CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

California Regional Water Quality Control Board
Central Coast Region

Nitrate Total Maximum Daily Loads for Glen Annie Canyon, Tecolotito Creek, and Carneros Creek in Santa Barbara County, California

Final Project Report

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California Regional Water Quality Control Board
Central Coast Region
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http://www.waterboards.ca.gov/centralcoast/water_issues/programs/tmdl/docs/glen_annie_loscarneros_nitrate/index.shtml

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LIST OF ACRONYMS AND ABBREVIATIONS

CCAMP	Central Coast Ambient Monitoring Program
CMP	Cooperative Monitoring Program
GIS	Geographic Information System
MCLs	Maximum Contaminant Levels
mg/L	Milligrams per liter
MUN	Municipal and domestic water supply beneficial use
N	Nitrogen
NO_3 as NO_3	Nitrate as nitrate
NO_3 as N	Nitrate as nitrogen
NO_3 + NO_2 as N	Nitrate plus nitrite as nitrogen or joint nitrate/nitrite as nitrogen
NPDES	National Pollutant Discharge Elimination System
OEHHA	California Office of Environmental Health Hazard Assessment
PHGs	Public Health Goals
ppm	Parts per million
TMDL	Total Maximum Daily Load
USEPA	United States Environmental Protection Agency
USGS	United States Geologic Survey
Water Board	Regional Water Quality Control Board, Central Coast Region
WDR	Waste Discharge Requirements

EXECUTIVE SUMMARY

The following Preliminary Project Report provides information pertaining to development of nitrate TMDLs for waters of Glen Annie Canyon, including Tecolotito Creek, and Carneros Creek in Santa Barbara County.

Total Maximum Daily Load

Information contained in this Project Report will be used to develop nitrate TMDLs for waters of Glen Annie Canyon, Tecolotito Creek, and Carneros Creek. TMDL is a term used to describe the maximum amount of pollutants, in this case, nitrate, that a waterbody can receive and still meet water quality standards. A TMDL study identifies the probable sources of pollution, establishes the maximum amount of pollution a waterbody can receive and still meet water quality standards, and allocates that amount to all probable contributing sources. By “allocating” an amount to a contributing source, we are assigning responsibility to someone, an agency, group, or individuals, to reduce their contribution in order to meet water quality standards.

The federal Clean Water Act requires every state to evaluate its waterbodies and maintain a list of waters that are considered “impaired” either because the water exceeds water quality standards or does not achieve its designated use. For each waterbody on the Central Coast’s 303(d) Impaired Waters List, the Central Coast Regional Water Quality Control Board (Central Coast Water Board) must develop and implement a plan to reduce pollutants so that the waterbody is no longer impaired and can be de-listed.

Glen Annie Canyon was listed as impaired on the 2008-2010 303(d) list because 81 of 120 samples exceeded the nitrate water quality objective (WQO) as it applies to the municipal (MUN) drinking water standard (10 mg/L nitrate as nitrogen). In addition, 8 of 12 samples exceeded the OEHHA joint nitrate/nitrite public health goal as it applies to drinking water (10 mg/L nitrate/nitrite as nitrogen), and 5 of 120 samples exceeded the WQO for Agricultural Supply (30 mg/L nitrate as nitrogen). Carneros Creek is listed because 27 of 56 samples exceeded the MUN drinking water objective (10 mg/L nitrate as nitrogen).

Impaired Waterbody

The geographic scope of these TMDLs encompasses approximately 4.5 mi^2 (3,517 acres) for the Glen Annie Canyon watershed, including Tecolotito Creek, and 4.2 mi^2 (2,725 acres) for Carneros Creek watershed, located in southern Santa Barbara County.

The watersheds are composed primarily of shrubs/scrubs, forested lands, low and medium intensity development, and cultivated crops.

Attachment 2 to Staff Report

Numeric Targets and Allocations

Numeric targets are water quality targets developed to ascertain when and where water quality objectives are achieved, and hence, when beneficial uses are protected. The numeric target for these TMDLs is identical to the Basin Plan numeric water quality objective for nitrate protective of the municipal and domestic supply beneficial use.

Discharges of nitrate from irrigated agriculture exceed the water quality objectives for municipal and domestic supply. Owners and operators of irrigated lands are assigned allocations for nitrate to achieve the TMDL. Responsible parties are assigned allocations for nitrate equal to the numeric targets as represented in the table below.

This TMDL is a concentration-based TMDL equal to the numeric target.

The table below identifies the allocations assigned to responsible parties and the affected waterbodies.

LOAD ALLOCATIONS		
Waterbodies Assigned TMDLs (including all tributaries)	**Responsible Party Assigned Allocation (Source)**	**Receiving Water Allocation**
• Glen Annie Canyon (CAR31531020199903041027 35) • Carneros Creek (CAR31531020199903041436 58) • Tecolotito Creek	Owners/operators of irrigated agricultural lands (Discharges from irrigated lands)	10 mg/L Nitrate as Nitrogen

TMDL Implementation, Monitoring, and TMDL Timeline

Owners and operators of irrigated lands in the project area are required to comply with the conditions and requirements of the *Conditional Waiver of Waste Discharge Requirements For Discharges from Irrigated Lands* (Agricultural Order) and any renewals thereof. Owners and operators are required to comply with the requirements described in the Agricultural Order, which may include:

- Enroll in and comply with the Agricultural Order.
- Implement monitoring and reporting requirements described in the Agricultural Order.
    - Current reporting requirements include a description of discharges leaving the growers field, including the concentration of nitrate discharges and the volume of discharge. Reporting requirements also require a description of management practices used to mitigate nitrate loading.
- Implement, and update as necessary, management practices to reduce nitrate loading.
- Maintain existing, naturally occurring, riparian vegetative cover in aquatic habitat areas.
- Develop/update and implement Farm Plans. The Farm Plans should incorporate measures designed to achieve load allocations assigned in this TMDL.

- Develop, and initiate implementation of an Irrigation and Nutrient Management Plan (INMP) or alternative certified by a Professional Soil Scientist, Professional Agronomist, or Crop Advisor certified by the American Society of Agronomy, or similarly qualified professional (current requirements for tier-3 dischargers only).

Owners and operators of irrigated agricultural lands must perform monitoring and reporting in accordance with Monitoring and Reporting Program Orders R3-2012-0011-01, R3-2012-0011-02, and R3-2012-0011-03, as applicable to the operation.

The timeline to achieve this TMDL is by October 2016.

1 INTRODUCTION

1.1 Clean Water Act Section 303(d)

Section 303(d) of the federal Clean Water Act requires every state to evaluate its waterbodies and maintain a list of waters that are considered “impaired” either because the water exceeds water quality standards or does not achieve its designated use. For each water on the Central Coast’s “303(d) Impaired Waters List,” the California Central Coast Water Board must develop and implement a plan to reduce pollutants so that the waterbody is no longer impaired and can be de-listed. Section 303(d) of the Clean Water Act states:

Each State shall establish for the waters identified in paragraph (1)(A) of this subsection, and in accordance with the priority ranking, the total maximum daily load, for those pollutants which the Administrator identifies under section 1314(a)(2) of this title as suitable for such calculation. Such load shall be established at a level necessary to implement the applicable water quality standards with seasonal variations and a margin of safety which takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality.

The State complies with this requirement by periodically assessing the conditions of the rivers, lakes and bays and identifying them as “impaired” if they do not meet water quality standards. These waters, and the pollutant or condition causing the impairment, are placed on the 303(d) List of Impaired Waters. In addition to creating this list of waterbodies not meeting water quality standards, the Clean Water Act mandates each state to develop TMDLs for each waterbody listed. The Central Coast Water Board is the agency responsible for protecting water quality consistent with the Basin Plan, including developing TMDLs for waterbodies identified as not meeting water quality objectives.

1.2 Project Area

The geographic scope of these TMDLs encompasses approximately 4.5 mi^2 (3,517 acres) for the Glen Annie Canyon watershed, including Tecolotito Creek, and 4.2 mi^2

(2,725 acres) for Carneros Creek watershed, located in southern Santa Barbara County.

The watersheds are immediately adjacent to each other with Glen Annie Canyon to the west and Carneros Creek to the east. They are south trending drainages that extend from the southern face of the Santa Ynez Mountains, through the City of Goleta and Goleta Slough, and into the Pacific Ocean. Elevations range from a maximum of about 2,800 feet (900 meters), near Brush Peak, to sea level. Figure 1 shows the project area watersheds.

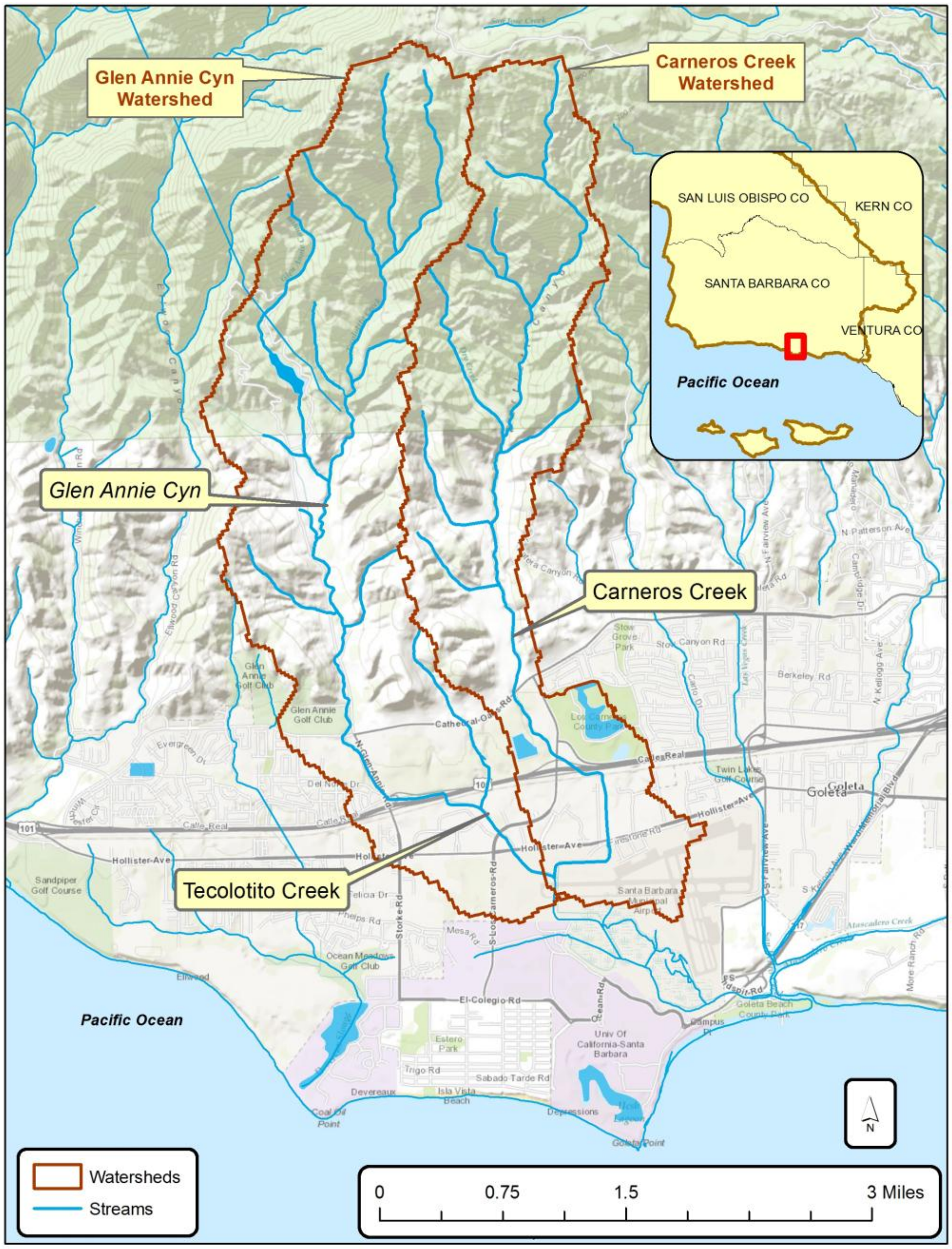


Figure 1. Project area watersheds.

It is important to note that staff has identified inconsistencies in the names of waterbodies contained in the project area. For example, the Water Quality Control Plan for the Central Coastal Basin (Basin Plan) refers to Glen Anne Creek and Carneros Creek, while the 2010 303(d) list refers to Glen Annie Canyon and Los Carneros Creek. Based on staff's review of U.S. Geological Survey (USGS) maps, the proper names of these two waterbodies are Glen Annie Canyon and Carneros Creek and referenced as such throughout this TMDL document. In addition, the Basin Plan also refers to Tecolotito Creek, which is a downstream segment of Glen Annie Canyon just south of Highway 101. Tecolotito Creek is not currently listed for nitrate impairment, however available water quality data indicates nitrate impairment (see Section 2.5 Data Analysis). As a result, Tecolotito Creek nitrate impairment is addressed in this TMDL project. Table 1 summarizes the waterbody names that have been reconciled to reflect the USGS naming convention and Figure 2 depicts them.

Table 1. Reconciliation of project area water body names.

Basin Plan Waterbody Name	303(d) Waterbody Name	USGS Waterbody Name [1]
Glen Anne Creek	Glen Annie Canyon	Glen Annie Canyon [2]
Carneros Creek	Los Carneros Creek	Carneros Creek [3]
Tecolotito Creek	N/A (not listed)	Tecolotito Creek [4]

[1] Names based on United States Geological Survey (USGS) 7.5 Minute (1:24,000) Quad Maps for Dos Pueblos Canyon and Goleta. USGS is the authoritative source for waterbody names and, as such, all waterbody names will be corrected to reflect the USGS naming convention.
[2] Staff will correct the Basin Plan, changing the name of Glen Anne Creek to Glen Annie Canyon.
[3] Staff will correct the 303(d) list, changing the name of Los Carneros Creek to Carneros Creek.
[4] Staff will correct the 303(d) list to indicate that Tecolotito Creek nitrate impairment is addressed in this TMDL.

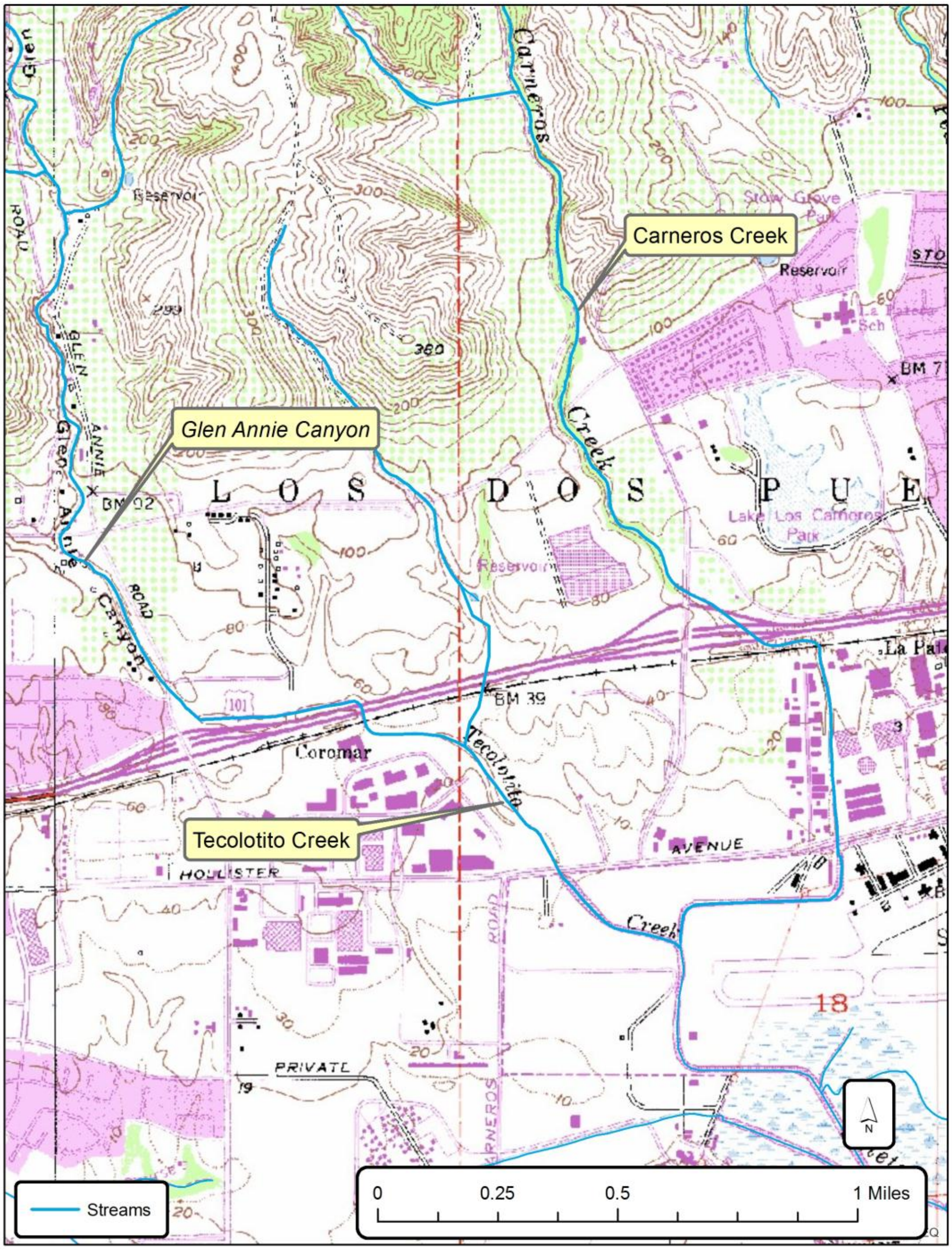


Figure 2. Project area waterbodies.

1.3 Pollutants Addressed

This project addresses water body impairments due to nitrate.

2 INTRODUCTION

2.1 Watershed Description

The watersheds are north-south trending drainages with headwater reaches originating from the southern face of the Santa Ynez Mountains in the north, and ultimately draining south through the Goleta Slough to the Pacific Ocean.

Upper reaches of these watersheds are characterized by forested lands, shrubs, and grasslands (source: National Land Cover Dataset, 2006). Middle reaches are comprised of agriculture (primarily orchards) and grazing lands, while the lower portion of these watersheds contain a mix of commercial, industrial, and residential land uses. See Figure 2 and Table 1 for land cover information. The State Waterbody ID for Glen Annie Canyon is CAR3153102019990304102735 and Carneros Creek is CAR3153102019990304143658.

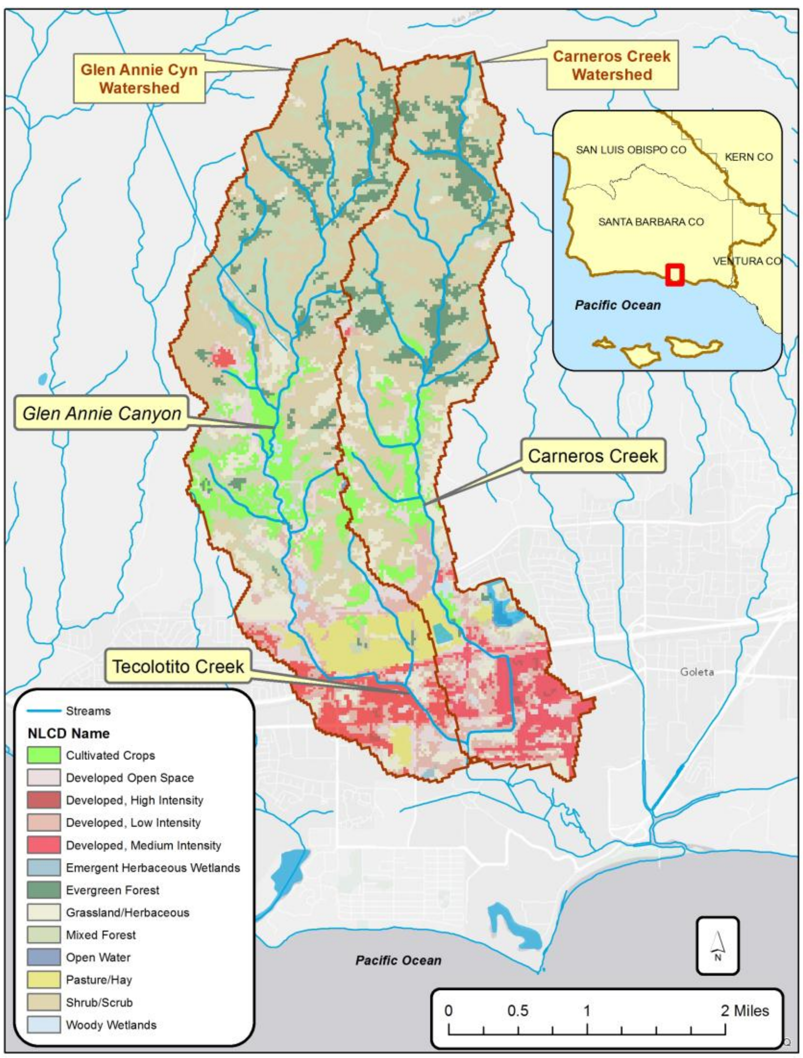


Figure 3. National Land Cover Database (NLCD, 2006).

Table 2. National Land Cover Database (NLCD, 2006) area and percent composition.

	Glen Annie Canyon Watershed		Carneros Creek Watershed	
2006 NLCD NAME	Acres	% of watershed	Acres	% of watershed
Open Water	1.8	0.1	9.3	0.3
Developed Open Space	292.0	8.3	182.8	6.7
Developed, Low Intensity	219.1	6.2	213.3	7.8
Developed, Medium Intensity	202.4	5.8	228.6	8.4
Developed, High Intensity	4.0	0.1	7.3	0.3
Evergreen Forest	232.9	6.6	273.1	10.0
Mixed Forest	655.4	18.6	398.3	14.6
Shrub/Scrub	1,083.8	30.8	909.6	33.4
Grassland/Herbaceous	302.2	8.6	262.9	9.6
Pasture/Hay	196.6	5.6	45.1	1.7
Cultivated Crops	301.1	8.6	170.1	6.2
Woody Wetlands	20.7	0.6	20.9	0.8
Emergent Herbaceous Wetlands	5.3	0.2	4.0	0.1
TOTALS	**3,517.3**	**100.0**	**2,725.3**	**100.0**

Most of the land in the watersheds are undeveloped and in private ownership. Land use is comprised primarily of shrubs and grasslands (40-44%), forested lands (25%), cultivated crops (8-6%), and low and medium intensity development (12-16%). Figure 3 above depicts NLCD[1] land use/land cover within the watersheds and Table 2 summarizes the NLCD land use/land cover acreage and percent cover within the watersheds.

Average annual precipitation within the watersheds ranges from around 18 inches near the coastline to around 27.5 inches in the Santa Ynez Mountains[2] as depicted in Figure 4. Precipitation statistics for Santa Barbara (site 047902) indicate that most of the annual precipitation occurs between October and April[3] as shown in Table 3. On average, there are 279 sunny days per year in Goleta and the July high is around 74^{o} degrees Fahrenheit (^{o}F) and the January low is 40 ^{o}F[4].

