CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

California Regional Water Quality Control Board
Central Coast Region

Total Maximum Daily Loads for Nitrogen Compounds and Orthophosphate for the Lower Santa Maria River Watershed and Tributaries to Oso Flaco Lake
in
Santa Barbara and San Luis Obispo Counties, California

Final Project Report

May 2013

Adopted by the
California Regional Water Quality Control Board
Central Coast Region
on _______________, 2012

and the
United States Environmental Protection Agency
on _________________. 2012

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In water quality issues of the Santa Maria River and Oso Flaco Lake watersheds.

TABLE OF CONTENTS

LIST OF APPENDICES

TABLE OF FIGURES

Appendix A Figures

Appendix B Figures

TABLE OF TABLES

Appendix A Tables

Appendix B Tables

LIST OF ACRONYMS

CCAMP	Central Coast Ambient Monitoring Program
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CWA	Clean Water Act
DFG (or CDFG)	Calif. Dept. of Fish and Game
DHS	California Department of Health Services
DO	Dissolved oxygen
FMMP	Farmland Mapping and Monitoring Program
FMMP	Farmland Mapping and Monitoring Program
GIS	Geographic Information System
HSG	Hydrologic Soil Group
HUC	Hydrologic Unit Code
HUA	Hydrologic Unit Area
IRWMP	Integrated Regional Watershed Management Plan
MEP	Maximum Extent Practicable
MMs	Management measures
MRLC	Multi-Resolution Land Characterization
MS4s	Municipal Separate Storm Sewer Systems
NHD	National Hydrography Dataset
NMFS	National Marine Fisheries Service (NOAA)
NOAA	National Oceanic and Atmospheric Administration
$NO_3^{-}N$ or NO3 as N	Nitrate as Nitrogen
NH_3	Un-ionized ammonia
NH_3	Un-ionized ammonia
NH_4^+	Ammonium
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NRCS	Natural Resources Conservation Service
OSDS	Onsite Waste Disposal System
PO4	Phosphate
RCD	Resource Conservation District
SBFCD	Santa Barbara Flood Control District
SSURGO	Soil Survey Geographic Database
SWRCB	State Water Resources Control Board (State Board)
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total phosphate
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geologic Survey
Water Board	Central Coast Water Quality Control Board (Region 3)
WDR	Waste Discharge Requirements
WWTP	Waste Water Treatment Plant

1. INTRODUCTION

The following draft TMDL project report addresses nutrient impairments for water bodies within the ower Santa Maria River watershed and tributaries to Oso Flaco Lake. In order to maintain consistency in developing nutrient TMDLs in the Central Coast region, it should be noted that a substantial portion of the information contained herein, for example descriptive text, references, and methodologies have been derived from the Lower Salinas River Watershed Nutrient TMDL Draft Project Report.

1.1 Clean Water Act Section 303(d) List

Section 303(d) of the Federal Clean Water Act (CWA) requires that states make a list of waters that are not attaining standards after the technology-based limits are put into place. For waters on this list (and where the U.S. EPA administrator deems they are appropriate) the states are to develop total maximum daily loads or TMDLs. A TMDL must account for all sources of the pollutants that caused the water to be listed. Federal regulations require that the TMDL, at a minimum, account for contributions from point sources (federally permitted discharges) and contributions from nonpoint sources. U.S. EPA is required to review and approve the list of impaired waters and each TMDL.

The Clean Water Act does not expressly require the implementation of TMDLs. In California, the State Water Resources Control Board has interpreted state law (Porter-Cologne Water Quality Control Act, California Water Code Section 13000 et. seq.) to require that implementation be addressed when TMDLs are incorporated into Basin Plans (water quality control plans). The Porter-Cologne Act requires each Regional Board to formulate and adopt water quality control plans for all areas within its region. It also requires that a program of implementation be developed that describes how water quality standards will be attained. TMDLs can be developed as a component of the program of implementation, thus triggering the need to describe the implementation features, or alternatively as a Water Quality Standard. When the TMDL is established as a standard, the program of implementation must be designed to implement the TMDL. Typically a revision to the program of implementation is needed whenever a new standard is adopted.

1.2 Project Area

Staff assessed nutrient-related water quality impairments within the entire of 1.2 million acre Santa Maria River watershed which included the three counties of San Luis Obispo, Santa Barbara and Ventura as shown in Figure 1-1. Based on this assessment of nutrient-related water quality impairments within the greater Santa Maria River watershed area, staff concluded that impaired waters; and hence the TMDL project area, should be limited to the lower portion of the Santa Maria River watershed downstream from the Sisquoc River confluence, including the Oso Flaco Lake watershed. The project area generally corresponds to the extent of the Guadalupe Hydrologic Area (312.10) as contained in the Basin Plan and shown in Figure 1-2.

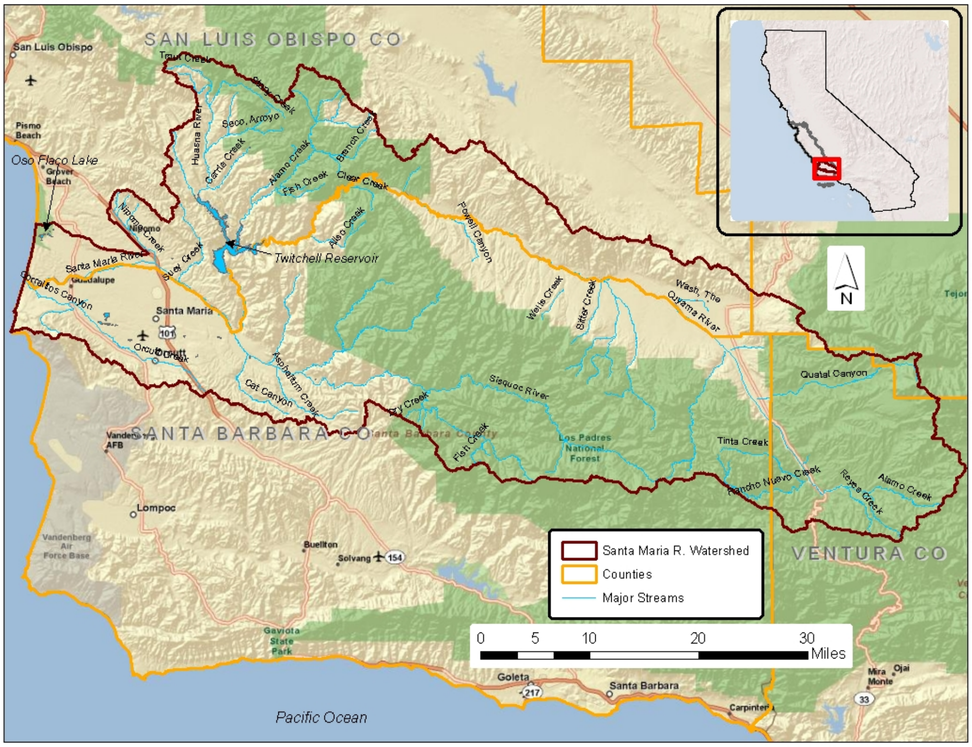


Figure 1-1. Santa Maria River watershed and major water bodies.

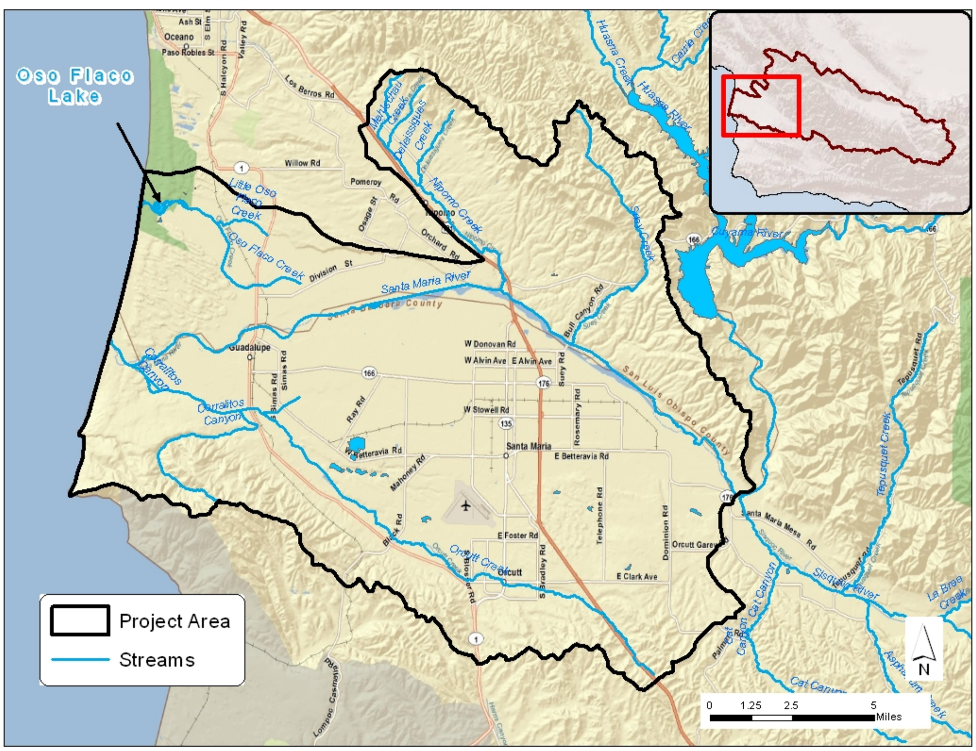


Figure 1-2. Project Area.

TMDLs are proposed for the following 12 waterbodies: Santa Maria River Estuary, Santa Maria River, Orcutt Creek[1], Greene Valley Creek[2], Blosser Channel, Bradley Canyon Creek, Bradley Channel, Nipomo Creek, Main Street Canal, North Main Street Channel, Little Oso Flaco Creek, and Oso Flaco Creek.

It is important to note that the information necessary to develop a nutrient TMDL for Oso Flaco Lake is not currently available; however, the monitoring plan included in this TMDL contains provisions for obtaining the appropriate data necessary to complete this TMDL in the future. Additional information pertaining to the development of nutrient TMDLs for Oso Flaco Lake is contained in Appendix D.

1.3 Pollutants Addressed and Their Environmental Impacts

The pollutants addressed in this TMDL are un-ionized ammonia, nitrate, and low dissolved oxygen. In addition, to protect waters from biostimulatory substances, orthophosphate is included as a pollutant. Nitrate and un-ionized ammonia pollution of both surface waters and groundwater has long been recognized as a problem in the lower Santa Maria River valley. Elevated levels of nitrate or un-ionized ammonia can degrade municipal and domestic water supply, groundwater, and also can impair freshwater aquatic habitat. Many surface waterbodies in the lower Santa Maria River valley routinely exceed the water quality objective for nitrate in drinking water and may therefore degrade drinking water supplies (MUN) and impair designated groundwater recharge (GWR) beneficial uses[3]. The Water Quality Control Plan for the Central Coast Region (Basin Plan) explicitly requires that the GWR beneficial use of surface waters be maintained to protect the water quality of the underlying groundwater resources[4]. It is noteworthy that a major segment of the Santa Maria River is actively managed to facilitate aquifer recharge through releases from Twitchell Dam[5].

Regarding nitrate-related health concerns, it has been well-established that infants below six months who are fed formula made with water containing nitrate in excess of the U.S. Environmental Protection Agency's safe drinking water standard (i.e., 10 milligrams of nitrate per liter) are at risk of becoming seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue baby syndrome, also known as methemoglobinemia.[6] The well-established linkage

[1] Orcutt Creek is commonly known as Orcutt-Solomon Creek
[2] Greene Valley Creek is commonly known as Green Canyon Channel.
[3] "Beneficial uses" is a regulatory term which refers to the legally-protected current, potential, or future designated uses of the waterbody. The Water Board is required by law to protect all designated beneficial uses.
[4] See Basin Plan, Chapter 2 Beneficial Use Definitions, page II-19
[5] The purpose of the releases from Twitchell Dam is to recharge the Santa Maria groundwater basin. During dry periods of the year, water is released at a rate to ensure percolation occurs upstream of the Bonita School Road crossing (Santa Maria Valley Water Conservation District).
[6] U.S. Environmental Protection Agency: http://water.epa.gov/drink/contaminants/basicinformation/nitrate.cfm

between nitrate and methemoglobinemia alone should be sufficient to warrant TMDL development. High nitrate levels may also affect the oxygen-carrying ability of the blood of pregnant women[7]. There is some evidence to suggest that exposure to nitrate in drinking water is associated with adverse reproductive outcomes such as intrauterine growth retardations and various birth defects such as anencephaly; however, the evidence is inconsistent (Manassaram et al., 2006). Additionally, some public health concerns have been raised about the linkage between nitrate and cancer. Some peer-reviewed epidemiological studies have suggested elevated nitrate in drinking water may be associated with elevated cancer risk; however currently there is no strong evidence linking higher risk of cancer in humans to elevated nitrate in drinking water. Further research is recommended by scientists to confirm or refute the linkage between nitrates in drinking water supply and cancer.

Another water quality impairment addressed in this TMDL which is associated with nutrients is biostimulation. Biostimulation can result in eutrophication of the water body. While nutrients - specifically nitrogen and phosphorus – are essential for plant growth, and are ubiquitous in the environment, they are considered pollutants when they occur at levels which have adverse impacts on water quality; for example when they cause toxicity or eutrophication. Eutrophication is the excessive and undesirable growth of algae and aquatic plants that may be caused by excessive levels of nutrients. Eutrophication effects typically occur at somewhat lower nutrient concentrations than toxic effects. Either of these modes of water quality impairment can affect the entire aquatic food web, from algae and other microscopic organisms, through benthic macroinvertebrates (principally aquatic insect larvae), through fish, to the mammals and birds at the top of the food web. Additionally, several stream reaches in the project area are impaired by elevated levels of unionized ammonia in the water column. Unionized ammonia is highly toxic to aquatic species. Reducing the amount of nutrients that enter a water bodies will help preserve and maintain the aquatic beneficial uses.

In addition to impacts to aquatic habitat, algal blooms resulting from biostimulation may also constitute a potential health risk and public nuisance to humans, their pets, and to livestock. The majority of freshwater harmful algal blooms (HABs) reported in the United States and worldwide is due to one group of algae, cyanobacteria (CyanoHABs, or blue-green algae), although other groups of algae can be harmful (Worcester and Taberski, 2012). Possible health effects of exposure to blue-green algae blooms and their toxins can include rashes, skin and eye irritation, allergic reactions, gastrointestinal upset, and other effects[8]. At high levels, exposure can result in serious illness or death. These effects are not theoretical; worldwide animal poisonings and adverse human

[7] California Department of Public Health.
www.cdph.ca.gov/certlic/drinkingwater/Pages/Nitrate.aspx
[8] California Department of Public Health website.
http://www.cdph.ca.gov/HealthInfo/environhealth/water/Pages/Bluegreenalgae.aspx

health effects have been reported by the World Health Organization (WHO, 1999). The California Department of Public Health and various County Health Departments have documented cases of dog die-offs throughout the state and the nation due to blue-green algae. Dogs can die when their owners allow them to swim or wade in waterbodies with algal blooms; dogs are also attracted to fermenting mats of cyanobacteria near shorelines of waterbodies (Carmichael, 2011). Dogs reportedly die due to ingestion associated with licking algae and associated toxins from their coats. Additionally, algal toxins have been implicated in the deaths of central California southern sea otters according to recent findings (Miller et al., 2010). Currently, there reportedly have been no confirmations of human deaths in the U.S. from exposure to algal toxins, however many people have become ill from exposure, and acute human poisoning is a distinct risk (source: Dr. Wayne Carmichael of the Wright State University-Department of Biological Sciences, as reported in NBC News, 2009). Section 3.2.1 of this report presents available information and data on algal toxins in the TMDL project area.

