7,859	$37,641	$271
Infiltration Trench	8	$15,395	$24,626	$65,737	$7,127
Austin Sand Filter	15	$24,307	$40,737	$171,438	$1,828
Delaware Sand Filter	4	$118,933	$117,938	$193,484	$40,404
Bioretention	2	$60,498	$60,498	$95,582	$25,414

Source: Caltrans (2001); escalated to 2007 dollars (from 1999 dollars) using the CCI.
1. Does not include Caltrans pilot program costs. Caltrans adjusted all costs for difference in regional economics and date of construction using RS Means Heavy Construction Cost Data and the CCI, respectively.

However, the costs incurred by Caltrans for BMPs constructed during their retrofit program are, in general, substantially higher than costs reported by the other entities Caltrans used for comparison. Caltrans (2001) indicated several reasons for these higher costs:

- Experience and efficiency in planning and design can contribute significantly to savings; Caltrans had relatively little experience and a relatively short planning horizon.
- BMP retrofit work was not combined with any ongoing construction projects.
- Pilot program did not reflect lowest cost technology for a given site.

Caltrans estimated that the retrofit program costs could be lowered by between 41% and 76%. Therefore, although the retrofit program provides valuable information related to storm water controls, the costs are likely to overstate those that would be incurred by other entities for the same practices.

The Westside Water Quality Improvement (WWQI) Project is an example of a structural storm water control project designed and constructed in California. The WWQI Project is a system designed to treat, to the maximum extent possible, dry weather and storm water runoff from eastern parts of Santa Monica and parts of west Los Angeles. The system is capable of treating dry weather runoff up to 3 cubic feet per second (cfs) and storm water runoff up to 33 cfs in a 24-hour period. The runoff comes from approximately 220 acres within Santa Monica's Centinela Sub-Watershed area and 2,280 acres from parts of west Los Angeles (CSM, No Date).

The facility utilizes three separate processes to treat and improve the quality of runoff: screening, sedimentation, and direct filtration. Direct filtration takes place in the Contech Stormwater Management StormFilter® unit which removes oil and grease, dissolved heavy metals, herbicides and pesticides. Removal of trash and other floatables, and suspended particulates by sedimentation occurs in the StormFilter, Bio Clean Nutrient Separating Baffle Box™, and at the transverse diversion weir (CSM, No Date). The facility operates totally on a gravity follow basis. Isolation gate valves may be closed for maintenance or to protect the system from being overloaded during heavy storm events (typically once or twice in a season) (CSM, No Date). The estimated cost of this project was approximately $2 million (ACC, 2007).

E.3 Controls for Marinas

Coastal Boatworks in Morro Bay, California completed a pollution prevention project in 1999 to reduce the amount of heavy metals and toxic pollutants that reached the bay from the marina. In addition to distributing 500 pamphlets to various agencies and organizations promoting pollution prevention along the waterfront, the facility also purchased new cleaning equipment including dustless sanders and a Vacu-boom system (used to prevent runoff from washing operations) for boaters to use during maintenance operations (MBNEP, 2000). The marina spent approximately $14,500 on the program (includes $5,400 in funding from the MBNEP) (MBNEP, 2000).

The Vacu-boom system is a hollow, flexible tube placed directly on a hard surface to form a downslope side dam or to completely encircle the wash or containment area. During use, the boom is connected by a portable wet vacuum recovery unit (Pressure Power Systems, 2007). When the wet vacuum system is turned on, the Vacu-Boom tightly seals itself to the surface to form an impervious liquid barrier and water is extracted into the boom into the vacuum unit (Pressure Power Systems, 2007). The water is discharged from the vacuum unit through a discharge hose into a holding tank, filter unit, or sanitary sewer (Pressure Power Systems, 2007). **Exhibit E-11** shows costs for various size units.

Exhibit E-11. Capital Costs for Vacu-Boom System (2007 dollars)

Tube Size	Capital Cost[1]
20 feet	$3,200
25 feet	$3,350
30 feet	$3,600
40 feet	$4,100
50 feet	$4,500

Source: Pressure Power Systems (2007).
1. Includes cost of shipping.