[1] National Land Cover Data (NLCD, 2006) provided by the Multi-Resolution Land Characteristics Consortium (MRLC). The Consortium includes multiple federal agencies led by the U.S. Geological Survey (USGS). The NLCD serves as the definitive Landsat-based, 30-meter resolution, land cover database for the Nation.

[2] California Department of Forestry and Fire Protection (FRAP, http://frap.cdf.ca.gov).

[3] National Oceanic and Atmospheric Administration, Western Regional Climate Center. http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca7902. Accessed November 15, 2013.

[4] Best Places, 2013. http://www.bestplaces.net/climate/city/california/goleta. Accessed January 7, 2013.

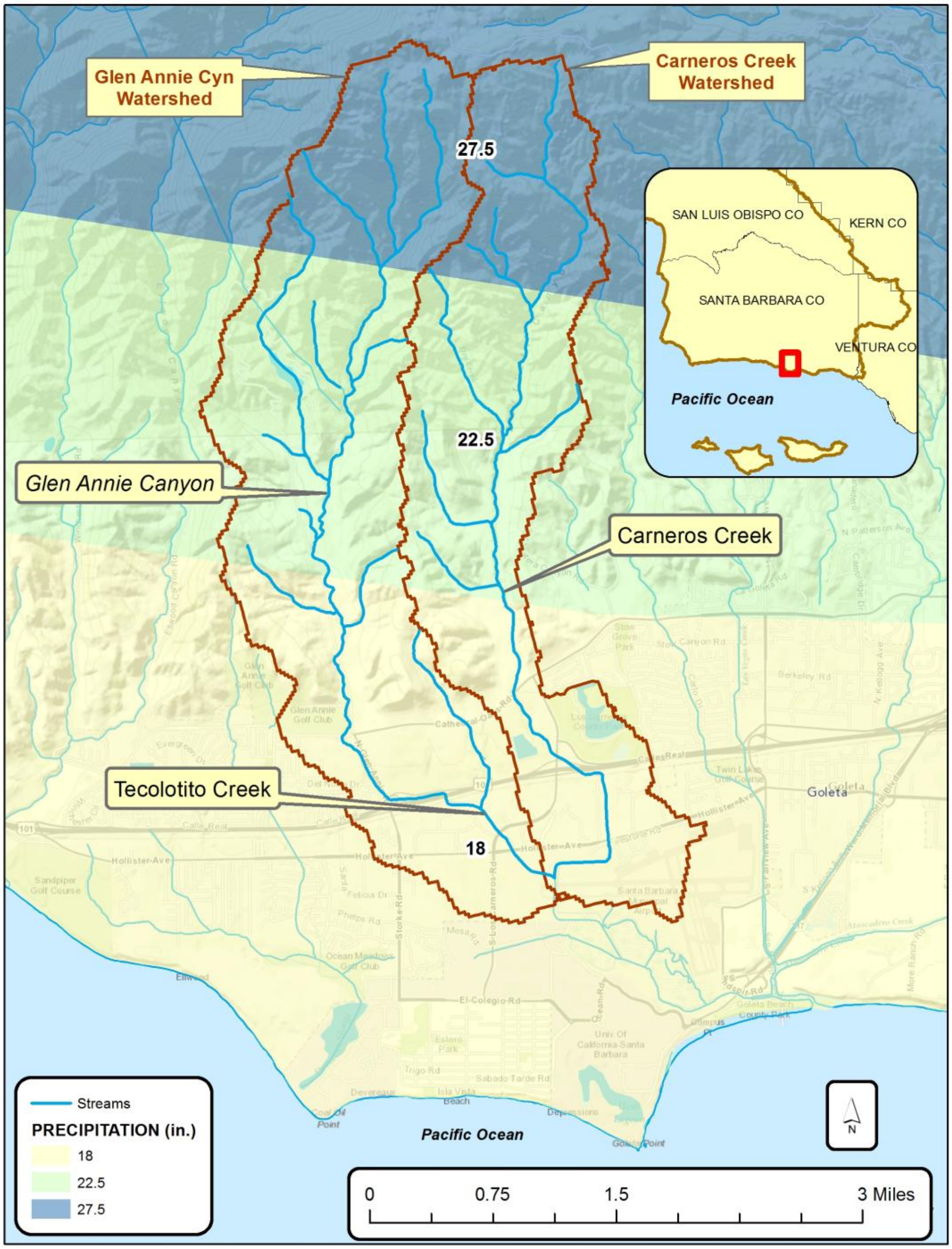


Figure 4. Average annual precipitation.

Table 3. Precipitation (in.) Statistics for Santa Barbara (1893-2013).

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Period of Record Statistics													
MEAN	3.95	3.82	2.95	1.21	0.36	0.08	0.02	0.03	0.2	0.69	1.51	2.82	18.08
S.D.	4.21	3.7	2.65	1.49	0.67	0.2	0.09	0.1	0.61	1.04	1.76	2.52	7.76
SKEW	2.05	1.69	1.2	1.85	2.22	3.57	6.5	5.12	4.33	2.62	1.54	0.76	0.95
MAX	24.2	21.76	11.71	6.55	2.96	1.21	0.81	0.7	4.01	6.23	8.26	9.84	41.48
MIN	0	0	0	0	0	0	0	0	0	0	0	0	3.99
NO YRS	111	109	112	111	112	110	103	100	109	109	110	106	70

NOAA Statistics for Santa Barbara, CA (047902), Latitude: 34º25'00" **|** Longitude: -119º41'07" **|** Elevation: 5 feet (1893-2013).

Table 4 shows monthly mean discharge in cubic feet per second (cfs) for USGS gage located at Tecolotito Creek (USGS 11120530) and Figure 5 depicts the gage location. USGS calculated the monthly mean discharge values based on data obtained from October 1, 1970 to September 1991. Mean monthly flow is below 0.3 cfs from June to November.

Table 4. Monthly mean discharge (cfs) for Tecolotito Creek near Goleta (USGS 11120530, 1970-1991).

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1970										0.000	0.899	1.77
1971	0.887	0.475	0.517	0.490	0.533	0.387	0.282	0.241	0.215	0.128	0.026	4.03
1972	0.865	0.321	0.337	0.975	0.195	0.125	0.145	0.200	0.201			
1980		20.9	4.99	1.10	5.00	0.797	0.459	0.369	0.337	0.315	0.356	0.908
1981	1.96	1.51	10.7	0.848	0.408	0.296	0.355	0.244	0.175	0.226	0.393	0.297
1982	1.46	0.308	1.52	2.36	0.421	0.289	0.210	0.229	0.219			
1987										0.345	0.250	0.503
1988	1.06	0.723	0.368	1.04	0.292	0.205	0.201	0.106	0.111	0.093	0.094	0.604
1989	0.184	0.630	0.224	0.134	0.088	0.089	0.054	0.069	0.043	0.073	0.066	0.055
1990	0.096	0.419	0.085	0.087	0.082	0.024	0.028	0.038	0.019	0.035	0.026	0.027
1991	0.110	0.424	17.4	0.425	0.345	0.252	0.215	0.174	0.114			
Mean of monthly Discharge	0.83	2.9	4.0	0.83	0.82	0.27	0.22	0.19	0.16	0.15	0.26	1.0

Figure 5. USGS Gage station 11120530 located at Tecolotito Creek.

2.2 Beneficial Uses

The Basin Plan specifically identifies beneficial uses for the water bodies in the Project Area. These beneficial uses are shown in Table 5.

Table 5. Beneficial Uses for Project Area Waterbodies.

Beneficial Use	Water Body		
	Glen Annie Creek	Tecolotito Creek	Carneros Creek
Municipal and Domestic Supply (MUN)	X	X	X
Agricultural Supply (AGR)	X		X
Industrial Process Supply (PROC)	X		
Industrial Service Supply (IND)	X		
Ground Water Recharge (GWR)	X	X	X
Water Contact Recreation (REC-1)	X	X	X
Non-Contact Water Recreation (REC-2)	X	X	X
Wildlife Habitat (WILD)	X	X	X
Cold Fresh Water Habitat (COLD)	X	X	X
Warm Fresh Water Habitat (WARM)	X	X	X
Migration of Aquatic Organisms (MIGR)	X	X	
Spawning, Reproduction, and/or Early Development (SPWN)	X		
Rare, Threatened, or Endangered Species (RARE)	X		
Freshwater Replenishment (FRSH)	X	X	X
Commercial and Sport Fishing (COMM)	X	X	X

Beneficial uses are regarded as existing whether the water body is perennial or ephemeral, or the flow is intermittent or continuous. A narrative description of the designated beneficial uses of project area surface waters which are most likely to be potentially at risk of impairment by water column nutrients are presented below.

<u>Municipal and Domestic Supply (MUN)</u> - Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply. According to State Board Resolution No. 88-63, "Sources of Drinking Water Policy" all surface waters are considered suitable, or potentially suitable, for municipal or domestic water supply except where:

a. TDS exceeds 3000 mg/l (5000 uS/cm electrical conductivity);
b. Contamination exists, that cannot reasonably be treated for domestic use;
c. The source is not sufficient to supply an average sustained yield of 200 gallons per day;
d. The water is in collection or treatment systems of municipal or industrial wastewaters, process waters, mining wastewaters, or storm water runoff; and
e. The water is in systems for conveying or holding agricultural drainage waters.

Agricultural Supply (AGR) - Uses of water for farming, horticulture, or ranching including, but not limited to, irrigation, stock watering, or support of vegetation for range grazing.

Industrial Process Supply (PROC) - Uses of water for industrial activities that depend primarily on water quality (i.e., waters used for manufacturing, food processing, etc.).

Industrial Service Supply (IND) - Uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well repressurization.

Ground Water Recharge (GWR) - Uses of water for natural or artificial recharge of ground water for purposes of future extraction, maintenance of water quality, or halting of saltwater intrusion into freshwater aquifers. Ground water recharge includes recharge of surface water underflow.

Water Contact Recreation (REC-1) - Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs.

Non-Contact Water Recreation (REC-2) - Uses of water for recreational activities involving proximity to water, but not normally involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating tidepool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.

*Wildlife Habitat (WILD) - Uses of water that support terrestrial ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.

*Cold Fresh Water Habitat (COLD) - Uses of water that support cold water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish or wildlife, including invertebrates.

*Warm Fresh Water Habitat (WARM) - Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

*Migration of Aquatic Organisms (MIGR) - Uses of water that support habitats necessary for migration or other temporary activities by aquatic organisms, such as anadromous fish.

*Spawning, Reproduction, and/or Early Development (SPWN) - Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish.

*Rare, Threatened, or Endangered Species (RARE) - Uses of water that support habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under state or federal law as rare, threatened, or endangered.

Freshwater Replenishment (FRSH) - Uses of water for natural or artificial maintenance of surface water quantity or quality (e.g., salinity) which includes a water body that supplies water to a different type of water body, such as, streams that supply reservoirs and lakes, or estuaries; or reservoirs and lakes that supply streams. This includes only immediate upstream water bodies and not their tributaries.

Commercial and Sport Fishing (COMM) - Uses of water for commercial or recreational collection of fish, shellfish, or other organisms including, but not limited to, uses involving organisms intended for human consumption or bait purposes.

* = Aquatic habitat beneficial use.

2.3 Water Quality Objectives

Relevant water quality objectives for this project pertain to the protection of municipal and domestic supply and the prevention of toxic water quality conditions. The applicable water quality objectives for this project include:

2.3.1 Basin Plan Water Quality Objective for Municipal and Domestic Supply (MUN)

The Central Coast Region's Water Quality Control Plan (Basin Plan) contains the following specific water quality objective that applies to the Municipal and Domestic Supply (MUN) beneficial use:

> *Waters shall not contain concentrations of chemical constituents in excess of the limits specified in California Code of Regulations, Title 22, Article 4, Chapter 15, Section 64435, Tables 2 and 3 as listed in Table 3-2 (Region 3 Basin Plan, p III-3). In Table 3-2, the maximum contaminant level (MCL) for Nitrate (as NO_3) in Domestic or Municipal Supply is 45 milligrams per liter (mg/L).*

The MUN water quality objective of 45 mg/L nitrate as nitrate (NO_3 as NO_3) is equivalent to 10 mg/L nitrate as nitrogen (NO_3 as N).

2.3.2 Basin Plan Water Quality Objectives for Toxicity

The Central Coast Region's Water Quality Control Plan (Basin Plan) contains specific water quality objectives that apply to all inland surface waters, enclosed bays and estuaries (CCRWQCB, 1994, pg. III-3).

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 Board.

Survival of aquatic life in surface waters subjected to a waste discharge or other controllable water quality conditions, shall not be less than that for the same water body in areas unaffected by the waste discharge or, when necessary, for other control water that is consistent with the requirements for "experimental water" as described in Standard Methods for the Examination of Water and Wastewater, latest edition. As a minimum, compliance with this objective shall be evaluated with a 96-hour bioassay.

In addition, effluent limits based upon acute bioassays of effluents will be prescribed where appropriate, additional numerical receiving water objectives for specific toxicants will be established as sufficient data become available, and source control of toxic substances is encouraged.

2.3.3 OEHHA Public Health Goals for Drinking Water

The California Office of Environmental Health Hazard Assessment (OEHHA) developed Public Health Goals (PHGs) of 45 mg/L for nitrate (equivalent to 10 mg/L nitrate as nitrogen), 1 mg/L for nitrite as nitrogen, and 10 mg/L for joint nitrate/nitrite (expressed as nitrogen) in drinking water (OEHHA, 1997). The calculation of these PHGs is based on the protection of infants from the occurrence of methemoglobinemia, the principal toxic effect observed in humans exposed to nitrate or nitrite. The PHGs are equivalent to California's current drinking water standards for nitrate (45 mg/L nitrate as nitrate), nitrite (1 mg/L nitrite as nitrogen), and 10 mg/L (joint nitrate/nitrite expressed as nitrogen) which were adopted by the California Department of Health Services (DHS) in 1994 from the U.S. Environmental Protection Agency's (USEPA's) Maximum Contaminant Levels (MCLs) promulgated in 1991.

2.4 Pollutants Addressed

Glen Annie Canyon and Carneros Creek are included on the 2008-2010 303(d) List for nitrate in accordance with the State Water Resources Control Board Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List, September 2004 (Listing Policy, SWRCB, 2004b). Table 3.1 of the Listing Policy specifies the minimum number of measured exceedances needed to place a water segment on the Section 303(d) list for toxicants (SWRCB, 2004b, pg. 9).

Glen Annie Canyon was listed as impaired on the 2008-2010 303(d) list because 81 of 120 samples exceeded the nitrate water quality objective (WQO) as it applies to the municipal (MUN) drinking water standard (10 mg/L nitrate as nitrogen). In addition, 8 of 12 samples exceeded the OEHHA joint nitrate/nitrite PHG as it applies to drinking water (10 mg/L nitrate/nitrite as nitrogen), and 5 of 120 samples exceeded the WQO for Agricultural Supply (30mg/L nitrate as nitrogen). Carneros Creek is listed because 27 of 56 samples exceeded the MUN drinking water objective (10 mg/L nitrate as nitrogen).

Tecolotito Creek was not included on the 2008-2010 303(d) List for nitrate impairment, however, monitoring sites (315ANN and GA1) indicate that 79 of 139 samples (57%) exceed the water quality objective for municipal supply. Additional information is provided in the following section.

2.5 Data Analysis

This section provides information pertaining to data sources and the results of water quality data used to assess water quality conditions and impairment. Water quality data and available flow information is contained in APPENDIX A – Water Quality Data.

Staff used the following water quality data for Glen Annie Canyon:
- Central Coast Ambient Monitoring Program (CCAMP) site 315ANN.
- Cooperative Monitoring Program (CMP) sites 315GBR and 315GAN.
- Santa Barbara Channelkeeper (SBCK) sites GA1 and GA2.

Staff used the following water quality data for Carneros Creek:
- Central Coast Ambient Monitoring Program (CCAMP) site 315LCR.
- Santa Barbara Channelkeeper (SBCK) sites LC1 and LC2.

Monitoring site information is contained in Table 6 and the sites are depicted in Figure 6 and Figure 7.

Table 6. Water qualtiy monitoring site informaton

Glen Annie Sites			
Program	Site Id	Site Description	Data Period / Frequency
CMP	315GBR	Glen Annie Creek @ Bishop Ranch Rd	Jan 2008-Dec 2008 / monthly
CMP	315GAN	Glen Annie Creek	Jan 2006-Jun 2011 / monthly
SBCK	GA2	Glen Annie Creek at Cathedral Oaks	Dec 2002-Mar 2012 / monthly
CCAMP	315ANN	Glen Annie/Tecolotito Creek u/s Holister Rd	Feb 2001-Mar 2002 / monthly Jan 2008–Dec 2008 / monthly
SBCK	GA1	Glen Annie/Tecolotito Creek at Hollister Rd	Jun 2002-Mar 2012 / monthly
Carneros Sites			
SBCK	LC2	Carneros Creek at Calle Real	Jun 2002-Jan 2007 / monthly
CCAMP	315LCR	Carneros Creek at Hollister Rd	May 2001-Dec 2008 / variable
SBCK	LC1	Carneros Creek at Hollister Rd	Jan 2003-Feb 2005 / variable

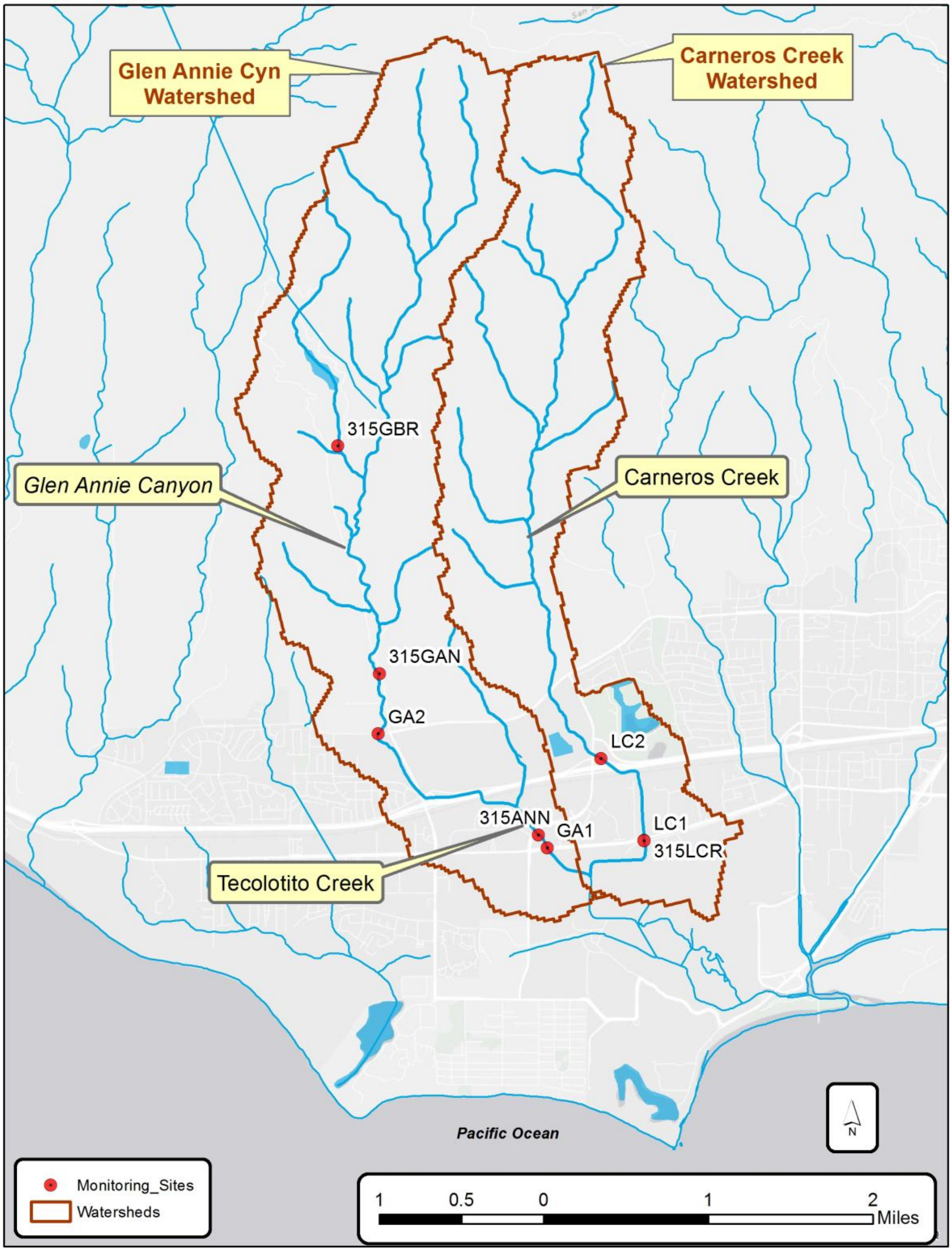


Figure 6. Location of Water Quality Monitoring Stations.

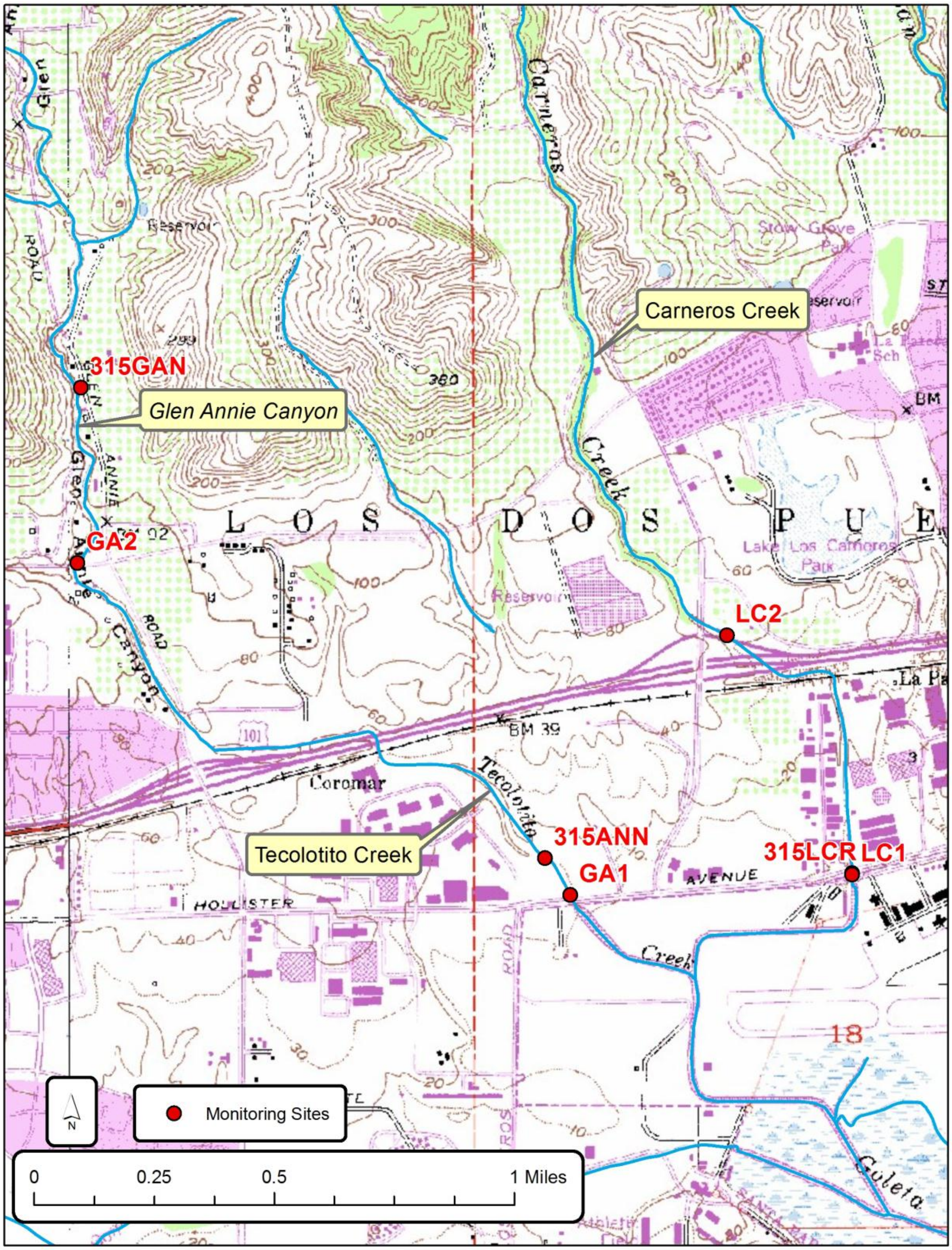


Figure 7. Detail of Lower Water Quality Monitoring Station Locations.