The intent of these TMDLs is to reduce risks to human health and address degradation of aquatic habitat. These intentions are consistent with the Water Board's two highest priority missions[9] as listed in priority order below:

Water Board Top Two Priorities (July 2012)

1) "Preventing and Correcting Threats to Human Health"
   Nitrate contamination is by far the most widespread threat to human health in the central coast region
2) "Preventing and Correcting Degradation of Aquatic Habitat"
   "Including requirements for aquatic habitat protection in Total Maximum Daily Load Orders"

The U.S. Environmental Protection Agency recently reported that nitrogen and phosphorus pollution, and the associated degradation of drinking and environmental water quality, has the potential to become one of the costliest and most challenging environmental problems the nation faces[10]. Over half of the nation's streams, including most steams in the lower Santa Maria River valley, have medium to high levels of nitrogen and phosphorus. Nitrate drinking water standard violations have doubled nationwide in eight years, and it has been widely demonstrated that drinking water supplies in the Santa Maria valley have been substantially impacted by nitrate. Algal blooms, resulting from the biostimulatory effects of nutrients, are steadily on the rise nationwide; related toxins have potentially serious health and ecological effects. Biostimulation of surface waters in the lower Santa Maria River valley are documented in this report; these water quality impairments are also having significant adverse

[9] See Staff Report for the July 11, 2012 Water Board meeting

[10] U.S. Environmental Protection Agency: Memorandum from Acting Assistant Administrator Nancy K. Stoner. March 16, 2011. Subject: "Working in Partnership with States to Address Phosphorus and Nitrogen Pollution through Use of a Framework for State Nutrient Reductions".

downstream impacts to the ecologically sensitive Santa Maria River Estuary and Oso Flaco Lake.

1.4 Watershed Description

The project area is approximately 237 square miles, comprised primarily of farmland (42%), grazing lands (31%), urban lands (11%), and other forms of land use/cover, such as forest, dunes, and beaches (16%). The Oso Flaco Lake watershed drains about 20 square miles of primarily agricultural land (strawberries/vegetables) and is located in south San Luis Obispo County, just north of the Lower Santa Maria River watershed. Prior to the 1860's, the outlet of the Santa Maria River was in the proximity of Oso Flaco Lake. Early in the 20th century, some of the floodwater from the Santa Maria River was routed through Oso Flaco Creek; however, this route was permanently blocked when the Santa Maria River levees were constructed in the early 1960s [11]. As such, Oso Flaco Lake is no longer hydrologically connected to surface water flows of the Santa Maria River. Figure 1-3 and Table 1-1 depict land use/land cover within the project area.

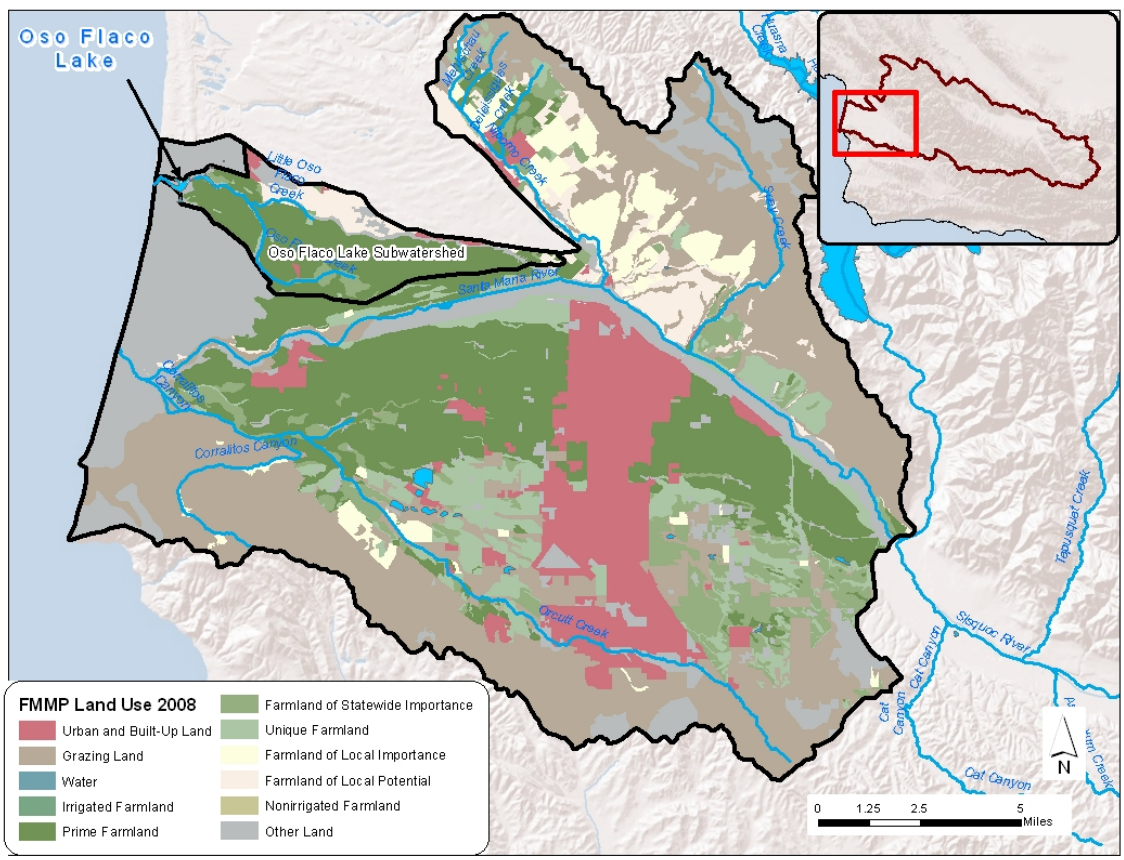
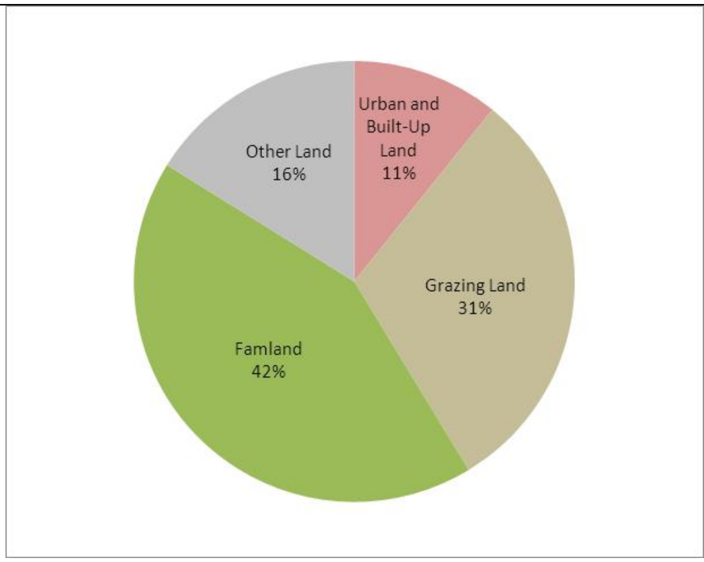


Figure 1-3. Project Area Land Use
Source: 2008 Farmland Mapping and Monitoring Program (FMMP)

[11] Cachuma Resource Conservation District. 2004. Nitrate and Sediment Assessment, Oso Flaco Lake.

Table 1-1. Tabulation of Project Area Land Use

Land Use	Square Miles
Urban Lands	25.5
Grazing Lands	72.3
Farmland [A]	100.7
Other Lands [B]	38.3
Total	**237**



Source: Farmland Mapping and Monitoring Program (FMMP), 2008.
[A] FMMP farmlands identified as prime, unique, state-wide importance, or of local importance are aggregated.
[B] Includes low density rural development, heavily forested land, mined land, or government land with restrictions on use.

Staff used information contained in the Santa Maria Valley Watershed Map[12] to define and delineate fifteen (15) subwatersheds within the Project Area. Figure 1-4 depicts the subwatersheds, and Table 1-2 tabulates the subwatershed names. Table 1-3 summarizes land use area by Subwatershed.

[12] Santa Barbara County Flood Control and Water Conservation District. 1985. Santa Maria Valley Watershed Map, by Ernst Wiedmann.

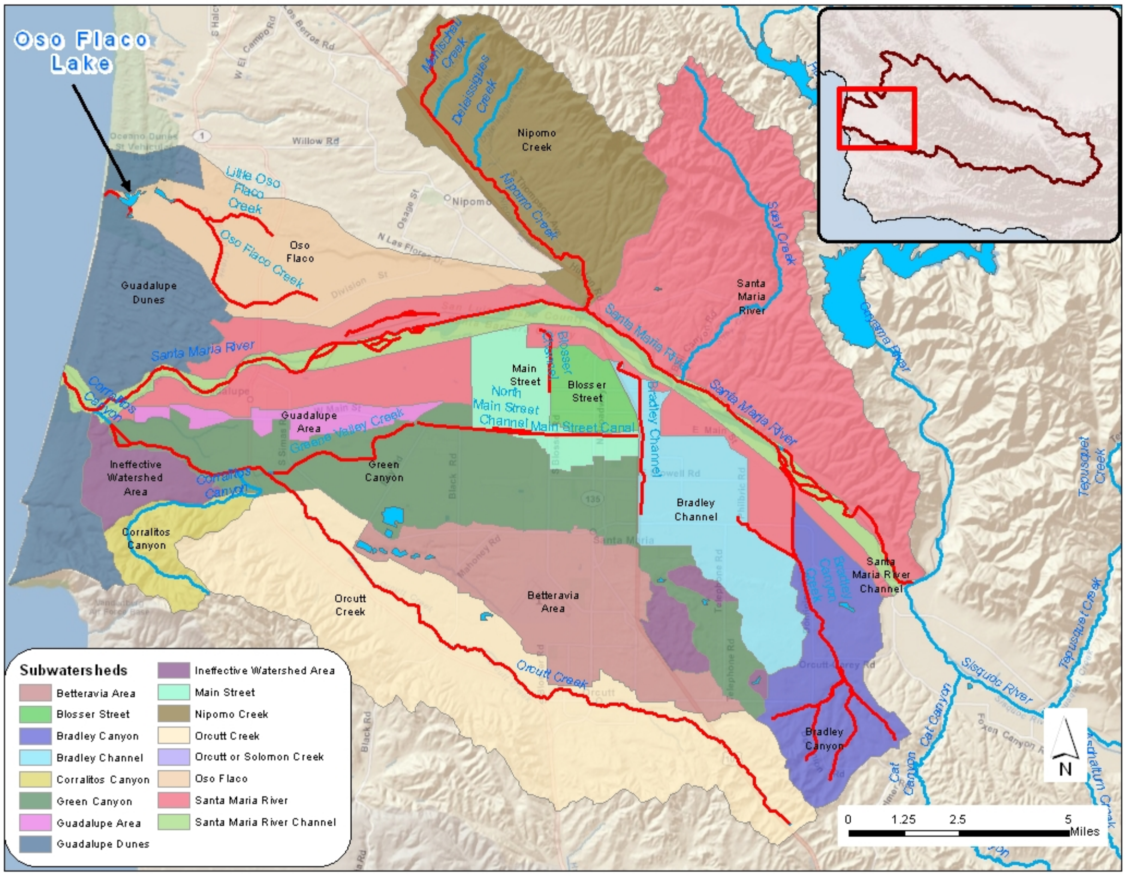


Figure 1-4. Subwatersheds within the TMDL Project Area.

Table 1-2. Project Area Subwatersheds

Subwatershed Name	Notes
Betteravia Area	Eventually drains to Orcutt
Blosser Street	Blosser Channel
Bradley Canyon	Bradley Canyon Creek
Bradley Channel	Bradley Channel
Corralitos Canyon	Corralitos Canyon
Greene Canyon	Greene Valley Creek and Orcutt Creek
Guadalupe Area	Drains to the Lower Santa Maria River
Guadalupe Dunes	Drains to Pacific Ocean or Percolates
Ineffective Watershed Area	No drainage. Water either percolates or evaporates
Main Street	Main St. Canal
Nipomo Creek	Nipomo Creek
Orcutt Creek	Orcutt Creek
Oso Flaco	Oso Flaco Creek and Oso Flaco Lake
Santa Maria River	Drains to Santa Maria River
Santa Maria River Channel	Santa Maria River

Table 1-3. FMMP Land Use area (acres) by Subwatershed.

	Land Use			
Subwatershed Name	Urban	Grazing	Farmland[A]	Other Lands[B]
Betteravia Area	5,196.5	1,568.9	2,732.7	703.4
Blosser Street	1,900.4	0.0	0.0	66.3
Bradley Channel	913.4	390.4	5,723.2	379.3
Bradley Canyon	0.0	2,651.7	3,712.3	1,318.5
Corralitos Canyon	0.0	2,751.1	184.1	0.0
Green Canyon	2,622.2	1,020.2	11,100.2	552.4
Guadalupe Area	165.7	0.0	1,694.1	0.0
Guadalupe Dunes	0.0	1,252.2	29.5	9,895.9
Ineffective Watershed Area	3.7	2,869.0	898.6	408.8
Main Street	1,057.0	0.0	2,515.4	33.1
Nipomo Creek	578.2	4,673.6	7,619.9	515.6
Oso Flaco	324.1	11.0	8,135.5	1,134.3
Orcutt or Solomon Creek	2,051.4	15,416.6	4,566.8	1,642.6
Santa Maria River	1,451.1	13,019.0	14,945.1	3,550.3
Santa Maria River Channel	58.9	666.6	626.1	4,275.8

Source: Farmland Mapping and Monitoring Program (FMMP), 2008.

[A] FMMP farmlands identified as prime, unique, state-wide importance, or of local importance are aggregated.

[B] Includes low density rural development, heavily forested land, mined land, or government land with restrictions on use.

Please see Appendix A for additional information pertaining to watershed description, physical setting, land use, and other information used to characterize the project area.

2 PROBLEM IDENTIFICATION

Twelve waterbodies (Santa Maria River Estuary, Santa Maria River, Orcutt Creek, Greene Valley Creek, Blosser Channel, Bradley Canyon Creek, Bradley Channel, Nipomo Creek, Main Street Canal, North Main Street Channel, Little Oso Flaco Creek, and Oso Flaco Creek) in the Santa Maria River and Oso Flaco Lake watersheds are impaired due to exceedance of quality objective(s) for the pollutants identified in Section 1.3.

2.1 Water Quality Standards

TMDLs are requirements pursuant to the federal Clean Water Act. The broad objective of the federal Clean Water Act is to “restore and maintain the chemical, physical and biological integrity of the Nation’s waters42.” Water quality standards are provisions of state and federal law intended to implement the federal Clean Water Act. In accordance with state and federal law, California’s water quality standards consist of:

- Beneficial uses, which refer to legally-designated uses of waters of the state that may be protected against water quality degradation (e.g., drinking water supply, recreation, aquatic habitat, agricultural supply, etc.)
- Water quality objectives, which refer to limits or levels (numeric or narrative) of water quality constituents or characteristics that provide for the reasonable protection of beneficial uses of waters of the state.
- Anti-degradation policies, which are implemented to maintain and protect existing water quality, and high quality waters.

Therefore, beneficial uses, water quality objectives, and anti-degradation policies collectively constitute water quality standards. Beneficial uses, relevant water quality objectives, and anti-degradation requirements that pertain to this TMDL are presented below in Section 2.2, Section 2.3, and Section 2.5, respectively. For a detailed discussion of anti-degradation policies, please refer to Section 7.2.3.

2.2 Beneficial Uses

The Central Coast Water Quality Control Plan (Basin Plan) specifically identifies beneficial uses for some of the listed water bodies included in this analysis. The Santa Maria River, Orcutt Creek, Oso Flaco Creek, and Oso Flaco Lake have designated beneficial uses specified in the Basin Plan (see Table 2-1 below).