The Los Angeles Regional Water Board, among others, has identified copper-based antifouling paints as a source of copper pollution in marinas and bays (LARWQCB, 2005a; 2005b). Reduction or elimination of this pollution may require the transition to alternatives. Few, if any, areas in California have begun the transition to less toxic alternatives. The San Diego Regional Water Board (2005) provides information on the potential costs associated with the use of nontoxic paints on boats, based on findings in Carson, et al. (2002). **Exhibit E-12** provides a comparison between copper-based antifouling paints and nontoxic epoxy coatings. Boat owners may save small amounts of money on nontoxic hull coatings and maintenance over the life of the boat. In some situations, individual boat owners could spend slightly more money on nontoxic coating maintenance but the amount will be small compared to hull maintenance cost over the life of the boat (SDRWQCB, 2005).

Exhibit E-12. Comparison of Copper-Based Antifouling Paints to Nontoxic Epoxy Coatings[1]

Copper-Based Antifouling Paints	Nontoxic Epoxy Coatings
Initially less expensive to apply ($30 per foot)	Initially more expensive to apply ($30 - $50 per foot)
Do not need to be cleaned as often (14 times per year)	Need to be cleaned more often (22 times per year)
Need to be reapplied more often (every 2.5 years)	Do not need to be re-applied very often (every 5 years to 10 years)
Need to be stripped about every 6th application (every 15 years if paint reapplied every 2.5 years)	Do not need to be stripped (in first 30 – 60 years)

Source: SDRWQCB (2005).

1. Based on a typical stylized 40-foot long boat with 11-foot beam width and 375 square feet of wetted hull surface.

Variability in costs from this transition depends primarily on whether stripping for a boat is required prior to application of the nontoxic alternative. Stripping is not needed for new, unpainted boats. For older boats (approximately 15 years old), stripping is required for both application of nontoxic epoxy coatings, and continued application of copper-based paints. Thus, only boats less than 15 years old would have the option of stripping prior to applying the new paint. Stripping costs are approximated at $120/foot (Carson, et al., 2002). Long term cost estimates for transitioning from copper-based antifouling paints to nontoxic coatings also vary depending on assumptions regarding the performance of the nontoxic coatings and their price (SDRWQCB, 2005).

For example, Carson, et al. (2002) estimated the cost of remaining life hull maintenance for 40 foot length, 11 foot width boats to range from a savings of $1,354 (new boat with nontoxic coating, good performance, and lower prices) to a cost of $6,251 (2.5 year old boat requiring stripping, fair performance, and higher prices). Carson, et al. (2002) estimated that the least costly alternative for the transition to nontoxic paint (i.e., allowing boat owners to convert when the epoxy-copper cost differential is most favorable) would cost the boating community (about 7,000 boats) in San Diego Bay approximately $1.5 million over 15 years (2002 year dollars). If all boat owners were required to convert to nontoxic paints immediately, costs to boaters would be approximately $33.8 million (Carson, et al., 2002).

E.4 Sediment Remediation and Cleanup

There are a number of limitations associated with estimates of unit costs for sediment remediation and cleanup. Unit costs are generally only applicable to the conditions and constraints of the site remediated (Myers, 2005). Factors such as project scale, beneficial use opportunities, and the need for land are highly site-specific and greatly influence project costs (Myers, 2005). Myers (2005) also points out that unit costs for a one time remediation job will generally be greater than unit costs of a long term project in which a specific amount of sediment is treated each year over many years, due to economies of scale.

The types of remedial or cleanup activities implemented and their effectiveness are also highly site-specific. For example, sediment capping may be feasible in a deep water area but not feasible in a shallower area through which large ships have to pass. Also, dredging may be cost-effective where only the top layer of sediment is contaminated. However, where contamination exists beneath the top layer of sediment, dredging may not be feasible or cost-effective. Thus, information on the extent of contamination and water body uses is important in determining feasible cleanup options.