2.5.1 Summary of Water Quality Data

Water quality analytical results are available for five monitoring sites within Glen Annie Canyon and three monitoring sites within Carneros Creek. *APPENDIX A – Water Quality Data* contains nitrogen compound data for each monitoring station, along with available flow measurements.

Table 7 and Table 8 contain a summary of nitrogen compound data for Glen Annie and Carneros Creek, respectively. Results are compared to existing water quality objectives for municipal supply (MUN 10 mg/L nitrate as nitrogen and/or the OEHHA PHG of 10 mg/L joint nitrate/nitrite as nitrogen) and agricultural supply (AGR at 30 mg/L nitrate as nitrogen).

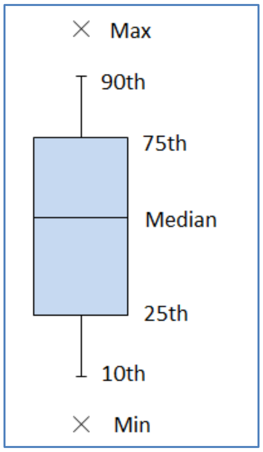
Table 7. Summary of water qualtiy monitoring data for Glen Annie Canyon (mg/L as nitrogen)

Program	Site ID	Constituent	Count	Max	Min	Median	Ave	Count >10	% >10	Count >30	% >30
CMP	315GBR	Joint NO3/NO2 as N	12	1.41	0.02	0.23	0.37	0	0.0	0	0
CMP	315GAN	Joint NO3/NO2 as N	63	40	0.01	16.90	17.19	47	74.6	5	7.9
SBCK	GA2	Nitrate as N	100	41.1	1.0	13.6	14.6	65	65	5	5
CCAMP	315ANN	Joint NO3/NO2 as N	27	28.8	3.44	13.13	15.41	20	74.1	0	0
SBCK	GA1	Nitrate as N	112	23.8	0.8	10.8	10.6	59	52.7	0	0

Table 8. Summary of water qualtiy monitoring data for Carneros Creek (mg/L as nitrogen)

Program	Site ID	Constituent	Count	Max	Min	Median	Ave	Count >10	% >10	Count >30	% >30
SBCK	LC2	Nitrate as N	40	30.1	1.25	11.57	11.46	25	62.5	1	2.5
SBCK	LC1	Nitrate as N	10	11.2	0.72	5.56	4.98	1	10.0	0	0
CCAMP	315LCR	Joint NO3/NO2 as N	9	12.3	1.01	7.35	6.55	1	11.1	0	0

For Glen Annie Canyon sites (315GBR, 315GAN, and GA2), 112 of 175 samples (64%) exceeded the water quality objective for municipal supply (MUN and OEHHA PHGs) and 10 of 175 samples (6%) exceeded the water quality guideline for agricultural supply (AGR). For Tecolotito Creek sites (315ANN and GA1), 79 of 139 samples (57%) exceed the water quality objective for municipal supply. And finally, for Carneros Creek sites (LC2, LC1, and 315LCR), 27 of 59 (46%) samples exceeded the water quality objective for municipal supply (MUN and OEHHA PHGs) and one sample exceeded the water quality guideline for AGR.



For box and whisker plots, as shown in Figure 8, maximum and minimum values are depicted as exes at the top and bottom of the plot, respectively. Values representing the 90th and 10th percentiles are shown as whiskers, while the 75th, 50th (median), and 25th percentiles comprise the box.

Figure 8. Explanation of box and whisker plot.

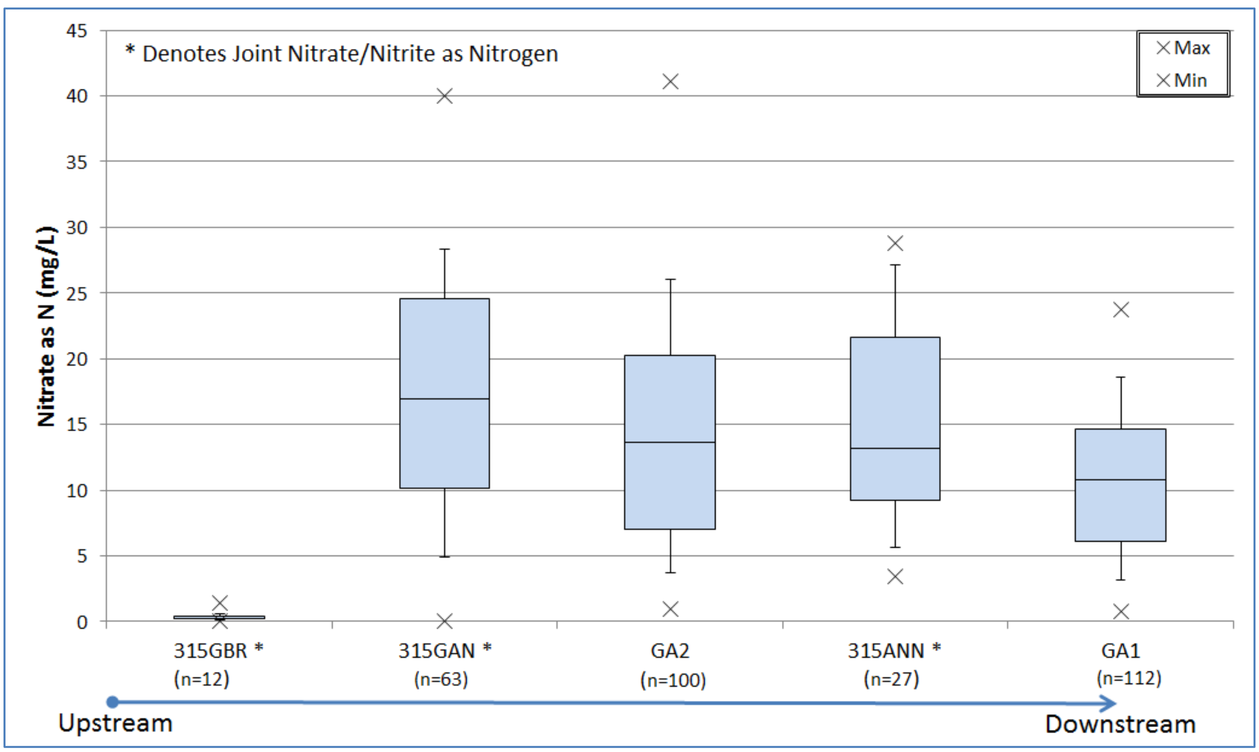


Figure 9. Nitrogen plots for Glen Annie Canyon and Tecolotito Creek sites.
Note: Data reported as nitrate as nitrogen unless otherwise noted.

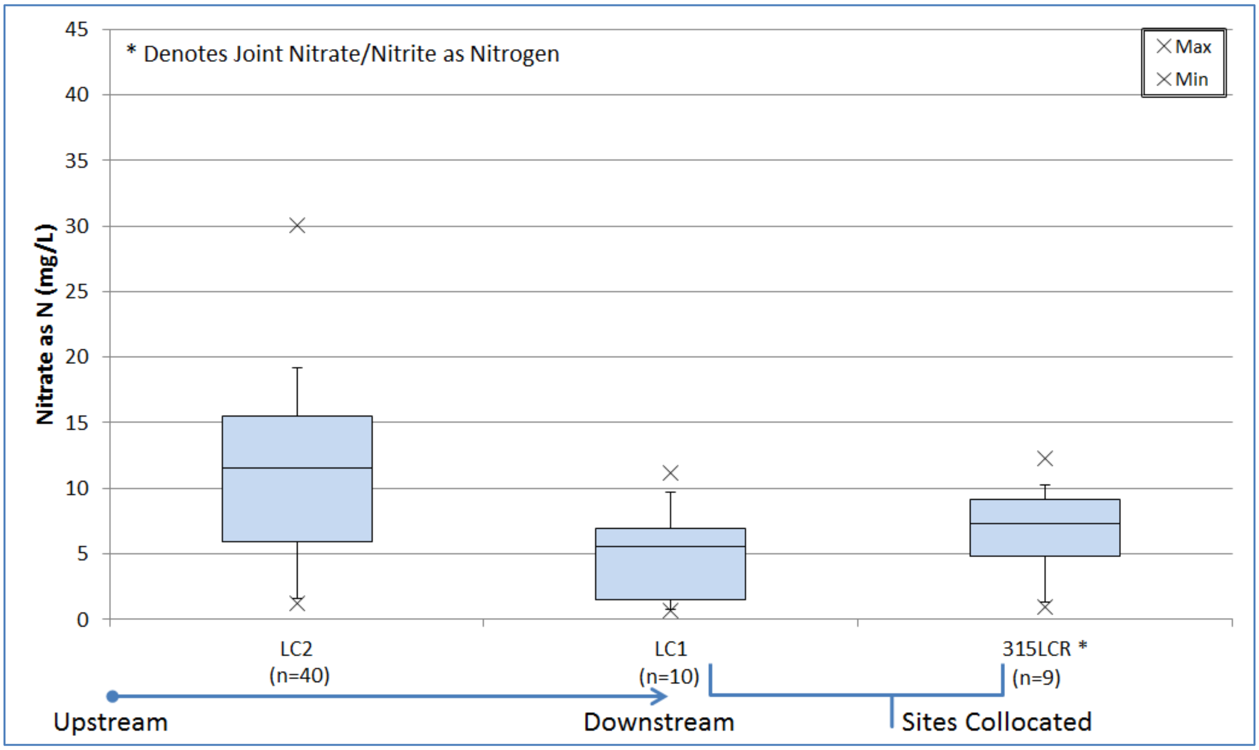


Figure 10. Nitrogen plots for Carneros Creek sites.
Note: Data reported as nitrate as nitrogen unless otherwise noted.

Figure 9 and Figure 10 (above) show the water quality monitoring results for Glen Annie Canyon/Tecolotito Creek and Carneros Creek sites, respectively, with upstream to downstream locations shown from left to right in the figures. The uppermost monitoring station (315GBR) has a median value of 0.23 mg/L joint nitrate/nitrite as nitrogen and a maximum value of 1.41 mg/L. This site is generally located above anthropogenic land disturbances (e.g., developed lands, croplands, etc.) and reflects good nitrate water quality conditions.

Glen Annie Canyon sites 315GAN and GA2, as well as Carneros Creek site LC2 have median nitrate concentrations that are all greater than the water quality objective of 10 mg/L. These sites are located within or downstream of cultivated agricultural lands.

Tecolotito Creek sites 315ANN and GA1 and Carneros Creek sites 315LCR and LC2 are located downstream of agricultural lands and are generally adjacent to developed (urban) lands. Median concentrations for the Tecolotito Creek sites exceed the nitrate water quality objective of 10 mg/L, while median concentration for the Carneros Creek sites are below 8 mg/L with only two samples exceeding the water quality objective.

Figure 11 shows land use and median nitrate concentrations for monitoring sites within the project area.

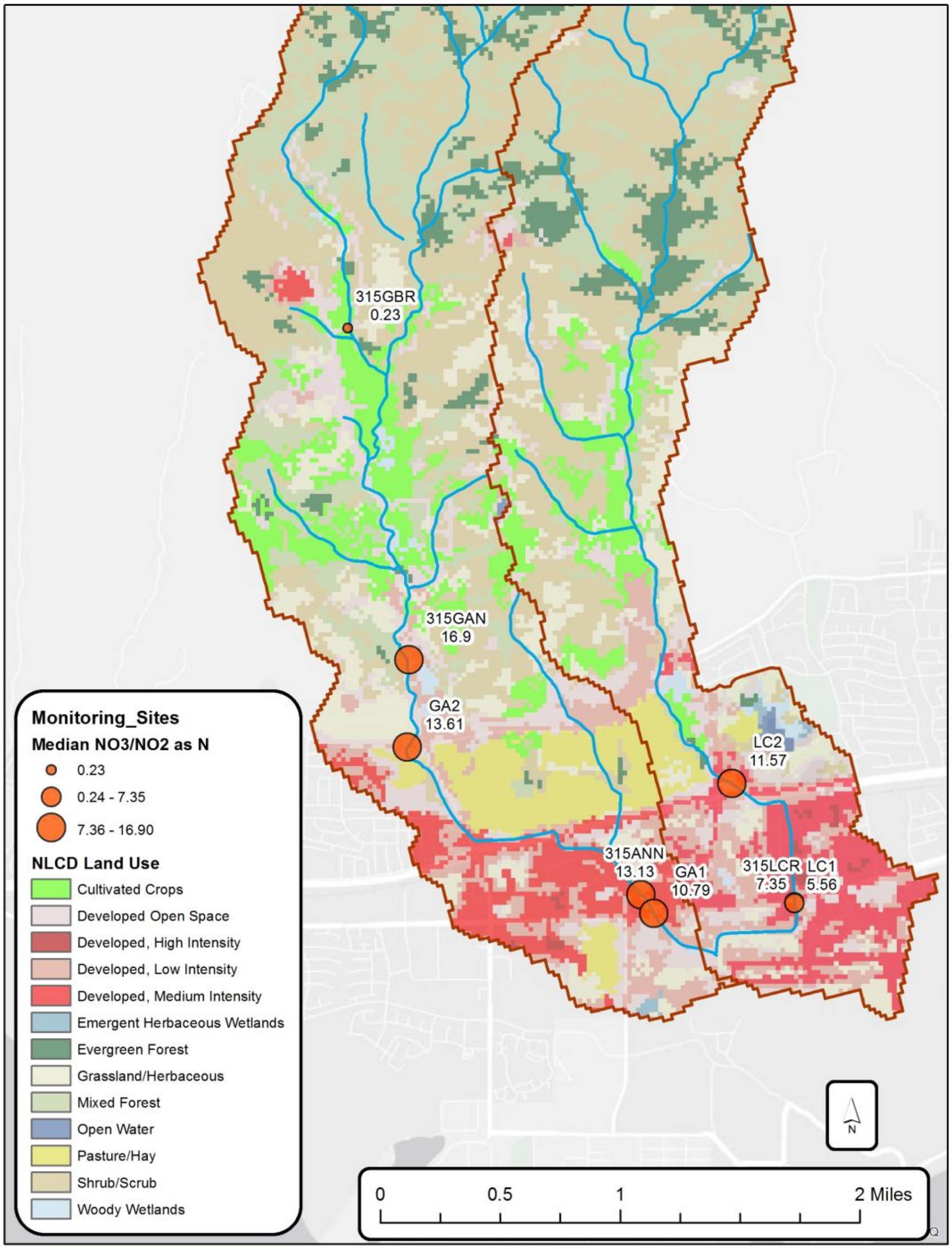


Figure 11. Land use and median nitrate concentrations.

It is important to note that nitrite generally comprises less than one percent of the joint nitrate/nitrite concentrations (see APPENDIX A – Water Quality Data). As a result, staff has concluded that nitrate as nitrogen is comparable to joint nitrate/nitrite as nitrogen concentrations. It is also important to note that nitrite concentrations exceeded the OEHHA public health goal of 1 mg/L nitrite as nitrogen on one occasion at site 315ANN (1.3 mg/L nitrite as nitrogen on 10/29/2008).

2.5.2 Problem statement

Waters of Glen Annie Canyon, Tecolotito Creek, and Carneros Creek are impaired due to exceedance of the water quality objective protecting the drinking and domestic water supply beneficial use (MUN), as well as the OEHHA public health goal (PHG) for joint nitrate/nitrite as nitrogen. In addition, agricultural supply guidelines for nitrate are exceeded in waters of Glen Annie Canyon so that the AGR beneficial use is not protected.

3 NUMERIC TARGETS

This section describes the numeric targets used to develop the TMDL. Numeric targets are water quality targets developed to ascertain when and where water quality objectives are achieved, and hence, when beneficial uses are protected. For this TMDL, the numeric targets are equal to the existing water quality objective.

3.1 Water Column Numeric Targets

Staff selected water column numeric target values for nitrate as a direct measure of water quality conditions for the protection of municipal and domestic supply (MUN) beneficial use. The Basin Plan numeric water quality objective for nitrate (as nitrogen) is 10 mg/L; therefore the nitrate target is set at the Basin Plan water quality objective as follows:

- *Receiving water column nitrate must not exceed 10 mg/L-N.*

4 SOURCE ANALYSIS

4.1 Introduction: Source Assessment Using STEPL Model

Excessive levels of nitrogen may reach surface waters as a result of human activities (USEPA, 1999). In this TMDL project report, nutrient source loading estimates were accomplished using the US Environmental Protection Agency's STEPL model. STEPL (Spreadsheet Tool for Estimating Pollutant Load) allows the calculation of nutrient loads from different land uses and source categories. STEPL provides a Visual Basic (VB) interface to create a customized, spreadsheet-based model in Microsoft (MS) Excel. STEPL calculates watershed surface runoff; nutrient loads, including nitrogen, phosphorus based on various land uses and watershed characteristics. For preliminary source assessment purposes, STEPL was used to estimate nutrient loads at the project area-scale. STEPL has been used previously in USEPA-approved TMDLs to estimate source loading[5].

[5] For example, see USEPA, 2010: Decision Document for Approval of White Oak Creek Watershed (Ohio) TMDL Report. February 25, 2010; and Indiana Dept. of Environmental Management, 2008. South Fork Wildcat Creek Watershed Pathogen, Sediment, and Nutrient TMDL.

For source assessment purposes, STEPL was used to estimate nutrient loads at the project area-scale. STEPL could also be used to allow for subwatershed-scale loading estimates. The annual nutrient loading estimate in STEPL is calculated based on the runoff volume and the pollutant concentrations in the runoff water as influenced by factors such as the land use distribution, precipitation data, soil characteristics, groundwater inputs, and management practices. Additional details on the model can be found at: http://it.tetratech-ffx.com/stepl/.

To estimate nitrate loads, STEPL requires area estimates for the following four land use classifications; urban, cropland, pastureland, and forest. Staff aggregated the NLDC land use/land cover classification to derive land use acreage required for STEPL as shown in Table 9.

Table 9. Aggregation of NLCD land use/land cover classifications for STEPL.

NLCD Name	Acres		STEPL Land Use Classification
	Glen Annie Canyon	Carneros Creek	
Open Water	1.8	9.3	Forest
Developed Open Space	292.0	182.8	Urban
Developed, Low Intensity	219.1	213.3	Urban
Developed, Medium Intensity	202.4	228.6	Urban
Developed, High Intensity	4.0	7.3	Urban
Evergreen Forest	232.9	273.1	Forest
Mixed Forest	655.4	398.3	Forest
Shrub/Scrub	1083.8	909.6	Forest
Grassland/Herbaceous	302.2	262.9	Pastureland
Pasture/Hay	196.6	45.1	Pastureland
Cultivated Crops	301.1	170.1	Cropland
Woody Wetlands	20.7	20.9	Forest
Emergent Herbaceous Wetlands	5.3	4.0	Forest
Aggregated STEPL Land Use Classification			
STEPL Land Use Classification	**Acres**		
	Glen Annie Canyon	**Carneros Creek**	
Urban	717.5	632	
Cropland	301.1	170.1	
Pastureland	498.8	308	
Forest	1,999.9	1,615.2	

STEPL input parameters used in this nitrate source assessment are shown in Table 10 and the spreadsheet results are presented in APPENDIX B – STEPL Spreadsheets. It should be emphasized that nutrient load estimates calculated by STEPL are merely estimates and subject to uncertainties; actual loading at the local stream-reach scale can vary substantially due to numerous factors over various temporal and spatial scales.

Table 10. STEPL input data.

Input Category	Input Data	Sources of Data
Mean Annual Rainfall	18.68 inches/year	Santa Maria WSO Airport as provided in STEPL
Mean Rain Days/Year	42.3 days/year	Santa Maria WSO Airport as provided in STEPL
Weather Station (for rain correction factors)	0.865 Mean Annual Rainfall- 0.418 Mean Rain Days/Yr.	Santa Maria WSO Airport as provided in STEPL
Land Cover	NLCD (see Table 9)	Aggregated NLCD land use/ land cover as represented in Table 9
Urban Land Use Distributions (impervious surfaces categories)	STEPL default values	STEPL
Septic system discharge and failure rate data	18 Systems 2.43 persons/system 2% failure rate	Estimated 18 systems based on 2010 NAIP Imagery. Population per system = 2.43 persons/system (National Average contained in STEPL). Failure rate of 2% (Typical range between 1 and 5%/year. De Walle, 1981 as cited in USEPA Preventing Septic system Failure)
Hydrologic Soil Group (HSG)	HSG "D"	HSG based on SSURGO soil data for TMDL project area
Soil N concentrations (%)	N = 0.10%	• N (%) – estimated national median value from information in GWLF User's Manual, v. 2.0 (Cornell University, 1992 - http://www.avgwlf.psu.edu/Downloads/GWLFManual.pdf).
NRCS reference runoff curve numbers	STEPL default values	NRCS default curve numbers provided in STEPL
Nutrient concentration in runoff (mg/L)	1.5 – 2.5 mg/L (urban) 13.8 mg/L (cropland) 1.26 mg/L (pastureland) 0.2 mg/L (forest)	• Urban lands –Used STEPL default values that contain a range of N runoff concentrations based on specific urban land use type (e.g., commercial, industrial, residential. Transportation, etc.). • N Concentration data for cropland from Southern California Coastal Water Research Project, Technical Report 335 (Nov. 2000), Appendix C. • N mean concentration for rangeland/pasture from USDA MANAGE database http://www.ars.usda.gov/Research/docs.htm?docid=11079 • Forest N and P runoff concentration: used STEPL default values
Nutrient concentration in shallow groundwater (mg/L).	2.2 mg/L (ag and urban) 1.44 mg/L (pastureland) 0.11 mg/L (forest)	• NO3-N (ag and urban) – mean value for project area using USGS GWAVA model dataset . http://water.usgs.gov/GIS/metadata/usgswrd/XML/gwava-s_out.xml • NO3-N (grazing Lands and forest) - N default values from STEPL

Staff ran the STEPL model for Glen Annie Canyon and Carneros Creek watersheds.