The Basin Plan states that surface water bodies within the region that do not have beneficial uses specifically designated for them are assigned the beneficial uses of “municipal and domestic water supply” and “protection of both recreation and aquatic life.” Staff interpreted this general statement of beneficial uses to encompass the beneficial uses of REC-1 and REC-2, MUN, along with all beneficial uses associated with aquatic life. Therefore, the following waterbodies, which were not specifically listed in the Basin Plan, are assigned the beneficial uses REC-1, REC-2, MUN, and all beneficial uses associated with aquatic life:

Blosser Channel, Bradley Canyon Creek, Bradley Channel, Greene Valley Creek, Little Oso Flaco Creek, Main Street Canal, Nipomo Creek, and North Main Street Channel.

Table 2-1. Beneficial Uses for Project Area Waterbodies.

Beneficial Use	Water Body				
	Santa Maria River Estuary	Santa Maria River	Orcutt Creek	Oso Flaco Lake	Oso Flaco Creek
Municipal and Domestic Supply (MUN)		X	X		X
Agricultural Supply (AGR)		X	X		X
Industrial Service Supply (IND)		X			
Ground Water Recharge (GWR)	X	X	X	X	X
Water Contact Recreation (REC-1)	X	X	X	X	X
Non-Contact Water Recreation (REC-2)	X	X	X	X	X
Wildlife Habitat (WILD)	X	X	X	X	X
Cold Fresh Water Habitat (COLD)		X	X		
Warm Fresh Water Habitat (WARM)	X	X		X	X
Migration of Aquatic Organisms (MIGR)	X	X			
Spawning, Reproduction, and/or Early Development (SPWN)	X			X	
Preservation of Biological Habitats of Special Significance (BIOL)	X			X	X
Rare, Threatened, or Endangered Species (RARE)	X	X	X	X	X
Estuarine Habitat (EST)	X		X		
Freshwater Replenishment (FRSH)		X	X		X
Commercial and Sport Fishing (COMM)	X	X	X	X	X
Navigation (NAV)				X	

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.

2.2.1 Municipal and Domestic Water Supply (MUN)

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 under certain conditions (see Basin Plan, Chapter 2, Section II.)

The nitrate numeric water quality objective protective of the MUN beneficial use is legally established as 10 mg/L[13] nitrate as nitrogen (see Basin Plan, Table 3-2).

2.2.2 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*

[13] This value is equivalent to, and may be expressed as, 45 mg/L nitrate as nitrate.

of saltwater intrusion into freshwater aquifers. Ground water recharge includes recharge of surface water underflow. (emphasis added) - (see Basin Plan, Chapter 2, Section II.)

Most surface waters and ground waters of the central coast region are designated with the MUN beneficial use. The MUN nitrate water quality objective (10 mg/L) therefore applies to *both* the creek water, and to the underlying groundwater. This numeric water quality objective and the MUN designation of underlying groundwater is relevant to the extent that portions project area streams recharge the underlying groundwater resource. The Basin Plan GWR beneficial use explicitly states that the designated groundwater recharge use of surface waters are to be protected to maintain groundwater quality. Note that surface waters and ground waters are often in direct or indirect hydrologic communication. As such, where necessary, the GWR beneficial uses of the surface waters need to be protected so as to support and maintain the MUN beneficial use of the underlying ground water resource. Indeed, protection of the GWR beneficial use of surface waters has been recognized in approved California TMDLs[14].

2.2.3 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 (see Basin Plan, Chapter 2, Section II.).

In accordance with the Basin Plan, interpretation of the amount of nitrate which adversely affects the agricultural supply beneficial use of waters of the State shall be derived from the University of California Agricultural Extension Service guidelines, which are found in Basin Plan Table 3-3. Accordingly, severe problems for sensitive crops could occur for irrigation water exceeding 30 mg/L[15]. It should be noted that The University of California Agricultural Extension Service guideline values are flexible, and may not necessarily be appropriate due to local conditions or special conditions of crop, soil, and method of irrigation.

High concentrations of nitrates in irrigation water can potentially create problems for sensitive crops (e.g., grapes, avocado, citrus, sugar beets, apricots) by detrimentally impacting crop yield or quality. Nitrogen in the irrigation water acts the same as fertilizer nitrogen and excesses may cause problems just as fertilizer excesses cause problems[16]. For example, according to Ayers and Westcot

[14] for example, see RWQCB-Los Angeles Region, Calleguas Creek Nitrogen Compounds TMDL, 2002. Resolution No. 02-017, and approved by the State of California Office of Administrative Law, OAL File No. 03-0519-02 SR.
[15] The University of California Agricultural Extension Service guideline values are flexible, and may not necessarily be appropriate due to local conditions or special conditions of crop, soil, and method of irrigation
[16] 1 mg/L NO3-N in irrigation water = 2.72 pounds of nitrogen per acre foot of applied water.

(1985)[17] grapes are sensitive to high nitrate in irrigation water and may continue to grow late into the season at the expense of fruit production; yields are often reduced and grapes may be late in maturing and have a lower sugar content. Maturity of fruit such as apricot, citrus and avocado may also be delayed and the fruit may be poorer in quality, thus affecting the marketability and storage life. Excessive nitrogen can also trigger the production of green tissue (leaves) over vegetative tissue in sensitive crops. In many grain crops, excess nitrogen may promote excessive vegetative growth producing weak stalks that cannot support the grain weight. These problems can frequently (but not universally) be overcome by good fertilizer and irrigation management. However, regardless of the crop many resource professionals recommend that nitrate in the irrigation water should be credited toward the fertilizer rate especially when the concentration exceeds 10 mg/L nitrate as N[18]. Should this be ignored, the resulting excess input of nitrogen could cause problems such as excessive vegetative growth and contamination of groundwater[19].

Also noteworthy is that the AGR beneficial use of surface water not only applies to several stream reaches of the project area, but can also apply to the groundwater resources underlying those stream reaches. The groundwater in some of these reaches is recharged by stream infiltration. Therefore, the groundwater recharge (GWR) beneficial use of the creek provides the nexus between protection of designated AGR beneficial uses of both the surface waters and the underlying groundwater resource (refer back to Section 2.2.2).

2.2.4 Aquatic Habitat (WARM, COLD, MIGR, SPWN, WILD, BIOL, RARE, EST)

***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.*

***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.*

***MIGR**: Uses of water that support habitats necessary for migration or other temporary activities by aquatic organisms, such as anadromous fish.*

***SPWN**: Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish.*

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[17] R.S. Ayers (Soil and Water Specialist, Univ. of Calif.-Davis) and D.W. Westcot (Senior Land and Water Resources Specialist – Calif. Central Valley Regional Water Quality Control Board) published in UN-FAO Irrigation and Drainage Paper 29 Rev.1

[18] Colorado State University Extension - Irrigation Water Quality Criteria. Authors: T.A. Bauder, Colorado State University Extension water quality specialist; R.M. Waskom, director, Colorado Water Institute; P.L. Sutherland, USDA/NRCS area resource conservationist; and J.G. Davis, Extension soils specialist and professor, soil and crop sciences

[19] University of Calif.-Davis, Farm Water Quality Planning Reference Sheet 9.10. Author: S. R. Grattan, Plant-Water Relations Specialist, UC-Davis.

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.*

BIOL: *Uses of water that support designated areas or habitats, such as established refuges, parks, sanctuaries, ecological reserves, or Areas of Special Biological Significance (ASBS), where the preservation or enhancement of natural resources requires special protection.*

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.*

EST: *Uses of water that support estuarine ecosystems including, but not limited to, preservation or enhancement of estuarine habitats, vegetation, fish, shellfish, or wildlife (e.g., estuarine mammals, waterfowl, shorebirds). An estuary is generally described as a semi-enclosed body of water having a free connection with the open sea, at least part of the year and within which the seawater is diluted at least seasonally with fresh water drained from the land. Included are water bodies which would naturally fit the definition if not controlled by tidegates or other such devices.*

The Basin Plan water quality objective protective of COLD and MIGR, and which is most relevant to nutrient pollution[20], is the biostimulatory substances objective and dissolved oxygen objectives for aquatic habitat. The biostimulatory substances objective is a narrative water quality objective that states "*Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses*." The Basin Plan also requires that waterbodies designated for WARM habitat dissolved oxygen concentrations shall not be depressed below 5 mg/L and that waterbodies designated for COLD and SPWN dissolved oxygen shall not be depressed below 7 mg/L. Further, since unionized ammonia is highly toxic to aquatic species, the Basin Plan requires that the discharge of waste shall not cause concentrations of unionized ammonia (NH3) to exceed 0.025 mg/L (as n) in receiving waters.

2.2.5 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. (see Basin Plan, Chapter 2, Section II.).

[20] Nutrients, such as nitrate, do not by themselves necessarily directly impair aquatic habitat beneficial uses. Rather, they cause indirect impacts by promoting algal growth and low dissolved oxygen that impair aquatic habitat uses.

The Basin Plan water quality objective protective of water contact recreation beneficial uses and which is most relevant to nutrient pollution is the general toxicity objective for all inland surface water, enclosed bays, and estuaries (Basin Plan Chapter 3, section II.A.2.a.). The general toxicity objective is a narrative water quality objective that states:

"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."

Because illnesses are considered detrimental physiological responses in humans, the narrative toxicity objective applies to algal toxins. Possible health effects of exposure to blue-green algae blooms and their toxins can include rashes, skin and eye irritation, allergic reactions, gastrointestinal upset, and other effects including poisoning (refer back to Section 1.3) Note that microcystins are toxins produced by cyanobacteria (blue-green algae) and are associated with algal blooms, elevated nutrients, and biostimulation in surface waterbodies. The State of California Office of Environmental Health Hazard Assessment (OEHHA) has published peer-reviewed public health action-level guidelines for algal cyanotoxins (microcystins) in recreational water uses; this public health action-level for microcystins is 0.8 µg/L[21] (OEHHA, 2012). This public health action level can therefore be used to assess attainment or non-attainment of the Basin Plan's general toxicity objective and to ensure that REC-1 designated beneficial uses are being protected and supported.

2.3 Water Quality Objectives & Criteria

The Central Coast Region's Water Quality Control Plan (Basin Plan) contains specific water quality objectives that apply to nutrients and nutrient-related parameters. In addition, the Central Coast Water Board uses established, scientifically-defensible numeric criteria to implement narrative water quality objectives, and for use in Clean Water Act Section 303(d) Listing assessments. These water quality objectives and criteria are established to protect beneficial uses and are compiled in Table 2-2.

2.4 Anti-degradation Policy

In accordance with Section II.A. of the Basin Plan, wherever the existing quality of water is better than the quality of water established in the Basin Plan as objectives, **such existing quality shall be maintained** unless otherwise provided by provisions of the state anti-degradation policy. Also, see Section 7.2.3 for a full description of anti-degradation requirements.

[21] Includes microcystins LR, RR, YR, and LA.

Table 2-2. Compilation of Basin Plan water quality objectives and numeric criteria for nutrients and nutrient-related parameters.

Constituent Parameter	Source of Water Quality Objective/Criteria	Numeric Target	Primary Use Protected
Unionized Ammonia as N	Basin Plan numeric objective	0.025 mg/L	General Objective for all Inland Surface Waters, Enclosed Bays, and Estuaries *(toxicity objective)*
Nitrate as N	Basin Plan numeric objective	10 mg/L	MUN, GWR (Municipal/Domestic Supply; Groundwater Recharge)
Nitrate as N	Basin Plan numeric criteria (Table 3-3 in Basin Plan)	5 – 30 mg/L *California Agricultural Extension Service guidelines*	AGR (Agricultural Supply – irrigation water) *“Severe” problems for sensitive crops at greater than 30 mg/L* *“Increasing problems” for sensitive crops at 5 to 30 mg/L*
Dissolved Oxygen	General Inland Surface Waters numeric objective	Dissolved Oxygen shall not be depressed below 5.0 mg/L Median values should not fall below 85% saturation.	General Objective for all Inland Surface Waters, Enclosed Bays, and Estuaries.
	Basin Plan numeric objective WARM, COLD, SPWN	Dissolved Oxygen shall not be depressed below 5.0 mg/L (WARM) Dissolved Oxygen shall not be depressed below 7.0 mg/L (COLD, SPWN)	Cold Freshwater Habitat, Warm Freshwater Habitat, Fish Spawning
	Basin Plan numeric objective AGR	Dissolved Oxygen shall not be depressed below 2.0 mg/L	AGR (Agricultural Supply)
pH	General Inland Surface Waters numeric objective	pH value shall not be depressed below 7.0 or raised above 8.5.	General Objective for all Inland Surface Waters, Enclosed Bays, and Estuaries.
	Basin Plan numeric objective MUN, AGR, REC1, REC-2	The pH value shall neither be depressed below 6.5 nor raised above 8.3.	Municipal/Domestic Supply, Agricultural Supply, Water Recreation
	Basin Plan numeric objective WARM, COLD	pH value shall not be depressed below 7.0 or raised above 8.5	Cold Freshwater Habitat, Warm freshwater habitat
Biostimulatory Substances	Basin Plan narrative objective[A]	see report Section 4.3	General Objective for all Inland Surface Waters, Enclosed Bays, and Estuaries *(biostimulatory substances objective)* -- (e.g., WARM, COLD, REC, WILD, EST)
Chlorophyll *a*	Basin Plan narrative objective[A]	40 □g/L *Source: North Carolina Administrative Code, Title 151, Subchapter 2B, Rule 0211*	Numeric listing criteria to implement the Basin Plan biostimulatory substances objective for purposes of Clean Water Act Section 303(d) Listing assessments.
Microcystins *(includes Microcytins LA, LR, RR, and YR)*	Basin Plan narrative objective[B]	0.8 □g/L *Calif. Office of Environmental Health Hazard Assessment Suggested Public Health Action Level*	REC-1 (water contact recreation)

[A] *The Basin Plan biostimulatory substances narrative objective states: “Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses.” (Biostimulatory Substances Objective, Basin Plan, Chapter 3)*

[B] *The Basin Plan toxicity narrative objective states: “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..” (Toxicity Objective, Basin Plan, Chapter 3)*

2.5 Waste Discharge Prohibitions

To protect public health and achieve water quality objectives the Water Board can prohibit specific types of discharges to certain areas (California Porter-Cologne Water Quality Control Act Section 13243). These discharge prohibitions may be revised, rescinded, or adopted as necessary. Discharge prohibitions are described in pertinent sections of Chapter 4, "Implementation Plan" and Chapter 5, "Plans and Policies" in the Regional Board Discharge Prohibition Section (Basin Plan).

The following information is contained in the Basin Plan, and relates to the TMDLs:

> *Waste discharges to the following inland waters are prohibited: Santa Maria River downstream from the Highway One bridge (pg. V-8).*
>
> *Waste discharged to ground waters shall be free of toxic substances in excess of accepted drinking water standards; taste, odor, or color producing substances; and nitrogenous compounds in quantities which could results in a ground water nitrate concentration above 45 mg/L (or 10 mg/L-N) (pg. V-10).*

3 DATA ANALYSIS

The standards that are being used to assess water quality conditions are contained in the Basin Plan for un-ionized ammonia, nitrate, low dissolved oxygen, and pH. In addition, staff evaluated water quality conditions related to biostimulatory substances. Note that staff conducted this analysis using all available data for the Santa Maria River and Oso Flaco Lake watersheds, including those waterbodies that are not 303(d) listed. Please see Section 2.3 Water Quality Objectives for a description of standards and criteria used in the following analysis.