Another limitation to most unit cost estimates is a lack of detail on how the costs were derived. Tetra Tech and Averett (1994) (as cited in Myers, 2005) estimate that unit costs for a thermal gas phase reduction process range from $426/cy to $506/cy. This estimate reflects the build up of costs in a number of categories, including site preparation, permitting, capital equipment, pretreatment, labor, consumables, supplies, and utilities, effluent treatment and disposal, monitoring, maintenance, site demobilization and cleanup, dredging, construction of and transportation to temporary storage facility, land leases, and disposal of residual material. However, due to site-specific conditions in another area (e.g., lack of available space to construct a temporary storage facility), these particular estimates may not be applicable. If documentation regarding the buildup of costs for each category is available, the estimates could potentially be modified to take site-specific conditions into account.

In 1997, the National Academy of Sciences (NAS) published comparison unit cost and cost-effectiveness information for a number of remediation strategies (**Exhibit E-13**). NAS (1997) ranked the alternatives based on feasibility, effectiveness, practicality, and cost (<$1/cy to $1,000/cy). The lowest cost option (natural recovery) does not rank high in feasibility or practicality. In comparison, the highest cost option (thermal ex situ treatment) ranks high in feasibility, effectiveness, and practicality.

Exhibit E-13. Cost-Effectiveness of Sediment Remediation Approaches

Approach	Feasibility	Effective	Practicality	Cost
Interim Control				
Administrative	0	4	2	4
Technological	1	3	1	3
In Situ Treatment				
Natural Recovery	0	4	1	4
Capping	2	3	3	3
Treatment	1	1	2	2
Sediment Removal and Transport	2	4	3	2
Ex Situ Treatment				
Physical	1	4	4	1
Chemical	1	2	4	1
Thermal	4	4	3	0
Biological	0	1	4	1
Ex Situ Containment	2	4	2	2

Exhibit E-13. Cost-Effectiveness of Sediment Remediation Approaches

Approach	Feasibility	Effective	Practicality	Cost
Scoring	**Feasibility**	**Effective**	**Practicality**	**Cost**
0	<90%	Concept	Not acceptable, very uncertain	$1,000/cy
1	90%	Bench		$100/cy
2	99%	Pilot		$10/cy
3	99.9%	Field		$1/cy
4	99.99%	Commercial	Acceptable, certain	<$1/cy

Source: SWRCB (1998), as adapted from and reprinted with permission from Contaminated Sediments in Ports and Waterways Cleanup Strategies and Technologies. Copyright 1997 by the National Academy of Sciences. Courtesy of the National Academy Press, Washington, D.C.

Comparable to the NAS estimates from 1997, USACE (2001) indicates that sediment treatment costs can range from around $50/cubic meter ($65/cy) for a process such as stabilization to over $1,000/cubic meter ($1,300/cy) for high temperature thermal processes. These estimates are based on project costs throughout the United States. However, preliminary estimates from USACE (1999) for capping sediments in the Palos Verdes Shelf in California range from $1.79/cy to $5.06/cy, which is greater than the $1/cy estimate in the exhibit.

As part of a cleanup and abatement order, the San Diego Regional Water Board developed unit cost estimates for dredging contaminated sediments in the San Diego Bay based on preliminary cost estimates from Exponent (2003). **Exhibit E-14** shows these unit costs. All of the estimates are for dredging with a mechanical dredge and do not include the sediment volume from areas beneath piers or within 10 feet of structures because of stability concerns.

Exhibit E-14. Dredging Unit Cost Estimates

Cleanup Alternative	Approximate Dredge Volume (cubic yards)	Approximate Total Cost	Approximate Cost per Cubic Yard
LAET	75,000	$15,000,000	$200
5x Background	754,000	$88,000,000	$117
Background	1,200,000	$120,000,000	$102

Sources: SDRQWCB (2007b)
LAET = lowest apparent effects threshold