4.1.1 Urban Runoff

The Water Board is the permitting authority for NPDES stormwater permits in the Central Coast region. Urban runoff can be a contributor of nutrients to waterbodies. Within residential areas, potential controllable nutrient sources can include lawn care fertilizers, trash, and pet waste (Tetratech, 2004). Many of these pollutants enter surface waters via runoff without undergoing treatment. Impervious cover characterizes urban areas and refers to roads, parking lots, driveways, asphalt, and any surface cover that precludes the infiltration of water into the soil. Pollutants deposited on impervious surface have the potential of being entrained by discharges of water from storm flows, wash water, or excess lawn irrigation, etc. and routed to storm sewers, and potentially being discharged to surface water bodies.

There are three NPDES-permitted stormwater dischargers in the project area, including the City of Goleta and County of Santa Barbara (Order No. 2013-0001-DWQ, NPDES General Permit CAS000004), and the State of California Department of Transportation (Order No. 2012-0011-DWQ, NPDES Permit CAS000003). These municipalities are small municipal separate storm sewer system (MS4s) requiring coverage under the National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges from Small Municipal Separate Storm Sewer Systems. There is no need to limit point source discharges from these facilities, as their nitrate discharges are insignificant; any de minimis discharges from these facilities are far below the applicable numeric water quality objectives and the numeric targets set for the TMDL (which are also equivalent to the TMDLs). To ensure that these point sources remain insignificant sources, the Regional Board will ensure in future permitting actions that nitrate discharges are evaluated, and that applicable permits incorporate limitations as needed to ensure the discharge is substantially below the applicable numeric WQO and TMDL limits.

There are numerous studies, both nationwide and from the central coast region, that characterize nitrate-nitrogen concentrations in urban runoff (see Figure 12). These data (n = 438) illustrate that nitrate concentrations in urban runoff virtually never exceed the 10 mg/L nitrate as nitrogen water quality objective protective of the MUN beneficial use. In fact, the central coast-specific urban runoff data (Santa Cruz and Monterey County) shown in Figure 12 infrequently exceed nitrate-N concentrations of 2 mg/L.

Median nitrate concentrations for sites located downstream of agricultural cropland and adjacent to urban land uses are lower than median concentrations for sites located downstream or adjacent to agricultural croplands (see Figure 11). Based on the preceding information, staff concludes that discharges of nitrate-nitrogen from urban lands to both Tecolotito Creek and Carneros Creek are negligible and do not cause or contribute to impairment from nitrate-nitrogen.

States are required to establish TMDLs at levels necessary to attain and retain numeric and narrative water quality standards.[6] As will be discussed in the following section, discharges from agricultural lands are the single source causing impairment of water quality standards for protection of the MUN beneficial use. Therefore, wasteload allocations for urban stormwater are not needed to retain and maintain water quality standards addressed in this TMDL.

[6] 40CFR130.7(c)(1)

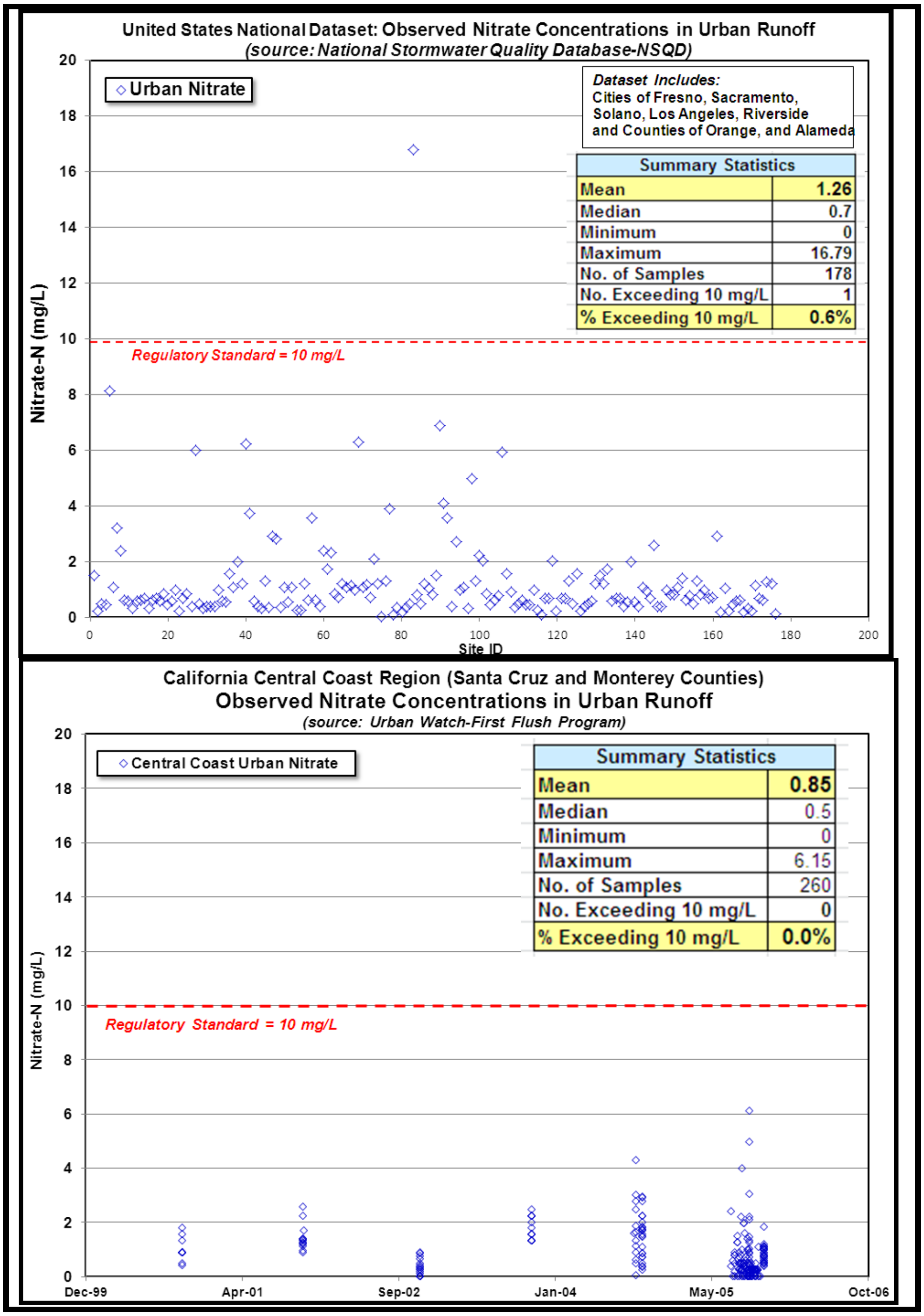


Figure 12. Nitrate concentration in urban runoff: national, California, and central coast regional data.

Using the parameter inputs identified in Section 4.1 the estimated annual nutrient load from urban runoff in the project area as calculated by STEPL is shown in Table 11.

Table 11. Urban Annual Nitrogen Load (lbs./year)

Source	Glenn Annie Canyon	Carneros Creek
Urban	2,487	2,513

4.1.2 Agricultural Sources

Fertilizers or manure applied to cropland can constitute a significant source of nutrient loads to waterbodies. The primary concern with the application fertilizers on crops or forage areas is that the application can exceed the uptake capability of the crop. If this occurs, the excess nutrients become mobile and can be transported to either nearby surface waters, the groundwater table, or the atmosphere (Tetratech, 2004).

Figure 13 illustrates temporal trends of fertilizer sales in Santa Barbara County. It is important to recognize that fertilizer sales in a county does not necessarily mean those fertilizers were actually applied in that same county. Recorded sales in one county may actually be applied on crops in other, nearby counties. However, Krauter et al. (2002) reported fertilizer application estimates that were obtained from surveys, county farm advisors and crop specialists; these data indicated that in the Central Coast region, county fertilizer recorded sales correlated well with estimated in-county fertilizer applications (within 10 percent). Also, it is important to recognize that not all fertilizing material is sold to or applied to farm operations. The California Department of Food and Agriculture reports that for the annual period July 2007 to June 2008, non-farm entities purchased about 2.6% of fertilizing materials sold in Santa Barbara County[7].

[7] California Department of Food and Agriculture, Fertilizing Materials Tonnage Report, January – June 2008, pg. 10.

Attachment 2 to Staff Report

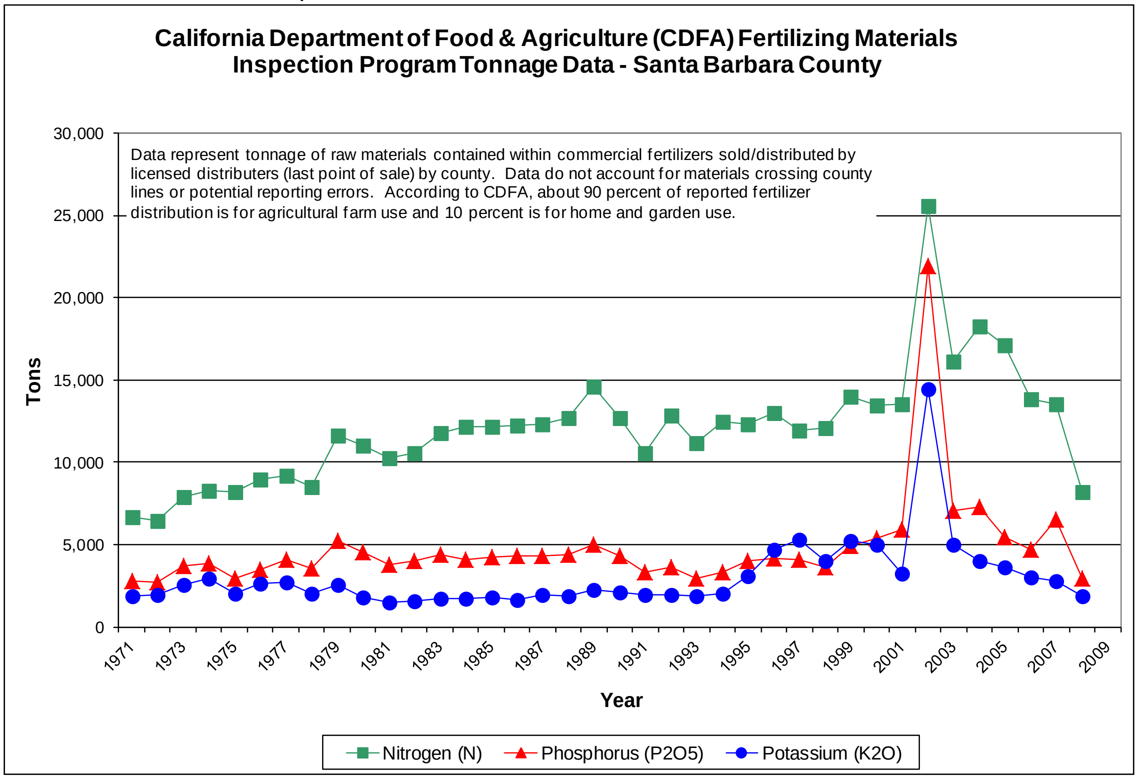


Figure 13. Fertilizer sales in Santa Barbara County.

California fertilizer application rates on specific crop types are available from the U.S. Department of Agriculture, National Agricultural Statistics Service (NASS), as shown in Table 12.

Table 12. California fertilizer application rates.

Crop	Application Rate per Crop Year in California (pounds per acre)			Source
	Nitrogen	Phosphate	Potash	
Tomatoes	243	133	174	2007 NASS report
Sweet Corn	226	127	77	2007 NASS report
Rice	124	46	34	2007 NASS report
Avocado	63	25	45	2009 NASS report
Lemon	67	39	59	2009 NASS report
Cotton	123	74	48	2008 NASS report
Barley	73	19	7	2004 NASS report
Oats[1]	64	35	50	2006 NASS report
Head Lettuce	200	118	47	2007 NASS report
Cauliflower	232	100	43	2007 NASS report
Broccoli	216	82	49	2007 NASS report
Celery	344	114	151	2007 NASS report
Asparagus	72	20	46	2007 NASS report
Spinach	150	60	49	2007 NASS report
Strawberries[2]	155	88	88	University of Delaware Ag, Nutrient Recommendations on Crops webpage

[1]insufficient reports to publish fertilizer data for P and potash; used national average from 2006 NASS report for P and K.
[2] median of ranges, calculated from table 1, table 4, and table 5 @ http://ag.udel.edu/other_websites/DSTP/Orchard.htm

Based on staff observations in the project area, croplands are comprised almost exclusively of orchards (avocado, citrus).

The estimated annual nutrient load from cropland in the project area as calculated by STEPL is shown in Table 13.

Table 13. Cropland Annual Load (lbs./year)

Source	Glenn Annie Canyon	Carneros Creek
Cropland	13,604	7,813

4.1.3 Pastureland

Livestock and other domestic animals that spend significant periods of time in or near surface waters can contribute significant loads of nitrogen and phosphorus because they use only a portion of the nutrients fed to them and the remaining nutrients are excreted (Tetratech, 2004). For example, in a normal finishing diet, a yearling cattle will retain only between 10 percent and 20 percent of the nitrogen and phosphorus it is fed. The rest of the nutrients are excreted as waste, and are thus available for runoff into nearby waterbodies or into the groundwater (Koelsch and Shapiro, 1997 as reported in Tetratech, 2004).

The estimated annual nutrient load from grazing lands in the project area as calculated by STEPL is shown in Table 14.

Table 14. Pastureland Annual Load (lbs./year)

Source	Glenn Annie Canyon	Carneros Creek
Pastureland	1,179	1,872

4.1.4 Forest and Undeveloped Lands

The estimated annual nutrient load from forest in the project area as calculated by STEPL is shown in Table 15. Note that the load from these lands represent loading from natural sources of nitrate.

Table 15. Forest Annual Load (lbs./year)

Source	Glenn Annie Canyon	Carneros Creek
Forested Lands	1,069	882

4.1.5 Onsite Disposal Systems (OSDS)

The estimated annual nitrate load from OSDS (i.e., septic systems) to surface waters in the project area as calculated by STEPL is shown in Table 16. Staff used National Agricultural Imagery Program (NAIP, 2010) aerial imagery to identify approximately 18 OSDS within Glen Annie Canyon and 8 within Carneros Creek watershed. Based on this information, staff has concluded that OSDS discharges to surface waters within the project area are inconsequential. While the impacts of OSDS to underlying groundwater may be locally significant, researchers have concluded that at the basin-scale and regional-scale of agricultural valleys, OSDS impacts to groundwater are insignificant relative to agricultural fertilizer impacts (University of California-Davis, 2012).

The estimated annual nitrate load from OSDS in the project area as calculated by STEPL is shown in Table 16.

Table 16. OSDS (Septic) Annual Load (lbs./year)

Source	Glenn Annie Canyon	Carneros Creek
OSDS (Septic)	11	5

4.1.6 Groundwater

Shallow groundwater provides the base flows to streams and can be a major source of surface water flows during the summer season. Therefore, dissolved nutrients in groundwater can be important nitrate source during dry periods. Ground water contamination from nitrate can occur from various sources, including septic systems, fertilizer application, animal waste, waste-lagoon sludge, and soil mineralization (USEPA, 1999).

The estimated annual nitrate load from groundwater in the project area as calculated by STEPL is shown in Table 17.

Table 17. Groundwater Annual Load (lbs./year)

Source	Glenn Annie Canyon	Carneros Creek
Groundwater	479	412

4.2 Summary of Sources

It is worth reiterating that these are estimates for the TMDL project area. It is understood that there will be substantial variation due to temporal or local, site specific conditions. More information will be collected during TMDL implementation to assess controllable sources of nitrate. Table 18 and Figure 14 summarize estimated loads of nitrate based on information provided in Section 4.1.

Table 18. Summary of Estimated Loads

Sources	Glen Annie Canyon N Load (lb/yr)	Carneros Creek N Load (lb/yr)
Urban	2,487	2,513
Cropland	13,604	7,813
Pastureland	1,179	1,872
Forest	1,069	882
OSDS (Septic)	11	5
Groundwater	479	412
Total	18,829	13,497

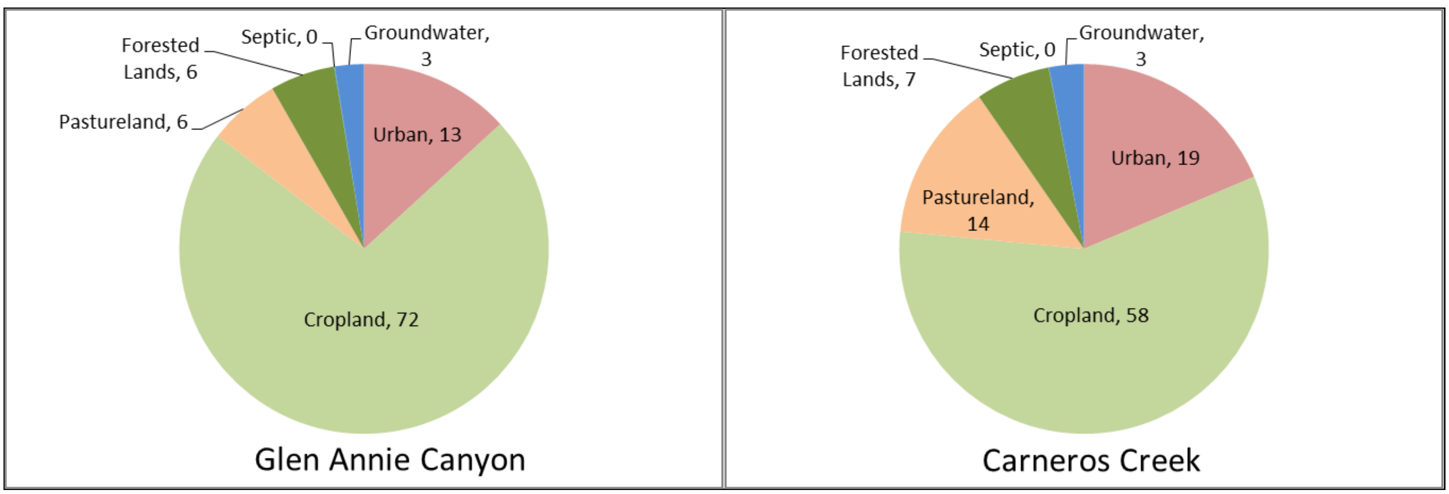


Figure 14. Summary of estimated nitrate loads (%).

4.3 Conclusions from Source Analysis

Staff concludes that discharges of nitrate from agricultural lands are the sole source of nitrate causing impairment. In the absence of discharges from agricultural lands, there would not be impairment due to nitrate.

4.4 Comparison of STEPL Predicted Loads to Observed Loads

As a preliminary validation of the STEPL annual load calculations, staff estimated annual loads using water quality monitoring data and USGS gage data.

Mean annual loads were estimated using a simple averaging technique where the annual load is calculated as the average concentration of all samples collected in each watershed multiplied by the mean annual discharge. For this screening assessment, staff used mean annual discharge for USGS station 11120530 (Tecolotito Creek near Goleta) for both Glen Annie and Carneros Creek watersheds. Table 19 summarizes the mean annual discharge record for the USGS station 11120530. The mean annual flow at this station is 0.717 cubic feet per second (cfs).

Table 19. Mean Annual Discharge for USGS station 11120530.

Water Year	Discharge cfs
1971	0.559
1972	0.634
1981	1.52
1982	0.662
1988	0.433
1989	0.19
1990	0.087
1991	1.65
Note: No Incomplete data have been used for statistical calculation. Statistics based on USGS approved daily-mean data.	

The mean nitrate nitrogen concentrations are 13.2 mg/L for Glen Annie Canyon water quality monitoring sites and 9.6 mg/L for Carneros Creek monitoring sites (Table 20). Using appropriate conversion factors the estimated mean annual nitrate load for the Glen Annie Canyon watershed is computed as follows:

Nitrate Load (lb/day) = Discharge (cfs) * 5.394 (conversion factor)* Nutrient Concentration (mg/L)

Nitrate Load (lbs/day) = 0.717 * 5.394 * 13.2
= 51.1

Nitrate Load (lbs/yr) = 51.1 * 365
= 18,652

Table 20. Estimated mean annual flows and mean concentrations.

Water body	Mean Annual Flow (cfs) *source: USGS* 11120530	Number of NO3-N Samples	Mean NO3-N Concentration (mg/L)
Glen Annie Canyon Watershed	0.717	314	13.2
Carneros Creek Watershed	0.717	59	9.6

Using the sum of STEPL predicted loads for project area watersheds (see Table 18), a comparison of STEPL estimated mean annual load to the estimated annual load for nitrate is shown in Figure 15, suggesting that the project area nitrate loads calculated by STEPL estimates comport well to estimated loads based on observed water quality monitoring data.

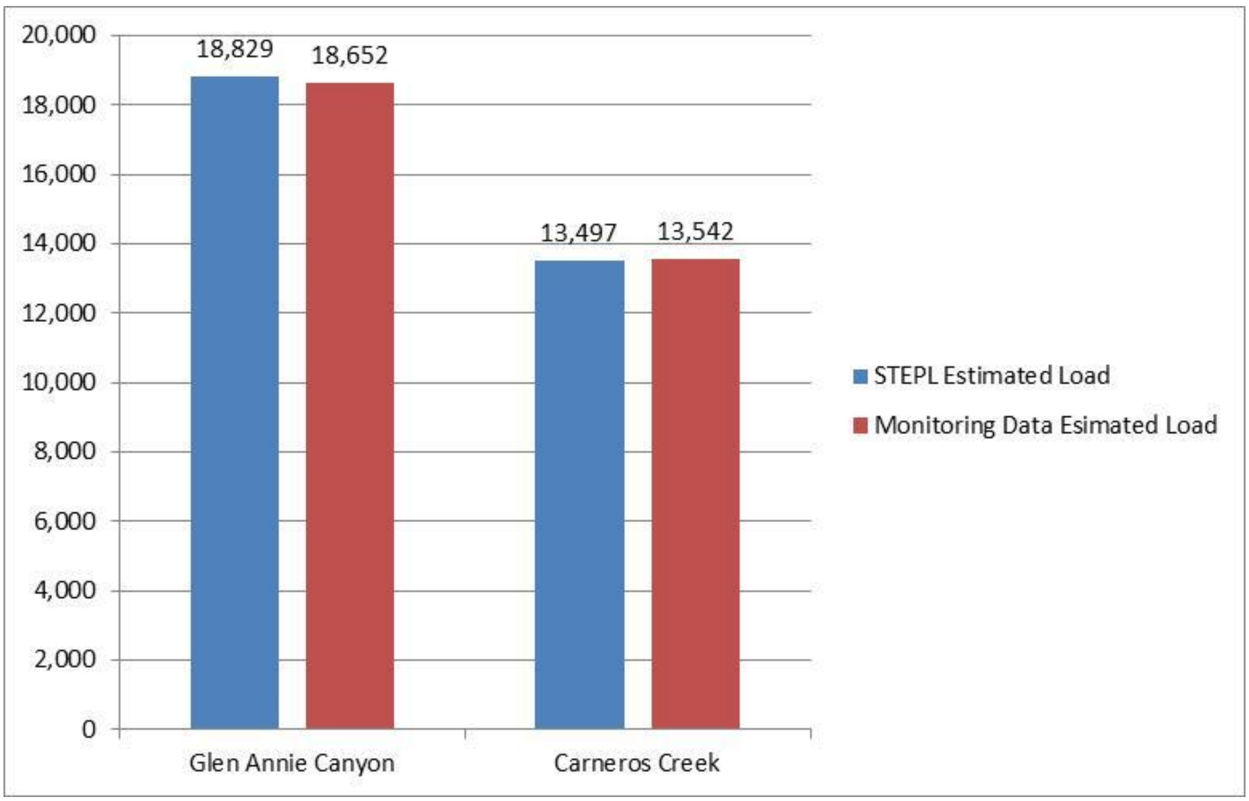


Figure 15. Comparison of STEPL predicted nitrogen loads (lbs/yr) to monitoring data loads.