3.1 Water Quality Impairments

The Central Coast Water Board assesses water quality monitoring data for surface waters every two years to determine if they contain pollutants at levels that exceed protective water quality standards. In accordance with the Water Quality Control Policy for developing California’s Clean Water Act Section 303(d) List (Listing Policy, SWRCB, 2004), water body and pollutants that exceed protective water quality standards are placed on the State’s 303(d) List of impaired waters. The Listing Policy also defines the minimum number of measured exceedances needed to place a water segment on the 303(d) list for toxicants (Listing Policy, Table 3.1) and for conventional or other pollutants (Listing Policy, Table 3.2). The minimum number of measured exceedances for toxicants is displayed in Table 3-1 and for conventional and other pollutants in Table 3-2

With regard to the water quality constituents addressed in this TMDL, it is important to note that unionized ammonia and nitrate are considered toxicants, while low dissolved oxygen and pH are conventional pollutants.

Table 3-1. Minimum number of measured exceedances needed to place a water segment on the 303(d) list for toxicants.

Sample Size	Number of Exceedances needed to assert impairment
2 – 24	2
25 – 36	3
37 – 47	4
48 – 59	5
60 – 71	6
72 – 82	7
83 – 94	8
95 – 106	9
107 – 117	10
118 – 129	11
For sample sizes greater than 129, the minimum number of measured exceedances is established where α and β < 0.2 and where |α - β| is minimized. α = Excel® Function BINOMDIST(n-k, n, 1 – 0.03, TRUE) β = Excel® Function BINOMDIST(k-1, n, 0.18, TRUE) where n = the number of samples, k = minimum number of measured exceedances to place a water on the section 303(d) list,	

Table 3-2. Minimum number of measured exceedances needed to place a water segment on the 303(d) list for conventional and other pollutants.

Sample Size	Number of Exceedances needed to assert impairment
5-30	5
31-36	6
37-42	7
43-48	8
49-54	9
55-60	10
61-66	11
67-72	12
73-78	13
79-84	14
85-91	15
92-97	16
98-103	17

Sample Size	Number of Exceedances needed to assert impairment
104-109	18
110-115	19
116-121	20
For sample sizes greater than 121, the minimum number of measured exceedances is established where α and β < 0.2 and where |α - β| is minimized. α = Excel® Function BINOMDIST(n-k, n, 1 – 0.10, TRUE) β = Excel® Function BINOMDIST(k-1, n, 0.25, TRUE) where n = the number of samples, k = minimum number of measured exceedances to place a water segment on section 303(d) list	

Table 3-3 identifies waterbodies in the Santa Maria River and Oso Flaco Lake watersheds that are listed as impaired on the 2008-2010 303(d) list. Figure 3-1 graphically portrays the impaired waterbodies in the TMDL project area.

Table 3-3. Waterbodies, State Board Water body Identification Codes, and Impairment Listings.

		Impairment Pollutant			
Water Body Name	SB Water Body ID	Unionized Ammonia	Nitrate	Low Dissolved Oxygen	pH
Blosser Channel	CAR3121003020011121135941	X	X		X
Bradley Canyon Creek	CAR3121003020011121144840	X	X	X	X
Bradley Channel	CAR3121003020021002233532	X	X		X
Cuyama R. (above Twitchell Res.)	CAR3123006020080611173645				X
Greene Valley Creek	CAR3121003020080611165954	X	X	X	
Little Oso Flaco Creek	CAR3121003020080611165546		X		
Main Street Canal	CAR3121003020020819110803	X	X		X
Nipomo Creek	CAR3121001120011129124911		X		
North Main Street Channel	CAR3121003020080620111045		X		
Orcutt Creek	CAR3121003020011129154708	X	X		
Oso Flaco Creek	CAR3121003020020124122144	X	X		
Oso Flaco Lake	CAL3121003020011121102545		X		
Santa Maria River	CAR3121003020011228103528		X		
	Totals	7	12	2	5
	Total Water Body/Pollutant Combinations	26			

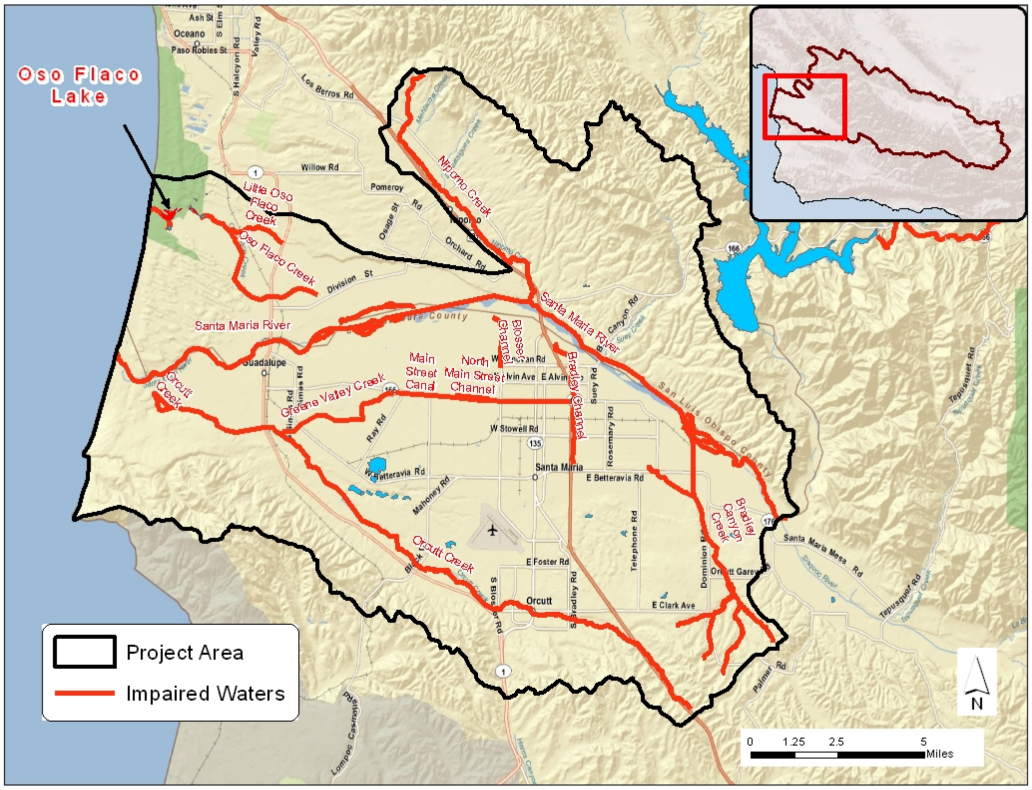


Figure 3-1. Impaired waterbodies in the Lower Santa Maria River watershed.

It should be noted that while water column pH impairments shown in Table 3-3 could possibly result from nutrient enrichment, staff is not addressing the aforementioned pH 303(d) listings in this TMDL. The reasons are as follows:

1) The California Nutrient Numeric Endpoints approach recommends that a pH of 9.0 (for COLD) or a pH of 9.5 (for WARM) represent the pH numeric endpoints which are indicative of a presumptive biostimulatory impairment[22]. These numeric endpoints are well over the upper Basin Plan standard of 8.5.
2) In some areas of the lower Santa Maria River valley, ambient soil conditions are quite alkaline (see Figure 3-2). Staff hypothesizes that some water body pH listings could be related to local alkaline soil conditions, which are unrelated to biostimulation

Therefore, at this time staff recommends that TMDL project area pH listing be addressed through a separate TMDL process or a future water quality standards action.

[22] See Table 3-2 in TetraTech (2006): Technical Approach to Develop Nutrient Numeric Endpoints for California (July 2006, prepared for USEPA Region IX, Contract No. 68-C-02-108-To-111).

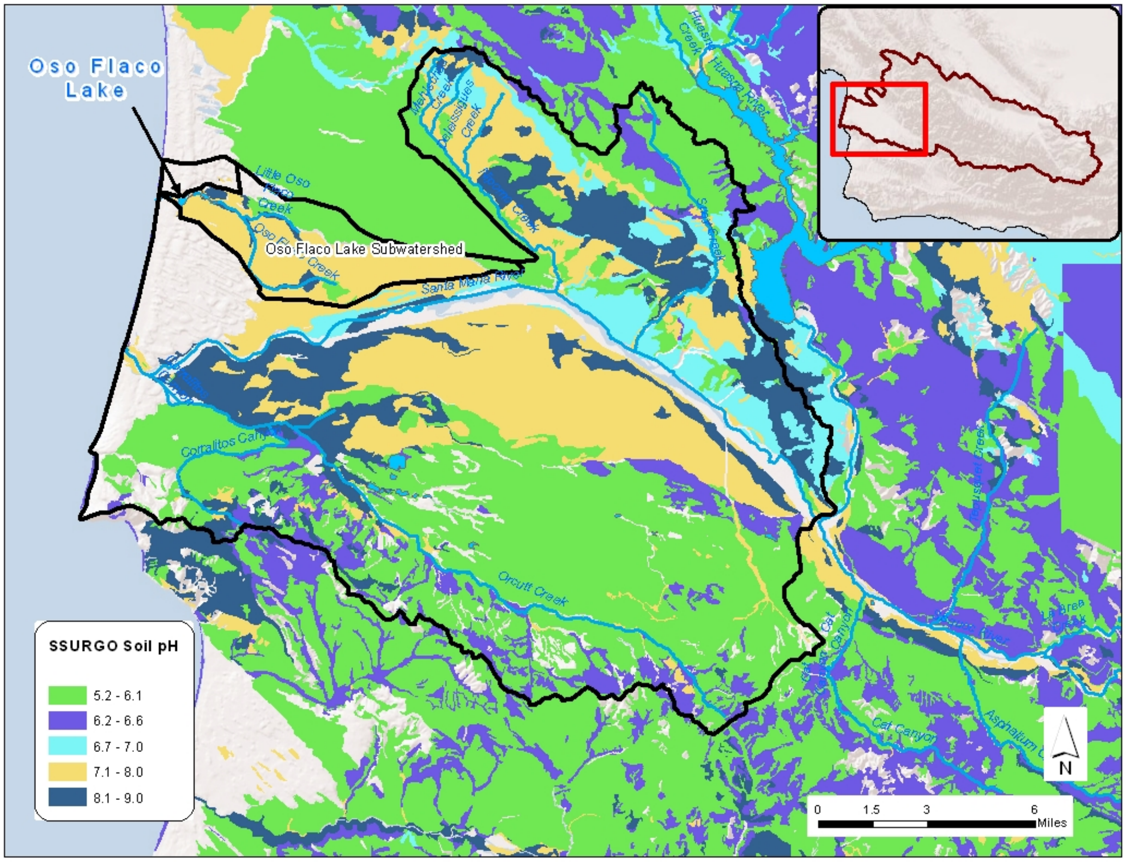


Figure 3-2. Soil pH conditions in the TMDL project area.

3.2 Sources of Data and Information Evaluated

Staff relied on data collected by the following entities or programs in preparing this TMDL Report:

- Central Coast Ambient Monitoring Program (CCAMP),
- Cooperative Monitoring Program (CMP),
- City of Santa Maria,
- County of Santa Barbara's Project Clearwater,
- United States Geological Survey flow (USGS) data, and
- Geographic Information System analysis of land uses.

The following discussion summarizes water quality monitoring activities and results from these efforts.

3.2.1 Central Coast Ambient Monitoring Program (CCAMP) and Cooperative Monitoring Program (CMP)

The Water Board's CCAMP staff conducted monthly water quality monitoring at 31 locations, or "sites", from 2000 to 2001 and from 2007 to 2008. In addition, CCAMP staff conducted monthly coastal confluence (CC) water quality monitoring at the Santa Maria River at Rancho Guadalupe Dunes Preserve site from 2001 through 2010.

The Cooperative Monitoring Program (CMP) collected water quality samples from 20 sites in the Santa Maria River and Oso Flaco Lake watersheds from 2005 to 2010. Many of the CMP sites are at the same location as the CCAMP sites; therefore the data and information provided through these two programs have been combined for discussion in this section.

Table 3-4 is a summary of the waterbodies, monitoring sites, site descriptions, and monitoring programs within the Santa Maria River and Oso Flaco Lake Watersheds.

Figure 3-3 and Figure 3-4 depict CCAMP and CMP monitoring sites within the Lower and Upper Santa Maria River watershed, respectively.

Table 3-4. Summary of waterbodies, monitoring sites, site descriptions, and monitoring program (CCAMP, CMP and CC) in the Santa Maria River and Oso Flaco Lake Watersheds.

Water body	Site ID	Site Description	CCAMP[1]	CMP[2]	CC[3]
Santa Maria River Estuary	312SMA	Santa Maria R @ Rancho Guadalupe Dunes Preserve	X	X	X
Santa Maria River	312SMI	Santa Maria River @ Highway 1	X	X	
	312SBC	Santa Maria River @ Bull Canyon Road	X		
Orcutt Creek	312ORC	Orcutt Solomon Creek u/s Santa Maria R @ Sand Plant	X	X	
	312ORN	Orcutt Creek North Fork Tributary (near sand plant)		X	
	312ORI	Orcutt Solomon Creek @ Highway 1	X	X	
	312GVT	Orcutt Creek @ Brown Road	X		
	312ORB	Orcutt Solomon Creek @ Black Road	X	X	
	312ORS	Orcutt Creek @ Solomon Rd	X	X	
Greene Valley Creek	312GVS	Greene Valley Creek @ Simas Road	X	X	
Main Street Canal	312MAB	Main Street Ditch @ Bonita School Road		X	
	312MSD	Main Street Canal u/s Ray Road @ Highway 166	X	X	
	312MSS	Main Street Canal @ S. Daylight location nr Hanson Way	X	X	
Betteravia Lakes Region	312MHD	Mahoney Dip between Betteravia and Black Rd		X	
Blosser Channel	312BCD	Blosser Channel d/s of groundwater recharge ponds	X		
Bradley Channel	312BCU	Bradley Channel u/s of ponds @ Magellan Dr	X		
	312BCJ	Bradley Channel @ Jones Street		X	
Nipomo Creek	312NIP	Nipomo Creek @ Highway 166	X		
	312NIT	Nipomo Creek @ Teft Street	X		
Bradley Canyon Creek	312BCC	Bradley Canyon Creek @ culvert u/s Santa Maria R.		X	
	312BCF	Bradley Canyon diversion channel @ Foxen Cyn Rd	X		
Cuyama River (below res.)	312CUT	Cuyama River below Twitchell @ White Rock Ln	X		
Huasna River	312HUA	Huasna River @ School Road Bridge	X		
Alamo Creek	312ALA	Alamo Creek at Alamo Creek Road	X		
Cuyama River (above res.)	312CUY	Cuyama River d/s Buckhorn Road	X		
	312CCC	Cuyama River d/s Cottonwood Canyon	X		
	312CUL	Cuyama River above Lockwood turnoff	X		
	312CAV	Cuyama River @ Highway 33	X		
Salisbury Creek	312SAL	Salisbury Creek @ Branch Canyon Wash	X		
Sisquoc River	312SIS	Sisquoc River @ Santa Maria Way	X		
	312SIV	Sisquoc River u/s Tepusquet Road	X		
La Brea Creek	312BRE	La Brea Creek u/s Sisquoc River	X		
Oso Flaco Lake	312OFL	Oso Flaco Lake @ culvert	X		
Little Oso Flaco Creek	312OFN	Little Oso Flaco Creek @ train trestle	X	X	
Oso Flaco Creek	312OFC	Oso Flaco Creek @ Oso Flaco Lake Road	X	X	
	312USC	Oso Flaco Creek @ Oso Flaco Lk. Rd. u/s of confluence		X	
	312OSR	Oso Flaco Creek @ Hwy 1 and south RR trestle		X	
	312OLR	Oso Flaco Creek @ Hwy 1 & Oso Flaco Lk Rd (N ditch)		X	
	312BSR	Oso Flaco Creek @ Bonita School & Division (S ditch)	X	X	

[1] Central Coast Ambient Monitoring Program (CCAMP).
[2] Cooperative Monitoring Program (CMP).
[3] Coastal Confluence (CC) monitoring conducted as part of CCAMP.

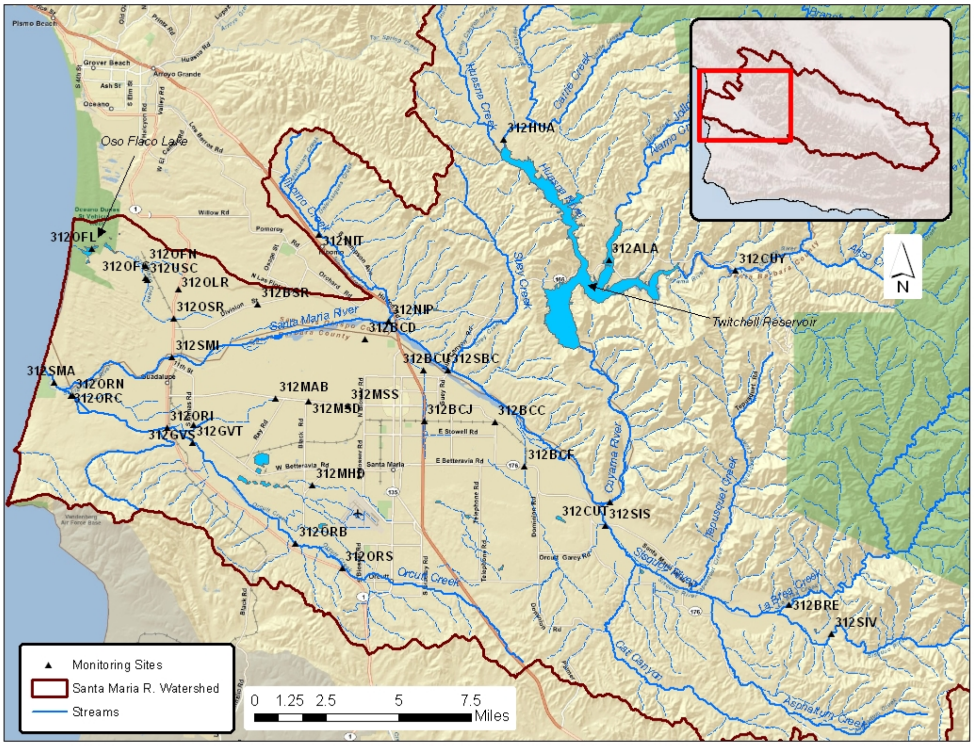


Figure 3-3. Monitoring sites in the Lower Santa Maria River watershed.

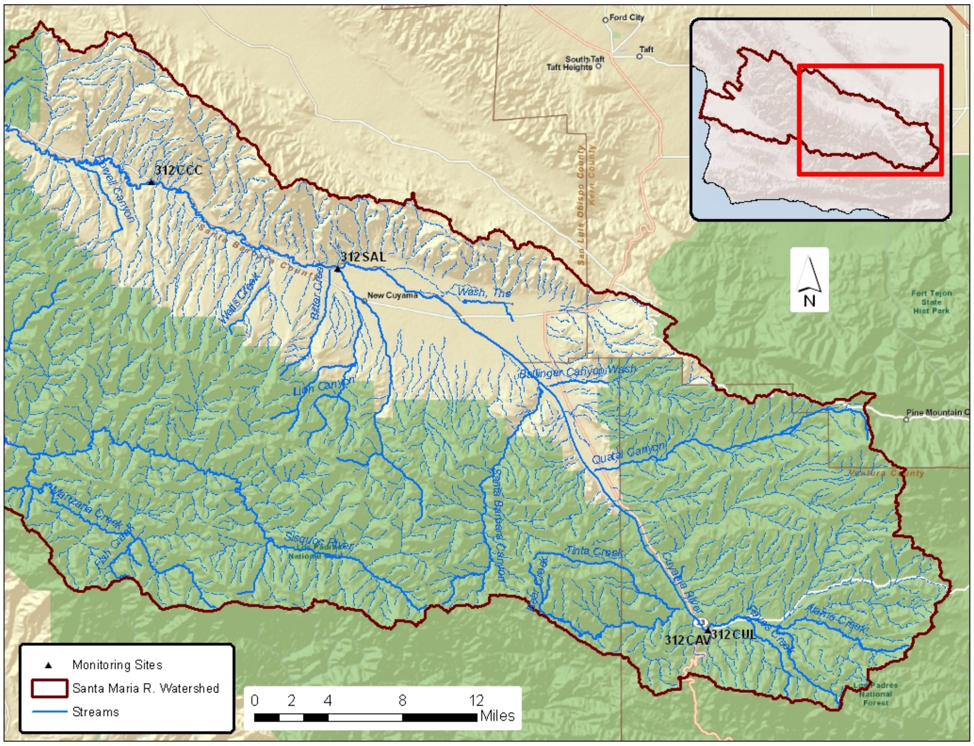


Figure 3-4. Monitoring sites in the Upper Santa Maria River watershed.

The data and information contained in the following sections provide a summary of data that was collected from the CCAMP and CMP monitoring programs to assess water quality conditions. The data summaries contained in the following sections have been extracted from the more detailed data set contained in Appendix B: Data Analysis. Note that data representing low exceedance rates have been omitted in the discussion below for brevity. Staff performed an assessment of water quality conditions pertaining to un-ionized ammonia, nitrate as nitrogen, dissolved oxygen, and pH using the water quality objectives and criteria presented in Section 2.3. This data is then compared to Listing Policy exceedance rates (see Table 3-1 and Table 3-2) to assess impairment.

3.2.1.1 Un-ionized ammonia Exceedances

The Basin Plan General Objective, Chapter III, Section II.A.2 (General Objectives for all Inland Surface Waters, Enclosed Bays and Estuaries) states that the discharge of wastes shall not cause concentrations of unionized ammonia (NH_3) to exceed 0.025 mg/l (as N) in receiving waters (page III-4). Staff used this objective to assess water quality impairment as presented Table 3-5 below.

Table 3-5. Summary of Un-ionized Ammonia (NH_3) as Nitrogen (mg/L).

Water body	Site ID	Count	Median	Mean	Count > 0.025	Percent > 0.025
Santa Maria River	312SMA	159	0.0036	0.0082	12	7.5
	312SMI	33	0.0021	0.0101	1	3.0
Orcutt Creek [1]	312ORC	81	0.0040	0.0100	11	13.6
	312ORN	12	0.0076	0.0149	2	16.7
	312ORI	80	0.0071	0.0472	23	28.8
	312GVT	12	0.0152	0.0172	4	33.3
	312ORB	34	0.0025	0.0298	5	14.7
Greene Valley Creek [1]	312GVS	68	0.0024	0.0723	14	20.6
Main Street Canal [1]	312MAB	9	0.0429	0.1083	7	77.8
	312MSD	68	0.0794	0.2935	46	67.6
	312MSS	23	0.2282	0.4239	17	73.9
Blosser Channel [1]	312BCD	21	0.0201	0.0416	9	42.9
Bradley Channel [1]	312BCU	25	0.0078	0.0287	5	20.0
	312BCJ	53	0.0372	0.3922	35	66.0
Bradley Canyon Creek [1]	312BCC	28	0.0167	0.1151	12	42.9
	312BCF	10	0.0046	0.1448	3	30.0
Little Oso Flaco Creek	312OFN	70	0.0021	0.0034	1	1.4
Oso Flaco Creek [1]	312OFC	77	0.0069	0.0730	21	27.3
	312USC	12	0.0387	0.3017	6	50.0
	312OSR	11	0.0110	0.0374	4	36.4
	312OLR	10	0.1142	0.3695	9	90.0
	312BSR	18	0.0110	0.0246	5	27.8

[1] Indicates waterbodies on the 2008-2010 303(d) List of Impaired waterbodies for this constituent.

Results from twenty-two monitoring sites, representing 9 waterbodies, often exceed the un-ionized ammonia water quality objective. The highest average concentrations were observed at Main Street Canal (312MSS) followed by Bradley Channel (312BCJ) and Oso Flaco Creek (312OLR). The greatest number of exceedances were observed at Oso Flaco Creek (90% at 312OLR), followed by Main Street Canal sites (ranging from 74-78%). Orcutt Creek, Greene Valley Creek, Main Street Canal, Blosser Channel, Bradley Channel, Bradley Canyon Creek, and Oso Flaco Creek meet the minimum number of measured exceedances (see Table 3-1) and are therefore considered impaired due to excessive un-ionized ammonia concentrations.

Box and whisker plots for unionized ammonia data are provided in Appendix B, Data Analysis.

Figure 3-5 is a scatter plot showing an increasing trend in CCAMP and CMP un-ionized ammonia (as nitrogen) concentrations over time (1999 to 2010).

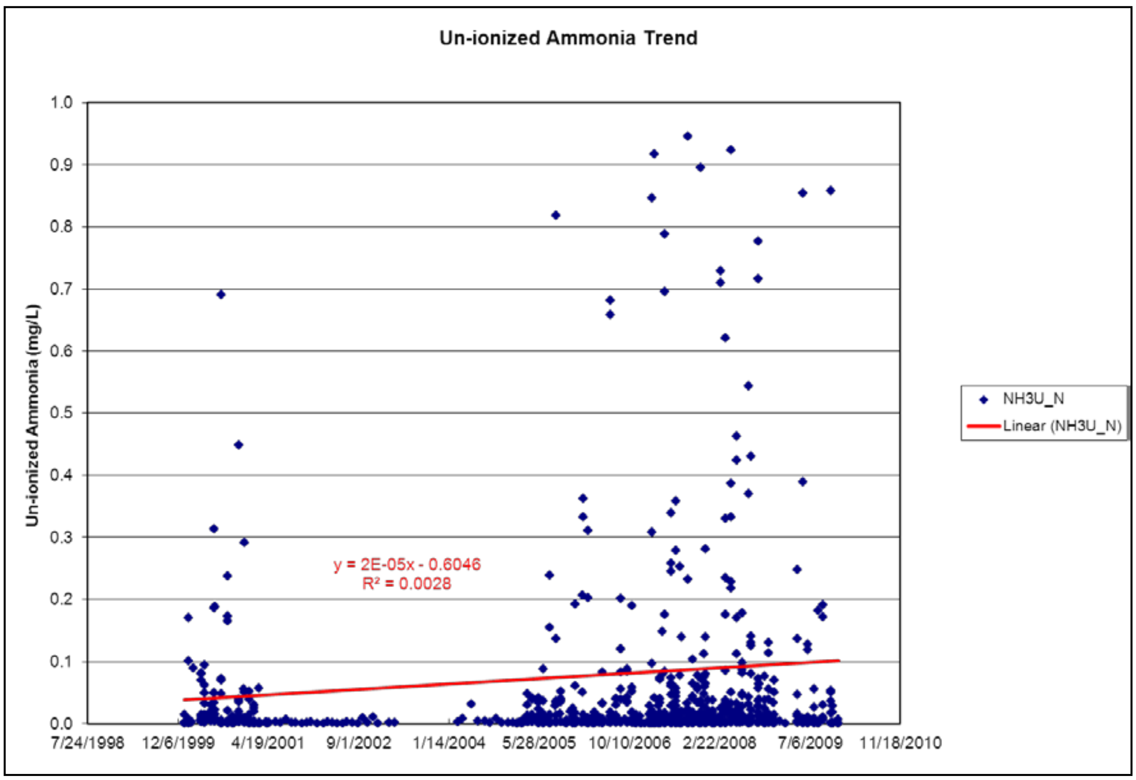


Figure 3-5. Un-ionized ammonia as nitrogen (mg/L) concentrations over time.
Note: Compilation of all CCAMP/CMP monitoring sites in Santa Maria/Oso Flaco Lake watersheds. Data for 19 values over 1.0 mg/L (max of 8.27 mg/L) are not plotted on graph for clarity; however values were used for regression.

3.2.1.2 *Nitrate Exceedances*

The Basin Plan objective for municipal and domestic supply (MUN) uses of inland surface waters (Section II.A.2) states the following: 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. The maximum contaminant level listed in Table 3-2 (inorganic and fluoride concentrations not to be exceeded in domestic or municipal supply) for nitrate is 10 mg/L (NO3 as N).

Additionally, as presented in Section 2.2.3, interpretation of the amount of nitrate which adversely affects the agricultural supply (AGR) beneficial use of waters of the State shall be derived from the University of California Agricultural Extension Service guidelines, which are found in Basin Plan Table 3-3. Accordingly, severe problems for sensitive crops could occur for irrigation water exceeding 30 mg/L (NO3 as N).

Staff used these values to assess water quality conditions as shown in Table 3-6 below.

Table 3-6. Summary of Nitrate as Nitrogen (mg/L).

Water body	Site ID	Count	Median	Mean	Count >10	Percent >10	Count >30	Percent >30
Santa Maria River [1]	312SMA	129	26.3	28.3	128	99.2	38	29.5
	312SMI	24	26.0	30.8	23	95.8	10	41.7
Orcutt Creek [1]	312ORC	48	31.0	35.5	48	100.0	29	60.4
	312ORN	3	38.2	36.0	3	100.0	2	66.7
	312ORI	46	52.4	52.4	44	95.7	38	82.6
	312GVT	12	36.0	36.4	12	100.0	7	58.3
	312ORB	29	11.1	13.5	15	51.7	1	3.4
Greene Valley Creek [1]	312GVS	30	51.3	53.8	30	100.0	26	89.7
Main Street Canal [1]	312MSD	36	15.5	21.6	27	75.0	7	19.4
	312MSS	14	7.7	14.1	5	35.7	2	14.3
Blosser Channel [1]	312BCD	21	2.9	5.4	3	14.3	0	0.0
Bradley Channel [1]	312BCU	26	9.4	11.9	11	42.3	2	7.7
	312BCJ	17	15.0	19.6	11	64.7	2	11.8
Nipomo Creek [1, 2]	312NIP	22	1.2	1.2	0	0.0	0	0.0
	312NIT	15	5.2	4.6	0	0.0	0	0.0
Bradley Canyon Creek [1]	312BCC	9	9.1	11.0	4	44.4	0	0.0
	312BCF	11	10.0	14.2	6	54.5	1	9.1
Oso Flaco Lake [1]	312OFL	28	30.0	30.6	28	100.0	17	60.7
Little Oso Flaco Creek [1]	312OFN	37	39.0	41.0	36	97.3	33	89.2
Oso Flaco Creek [1]	312OFC	41	34.5	38.6	41	100.0	28	68.3
	312USC	3	35.0	37.1	3	100.0	2	66.7
	312OSR	2	34.4	34.4	2	100.0	2	100.0
	312OLR	2	52.2	52.2	2	100.0	2	100.0

Water body	Site ID	Count	Median	Mean	Count >10	Percent >10	Count >30	Percent >30
	312BSR	9	80.0	80.8	9	100.0	9	100.0

[1] Indicates waterbodies on the 2008-2010 303(d) List of Impaired waterbodies for this constituent.
[2] Nipomo Creek listed on 2008-2010 303(d) List because 18 of the 26 samples exceeded the Evaluation Guideline for Nitrate (1 mg/L nitrate as N) established for aquatic life beneficial uses using the Numeric Nutrient Endpoint tool.

Results from twenty-two monitoring sites, representing 10 waterbodies, exceed the municipal and domestic supply nitrate water quality objective. The highest average concentrations were observed at Oso Flaco Creek (81mg/L at 312BSR), followed by Greene Valley Creek (54mg/L at 312GVS). Five Oso Flaco Creek sites exceeded the nitrate objective in 100% of the samples. Other waterbodies with a 100% exceedance rate are Greene Valley Creek (312GVS), two Orcutt Creek monitoring sites (312ORC and 312GVT), and Oso Flaco Lake (312OFL).