4.5 Estimates of Existing Loading

Existing mean annual loads were estimated using the averaging technique used in the preceding section where the load is calculated as the average concentration of samples multiplied by the mean flow.

Staff used CCAMP/CMP and Santa Barbara Channelkeeper water quality monitoring data and the USGS mean discharge data to calculate mean concentrations and derive the estimated loads. The mean annual loading capacity and percent reduction goals are based on the water quality objective of 10 mg/L nitrate as nitrogen. Table 21 presents a tabulation of estimated mean annual nitrate-N loads, loading capacity under TMDL conditions, and percent reduction goals for project area waterbodies. Note that percent reduction goals are for informational purposes only and should not be viewed as the TMDL.

Table 21. Estimated mean annual nitrate-N loads, loading capacities, and percent reduction goals.

Water body	Site ID	Estimated Mean Annual Flow (cfs)	Mean Annual Conc. (mg/L)	Est. Existing Mean Annual Load (lbs.)	Mean Annual Loading Capacity (lbs.)	% Reduction Goal [A]	NO3-N Numeric Target Used for Loading Capacity (mg/L)
Glen Annie Canyon	315GBR	0.717	0.37	522	14,116		(10)
	315GAN	0.717	17.19	24,266	14,116	42%	(10)
	GA2	0.717	14.64	20,666	14,116	32%	(10)
Tecolotito Creek	315AAN	0.717	15.41	21,753	14,116	35%	(10)
	GA1	0.717	10.59	14,949	14,116	6%	(10)
Carneros Creek	LC2	0.717	11.46	16,179	14,116	13%	(10)
	LC1	0.717	4.98	7,034	14,116		(10)
	315LCR	0.717	6.55	9,239	14,116		(10)

[A] Percent reduction goals are for informational purposes only and should not be viewed as the TMDL

5 LOADING CAPACITY AND ALLOCATIONS

5.1 Introduction

TMDLs are “[t]he sum of the individual waste load allocations for point sources and load allocations for nonpoint sources and natural background. TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure” in accordance with Code of Federal Regulations, Title 40, §130.2[i].

Staff proposes the establishment of concentration-based TMDLs in accordance with this provision of the Clean Water Act.

5.2 Loading Capacity (TMDL)

The TMDLs are set equal to the loading capacity. The loading capacity for the Glen Annie Canyon, Tecolotito Creek, and Carneros Creek is the amount of nitrate that can be assimilated without exceeding the water quality objectives. The allowable nitrate water column concentration that will achieve the water quality objectives for the municipal and domestic supply (MUN) beneficial use is equal to the numeric target.

The loading capacity, or Total Maximum Daily Load, for nitrate is a receiving water column concentration-based Total Maximum Daily Load and is applicable to each day of all seasons as indicated in Table 22.

Table 22. Concentration-based TMDL for nitrate

Impaired Waterbody Assigned TMDL	TMDL
	Nitrate as Nitrogen in receiving waters
Glen Annie Canyon (including all tributaries) Tecolotito Creek (including all tributaries) Carneros Creek (including all tributaries)	10 mg/L

5.3 Linkage Analysis

The goal of the linkage analysis is to establish a link between pollutant loads and desired water quality. This, in turn, ensures that the loading capacity specified in the TMDLs will result in attaining the desired water quality. For these TMDLs, this link is established because the load allocations are equal to the numeric targets, which are the same as the TMDLs. Therefore, reductions in nitrate loading will result in achieving the water quality standards.

5.4 Load Allocations

Table 23 shows load allocations assigned to responsible parties. The allocations are equal to the TMDLs. The allocations are receiving water allocations.

Table 23. TMDL allocations

LOAD ALLOCATIONS	
Responsible Party Assigned Allocation (Source)	**Receiving Water Allocation**
Owners/operators of irrigated agricultural lands in the Glenn Annie Canyon, Tecolotito Creek, and Carneros Creek Watersheds (Discharges from irrigated lands)	10 mg/L Nitrate as Nitrogen
Natural Sources	10 mg/L Nitrate as Nitrogen

5.5 Margin of Safety

This TMDL incorporates an implicit margin of safety. The water column nitrate numeric target is derived from promulgated USEPA MCLs and OEHHA PHGs protocols. Therefore the loading capacity has the same conservative assumptions used in these procedures.

5.6 Critical Conditions, Seasonal Variation

A critical condition is the combination of environmental factors resulting in the water quality standard being achieved by a narrow margin, i.e., that a slight change in one of the environmental factors could result in exceedance of the water quality standard. Such a phenomenon could be significant if the TMDL were expressed in terms of load, and the allowed load was determined on achieving the water quality standard by a narrow margin. However, this TMDL is expressed as a concentration, which is equal to the desired water quality condition. Consequently, there are no critical conditions and the TMDL is applicable during all seasons.

To evaluate seasonal conditions, staff aggregated all nitrate and joint nitrate/nitrite water quality monitoring data by dry season (May-Oct) and wet season (Nov-Apr) then calculated seasonal statistics as shown Figure 16 and Table 24. Concentrations are moderately higher during the dry season; however median concentrations exceed the nitrate water quality objective for both periods. Load allocations do not account for seasonal variation since the allocations are based on the water quality objective for nitrate, which is a concentration and applicable during all seasons. However, implementing parties might focus management efforts within the dry season.

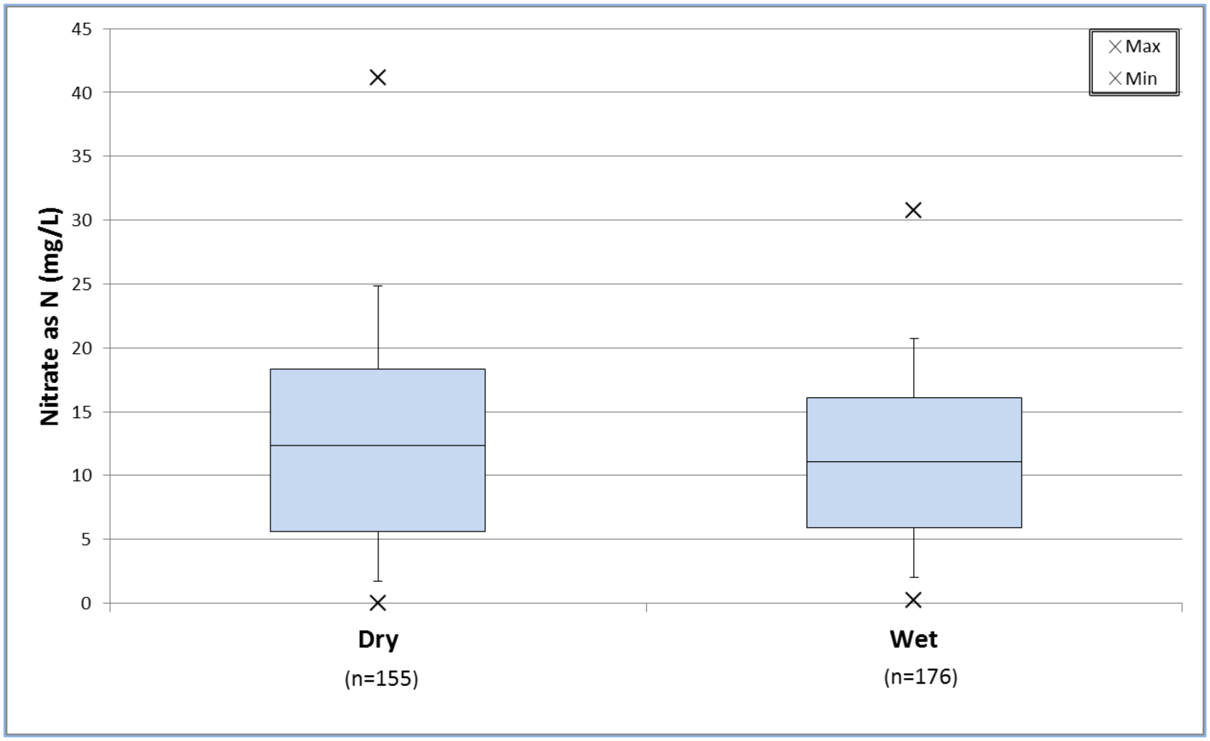


Figure 16. Wet season (Nov-Apr) and dry season (May-Oct) plots.

Table 24. Seasonal statistics.

Season	Mean	Max	90th percentile	75th percentile	Median	25th percentile	10th percentile	Min
Dry	12.89	41.14	24.86	18.34	12.37	5.63	1.72	0.02
Wet	11.23	30.73	20.75	16.10	11.10	5.93	1.99	0.23

6 IMPLEMENTATION AND MONITORING

6.1 Introduction

This TMDL is being implemented by the Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands (Agricultural Order); this includes the order currently in effect and renewals or modifications thereof. Central Coast Water Board staff will conduct a review of implementation activities when monitoring and reporting data is submitted as required by the Agricultural Order. Central Coast Water Board staff will pursue modification of Agricultural Order conditions or other regulatory means (e.g. waste discharge requirements), as necessary, to address remaining impairments during the TMDL implementation phase.

Note that the current Agricultural Order requires dischargers to comply with applicable TMDLs. If the Agricultural Order did not provide the necessary requirements to implement this TMDL, staff would propose modifications of the Agricultural Order in order to achieve this TMDL. Staff has concluded that the current Agricultural Order provides the requirements necessary to implement this TMDL. Therefore, no new requirements are proposed as part of this TMDL.

The Agricultural Order states that compliance is determined by: a) management practice implementation and effectiveness, b) treatment or control measures, c) individual discharge monitoring results, d) receiving water monitoring results, and e) related reporting. The Agricultural Order also requires that dischargers comply by implementing and improving management practices and complying with other conditions, including monitoring and reporting requirements, which is consistent with the Nonpoint Source Pollution Control Program (NPS Policy, 2004). Finally, the Agricultural Order states that dischargers shall implement management practices, as necessary, to improve and protect water quality and to achieve compliance with applicable water quality objectives. Therefore, compliance with this TMDL is demonstrated through compliance with the Agricultural Order, which provides several avenues for demonstrating compliance, including management practices that improve water quality that lead to ultimate achievement of water quality objectives.

The Agricultural Order should prioritize implementation and monitoring efforts in stream reaches or areas where:

1) Water quality data and land use data indicate the largest magnitude of nutrient loading and/or impairments;
2) Reductions in nutrient loading, reductions in-stream nutrient concentrations, and/or implementation of improved nutrient management practices that will have the greatest benefit to human health in receiving waters;
3) Crops that are grown that require high fertilizer inputs (see for example Table 12 and narrative following the table);
4) Other information such as proximity to water body; soils/runoff potential; irrigation and drainage practices, or relevant information provided by stakeholders, resource professionals, and/or researchers indicate a higher risk of nitrate impacts to receiving waters.

Based on information developed for this project report, staff anticipates that the following areas will require high priority mitigation efforts:

- Glen Annie Canyon and Carneros Creek north of Highway 101, including unnamed tributaries.

6.2 Implementation Requirements for Dischargers from Irrigated Agricultural Lands

Implementing parties must comply with the Conditional Waiver of Waste Discharge Requirements for Irrigated Lands (Order R3-2012-0011) and the Monitoring and Reporting Programs in accordance with Orders R3-2012-0011-01, R3-2012-0011-02, and R3-2012-0011-03, or its renewals or replacements to meet load allocations and achieve the TMDL. The requirements in these orders, and their renewals or replacements in the future, will implement the TMDLs and rectify the impairments addressed in this TMDL.

Current requirements in the Agricultural Order that will achieve the load allocations include:

a. Implement, and update as necessary, management practices to reduce nutrient loading.
b. Maintain existing, naturally occurring, riparian vegetative cover in aquatic habitat areas.
c. Develop/update and implement Farm Plans. The Farm Plans should incorporate measures designed to achieve load allocations assigned in this TMDL.

Implement monitoring and reporting requirements described in the Agricultural Order.

6.2.1 Monitoring and Reporting Requirements

Owners and operators of irrigated agricultural lands must perform monitoring and reporting in accordance with Monitoring and Reporting Program Orders R3-2012-0011-01, R3-2012-0011-02, and R3-2012-0011-03, as applicable to the operation.

Recommended receiving water monitoring sites are:

- Glen Annie Canyon site 315GAN
- Tecolotito Creek site 315ANN
- Carneros Creek sites LC2 and 315LCR

6.2.2 Determination of Compliance with Load Allocations

Demonstration of compliance with the load allocations is consistent with compliance with the Agricultural Order. Load allocations will be achieved through a combination of implementation of management practices and strategies to reduce nitrogen compound loading and water quality monitoring. Flexibility to allow owners and operators of irrigated lands to demonstrate compliance with load allocations is a consideration; additionally, staff is aware that not all implementing parties are necessarily contributing to or causing surface water impairment.

To allow for flexibility, Water Board staff will assess compliance with load allocations using one or a combination of the following:

A. Attaining the load allocations in the receiving water;
B. Demonstrating quantifiable receiving water mass load reductions;
C. Implementing management practices that are capable of achieving load allocations identified in this TMDL;
D. Providing sufficient evidence to demonstrate that they are and will continue to be in compliance with the load allocations; such evidence could include documentation submitted by the owner/operator to the Executive Officer that the owner/operator is not causing waste to be discharged to impaired waterbodies resulting or contributing to violations of the load allocations.

6.3 Timeline and Milestones

The discharge of nitrate at toxic levels is a serious water quality problem. As such, implementation should occur at an accelerated pace to achieve the allocations and TMDL in the shortest time-frame feasible.

The target date to achieve the allocations, numeric targets, and TMDL in the impaired waterbodies addressed in this TMDL is October 1, 2016. This date coincides with the time schedule of milestones described in Table 4 of the Agricultural Order. Additionally, staff concludes that the TMDL is achievable by this date because the results of best management practices will be realized quickly. Best management practices will benefit water quality quickly because groundwater is not significantly contributing to surface water nitrate loading; the soils in the watershed are shallow, with low permeability, and groundwater nitrate concentration averages 2.2 mg/L-N.

Water Board staff will reevaluate impairments caused by nitrate when monitoring data is submitted and during renewals of the Agricultural Order. Water Board staff will propose modifications of the Agricultural Order or other regulatory mechanisms, if necessary, to address remaining impairments.

6.4 Cost Estimate

Existing regulatory requirements are sufficient to attain water quality standards for nitrate in the project area. The Regional Board is not approving any new activity, but merely finding that ongoing activities and regulatory requirements are sufficient. Therefore, this TMDL is not a “project” that requires compliance with the California Environmental Quality Act (California Public Resources Code § 21000 et seq.) and the Central Coast Water Board is not directly undertaking an activity, funding an activity or issuing a permit or other entitlement for use by this action (Public Resources Code § 21065; 14 Cal. Code of Regs. §15378).

6.5 Existing Implementation Efforts

Some growers in the Glen Annie Canyon and Carneros Creek watersheds are enrolled in the Agricultural Order. Therefore, these growers have met requirements aimed at addressing impaired waters.

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APPENDIX A – WATER QUALITY DATA

CMP Data – Glen Annie Canyon Site 315GBR

Site ID	Date	Nitrate as N (mg/L)	Joint Nitrate/Nitrite as N (mg/L)	Flow (cfs)
315GBR	1/23/2008		1.41	13.195
315GBR	2/26/2008		0.388	1.7879
315GBR	3/25/2008		0.603	0.0471
315GBR	4/29/2008		0.287	0.2008
315GBR	5/27/2008		0.232	0.1528
315GBR	6/24/2008		0.208	0.0199
315GBR	7/29/2008		0.2	0.123
315GBR	8/14/2008		0.142	0.0813
315GBR	9/23/2008		0.02	0.0377
315GBR	10/28/2008	0.135	0.135	0.016
315GBR	11/18/2008	0.232	0.232	0.021375
315GBR	12/16/2008	0.553	0.553	0.19375

CMP Data – Glen Annie Canyon Site 315GAN

Site ID	Date	Joint Nitrate/Nitrite as N (mg/L)	Flow (cfs)
315GAN	1/25/2006	40	N/A
315GAN	2/22/2006	6.9	N/A
315GAN	3/29/2006	3.66	N/A
315GAN	4/26/2006	5.49	N/A
315GAN	5/14/2006	11.4	N/A
315GAN	6/27/2006	18.6	N/A
315GAN	7/26/2006	22.4	N/A
315GAN	8/22/2006	25	N/A
315GAN	9/26/2006	26.3	N/A
315GAN	10/25/2006	0.014	N/A
315GAN	11/15/2006	27.1	N/A
315GAN	12/13/2006	29.2	N/A
315GAN	1/30/2007	4.7	N/A
315GAN	2/13/2007	11	N/A
315GAN	3/20/2007	28.6	N/A
315GAN	4/9/2007	26	N/A
315GAN	5/29/2007	37.2	N/A
315GAN	6/26/2007	26.6	N/A
315GAN	7/25/2007	8.4	N/A
315GAN	8/29/2007	32	N/A
315GAN	9/25/2007	27.4	N/A

Site ID	Date	Joint Nitrate/Nitrite as N (mg/L)	Flow (cfs)
315GAN	10/23/2007	9.01	N/A
315GAN	11/28/2007	26.4	N/A
315GAN	12/17/2007	30.6	N/A
315GAN	1/23/2008	2.64	N/A
315GAN	2/26/2008	8.35	N/A
315GAN	3/25/2008	19.5	N/A
315GAN	4/29/2008	9.51	N/A
315GAN	5/27/2008	16.9	N/A
315GAN	6/24/2008	23.6	N/A
315GAN	7/29/2008	31	N/A
315GAN	8/14/2008	17.7	N/A
315GAN	9/23/2008	24.1	N/A
315GAN	10/28/2008	19.5	N/A
315GAN	11/18/2008	8.05	N/A
315GAN	12/16/2008	5.56	N/A
315GAN	1/26/2009	9.82	N/A
315GAN	2/6/2009	18.4	N/A
315GAN	3/24/2009	3.07	N/A
315GAN	4/28/2009	13.9	N/A
315GAN	5/27/2009	14	N/A
315GAN	6/24/2009	16	N/A
315GAN	7/28/2009	16.4	N/A
315GAN	8/19/2009	20.7	N/A
315GAN	9/16/2009	21.9	N/A
315GAN	1/20/2010	2.07	N/A
315GAN	2/22/2010	13.4	N/A
315GAN	3/29/2010	16.6	N/A
315GAN	4/27/2010	14.8	0.868
315GAN	5/24/2010	15.9	5.04025
315GAN	6/29/2010	18.5	0.4795
315GAN	7/27/2010	19.1	0.2765
315GAN	8/20/2010	20.5	0.2685
315GAN	9/23/2010	25.3	0.077375
315GAN	10/26/2010	18.2	0.16725
315GAN	11/15/2010	16.6	0.16225
315GAN	12/13/2010	18.1	0.191
315GAN	1/26/2011	10.5	1.28775
315GAN	2/24/2011	25	0.7345
315GAN	3/21/2011	1.91	35.90113
315GAN	4/27/2011	13.7	1.506

Site ID	Date	Joint Nitrate/Nitrite as N (mg/L)	Flow (cfs)
315GAN	5/25/2011	13.6	0.8495
315GAN	6/28/2011	14.4	0.719

Santa Barbara Channelkeepers Data – Glen Annie Canyon Site GA2

Site ID	Date	Nitrate as N (mg/L)
GA2	12/8/2002	6.4
GA2	1/12/2003	9.8
GA2	2/2/2003	8.0
GA2	3/2/2003	13.5
GA2	4/6/2003	13.5
GA2	5/4/2003	4.5
GA2	5/4/2003	5.3
GA2	6/8/2003	23.8
GA2	7/13/2003	25.5
GA2	8/3/2003	25.2
GA2	9/7/2003	28.8
GA2	10/5/2003	27.2
GA2	11/2/2003	22.7
GA2	12/7/2003	26.0
GA2	1/11/2004	26.5
GA2	2/8/2004	12.6
GA2	3/7/2004	23.4
GA2	4/4/2004	25.2
GA2	5/2/2004	32.6
GA2	6/6/2004	34.4
GA2	7/11/2004	27.5
GA2	8/8/2004	41.1
GA2	9/12/2004	24.4
GA2	10/3/2004	33.1
GA2	11/7/2004	30.7
GA2	12/5/2004	24.2
GA2	1/9/2005	1.6
GA2	2/6/2005	7.6
GA2	3/6/2005	5.8
GA2	4/3/2005	7.7
GA2	5/8/2005	1.7
GA2	6/5/2005	18.1
GA2	7/10/2005	27.6
GA2	8/7/2005	19.6

Site ID	Date	Nitrate as N (mg/L)
GA2	9/11/2005	4.7
GA2	10/2/2005	24.4
GA2	11/6/2005	22.3
GA2	12/4/2005	16.6
GA2	1/8/2006	9.3
GA2	2/5/2006	23.4
GA2	3/5/2006	9.5
GA2	4/2/2006	4.3
GA2	5/7/2006	8.3
GA2	6/4/2006	13.3
GA2	7/9/2006	1.8
GA2	8/6/2006	16.1
GA2	9/10/2006	17.5
GA2	10/8/2006	18.1
GA2	11/5/2006	18.9
GA2	12/3/2006	19.7
GA2	1/7/2007	16.4
GA2	2/4/2007	3.7
GA2	3/4/2007	16.8
GA2	5/6/2007	4.9
GA2	6/3/2007	18.3
GA2	7/8/2007	16.4
GA2	8/5/2007	21.6
GA2	9/9/2007	16.2
GA2	10/7/2007	2.8
GA2	11/4/2007	20.7
GA2	12/2/2007	22.8
GA2	1/6/2008	11.0
GA2	2/3/2008	5.9
GA2	3/2/2008	11.2
GA2	4/6/2008	17.3
GA2	5/4/2008	9.0
GA2	7/13/2008	13.7
GA2	9/7/2008	1.6
GA2	10/5/2008	3.8
GA2	11/2/2008	3.6
GA2	12/7/2008	1.4
GA2	2/8/2009	1.2
GA2	3/8/2009	6.1
GA2	4/5/2009	7.2

Site ID	Date	Nitrate as N (mg/L)
GA2	5/3/2009	5.8
GA2	6/7/2009	9.1
GA2	7/12/2009	12.4
GA2	11/8/2009	14.7
GA2	12/6/2009	16.8
GA2	1/10/2010	12.8
GA2	2/7/2010	6.1
GA2	4/11/2010	5.5
GA2	10/4/2010	20.0
GA2	11/8/2010	17.4
GA2	12/5/2010	16.0
GA2	1/9/2011	5.9
GA2	2/6/2011	12.8
GA2	3/6/2011	20.1
GA2	4/3/2011	5.9
GA2	5/8/2011	1.0
GA2	6/1/2011	12.7
GA2	7/10/2011	12.9
GA2	8/7/2011	13.4
GA2	9/7/2011	14.0
GA2	10/6/2011	14.3
GA2	11/6/2011	14.8
GA2	12/4/2011	13.1
GA2	1/8/2012	13.7
GA2	2/14/2012	11.7
GA2	3/4/2012	13.1