Santa Maria River, Orcutt Creek, Greene Valley Creek, Main Street Canal, Blosser Channel, Bradley Channel, Bradley Canyon Creek, Little Oso Flaco Creek, and Oso Flaco Creek meet the minimum number of measured exceedances (see Table 3-1) and are therefore considered impaired due to excessive nitrate as nitrogen concentrations.

Although the MUN beneficial use is not designated for Oso Flaco Lake, staff has concluded that there is evidence of a nuisance condition related to over growth of aquatic vegetation, algae and wide swings in dissolved oxygen levels (see Section 3.2.1 Diel Dissolve Oxygen Conditions). These nuisance conditions are caused (at least in part) by the high levels of nutrients, specifically nitrate, in the lake. As such, staff concurs with the 2008-2010 303(d) listing decision that Oso Flaco Lake is impaired due to excessive nitrate concentrations.

Note that North Main Street Channel is also listed for nitrate impairment; however, data that led to the listing of this water body was provided by City of Santa Maria Stormwater Monitoring program (see Section 3.2.2.1 for discussion).

Nitrate concentrations in Santa Maria River, Orcutt Creek, Greene Valley Creek, Main Street Canal, Little Oso Flaco Creek, and Oso Flaco Creek also do not support the agricultural supply (AGR) beneficial use and pose severe problems for sensitive crops. Although Oso Flaco Lake does not have an AGR beneficial use designation, it has been reported that water from the lake has been used in the past for crop irrigation[23].

Box and whisker plots for nitrate data are provided in Appendix B, Data Analysis.

Figure 3-6 is a scatter plot showing an increasing trend in CCAMP and CMP nitrate (as nitrogen) concentrations over time (1999 to 2010).

[23] Ronnie Glick, California Department of Parks and Recreation, personal communication.

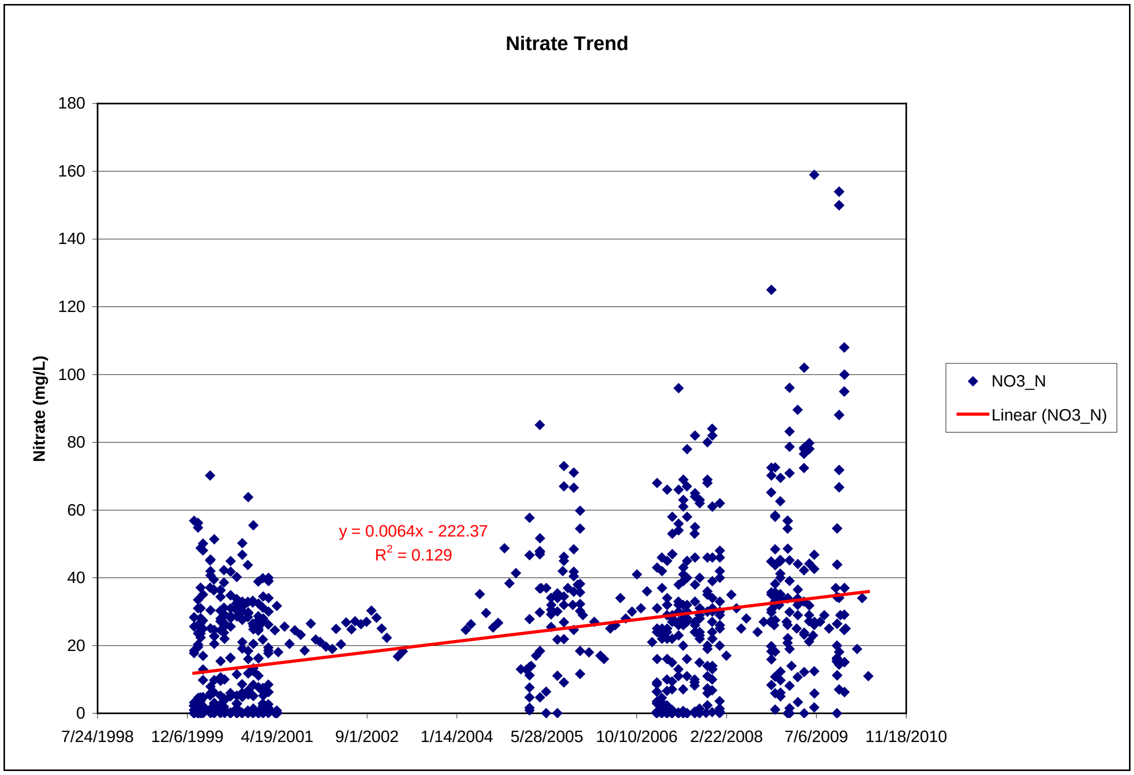


Figure 3-6. Nitrate as nitrogen concentrations (mg/L) over time.
Note: Compilation of all CCAMP/CMP monitoring sites in Santa Maria/Oso Flaco Lake watersheds.

3.2.1.3 <u>Low Dissolved Oxygen Exceedances</u>

The Basin Plan Cold Water Habitat Objective, Chapter III, Section II.A.2 General Objectives for all Inland Surface Waters, Enclosed Bays and Estuaries states the following: The dissolved oxygen concentration shall not be reduced below 7.0 mg/l at any time.

Though the Basin Plan does not specify COLD beneficial use for Greene Valley Creek, the creek is a tributary to Orcutt Creek and ultimately Santa Maria River. A recent publication, Steelhead/Rainbow Trout (Oncorhynchus mykiss) Resources South of the Golden Gate, California (Becker, G.S and I.J Reining, October 2008) identifies Santa Maria River as having "Definite run or population" and as being a viable migration corridor to the upper watershed of the Sisquoc River, where steelhead are still observed regularly. Therefore, staff asserts the 7.0 mg/l dissolved oxygen concentration objective is applicable to Greene Valley Creek. Santa Maria River and Orcutt Creek are specified in the Basin Plan as COLD beneficial use waterbodies. Staff used this objective to assess water quality conditions for the COLD beneficial use waterbodies as presented Table 3-7 below.

Table 3-7. Summary of Dissolved Oxygen (mg/L) for COLD and SPWN (Fish Spawning) Beneficial Use Waterbodies.

Water body	Site ID	Count	Median	Mean	Count < 7	Percent < 7
Santa Maria River (COLD)	312SMI	39	9.0	9.8	4	10.3
Orcutt Creek (COLD)	312ORB	38	9.0	9.3	4	10.5
	312ORS	7	7.8	7.6	3	42.9
Greene Valley Creek (COLD)[1]	312GVS	68	9.0	8.5	20	29.4
Oso Flaco Lake (SPWN)	312OFL	29	9.2	9.8	5	17.2

[1] Indicates water body is on the 2008-2010 303(d) List of Impaired waterbodies for this constituent.

Five monitoring sites representing four waterbodies exceed dissolved oxygen concentrations (< 7 mg/L) for protection of the COLD/SPWN beneficial use. The highest exceedance rate was observed within Orcutt Creek (43% at 312ORS), followed by Greene Valley Creek (29% at 312GVS). Greene Valley Creek and Oso Flaco Lake meet the minimum number of measured exceedances (see Table 3-2) and are therefore considered impaired due to low oxygen concentrations. Note that Oso Flaco Lake was not included on the 2008-2010 303(d) list for dissolved oxygen impairment. However, staff concluded that Oso Flaco Lake is impaired due to low dissolved oxygen concentrations and will therefore be addressed in a separate TMDL. The Oso Flaco Lake dissolved oxygen impairment will be partially addressed in this TMDL by establishing stream nutrient TMDLs for the two tributaries (Oso Flaco Creek and Little Oso Flaco Creek) that address biostimulatory upstream effects of these streams.

The Basin Plan General Objective, Chapter III, Section II.A.2 General Objectives for all Inland Surface Waters, Enclosed Bays and Estuaries states the following: For waters not mentioned by a specific beneficial use, dissolved oxygen concentration shall not be reduced below 5.0 mg/l at any time. Staff used this objective to assess water quality conditions of the remaining (e.g., non-COLD/SPWN beneficial use) waterbodies as presented in Table 3-8.

Table 3-8. Summary of Dissolved Oxygen (mg/L) for General Objectives for all Inland Surface Waters, Enclosed Bays and Estuaries.

Water body	Site ID	Count	Median	Mean	Count < 5	Percent < 5
Bradley Channel	312BCU	28	10.1	9.6	4	14.3
Bradley Canyon Creek [1]	312BCC	30	7.5	8.3	3	10.0
	312BCF	13	8.5	7.7	4	30.8

[1] Indicates waterbodies on the 2008-2010 303(d) List of Impaired waterbodies for this constituent.

Three monitoring sites representing two waterbodies exceed dissolved oxygen concentrations (< 5 mg/L) for protection of Surface Waters, Enclosed Bays and Estuaries. The highest exceedance rate was observed at Bradley Canyon Creek (31% at 312BCF). Bradley Canyon Creek meets the minimum number of measured exceedances (combined 7 of 33) and is therefore considered impaired due to low oxygen concentrations.

The Basin Plan General Objective, Chapter III, Section II.A.2 General Objectives for all Inland Surface Waters, Enclosed Bays and Estuaries, states that median values of dissolved oxygen saturation shall not fall below 85% saturation. Staff used this objective to assess water quality conditions.

Table 3-9. Summary of Dissolved Oxygen (% saturation) for General Objectives for all Inland Surface Waters, Enclosed Bays and Estuaries

Water body	Site ID	Count	Median
Orcutt Creek	312ORS	7	82.4
Main Street Canal	312MSS	22	85.25
Bradley Canyon Creek	312BCC	31	85
	312BCF	13	75.6

Two monitoring sites representing two waterbodies exceed the dissolved oxygen saturation water quality objective (median values not less than 85% saturation) for protection of Surface Waters, Enclosed Bays and Estuaries. The two sites are 312ORS and 312BCF representing Orcutt Creek and Bradley Canyon Creek, respectively. Note that Orcutt Creek was not included on the 2008-2010 303(d) list for dissolved oxygen impairment; however, staff concluded that the water body is impaired and will therefore be addressed in this TMDL. Also note that Bradley Canyon Creek is included on the 2008-2010 list of impaired waters due to low dissolved oxygen concentrations (see Table 3-8).

Note that this TMDL is addressing biostimulatory impairments; as such only dissolved oxygen impairments that are credibly linked to biostimulation problems (i.e., elevated algal biomass, wide diel swings in DO/pH, and elevated nutrients) will be addressed in this TMDL. It is important to recognize that there are other factors that affect the concentration of dissolved oxygen in a water body. Oxygen can be introduced by additions of higher DO water (e.g., from tributaries); additions of lower DO water (groundwater baseflow), temperature (warm water holds less oxygen than cold water), and reductions in oxygen due to organic decomposition. Dissolved oxygen impairments that are not credibly linked to biostimulation impairments will potentially be addressed in another TMDL process, or in a future water quality standards action.

3.2.1.4 pH

The Basin Plan contains pH water quality objectives for MUN, REC-1, REC-2, and AGR beneficial uses (see Section 2.2 for Beneficial Use descriptions), stating that “The pH value shall neither be depressed below 6.5 nor raised above 8.3.”

The Basin Plan General Objective, Chapter III, Section II.A.2 General Objectives for all Inland Surface Waters, Enclosed Bays and Estuaries states the following:

For waters not mentioned by a specific beneficial use, the pH value shall not be depressed below 7.0 or raised above 8.5. In addition, as contained in the Basin Plan, these pH values also pertain to COLD and WARM beneficial uses.

Staff used these water quality objectives to assess water quality conditions within the Santa Maria River and Oso Flaco Lake watersheds as presented Table 3-10 below.

Twenty-two monitoring sites, representing ten waterbodies, exceeded pH levels (less than 8.3) necessary for the protection of municipal water supply (MUN), recreational (REC-1/REC-2) and agricultural (AGR) beneficial uses. The highest exceedance rate was observed at Main Street Canal at Bonita School Road (89 % at 312MAB), followed by Bradley Channel (74% at 312BCJ) and Blosser Channel (71% at 312BCD). It should be noted exceedances were observed at Sisquoc River monitoring sites (312SIS and 312SIV); however, the 2008-2010 303(d) fact sheet for this water body states that these conditions are most likely attributable to natural geologic conditions.

Main Street Canal, Blosser Channel, Bradley Channel, Bradley Canyon Creek, Cuyama River upstream of Twitchell Reservoir, and Oso Flaco Creek upstream of monitoring station 312USC meet the minimum number of measured exceedances (see Table 3-2) and are therefore considered impaired due to high pH concentrations. Note that all waterbodies except for Oso Flaco Creek are included on the 2008-2010 303(d) list.

It is important to note that staff has concluded that the water column pH impairments shown in Table 3-10 may be the result of biostimulatory conditions, natural soil conditions (see Figure 3-2), or discharges from unidentified sources. Due to this uncertainty, staff is not proposing TMDLs that directly address the aforementioned pH 303(d) listings. pH impairments that are not credibly linked to biostimulation impairments will potentially be addressed in another TMDL process, or in a future water quality standards action.

Table 3-10. Summary of pH concentrations (-log[H+]).

Water body	Site ID	Count	Median	Mean	pH Objectives for MUN, REC-1, REC-2, and AGR Beneficial Uses				pH Objectives for COLD, WARM, and unspecified Beneficial Uses			
					Count < 6.5	Percent < 6.5	Count > 8.3	Percent > 8.3	Count < 7	Percent < 7	Count > 8.5	Percent > 8.5
Main Street Canal [1]	312MAB	9	8.51	8.47	0	0	8	88.9	0	0.0	5	55.6
	312MSD	71	7.96	7.92	0	0	8	11.3	0	0.0	2	2.8
	312MSS	23	8.07	8.00	0	0	5	21.7	1	4.3	2	8.7
Blosser Channel [1,]	312BCD	24	8.78	8.76	0	0	17	70.8	0	0.0	15	62.5
Bradley Channel [1]	312BCU	28	8.16	8.21	0	0	11	39.3	0	0.0	6	21.4
	312BCJ	53	8.56	8.68	0	0	39	73.6	0	0.0	28	52.8
Bradley Canyon Creek [1]	312BCC	29	7.98	8.06	0	0	9	34.6	0	0.0	3	11.5
	312BCF	13	7.93	7.94	0	0	3	23.1	0	0.0	0	0.0
Cuyama River (above res.) [1]	312CUY	16	8.17	8.17	0	0	4	25.0	0	0.0	0	0.0
	312CCC	19	7.94	7.98	0	0	3	15.8	0	0.0	0	0.0
	312CUL	3	8.25	8.26	0	0	1	33.3	0	0.0	0	0.0
	312CAV	23	7.99	7.99	0	0	3	13.0	0	0.0	0	0.0
Sisquoc River [2]	312SIS	6	8.47	8.46	0	0	5	83.3	0	0.0	2	33.3
	312SIV	26	8.02	8.04	0	0	7	26.9	0	0.0	2	7.7
La Brea Creek	312BRE	20	7.99	8.01	0	0	4	20.0	0	0.0	1	5.0
Oso Flaco Lake	312OFL	27	7.86	7.86	0	0	1	3.7	0	0.0	0	0.0
Little Oso Flaco Creek	312OFN	80	7.70	7.73	0	0	1	1.3	0	0.0	0	0.0
Oso Flaco Creek [3]	312OFC	81	7.66	7.68	0	0	2	2.5	0	0.0	0	0.0
	312USC	12	8.15	8.20	0	0	3	25.0	0	0.0	0	0.0
	312OSR	11	8.20	8.30	0	0	5	45.5	0	0.0	2	18.2
	312OLR	10	8.26	8.27	0	0	4	40.0	0	0.0	2	20.0
	312BSR	18	8.18	8.21	0	0	5	27.8	0	0.0	3	16.7

[1] Indicates waterbodies on the 2008-2010 303(d) List of Impaired waterbodies for this constituent.
[2] After review of the available data and information, RWQCB staff concludes that the water body- should not be placed on the section 303(d) list because there are no known unnatural sources in the upper Sisquoc River. Staff believe the elevated pH is natural and a result of geologic conditions.
[3] Water Board staff asserts impairment of Oso Flaco Creek upstream of monitoring site 312USC; whereby fourteen (14) of thirty-eight (38) samples exceed WQOs as sites 312OSR, 312 OLR, and 312BSR.

3.2.2 Other Studies

This section provides monitoring data and information obtained from other studies.

3.2.2.1 City of Santa Maria Stormwater Monitoring

The Water Board regulates stormwater through approval of Stormwater Management Plans that comply with the National Pollution Discharge Elimination General Permit (NPDES) for discharges (Permit No. CAS000004, Order No. 2003-0005-DWQ). The municipalities in the Santa Maria and Oso Flaco watersheds must obtain approval of these plans and comply with the general permit. Some municipalities are monitoring water quality as part of their proposed permit activities.

The City of Santa Maria began collecting data during storm events in 2004. City of Santa Maria staff chose monitoring stations to characterize land use contributions. Prell Basin primarily collected stormwater from agricultural areas to the West and was representative of flows which entered the City of Santa Maria. Hobbs Basin received urban runoff, and during overflows discharged to a channel along Stowell Road and eventually flowed to the Santa Maria River. The Main Street Channel consisted of two channels that ran on along Main Street and combined to become the Unit 2. Ditch, and ultimately discharges to the Santa Maria River. This site represented mixed contributions from urban and agricultural areas.

City of Santa Maria staff plans to continue stormwater monitoring efforts indefinitely, with a minimum of three sampling events per wet season. Additional sampling will provide further information to characterize urban and agricultural inputs. Water Board staff concluded that urban runoff was likely a source of nitrate and un-ionized ammonia to the nutrient impairment.

Table 3-11 shows a summary of concentrations collected between 2004 and 2006 by the City of Santa Maria at four monitoring stations. Nitrate levels in the North Channel of the Main Street Canal were higher (37 mg/L as N) than those measured elsewhere. Nitrate concentrations measured in stormwater runoff from Prell and Hobbs Basins and the South Channel of Main Street did not exceed water quality objectives. Un-ionized ammonia levels were not available, and staff recommends the City modify their MRP to include pH and temperature so that these values can be calculated.

Table 3-11. Summary of Stormwater Nitrate (mg/L as N) Collected by the City of Santa Maria Collected Between 2004 and 2006.

Station	Number of Samples	Nitrate Min	Nitrate Average	Nitrate Max
Prell Basin / West of Highway One and South of Nicholson Street	5	2.7	3.2	3.7
Hobbs Basin / South of Stowell Road and West of A Street	4	ND	1.3	1.8
Main St. Channel North / West Main and Hansen Lane which combine to become the Unit Two Ditch	4	2.2	14.2	37.0
Main St. Channel South / West Main and Hansen Lane which combine to become the Unit Two Ditch	5	1.0	2.3	5.9

The Water Quality Control Plan, Central Coast Basin Objective for municipal and domestic supply uses of inland surface waters (Section II.A.2) states the following: 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. The maximum contaminant level listed in Table 3-2 (inorganic and fluoride concentrations not to be exceeded in domestic or municipal supply) for nitrate is 10.0 mg/L (NO3 as N). Therefore, staff has concluded that the North Main Street Channel is impaired due to excessive nitrate concentrations.

3.2.2.2 Orcutt Creek Storm Event Monitoring

Santa Barbara County's Project Clean Water sponsors studies to help identify pollution sources and develop an understanding of how those pollutants move through the environment. Project Clean Water staff conducted nitrate and ammonical nitrogen in Orcutt Creek during four storm events at Black Road, monitoring site OR1 and at an upstream location, OR5. OR1 is the same location as CCAMP monitoring site 312ORB. Figure 3-7 shows the monitoring locations. Table 3-12 displays summary nitrate and ammonical nitrogen values.

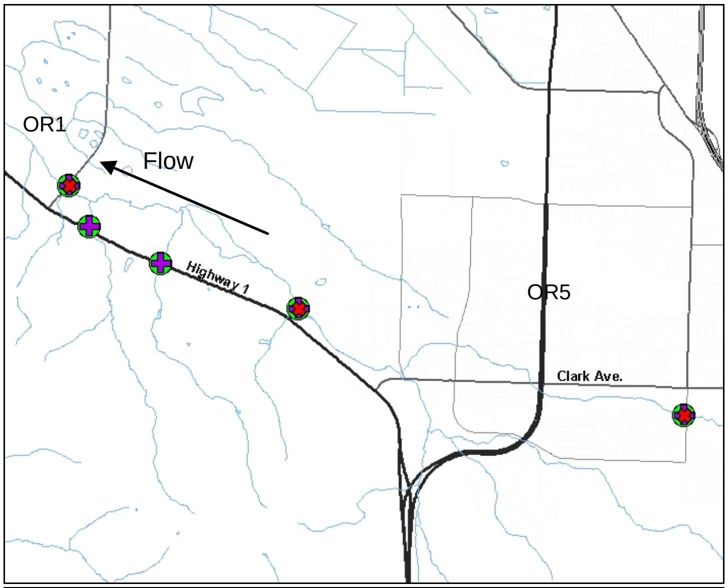


Figure 3-7. Project Clean Water Sampling Sites on Orcutt Creek.

Table 3-12. Summary of stormwater Nitrate (mg/L as N) and Ammonical Nitrogen Concentrations Collected by Project Clean Water in 2002-2003.

Station	Number of Samples	Time period	Nitrate (mg/L) Min.	Nitrate (mg/L) Average	Nitrate (mg/L) Max.	Number of Samples	Time period	Ammonical Nitrogen (mg/L) Min.	Ammonical Nitrogen (mg/L) Average	Ammonical Nitrogen (mg/L) Max.
OR1	9	2/2000 - 2/2003	1.5	6.1	10.0	3	11/2002 - 2/2003	ND	0.2	0.5
OR5	7	1/2001 - 2/2003	ND	0.1	0.7	3	11/2002 - 2/2003	ND	0.1	0.2

Nitrate levels at OR1 ranged from 3.7 to 10.0 mg/L. Nitrate levels at OR5 were non-detectable levels of nitrate, with the exception of one sample (0.7 mg/L). No stormwater samples exceeded the nitrate water quality objective. Ammonical nitrogen levels at OR1 were higher than those measured at OR5.

3.2.2.3 <u>Oso Flaco Nitrate Study</u>

The Coastal Conservancy contracted with The Dunes Center to conduct an Oso Flaco Watershed Nitrate and Sediment Assessment. Objectives of the study included developing a nitrate model. As part of this effort, the Cachuma Resources Conservation District (CRCD) collected nitrate data in 2002-2003 at eight locations within the Oso Flaco watershed. Staff summarized data in Table 3-13. Urban stormwater discharges from the rural residential area of Nipomo Mesa to Oso Flaco watershed did not exceed water quality objectives; runoff did not occur during dry periods. Samples taken from Oso Flaco Creek, and Little Oso Flaco Creek exceeded water quality objectives, but were typically less than samples taken from unnamed agricultural ditches. Irrigated agricultural discharges occurred during both wet and dry seasons.

Table 3-13. CRCD Monitoring Locations and Ambient Data Summary (Nitrate as N) in the Oso Flaco Watershed in 2002-2003.

Station (s)	Primary land use/location within drainage area	Number of Samples	Min. (mg/L)	Average (mg/L)	Max. (mg/L)
Site 1	Urban runoff from Nipomo Mesa via stormwater collection system on Division Road; stagnant flow	3	2	2	3
Site 2	County Road Ditch Culvert Outlet. Intersection of Bonita School Road and Division Rd. West of BSRd, South side of Division.	13	13	82	137
Site 3	Ag Ditch Coming from County Road Ditch Culvert Outlet. North Side of Division Rd. Approximately 4,650 feet west /south west of the split in the road of Division and Oso Flaco Lake Road.	11	12	82	154
Site 4	County Road Ditch. Intersection of Highway 1 and Oso Flaco Lake Road. Southwest Quadrant. West of Highway 1 and south of Oso Flaco Lake Road.	13	9	42	111
Site 5	County Road Ditch along Oso Flaco Lake Road, just west of the railroad tracks. South of Oso Flaco Lake Road.	11	12	26	56
Site 6	Oso Flaco Creek just north of Oso Flaco Lake Road.	15	25	43	65
Site 7	Little Oso Flaco Creek just west of the train trestle.	15	18	41	76
Site 8	At the causeway at Oso Flaco Lake. Downstream end of two culverts.	15	29	38	52

3.2.2.4 Santa Maria Estuary Enhancement and Management Plan

The State Coastal Conservancy prepared the Santa Maria Estuary Enhancement and Management Plan (Plan) in March 2004. The Plan included water quality data collection from sites between the Santa Maria River at Highway 1 to the Santa Maria River Estuary lagoon and focused on nitrate inputs. Table 3-14 provides a summary of data obtained during this study[24].

Table 3-14. Ambient Nitrate as N concentrations from the *SMRE* Study

October 31 and November 20, 2001[a]	
Sampling location	Nitrate as N (mg/L)
Hwy 1	8.3, 8.8 (8.5)
Lagoon	18, 22 (20)
May 22 and 23, 2002[b]	
Hwy 1	11.3, 7.9, (9.6)
8th Street	11.6, 7.9, 9.1 (9.5)
Ditch near Kiosk	48.4, 7.8 (28.1)
Orcutt Creek	18.5, 23.3 (20.9)
Lagoon	17.8, 14.7 (16.2)

[a] Data for samples taken on October 31 and November 20, 2001, mean data in parenthesis (Moffatt & Nichols Engineers Letter Report dated March 12, 2002 in Appendix B).
[b] Data for samples taken on May 22 and 23, 2002, mean data in parenthesis (Moffatt & Nichols Engineers Letter Report dated October 25, 2002 in Appendix B).

[24] Data contained in letter reports for the Santa Maria Estuary Enhancement and Management Plan (*SMRE)* Study, Appendix B, dated March 12, 2002 and October 25, 2002.

As reported in the Plan, nitrate concentrations measured at Highway 1 were lower than samples collected from the estuary. Researchers concluded this was likely due to substantial nutrient input from Orcutt Creek combined with the drainage ditch near the kiosk to Rancho Guadalupe Dunes Preserve. Together these two drainages accounted for about 96% of the nitrate input to the estuary (*SMRE* Study, Appendix B, Moffatt & Nichols Engineering letter report dated October 25, 2002). The percent nitrate load contribution to the estuary was 88% from Orcutt Creek, 8% from the drainage ditch near the kiosk, and 3% from the Santa Maria River at Highway 1. The study also reported ammonia as nitrogen concentrations of 0.27 and 0.82 mg/L for samples obtained from the Orcutt Creek drainage.

The Plan also reported a water budget for the estuary that was substantially affected by input from Orcutt Creek (86% inflow contribution) and the drainage ditch near the kiosk (6% inflow contribution). Combined, these two sources accounted for approximately 92% of the total inflow to the estuary. Water level rises in the estuary following rainfall when the barrier berm has not been breached and the rate of inflow (from upstream) exceeds the length and rate of seepage through the barrier berm to the ocean (about 0.8 cubic m/sec).

Based on the information contained in the Plan, staff concludes that the Santa Maria River Estuary is impaired due to excessive nitrate concentrations that originate from Orcutt Creek.

3.2.2.5 Santa Maria River Estuary Monitoring Conducted by University of California, Davis, Granite Canyon Marine Laboratory

As part of the California Surface Water Ambient Monitoring Program (SWAMP), the University of California, Davis, Granite Canyon Marine Laboratory (UCD-GC) performed dissolved oxygen monitoring of the Santa Maria River Estuary. Monitoring was conducted from January 2, 2008 to October 29, 2010 for two sites. The sites were located within the upper and lower portions of the estuary, respectively. The Santa Maria River Estuary is the furthest downstream receiving water body within the Santa Maria River watershed and drains directly to the Pacific Ocean. Table 3-15 presents the dissolved oxygen monitoring data and Table 3-16 provides a data summary.

Table 3-15. Santa Maria River Estuary (312SME) Dissolved Oxygen concentrations (mg/L)

Station Code	Sample Date	Agency Code	DO Result (mg/L)
312SME_L	1/5/2008	UCD-GC	5.55
312SME_L	2/22/2008	UCD-GC	8.18
312SME_L	4/28/2008	UCD-GC	11.92
312SME_L	4/28/2008	UCD-GC	11.78
312SME_L	5/28/2008	UCD-GC	9.99
312SME_L	8/11/2008	UCD-GC	10.69
312SME_L	9/11/2008	UCD-GC	11.71
312SME_L	10/9/2008	UCD-GC	10.11
312SME_L	9/8/2009	UCD-GC	9.75
312SME_L	9/23/2009	UCD-GC	7.78
312SME_L	9/23/2009	UCD-GC	7.68
312SME_L	10/15/2009	UCD-GC	6.48
312SME_L	10/21/2009	UCD-GC	8.89
312SME_L	10/29/2009	UCD-GC	6.83
312SME_U	1/5/2008	UCD-GC	3.42
312SME_U	2/22/2008	UCD-GC	5.35
312SME_U	5/28/2008	UCD-GC	9.64
312SME_U	8/11/2008	UCD-GC	9.32
312SME_U	9/11/2008	UCD-GC	10.64
312SME_U	10/9/2008	UCD-GC	8.62
312SME_U	10/9/2008	UCD-GC	8.48
312SME_U	9/8/2009	UCD-GC	9.13
312SME_U	9/23/2009	UCD-GC	20.80
312SME_U	10/15/2009	UCD-GC	6.82
312SME_U	10/21/2009	UCD-GC	6.6
312SME_U	10/29/2009	UCD-GC	7.15

Table 3-16. Summary of UCD-GC Dissolved Oxygen Concentrations at 312SME (mg/L)

Site	Count	Median (mg/L)	Mean (mg/L)	Count < 7	Percent < 7
312SME_L	14	9.3	9.1	3.0	21.4
312SME_U	12	8.6	8.8	4.0	33.3
All	26	8.8	9.0	7.0	26.9

Seven of 26 samples are below the dissolved oxygen level of 7 mg/L that is necessary to support the spawning beneficial use. The results meet the minimum number of measured exceedances (see Table 3-2) and therefore staff has concluded that the Santa Maria River Estuary is impaired due to low oxygen concentrations. Note that the Santa Maria River Estuary was not included on the 2008-2010 303(d) list for dissolved oxygen impairment; however, staff concluded that the water body is impaired and will therefore be addressed in this TMDL.

3.2.1 Diel Dissolved Oxygen Conditions

Excessive algal growth in waterbodies is characterized by wide swings in dissolved oxygen concentrations, typically dropping below concentrations set to protect for aquatic life at night, and often rising above the CCAMP upper screening limit of 13 mg/L (CCAMP, 2010). Low oxygen conditions can result in fish kills and harm to other aquatic life. Some species, such as trout, are particularly sensitive to low oxygen conditions, which is why more rigorous standards are necessary to support cold water fish habitat.

CCAMP collected diel (24-hour) data to determine if oxygen levels drop during the highest risk time of day, which is pre-dawn. The diel data is important because monitoring staff conducts routine monthly grab sampling between 9 a.m. and 4 p.m., when oxygen levels are typically highest. Therefore, results of CCAMP monthly grab samples, as presented in Section 3.2.1.3 *Low Dissolved Oxygen Exceedances*, generally represent higher daytime oxygen values, as opposed to the lower (high risk) oxygen values that occur before dawn.