Santa Barbara Channelkeepers Data – Glen Annie Canyon/Tecolotito Creek Site GA1

Site ID	Date	Nitrate as N (mg/L)
GA1	6/2/2002	18.1
GA1	7/7/2002	2.1
GA1	8/4/2002	15.5
GA1	9/8/2002	9.4
GA1	10/6/2002	5.7
GA1	11/3/2002	13.8
GA1	12/8/2002	6.4
GA1	1/12/2003	9.3
GA1	2/2/2003	8.3
GA1	3/2/2003	12.7
GA1	4/6/2003	12.9

Site ID	Date	Nitrate as N (mg/L)
GA1	5/4/2003	4.6
GA1	5/17/2003	12.7
GA1	6/8/2003	19.9
GA1	7/13/2003	18.6
GA1	8/3/2003	18.5
GA1	9/7/2003	19.6
GA1	10/5/2003	21.1
GA1	11/2/2003	14.7
GA1	11/2/2003	20.8
GA1	12/7/2003	19.1
GA1	1/11/2004	20.8
GA1	2/8/2004	9.6
GA1	3/7/2004	13.1
GA1	4/4/2004	18.2
GA1	5/2/2004	23.8
GA1	6/6/2004	12.0
GA1	7/11/2004	18.7
GA1	8/8/2004	2.9
GA1	9/12/2004	2.5
GA1	10/3/2004	15.4
GA1	11/7/2004	19.3
GA1	12/5/2004	7.2
GA1	1/9/2005	0.8
GA1	2/6/2005	7.0
GA1	3/6/2005	5.9
GA1	4/3/2005	7.7
GA1	5/8/2005	2.1
GA1	6/5/2005	16.2
GA1	7/10/2005	19.5
GA1	8/7/2005	15.6
GA1	9/11/2005	3.8
GA1	10/2/2005	15.3
GA1	11/6/2005	16.7
GA1	12/4/2005	13.3
GA1	1/8/2006	9.5
GA1	2/5/2006	19.3
GA1	3/5/2006	8.9
GA1	4/2/2006	6.6
GA1	5/7/2006	5.6
GA1	6/4/2006	11.7

Site ID	Date	Nitrate as N (mg/L)
GA1	7/9/2006	13.6
GA1	8/6/2006	12.6
GA1	9/10/2006	13.4
GA1	10/8/2006	1.5
GA1	11/5/2006	15.9
GA1	12/3/2006	16.3
GA1	1/7/2007	12.3
GA1	2/4/2007	3.8
GA1	4/1/2007	13.1
GA1	5/6/2007	6.3
GA1	6/3/2007	11.0
GA1	7/8/2007	4.9
GA1	8/5/2007	11.2
GA1	9/9/2007	3.1
GA1	11/4/2007	7.3
GA1	12/2/2007	15.7
GA1	1/6/2008	10.5
GA1	2/5/2008	4.4
GA1	3/2/2008	9.4
GA1	4/6/2008	14.6
GA1	5/4/2008	7.5
GA1	6/8/2008	12.4
GA1	7/13/2008	9.4
GA1	8/3/2008	11.8
GA1	10/5/2008	1.7
GA1	11/2/2008	2.3
GA1	12/7/2008	1.2
GA1	1/11/2009	2.5
GA1	2/8/2009	1.0
GA1	3/8/2009	6.1
GA1	4/5/2009	5.1
GA1	5/3/2009	8.1
GA1	6/7/2009	7.4
GA1	7/12/2009	6.7
GA1	8/2/2009	7.1
GA1	9/13/2009	5.0
GA1	10/4/2009	14.8
GA1	11/8/2009	14.7
GA1	12/6/2009	6.6
GA1	1/10/2010	5.8

Site ID	Date	Nitrate as N (mg/L)
GA1	2/7/2010	5.5
GA1	4/11/2010	5.5
GA1	6/9/2010	5.0
GA1	10/3/2010	4.6
GA1	11/10/2010	13.1
GA1	12/5/2010	13.6
GA1	1/9/2011	5.9
GA1	2/6/2011	12.1
GA1	3/6/2011	18.2
GA1	4/3/2011	6.4
GA1	5/8/2011	15.9
GA1	6/1/2011	11.8
GA1	7/10/2011	11.2
GA1	8/7/2011	11.2
GA1	9/7/2011	11.1
GA1	10/6/2011	10.6
GA1	11/6/2011	12.0
GA1	12/3/2011	9.9
GA1	1/8/2012	11.5
GA1	2/10/2012	10.1
GA1	3/4/2012	9.8

CCAMP Data – Glen Annie Canyon/Tecolotito Creek Site 315ANN

Site ID	Date	Nitrate as N (mg/L)	Nitrite as N (mg/L)	Joint Nitrate/Nitrite as N (mg/L)	Total Nitrogen (mg/L)	Flow (cfs)
315ANN	2/13/2001	3.4157288	0.0198	3.4355288	N/A	N/A
315ANN	3/7/2001	5.6404469	0.0234	5.6638469	N/A	N/A
315ANN	4/4/2001	20.5168447	0.099	20.6158447	N/A	N/A
315ANN	5/8/2001	6.4719072	0.048	6.5199072	N/A	N/A
315ANN	6/4/2001	27.415718	0.075	27.490718	N/A	N/A
315ANN	7/11/2001	27.865156	0.081	27.946156	N/A	N/A
315ANN	8/7/2001	22.921338	0.066	22.987338	N/A	N/A
315ANN	9/4/2001	18.6292051	0.102	18.7312051	N/A	N/A
315ANN	10/8/2001	28.764032	0.042	28.806032	N/A	N/A
315ANN	11/5/2001	26.9	0.057	26.957	N/A	N/A
315ANN	12/5/2001	21.9	0.092	21.992	N/A	N/A
315ANN	1/3/2002	20.9	0.077	20.977	N/A	N/A
315ANN	2/12/2002	22	0.046	22.046	N/A	N/A
315ANN	3/7/2002	16.5	0.092	16.592	N/A	N/A
315ANN	3/27/2002	21.2	0.13	21.33	N/A	N/A
315ANN	1/29/2008	4.9	0.025	4.925	5.5	9.5073
315ANN	2/27/2008	8.1	0.036	8.136	8.4	3.034675
315ANN	3/26/2008	15	0.22	15.22	16	0.670095
315ANN	4/23/2008	12	0.88	12.88	14	0.8361375
315ANN	5/20/2008	13	0.13	13.13	14	0.478225
315ANN	6/18/2008	12	0.11	12.11	13	0.22305
315ANN	7/23/2008	12	0.059	12.059	13	0.20515
315ANN	8/20/2008	12	0.051	12.051	13	0.105
315ANN	9/24/2008	11	0.037	11.037	12	0.072425
315ANN	10/29/2008	9	1.3	10.3	15	0.124875
315ANN	11/18/2008	6.6	0.029	6.629	7.4	0.12605
315ANN	12/17/2008	5.4	0.2	5.6	7.6	1.4555125

Santa Barbara Channelkeepers Data – Carneros Creek Site L2

Site ID	Date	Nitrate as N (mg/L)
LC2	6/2/02	27.0
LC2	7/7/02	30.1
LC2	1/12/03	7.3
LC2	2/2/03	13.6
LC2	3/2/03	11.9
LC2	4/6/03	13.2
LC2	5/4/03	1.4
LC2	6/8/03	13.0
LC2	7/13/03	16.0
LC2	8/3/03	15.3
LC2	9/7/03	20.7
LC2	10/5/03	17.6
LC2	11/2/03	19.1
LC2	12/7/03	19.8
LC2	1/11/04	18.1
LC2	2/8/04	11.3
LC2	3/7/04	11.3
LC2	4/4/04	16.3
LC2	3/6/05	2.2
LC2	4/3/05	4.9
LC2	5/8/05	1.4
LC2	6/5/05	9.3
LC2	7/10/05	11.9
LC2	8/7/05	18.4
LC2	9/11/05	2.8
LC2	10/2/05	14.9
LC2	11/6/05	14.7
LC2	12/4/05	10.8
LC2	1/8/06	7.3
LC2	2/5/06	9.3
LC2	3/5/06	4.7
LC2	4/2/06	1.6
LC2	5/7/06	5.6
LC2	6/4/06	6.0
LC2	7/9/06	1.6
LC2	8/6/06	10.5
LC2	9/10/06	11.2
LC2	10/8/06	1.3
LC2	11/5/06	12.1

Site ID	Date	Nitrate as N (mg/L)
LC2	1/7/07	13.1

Santa Barbara Channelkeepers Data – Carneros Creek Site LC1

Site ID	Date	Nitrate as N (mg/L)
LC1	1/12/03	5.5
LC1	2/2/03	11.2
LC1	3/2/03	7.3
LC1	4/6/03	9.5
LC1	5/4/03	1.4
LC1	5/17/03	6.0
LC1	7/13/03	1.9
LC1	1/11/04	0.7
LC1	1/9/05	0.8
LC1	2/6/05	5.6

CCAMP Data – Carneros Creek Site 315LCR

Site ID	Date	Nitrate as N (mg/L)	Nitrite as N (mg/L)	Joint Nitrate/Nitrite as N (mg/L)	Total Nitrogen (mg/L)
315LCR	5/8/2001	4.7865147	0.033	4.8195147	
315LCR	6/4/2001	9.0786476	0.042	9.1206476	
315LCR	7/11/2001	12.2247136	0.051	12.2757136	
315LCR	8/7/2001	7.3033675	0.048	7.3513675	
315LCR	12/5/2001	8.27	0.042	8.312	
315LCR	3/27/2002	9.45	0.26	9.71	
315LCR	1/29/2008	1.4	0.014	1.414	1.8
315LCR	2/27/2008	0.99	0.022	1.012	1.2
315LCR	12/17/2008	4.7	0.19	4.89	6.8

Percent Nitrite in Joint Nitrate/Nitrite for Paired Samples (mg/L as nitrogen)

Site ID	Date	Nitrate as N	Nitrite as N	Joint Nitrate/Nitrite as N	% Nitrite in Joint Nitrate/Nitrite
315GBR	10/28/2008	0.135	N/A	0.135	0
315GBR	11/18/2008	0.232	N/A	0.232	0
315GBR	12/16/2008	0.553	N/A	0.553	0
315ANN	2/13/2001	3.42	0.02	3.44	0.58
315ANN	3/7/2001	5.64	0.02	5.66	0.41
315ANN	4/4/2001	20.52	0.10	20.62	0.48
315ANN	5/8/2001	6.47	0.05	6.52	0.74
315ANN	6/4/2001	27.42	0.08	27.49	0.27
315ANN	7/11/2001	27.87	0.08	27.95	0.29
315ANN	8/7/2001	22.92	0.07	22.99	0.29
315ANN	9/4/2001	18.63	0.10	18.73	0.54
315ANN	10/8/2001	28.76	0.04	28.81	0.15
315ANN	11/5/2001	26.9	0.057	26.957	0.21
315ANN	12/5/2001	21.9	0.092	21.992	0.42
315ANN	1/3/2002	20.9	0.077	20.977	0.37
315ANN	2/12/2002	22	0.046	22.046	0.21
315ANN	3/7/2002	16.5	0.092	16.592	0.55
315ANN	3/27/2002	21.2	0.13	21.33	0.61
315ANN	1/29/2008	4.9	0.025	4.925	0.51
315ANN	2/27/2008	8.1	0.036	8.136	0.44
315ANN	3/26/2008	15	0.22	15.22	1.45
315ANN	4/23/2008	12	0.88	12.88	6.83
315ANN	5/20/2008	13	0.13	13.13	0.99
315ANN	6/18/2008	12	0.11	12.11	0.91
315ANN	7/23/2008	12	0.059	12.059	0.49
315ANN	8/20/2008	12	0.051	12.051	0.42
315ANN	9/24/2008	11	0.037	11.037	0.34
315ANN	10/29/2008	9	1.3	10.3	12.62
315ANN	11/18/2008	6.6	0.029	6.629	0.44
315ANN	12/17/2008	5.4	0.2	5.6	3.57
315LCR	5/8/2001	4.79	0.033	4.82	0.68
315LCR	6/4/2001	9.08	0.042	9.12	0.46
315LCR	7/11/2001	12.22	0.051	12.28	0.42
315LCR	8/7/2001	7.30	0.048	7.35	0.65
315LCR	12/5/2001	8.27	0.042	8.31	0.51
315LCR	3/27/2002	9.45	0.26	9.71	2.68
315LCR	1/29/2008	1.4	0.014	1.414	0.99
315LCR	2/27/2008	0.99	0.022	1.012	2.17
315LCR	12/17/2008	4.7	0.19	4.89	3.89

APPENDIX B – STEPL SPREADSHEETS

STEPL Spreadsheets for Glen Annie Canyon and Carneros Creek Watersheds

Step 1: Select the state and county where your watersheds are located. Select a nearby weather station. This will automatically specify values for rainfall parameters in Table 1 and USLE parameters in Table 4.
Step 2: (a) Enter land use areas in acres in Table 1; (b) enter total number of agricultural animals by type and number of months per year that manure is applied to croplands in Table 2;
(c) enter values for septic system parameters in Table 3; and (d) if desired, modify USLE parameters associated with the selected county in Table 4.
Step 3: You may stop here and proceed to the BMPs sheet. If you have more detailed information on your watersheds, click the Yes button in row 10 to display optional input tables.
Step 4: (a) Specify the representative Soil Hydrologic Group (SHG) and soil nutrient concentrations in Table 5; (b) modify the curve number table by landuse and SHG in Table 6;
(c) modify the nutrient concentrations (mg/L) in runoff in Table 7; and (d) specify the detailed land use distribution in the urban area in Table 8.
Step 5: Select BMPs in BMPs sheet. **Step 6**: View the estimates of loads and load reductions in Total Load and Graphs sheets.

Show optional input tables? Yes No ☐ **Treat all the subwatersheds as parts of a single watershed** ☑ **Groundwater load calculation**

State: California **County**: Santa Barbara **Weather Station (for rain correction factors)**: CA SANTA MARIA WSO ARPT

1. Input watershed land use area (ac) and precipitation (in)

									Rain correction factors		
									0.865	0.418	
Watershed	Urban	Cropland	Pastureland	Forest	User Defined	Feedlots	Feedlot Percent Paved	Total	Annual Rainfall	Rain Days	Avg. Rain/Event
Glen Annie	718	301	199	2000	0	0	0-24%	3218	18.68	42.3	0.914
Carneros	632	170	308	1615	0	0	0-24%	2725	18.68	42.3	0.914

2. Input agricultural animals

Watershed	Beef Cattle	Dairy Cattle	Swine (Hog)	Sheep	Horse	Chicken	Turkey	Duck	# of months manure applied
Glen Annie	0	0	0	0	0	0	0	0	0
Carneros	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	

3. Input septic system and illegal direct wastewater discharge data

Watershed	No. of Septic Systems	Population per Septic System	Septic Failure Rate, %	Wastewater Direct Discharge, # of People	Direct Discharge Reduction, %
Glen Annie	18	2.43	2	0	0
Carneros	8	2.43	2	0	0

4. Modify the Universal Soil Loss Equation (USLE) parameters

Watershed	Cropland					Pastureland					Forest				
	R	K	LS	C	P	R	K	LS	C	P	R	K	LS	C	P
Glen Annie	62.886	0.269	9.274	0.200	0.998	62.886	0.269	9.274	0.040	1.000	62.886	0.269	9.274	0.003	1.000
Carneros	62.886	0.269	9.274	0.200	0.998	62.886	0.269	9.274	0.040	1.000	62.886	0.269	9.274	0.003	1.000

Optional Data Input:

5. Select average soil hydrologic group (SHG), SHG A = highest infiltration and SHG D = lowest infiltration

Watershed	SHG A	SHG B	SHG C	SHG D	SHG Selected	Soil N conc.%	Soil P conc.%	Soil BOD conc.%
Glen Annie					D	0.080	0.031	0.160
Carneros					D	0.080	0.031	0.160

Optional Data Input:

5. Select average soil hydrologic group (SHG), SHG A = highest infiltration and SHG D = lowest infiltration

Watershed	SHG A	SHG B	SHG C	SHG D	SHG Selected	Soil N conc.%	Soil P conc.%	Soil BOD conc.%
Glen Annie					D	0.080	0.031	0.160
Carneros					D	0.080	0.031	0.160

6. Reference runoff curve number (may be modified)

SHG	A	B	C	D
Urban	83	89	92	93
Cropland	67	78	85	89
Pastureland	49	69	79	84
Forest	39	60	73	79
User Defined	50	70	80	85

6a. Detailed urban reference runoff curve number (may be modified)

Urban\SHG	A	B	C	D
Commercial	89	92	94	95
Industrial	81	88	91	93
Institutional	81	88	91	93
Transportatic	98	98	98	98
Multi-Family	77	85	90	92
Single-Famil	57	72	81	86
Urban-Cultiv	67	78	85	89
Vacant-Devel	77	85	90	92
Open Space	49	69	79	84

7. Nutrient concentration in runoff (mg/l)

Land use	N	P	BOD
1. L-Croplan	**13.8**	**0.3**	**4**
1a. w/ manur	8.1	2	12.3
2. M-Croplan	**13.8**	**0.4**	**6.1**
2a. w/ manur	12.2	3	18.5
3. H-Croplan	**13.8**	**0.5**	**9.2**
3a. w/ manur	18.3	4	24.6
4. Pasturelar	**1.26**	**0.3**	**13**
5. Forest	**0.2**	**0.1**	**0.5**
6. User Defin	**0**	**0**	**0**

7a. Nutrient concentration in shallow groundwater (mg/l) (may be modified)

Landuse	N	P	BOD
Urban	2.2	0.063	0
Cropland	2.2	0.063	0
Pastureland	1.44	0.063	0
Forest	0.11	0.009	0
Feedlot	6	0.07	0
User-Defined	0	0	0

8. Input or modify urban land use distribution

Watershed	Urban Area (ac.)	Commercial %	Industrial %	Institutional %	Transportation %	Multi-Family %	Single-Family %	Urban-Cultivated %	Vacant (developed)	Open Space %	Total % Area
Glen Annie	718	10	5	5	5	4	30	0	0	41	100
Carneros	632	10	5	5	10	10	30	0	0	30	100

9. Input irrigation area (ac) and irrigation amount (in)

Watershed	Total Cropland (ac)	Cropland: Acres Irrigated	Water Depth (in) per Irrigation - Before BMP	Water Depth (in) per Irrigation - After BMP	Irrigation Frequency (#/Year)
Glen Annie	301	0	0	0	0
Carneros	170	0	0	0	0

Input Ends Here.

Total Load This is the summary of annual nutrient and sediment load for each subwatershed. This sheet is initially protected.

1. Total load by subwatershed(s)

Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)	N Reduction	P Reduction	BOD Reduction	Sediment Reduction	N Load (with BMP)	P Load (with BMP)	BOD (with BMP)	Sediment Load (with BMP)	%N Reduction	%P Reduction	%BOD Reduction	%Sed Reduction
	lb/year	lb/year	lb/year	t/year	lb/year	lb/year	lb/year	t/year	lb/year	lb/year	lb/year	t/year	%	%	%	%
Glen Annie	18907.4	3837.9	31848.8	2483.7	0.0	0.0	0.0	0.0	18907.4	3837.9	31848.8	2483.7	0.0	0.0	0.0	0.0
Carneros	13539.2	2937.4	28391.5	1793.8	0.0	0.0	0.0	0.0	13539.2	2937.4	28391.5	1793.8	0.0	0.0	0.0	0.0
Total	32446.7	6775.3	60240.3	4277.5	0.0	0.0	0.0	0.0	32446.7	6775.3	60240.3	4277.5	0.0	0.0	0.0	0.0

c. Nutrient and sediment load by land uses with BMP (lb/year)

Watershed	Urban				Cropland				Pastureland				Forest			
	N	P	BOD	Sediment	N	P	BOD	Sediment	N	P	BOD	Sediment	N	P	BOD	Sediment
Glen Annie	2486.6	361.6	9501.5	111749.1	13603.6	2585.9	14724.5	3940259.7	1179.0	403.4	5218.4	521963.5	1069.4	462.3	2358.6	393439.8
Carneros	2513.3	384.5	9682.1	114282.0	7813.1	1510.5	8576.2	2306652.6	1872.0	642.5	8171.2	837360.9	882.1	380.4	1941.7	329303.0
Total	4999.9	746.1	19183.6	226031.1	21416.7	4096.4	23300.7	6246912.2	3051.1	1046.0	13389.6	1359324.4	1951.4	842.7	4300.3	722742.8

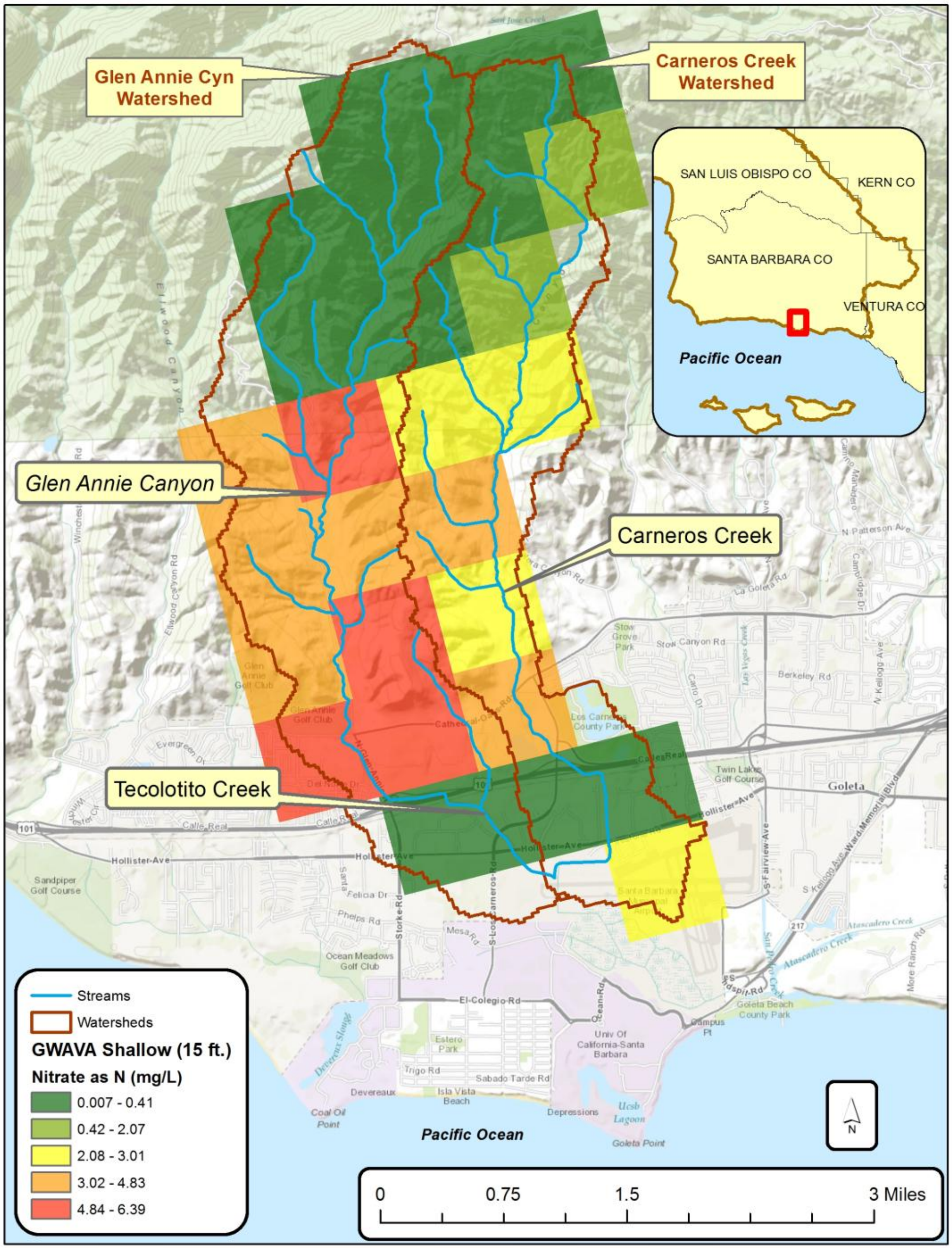
d. Load from groundwater by land uses with BMP (lb/year)

Watershed	Urban				Cropland				Pastureland				Forest			
	N	P	BOD	Sediment	N	P	BOD	Sediment	N	P	BOD	Sediment	N	P	BOD	Sediment
Glen Annie	237.0	6.8	0.0		181.7	5.2	0.0		78.6	3.4	0.0		60.4	4.9	0.0	
Carneros	180.7	5.2	0.0		102.6	2.9	0.0		121.7	5.3	0.0		48.7	4.0	0.0	
Total	417.6	12.0	0.0	0.0	284.3	8.1	0.0	0.0	200.3	8.8	0.0	0.0	109.1	8.9	0.0	0.0

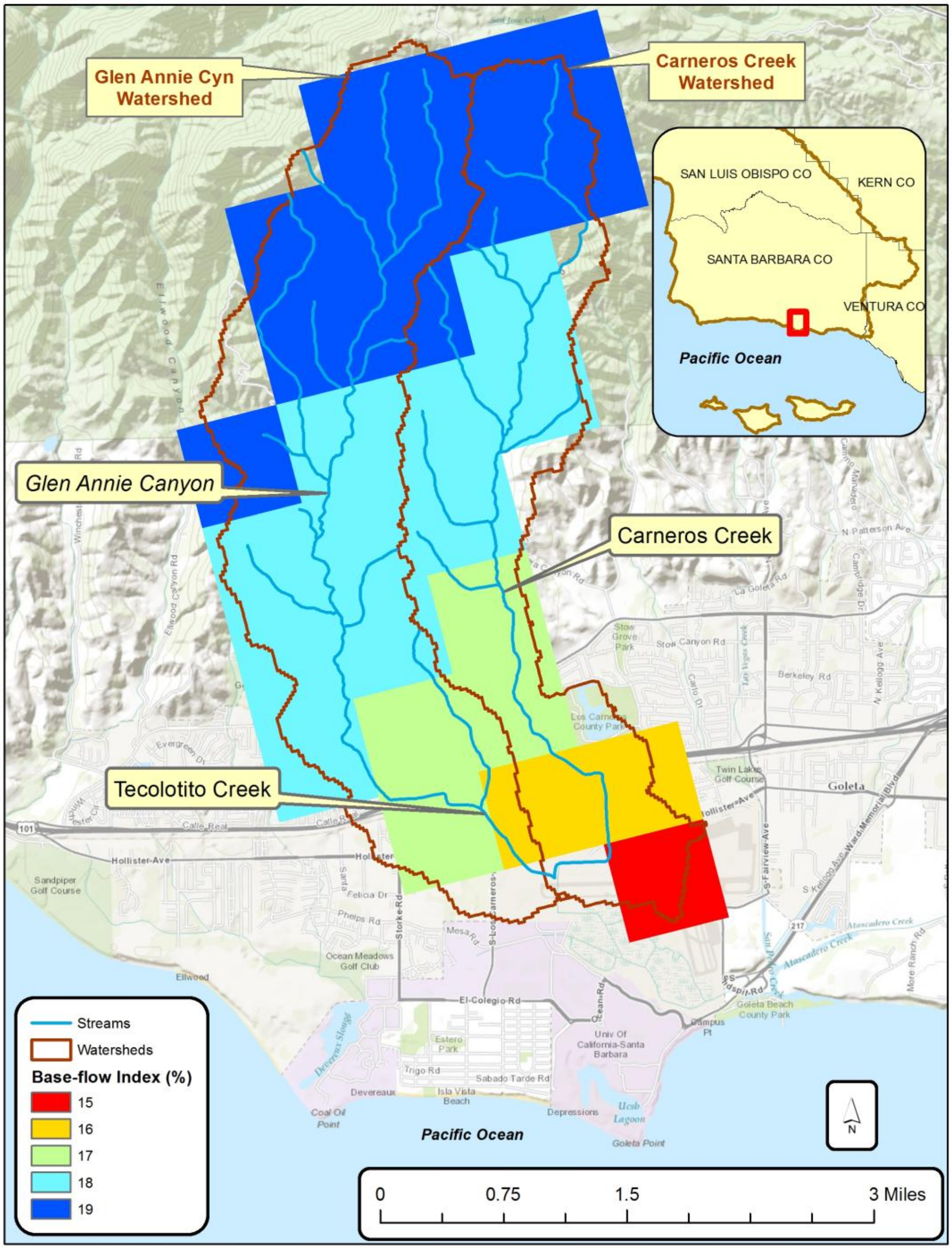
2. Total load by land uses (with BMP)

Sources	N Load (lb/yr)	P Load (lb/yr)	BOD Load (lb/yr)	Sediment Load (t/yr)
Urban	4999.88	746.09	19183.60	113.02
Cropland	21416.71	4096.39	23300.74	3123.46
Pastureland	3051.08	1045.95	13389.62	679.66
Forest	1951.42	842.72	4300.35	361.37
Feedlots	0.00	0.00	0.00	0.00
User Defined	0.00	0.00	0.00	0.00
Septic	16.17	6.33	66.01	0.00
Gully	0.00	0.00	0.00	0.00
Streambank	0.00	0.00	0.00	0.00
Groundwater	1011.40	37.79	0.00	0.00
Total	32446.66	6775.29	60240.33	4277.51

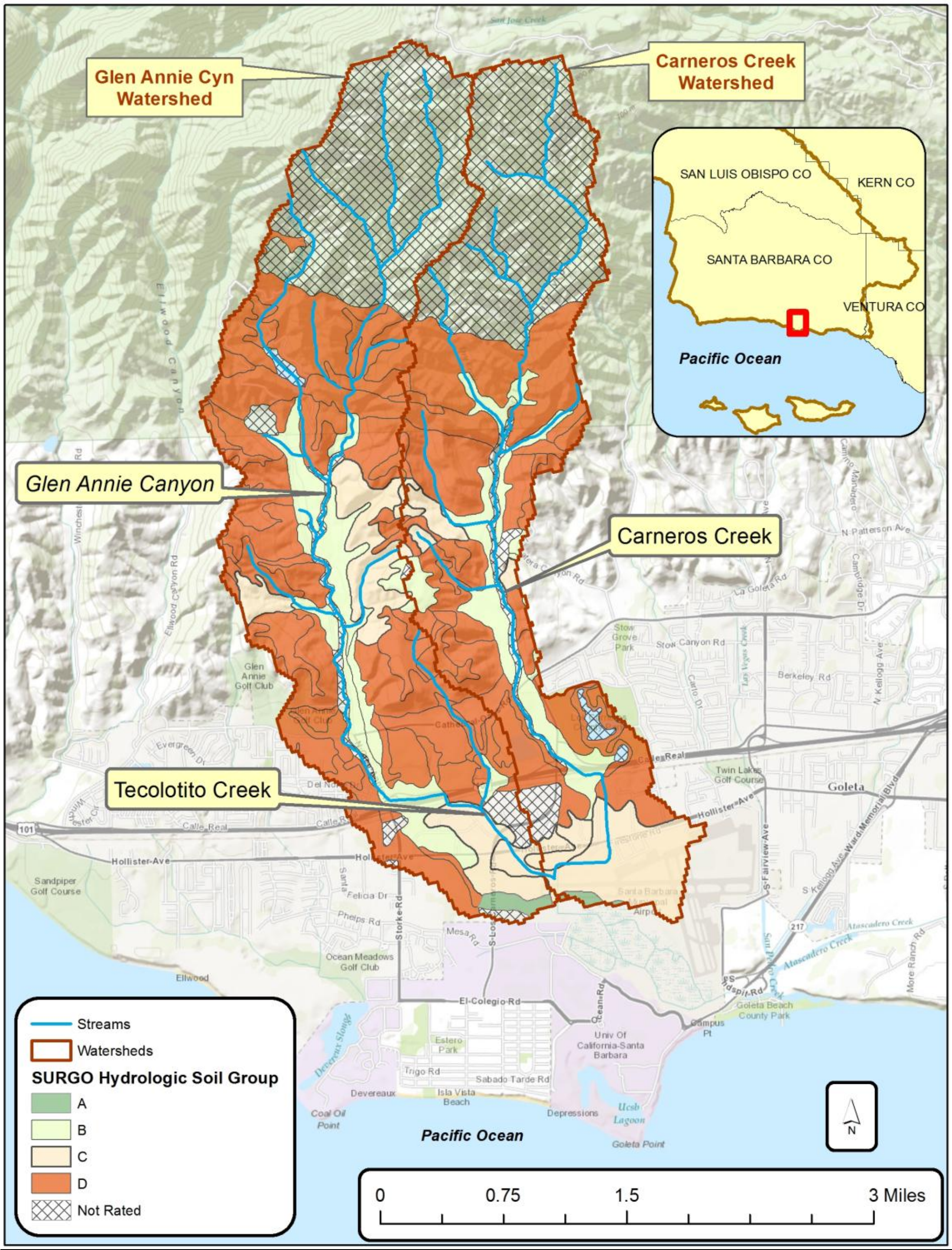
APPENDIX C – SUPPLEMENTAL FIGURES



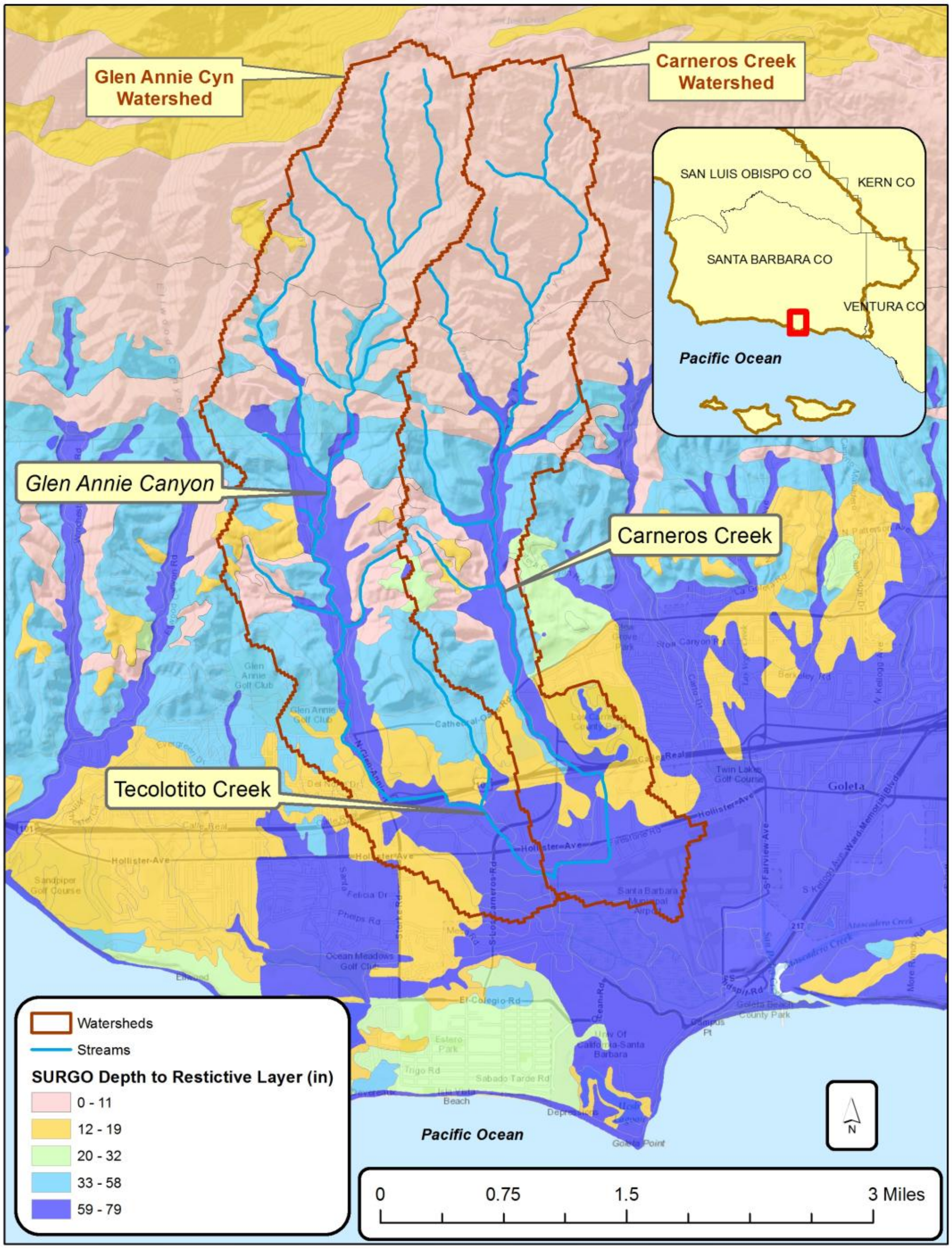
Nolan, B.T. and Hitt, K.J., 2006, *Vulnerability of shallow ground water and drinking-water wells to nitrate in the United States*: Environmental Science and Technology, vol. 40, no. 24, pages 7834-7840.

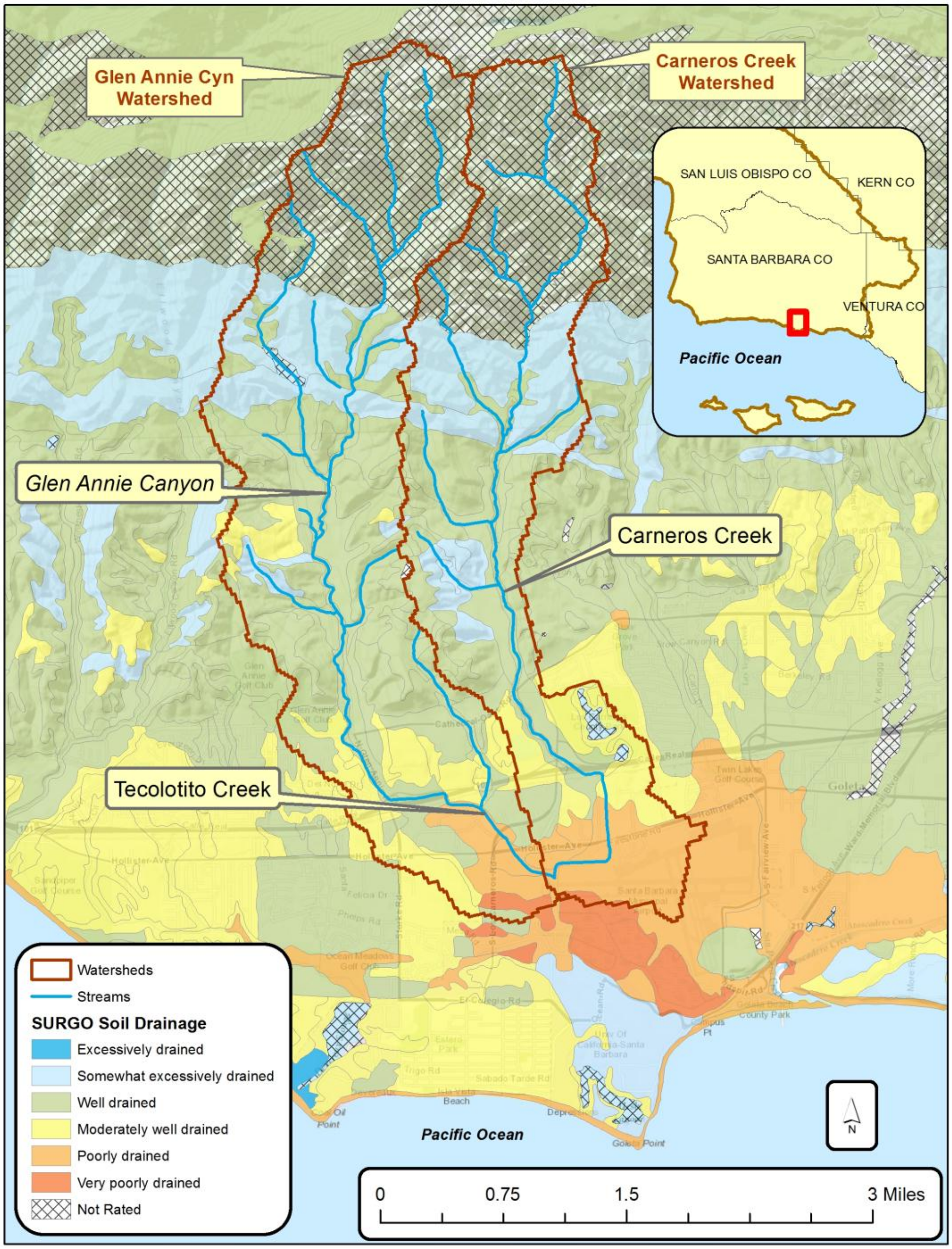


David M. Wolock. 2003. *Base-flow index grid for the conterminous United States*: U.S. Geological Survey Open-File Report 03-263
http://water.usgs.gov/GIS/metadata/usgswrd/XML/bfi48grd.xml
Base flow is the component of streamflow that can be attributed to ground-water discharge into streams. The BFI is the ratio of base flow to total flow, expressed as a percentage.

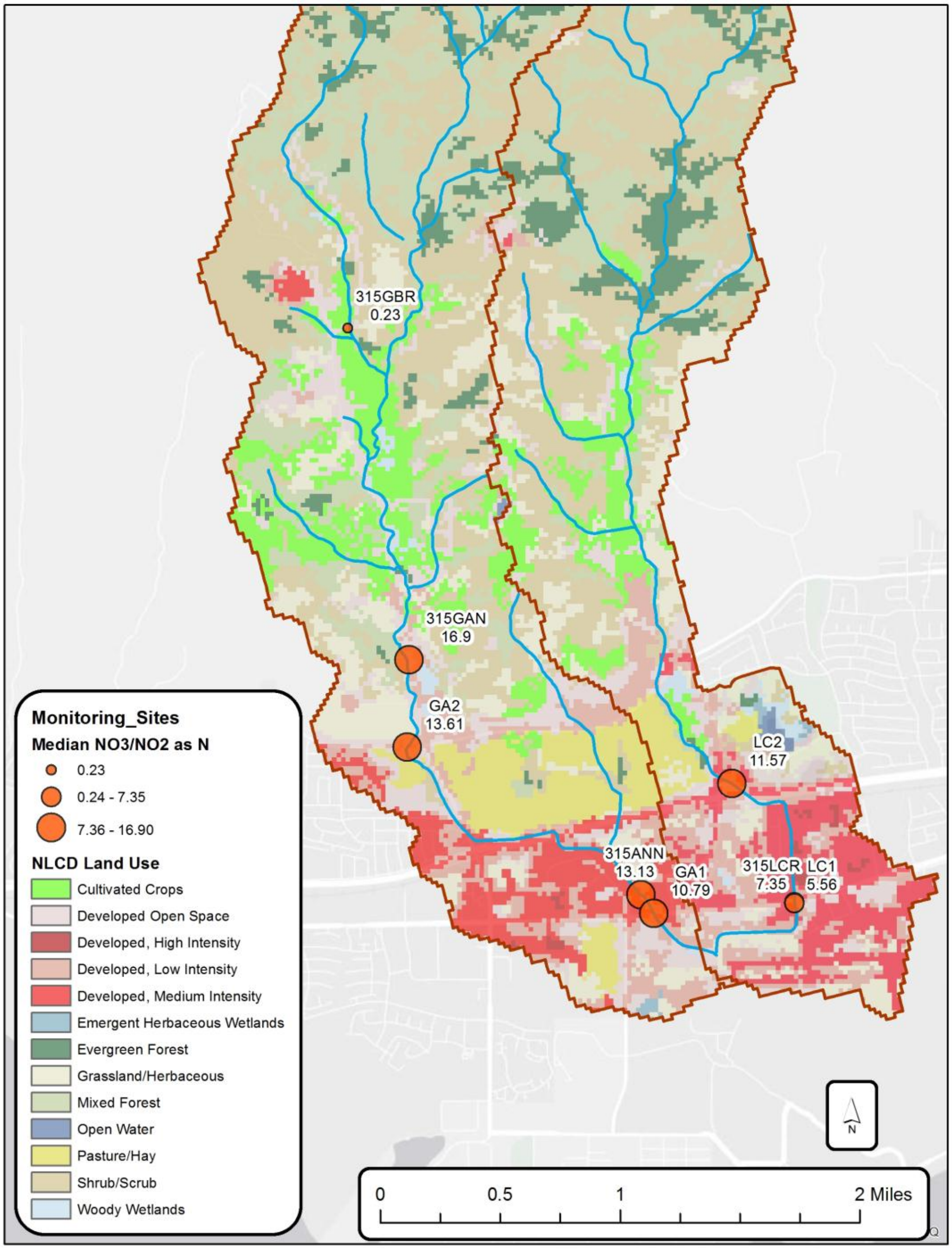


Hydrologic Soil Group Descriptions:	
A	Well-drained sand and gravel; high permeability
B	Moderate to well-drained; fine to moderately course texture; moderate permeability
C	Poor to moderately well-drained; moderately fine to fine texture; slow permeability
D	Poorly drained; clay soils, or shallow soils over nearly impervious layers(s)


Glen Annie Cyn Watershed
Carneros Creek Watershed
SAN LUIS OBISPO CO
KERN CO
SANTA BARBARA CO
VENTURA CO
Pacific Ocean
Glen Annie Canyon
Carneros Creek
Tecolotito Creek
Watersheds
Streams
SURGO Depth to Restictive Layer (in)
0 - 11
12 - 19
20 - 32
33 - 58
59 - 79
Pacific Ocean
N
0
0.75
1.5
3 Miles



Glen Annie Cyn Watershed
Carneros Creek Watershed
SAN LUIS OBISPO CO
KERN CO
SANTA BARBARA CO
VENTURA CO
Pacific Ocean
Glen Annie Canyon
Carneros Creek
Tecolotito Creek
Watersheds
Streams
SURGO Soil Drainage
Excessively drained
Somewhat excessively drained
Well drained
Moderately well drained
Poorly drained
Very poorly drained
Not Rated
Pacific Ocean
N
0
0.75
1.5
3 Miles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0.23
315GAN
16.9
GA2
13.61
LC2
11.57
315ANN
13.13
GA1
10.79
315LCR
7.35
LC1
5.56
Monitoring_Sites
Median NO3/NO2 as N
0.23
0.24 - 7.35
7.36 - 16.90
NLCD Land Use
Cultivated Crops
Developed Open Space
Developed, High Intensity
Developed, Low Intensity
Developed, Medium Intensity
Emergent Herbaceous Wetlands
Evergreen Forest
Grassland/Herbaceous
Mixed Forest
Open Water
Pasture/Hay
Shrub/Scrub
Woody Wetlands
N
0
0.5
1
2 Miles

SANTA BARBARA, CALIFORNIA (047902)

Monthly Total Precipitation (inches)

Latitude: 34º25’00”| Longitude: -119º41’07”| Elevation: 5 feet

Year(s)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1893	3.92	3.1 x	7.8	0.38	0.09	0	0	0	0	0.82	0.07	2.94	16.02
1894	0.99	0 z	0.29	0	0.91	0	0.12	0 z	1.36	0.68	0.07	0 z	4.42
1895	6.25	0.67	1.99	0.46	0.02	0.05	0	0	0	0.55	0.77	0.93	11.69
1896	6.84	0	2.37	1.78	0.08	0	0.4	0	0 z	0.92	3.51	2.92	18.82
1897	4.35	3.65	0 z	0.02	0	0	0 z	0 z	0 z	1.44	0	0	9.46
1898	0.63	1.39	0.28	0	1.25	0	0	0	3.17	0.14	0	0.36	7.22
1899	4.48	0	2.78	0.64	0	0	0	0	0	2.06	1.97	2.35	14.28
1900	2.32	0.05	1.58	0.42	1.9	0 z	0.02	0 z	0.04	0.15	0 z	0.02 z	6.48
1901	4.86	3.65	0.16	2.07	0.34	0.1	0.06	0.09	0.36	2.42	1.16	0	15.27
1902	1.36	4.4	2.89	1.4	0.07	0	0	0 z	0	1.48	4.01	2.24	17.85
1903	2.06	1.63	6.12	2.91	0.27	0.02	0	0 z	0	0	0.05	0	13.06
1904	0.46	4.69	4.4	1.89	0.09	0	0	0.1	0 z	0.51	0	1.53	13.67
1905	3.73	8.22	6.4	0.51	1.44	0.05	0.18	0 z	0.03	0.16	1.14	0.07	21.93
1906	4.26	3.67	9.96	0.83	2.4	0 z	0	0.04	0	0	0.35	6.46	27.97
1907	12.46	2.34 z	5.64	0.27	0	0.16	0 z	0.03	0	6.23	0	1.8	26.59
1908	4.29 x	5.96	0.21	0.49 z	0.2	0	0	0	1.16 z	0.2 z	1.84	2.48	10.69
1909	15.67	7.92	6.91	0	0.03	0.08	0	0 z	0.17	0.57	2.34	9.53	43.22
1910	2.91	0.08	3.62	0.39	0	0	0.02	0	2.56	0.29	0.33	0.75	10.95
1911	14.21	4.92	7.76	1.02	0.03	0.05	0	0	0.12	0.28	0.02	2.33	30.74
1912	0.42	0	9.48	2.12	1.58	0	0	0	0	0.28	0.21	0	14.09
1913	3.14	6.28 s	0.64	1.04	0.19	0.5	0.09	0.07	0.17	0	3.43 w	2.71	8.55
1914	15.91	7.3	0.95	0.7	0.03 z	0.16	0.05	0	0	0.12	0.04	4.38	29.61
1915	4.94	8.03 p	1.15	0.97	1.57 z	0 z	0 z	0 z	0.05	0 z	0.65	4.06	11.82
1916	17.22 n	1.89 w	1.71 y	0.3 z	0	0 a	0 z	0.11 z	2.02 z	2.82	0.1 z	6.12	8.94
1917	3.05 v	7.61 t	0.28 z	0.28	0.09	0 z	0 z	0.03 z	0.05 z	0 z	0.17 z	0.03 z	0.37
1918	0.51	10.47	11.63 t	0.05	0 z	0 z	0.25	0.58 y	2.13	0.02 z	6.04 w	0.83	14.24
1919	1.2	1.95 s	2.62 a	0.17	1.07	0 z	0 z	0 z	0.84 z	0.27	0.23	2.11	7.67

Year(s)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1920	0.33	6.26 u	4.2	0.81 z	0 z	0.08 z	0 z	0	0 z	0.4	0.56	1.51	7
1921	5.32	1.58	1.77	0.38 z	2.69 x	0.1	0 z	0 z	0.24	0.32 z	0.02	7.25	16.28
1922	4.64	3.48	2.73	0.09 z	0.45	0 z	0 z	0 z	0 z	0.37 z	1.98	8.66 u	13.28
1923	1.93 x	0.91	0	3.29	0 z	0.03	0 z	0.03 z	0.13	0.25	0 z	0.08	4.69
1924	0 z	0.06	3.56	0.62	0 z	0 z	0 z	0 z	0 z	0.85	1.2	1.2	7.49
1925	0.6	1.45	2.79	1.89	2.23	0.05	0.05	0 z	0	0.71	0.8	2.57	13.14
1926	2.08	4.28	0.25	6.13	0	0	0	0	0	0.36	6.84	0.62	20.56
1927	1.94	9.86	2.28 a	0.78	0	0	0 z	0.05	0.11	3.48	1.49	3.28	23.27
1928	0	1.95	2.46	0.17	0.5	0.05	0	0	0	0.1	2.46	4.41	12.1
1929	1.53	2.28	2.39	1.17	0	0.2	0	0	0.05	0	0	0	7.62
1930	5.82	1.21	4.93	0.95	0.63	0.12	0	0	0.01	0.04	2.64	0	16.35
1931	4.25	4.07	0	1.43	2.11	0	0	0.23	0.01	0	2.81	9.84	24.75
1932	2.4	6.17	0.23	0.35	0.09	0	0	0	0.11	0.1	0	0.67	10.12
1933	6.42	0	0.3	0.2	0.11	0.75	0	0	0	0.88	0.11	6.28	15.05
1934	1.49	3.67	0	0	0	1	0	0	0.04 a	1.89	3.48	3.63	15.2
1935	4.1	1.58	3.16	3.32	0	0	0.07	0.27	0.02	0.78	0.71	1.46	15.47
1936	0.73	10.49	1.97	0.65	0.01	0.01	0.01	0.7	0	1.86	0	6.93	23.36
1937	3.09	7.99	4.79	0.03	0.11	0	0	0	0	0.16 a	0.09	4.4	20.66
1938	1.9	8.2	10.26	1.09	0	0	0	0 a	0.19	0.14	0.08	4.94	26.8
1939	2.84	1.27	3.62	0.17	0.1	0	0	0	0.26	0.09	0.02	1.41	9.78
1940	6.39	4.87	0.82	1.06	0.02	0	0	0	0	0.75	0.43	8.92	23.26
1941	9.68	8.21	11.71	5.5	0.01	0	0.03	0.01	0	0.89	0.44	5	41.48
1942	0.8	0.75	1.76	3.19	0	0	0	0	0.03	1.44	0.62	1.36	9.95
1943	12.84	4.21	2.92	0.92	0.03	0	0	0	0	0.39	0.12 a	5.57	27
1944	1.44	7.05	1.74	1.57	0.01	0.06	0	0	0	0	2.66	1.23	15.76
1945	0.6	5.87	4.87	0	0	0	0	0	0.06	0.73	0.37	6.35	18.85
1946	0.4	0.72	2.69	0	0.05	0.02	0	0	0	0.89	5.95	3.17	13.89
1947	0.6	0.76	1.8	0.1	0.08	0	0	0.01	0.05	0.22	0	0.37	3.99
1948	0	1.71	4.29	2.01	0.35	0.09	0	0	0	0.08 f	0	2.64	11.09
1949	1.4	1.35	2.78	0.24	2.43	0.03	0	0	0	0.02	1.72	4.16	14.13

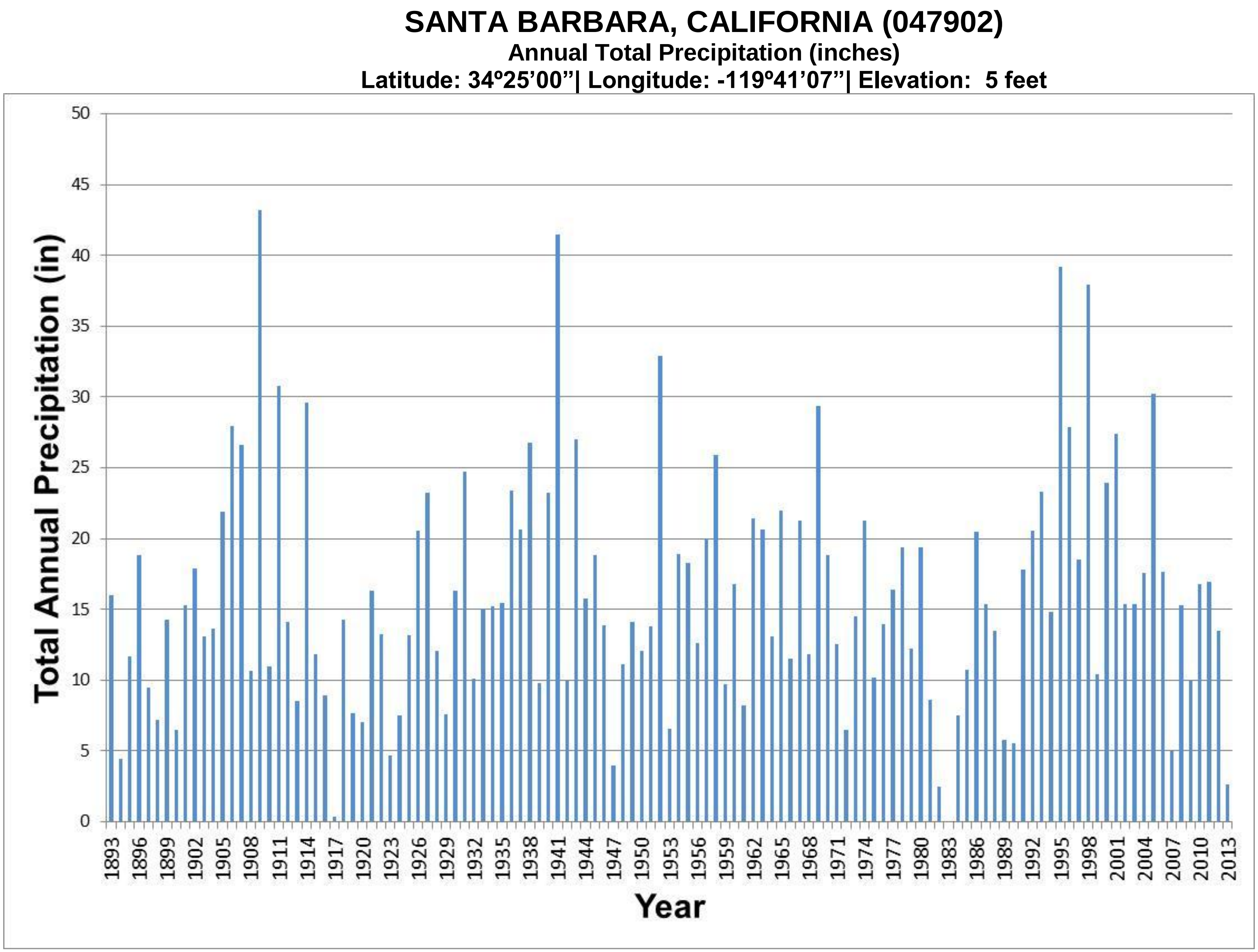
Year(s)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1950	2.54	2.76	1.29	0.61	0.05	0.01	0.81	0.02	0.41	1.21	1.88	0.5	12.09
1951	2.53	1.21	1.2	1.45	0.01	0.01	0	0.06	0	0.49	2.04	4.8	13.8
1952	13.89	0.71	7.37	1.79	0	0.08	0.03	0.01	0.04	0.1	3.6	5.26	32.88
1953	1.78	0.03	0.71	1.42	0.17	0.27 c	0	0	0.01	0	2.08	0.09	6.56
1954	5.98	2.95	3.81	0.44	0.06	0.02	0	0.02	0	0.03	2.03	3.6	18.94
1955	4.39	2.29	0.7	3.45	0.4 h	0.01 a	0	0.01	0	0	1.36	6.07	18.28
1956	7.19	1.15	0	2.42	1.64	0	0	0	0	0.11	0	0.14	12.65
1957	5.39	3.74	0.54	2.31	1.57	0.06	0	0	0	1.41	0.51	4.51	20.04
1958	3.71	9.84	6.2	5.43	0.33	0	0	0	0.27	0	0.11	0.04	25.93
1959	2.68	5.05	0	0.89	0.02	0	0	0	0.01	0.01	0	1.01	9.67
1960	3.12	3.39	0.63	2.64	0	0.01 a	0	0	0	0.01 f	6.57	0.41	16.77
1961	1.81	0.02	0.8	0.2	0.09	0	0 j	0.01	0.04	0	3.74	1.47	8.18
1962	2.18	17.33	1.41	0	0	0	0	0	0	0.42	0	0.12	21.46
1963	1.79	5.39	4.09	2.42	0.29	1.21	0	0.07	0.91	0.88	3.56	0	20.61
1964	1.45	0	2.33	0.84	0.1	0.05	0	0	0.01	0.8	2.59	4.94	13.11
1965	0.76	0.46	2.33	6.55	0.02	0	0	0	0.05	0	8.26	3.53	21.96
1966	1.51	0.78	0.06	0.02	0.12	0.01	0.01	0	0.04	0.04	3.31	5.63	11.53
1967	7.61	0.5	2.57	5.18	0	0	0	0	0.23	0	4.05	1.09	21.23
1968	1.44	2.02	4.22	0.62	0	0	0	0.02	0	1.03	0.65	1.81	11.81
1969	15.55	8.35	1	1.92	0.06	0.08	0.02	0	0.05	0.07	2.03	0.2	29.33
1970	3.23	3.8	2.48	0	0	0	0.02	0	0	0.05	4.54	4.67	18.79
1971	1.21	0.88	0.82	0.73	1.1	0	0	0	0	0	0.48	7.33	12.55
1972	0.12	0.53	0	0.15	0.02	0.01	0.01	0	0.01	0.13	5.47	0 z	6.45
1973	0 z	7.38	3.01	0.05	0.03	0.03	0 z	0.03	0.01	0.7	1.75	1.54	14.53
1974	8.04	0	4.93	0 z	0	0.05	0	0	0.05	0.9	0.09	7.21	21.27
1975	0	5.27	3.86	0.8	0	0	0	0.03	0	0.03	0.2	0 z	10.19
1976	0	5.61	1.25	0.79	0.01	0.2	0	0	4.01	0.12	1.06	0.94	13.99
1977	4.01	0.19	1.59	0	2.96	0.1	0	0.5	0	0	0	7.04	16.39
1978	5.35 d	7.87	0 z	1.8	0	0 z	0	0	1.16	0	3.18	0 z	19.36
1979	4.3	4.82	2.14	0	0	0	0 z	0 z	0	0.45	0.53	0 z	12.24

Year(s)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1980	6.71	8.98 a	3.05	0.52	0.09	0	0 z	0 z	0	0 z	0	0 b	19.35
1981	0 z	2.66	5.95	0 z	0	0	0	0	0	0 b	0 f	0 z	8.61
1982	0 z	0	0	0 z	0	0	0	0	0	0	0 z	2.49	2.49
1983	0 z	0 z	0 z	0 z	0	0	0	0 z	0	0	0 z	0 z	0
1984	0	0 z	0	0.12	0	0.01	0.01	0.16	0.67	0.35	1.99	4.17	7.48
1985	1.57	2.19	1.87	0.02	0	0	0.01	0	0.09	0.58	3.5	0.88	10.71
1986	2.07	7.94	6.2	0.87	0	0	0	0	1.45	0	1.8	0.12	20.45
1987	1.56	3	3.66	0.16	0	0.17	0.13	0	0	2.45	1.08	3.18	15.39
1988	2.43	2.19	0.02	3.97	0.04	0.02	0.02	0	0.17	0	1.01	3.64	13.51
1989	0.35	2.53	0.9	0.34	0.39	0.05	0	0	0 z	0.55	0.63	0	5.74
1990	2.01	2.36	0 z	0.09	0.8	0	0	0	0.1	0	0.15	0.05	5.56
1991	2.26	0 z	11.05	0.03	0.02	0.44	0	0.18	0.02	0.5	0.09	3.24	17.83
1992	2.38	8.74	4.16	0.02	0.27	0	0 z	0	0	0 z	0 z	4.97	20.54
1993	9.29	7.45	3.05	0	0.05	0.71	0.01	0	0	0.15	1.19	1.38	23.28
1994	1.5	6.27	1.81	0.6	0.4	0	0	0	0.07	0.53	1.87	1.76	14.81
1995	24.2	1.33	8.59	0.29	0.76	0.48	0	0	0	0	0.26	3.27	39.18
1996	2.99	8.31	2.58	0.84	0.6	0	0	0	0	3.02	2.99	6.56	27.89
1997	7.39	0.07	0	0	0.02	0	0.02	0.08	0.04	0.11	3.72	7.07	18.52
1998	5.62	21.76	4.3	1.42	2.76	0.09	0	0	0.14	0	0.79	1.08	37.96
1999	2.22	0.82	3.71	2.15	0.02	0.08	0	0	0.16	0	1.21	0.02	10.39
2000	2.28	9.79	3.78	3.96	0	0.15	0	0	0.08	3.8	0	0.11	23.95
2001	7	5.85	5.79	1.58	0.08	0	0	0	0	0.62	4.24	2.23	27.39
2002	1.03	0.46	0.4	0.08	0.1	0.03	0	0	0.23	0.03	6.82	6.15	15.33
2003	0	3.17	4.8	1.16	1.92	0.13	0.02	0	0	0.96	0.87	2.35	15.38
2004	0.48	4.95	0.59	0	0	0.02	0	0.01	0	3.91	0.18	7.45	17.59
2005	12.06	7.31	3.96	0.9	0.51	0	0	0	0.1	1.07	1.71	2.62	30.24
2006	2.01	2.74	4.01	6.31	1.1	0	0	0.1	0.02	0.2	0.25	0.89	17.63
2007	1.87	1.84	0.08	0.72	0	0	0	0.01	0.17	0.28	0	0 z	4.97
2008	11.2	1.88	0 z	0.11	0.01	0	0	0	0	0 z	2.08	0 z	15.28
2009	0 z	4.74	0.89	0.2	0	0.32	0	0.01	0	3.87	0	0 z	10.03

Year(s)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
2010	6.64	4.3	0 z	2.13	0.15	0.01	0.01	0	0	2	1.57	0 z	16.81
2011	1.04	3.98 a	7.18	0.06	0.63	0.64	0	0	0	1.1	1.99	0.35	16.97
2012	2.02	0.07	2.38	3.15	0	0	0	0	0.02	0.01	2.59	3.21	13.45
2013	1.28	0.18	1.15 a	0 z	0 z	0 z	0 z	0 z	0 z	0 z	0 z	0 z	2.61
Period of Record Statistics													
MEAN	3.95	3.82	2.95	1.21	0.36	0.08	0.02	0.03	0.2	0.69	1.51	2.82	18.08
S.D.	4.21	3.7	2.65	1.49	0.67	0.2	0.09	0.1	0.61	1.04	1.76	2.52	7.76
SKEW	2.05	1.69	1.2	1.85	2.22	3.57	6.5	5.12	4.33	2.62	1.54	0.76	0.95
MAX	24.2	21.76	11.71	6.55	2.96	1.21	0.81	0.7	4.01	6.23	8.26	9.84	41.48
MIN	0	0	0	0	0	0	0	0	0	0	0	0	3.99
NO YRS	111	109	112	111	112	110	103	100	109	109	110	106	70

File last updated on Apr 4, 2013
*** Note *** Provisional Data *** After Year/Month 201303
a = 1 day missing, b = 2 days missing, c = 3 days, ..etc..,
z = 26 or more days missing, A = Accumulations present
Long-term means based on columns; thus, the monthly row may not
sum (or average) to the long-term annual value.
MAXIMUM ALLOWABLE NUMBER OF MISSING DAYS : 5
Individual Months not used for annual or monthly statistics if more than 5 days are missing.
Individual Years not used for annual statistics if any month in that year has more than 5 days missing.

Source: National Oceanic and Atmospheric Administration, Western Regional Climate Center. http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca7902. Accessed November 15, 2013.


SANTA BARBARA, CALIFORNIA (047902)
Annual Total Precipitation (inches)
Latitude: 34º25'00"| Longitude: -119º41'07"| Elevation: 5 feet
Total Annual Precipitation (in)
0
5
10
15
20
25
30
35
40
45
50
1893
1896
1899
1902
1905
1908
1911
1914
1917
1920
1923
1926
1929
1932
1935
1938
1941
1944
1947
1950
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1962
1965
1968
1971
1974
1977
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
2010
2013
Year

SANTA BARBARA, CALIFORNIA (047902)

Mean Precipitation (inches)

Latitude: 34º25'00"| Longitude: -119º41'07"| Elevation: 5 feet

Year(s)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MEAN	3.95	3.82	2.95	1.21	0.36	0.08	0.02	0.03	0.2	0.69	1.51	2.82	18.08

USGS 11120530 TECOLOTITO C NR GOLETA CA

Santa Barbara County, California
Hydrologic Unit Code 18060013
Latitude 34°26'05", Longitude 119°52'04" NAD27
Drainage area 4.42 square miles

Monthly mean in ft3/s (Calculation Period: 1970-10-01 -> 1991-09-30)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1970										0.000	0.899	1.77
1971	0.887	0.475	0.517	0.490	0.533	0.387	0.282	0.241	0.215	0.128	0.026	4.03
1972	0.865	0.321	0.337	0.975	0.195	0.125	0.145	0.200	0.201			
1980		20.9	4.99	1.10	5.00	0.797	0.459	0.369	0.337	0.315	0.356	0.908
1981	1.96	1.51	10.7	0.848	0.408	0.296	0.355	0.244	0.175	0.226	0.393	0.297
1982	1.46	0.308	1.52	2.36	0.421	0.289	0.210	0.229	0.219			
1987										0.345	0.250	0.503
1988	1.06	0.723	0.368	1.04	0.292	0.205	0.201	0.106	0.111	0.093	0.094	0.604
1989	0.184	0.630	0.224	0.134	0.088	0.089	0.054	0.069	0.043	0.073	0.066	0.055
1990	0.096	0.419	0.085	0.087	0.082	0.024	0.028	0.038	0.019	0.035	0.026	0.027
1991	0.110	0.424	17.4	0.425	0.345	0.252	0.215	0.174	0.114			
Mean of monthly Discharge	0.83	2.9	4.0	0.83	0.82	0.27	0.22	0.19	0.16	0.15	0.26	1.0

Annual Statistics

Water Year	Discharge cfs
1971	0.559
1972	0.634
1981	1.52
1982	0.662
1988	0.433
1989	0.190
1990	0.087
1991	1.65
No Incomplete data have been used for statistical calculation	

Source: USGS National Water Information System.
http://waterdata.usgs.gov/ca/nwis/inventory/?site_no=11120530. Accessed Nov. 15, 2013.