The figures below show diel pH concentrations because algae can alter the pH of water through the uptake or release of CO_2. The following reactions demonstrate how photosynthetic organisms convert CO_2 and water to sugar and oxygen during photosynthesis and how during respiration the reaction is reversed. During daylight hours, photosynthesis and respiration occur simultaneously though photosynthesis occurs at a much faster rate. In the absence of sunlight, only respiration occurs.

$$\text{Photosynthesis: } 6CO_2 + 6H_2O + Sunlight \Rightarrow C_6H_{12}O_6 + 6O_2$$

$$\text{Respiration: } C_6H_{12}O_6 + 6O_2 \Rightarrow 6CO_2 + 6H_2O$$

During photosynthesis, CO_2 is consumed and pH increases. During respiration, CO_2 is released and dissolves in water to form carbonic acid (H_2CO_3), which lowers pH by adding hydrogen ions to the water.

$$H_2O + CO_2 \Leftrightarrow H_2CO_3 \Leftrightarrow H^+ + HCO_3^-$$

$$HCO_3^- \Leftrightarrow H^+ + CO_3^{2-}$$

Figure 3-8 through Figure 3-11 represent diel dissolved oxygen and pH conditions that portray wide swings in dissolved oxygen concentrations, often exceeding the CCAMP upper screening limit of 13 mg/L (CCAMP, 2010) during the day or dropping below oxygen levels necessary to support aquatic life during the night. The pH levels fluctuate in tandem with the dissolved oxygen levels, but do not exceed water quality objectives. Staff has concluded that this data provides an additional line of evidence indicating that biostimulatory conditions exist within the Project Area. Appendix B contains diel data for additional sites.

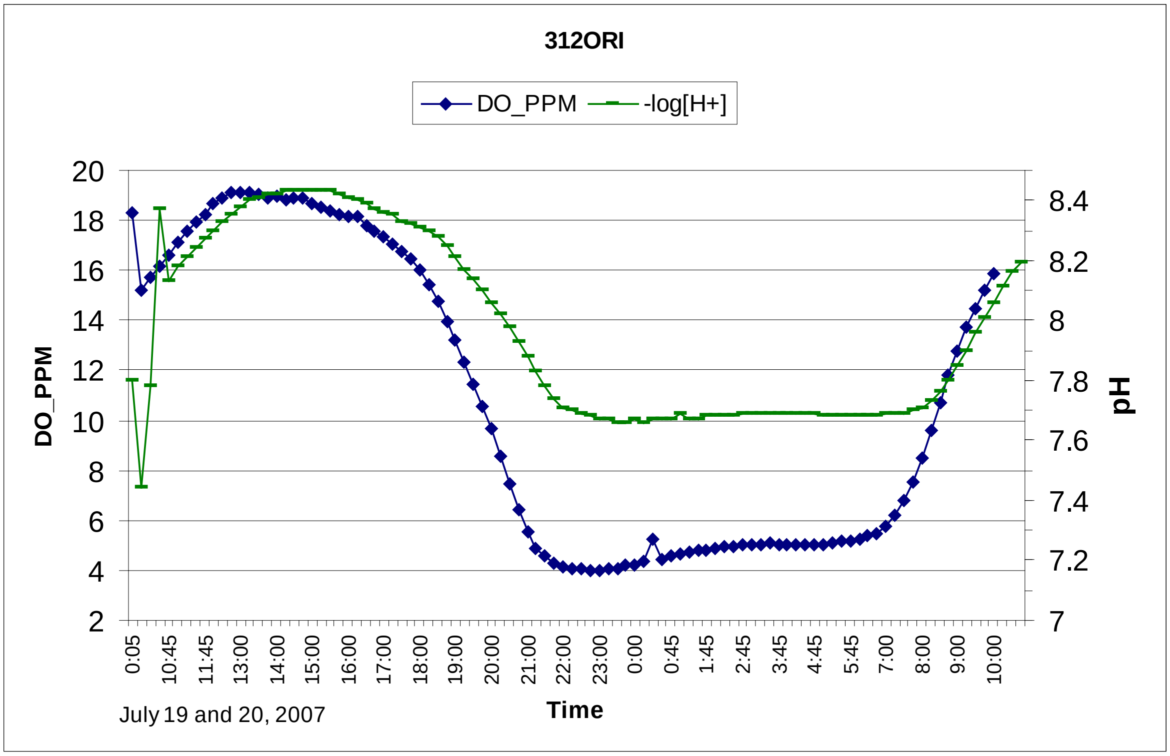


Figure 3-8. Diel monitoring results Orcutt Creek at Highway 1 (312ORI).

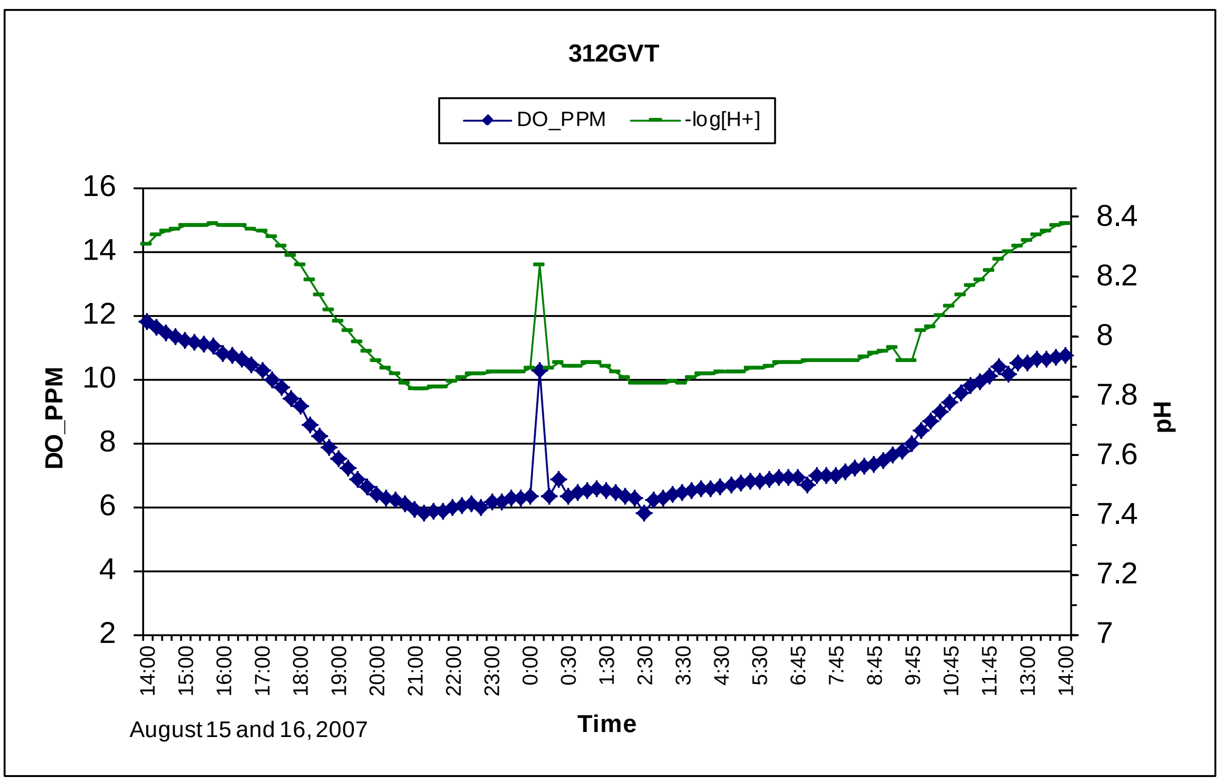


Figure 3-9. Diel monitoring results Orcutt Creek at Brown Road (312GVT).

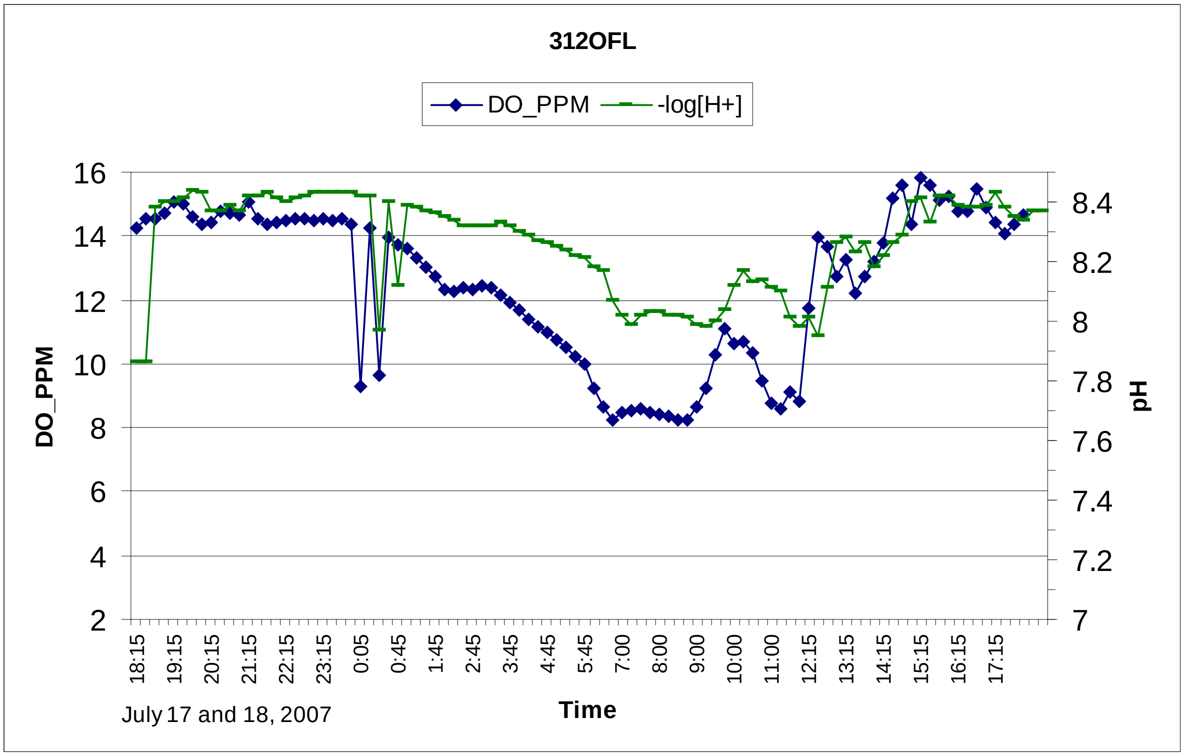


Figure 3-10. Diel monitoring results Oso Flaco Lake (312OFL).

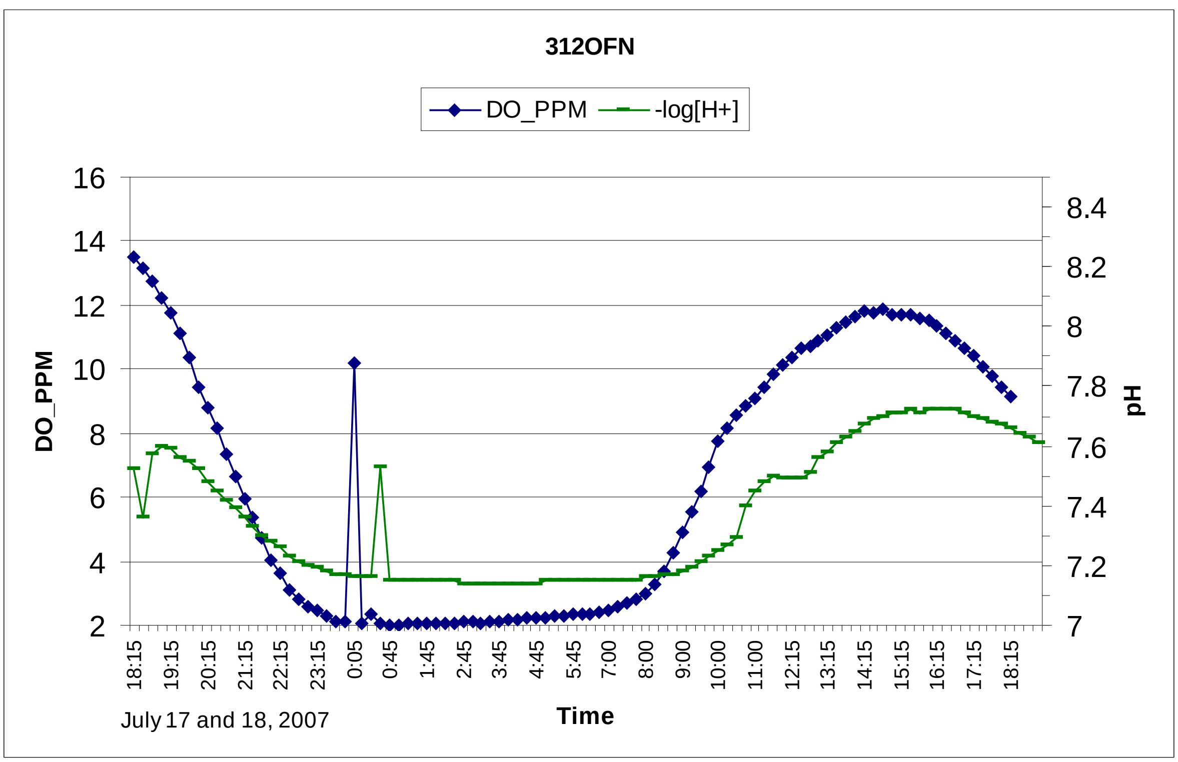


Figure 3-11. Diel monitoring results Little Oso Flaco Creek (312OFN).

3.2.1 Microcystin Water Quality Data

Microcystins are toxins produced by cyanobacteria (blue-green algae) and are associated with algal blooms and biostimulation in surface waterbodies[25]. Microcystin-LR was the first strain identified and is the most commonly studied. Other common microcystin strains are RR, YR and LA (USEPA, 2006). There currently are no regulatory water quality standards for microcystins, but the State of California Office of Environmental Health Hazard Assessment (OEHHA) has published peer-reviewed public health action-level guidelines for microcystins in recreational water uses; this public health action-level is 0.8 µg/L[26]. Due to biostimulation of surface waters in the TMDL project area, it is relevant to consider available microcystin data. Cyanobacterial blooms can persist with adequate levels of phosphorous and nitrogen, temperatures in the 15 to 30^{o} C range and pH in the 6 to 9 range, with most blooms occurring in late summer and early fall (WHO, 2003). Microcystins can be toxic for animals, including humans. The health risks to humans, their pets and to livestock from cyanobacteria were previously outlined in Section (OEHHA, 2012).

The Water Board contracted with the University of California-Santa Cruz to conduct microcystin sampling in 2011. The goal of the contract was to begin collection of regional baseline data at coastal confluence sites. Samples were collected from the Santa Maria River Estuary (312SMA) in September, October, and November 2011. Microcystins were detected in the September and October samples, however levels were below the reporting limit and therefore not quantified.

3.2.2 Photo Documentation of Biostimulation

CCAMP staff periodically photo-document evidence of biostimulation and excessive algal growth at water quality monitoring sites in the Project Area. Figure 3-12 shows the location of photo monitored sites. The photographic documentation for these sites is presented in Figure 3-13. It is important to recognize that not all biomass, including macrophytes, are harmful to aquatic ecosystems requiring complete removed from streams. While an overall goal of nutrient TMDLs is to significantly reduce the amount of biomass in the system, some level of biomass is necessary to provide habitat to fish and other aquatic organisms.

[25] U.S. Environmental Protection Agency. Drinking Water Treatability Database. Online linkage: http://iaspub.epa.gov/tdb/pages/contaminant/contaminantOverview.do?contaminantId=-1336577584.
[26] Includes microcystins LR, RR, YR, and LA.

Figure 3-12. Photo monitoring sites.

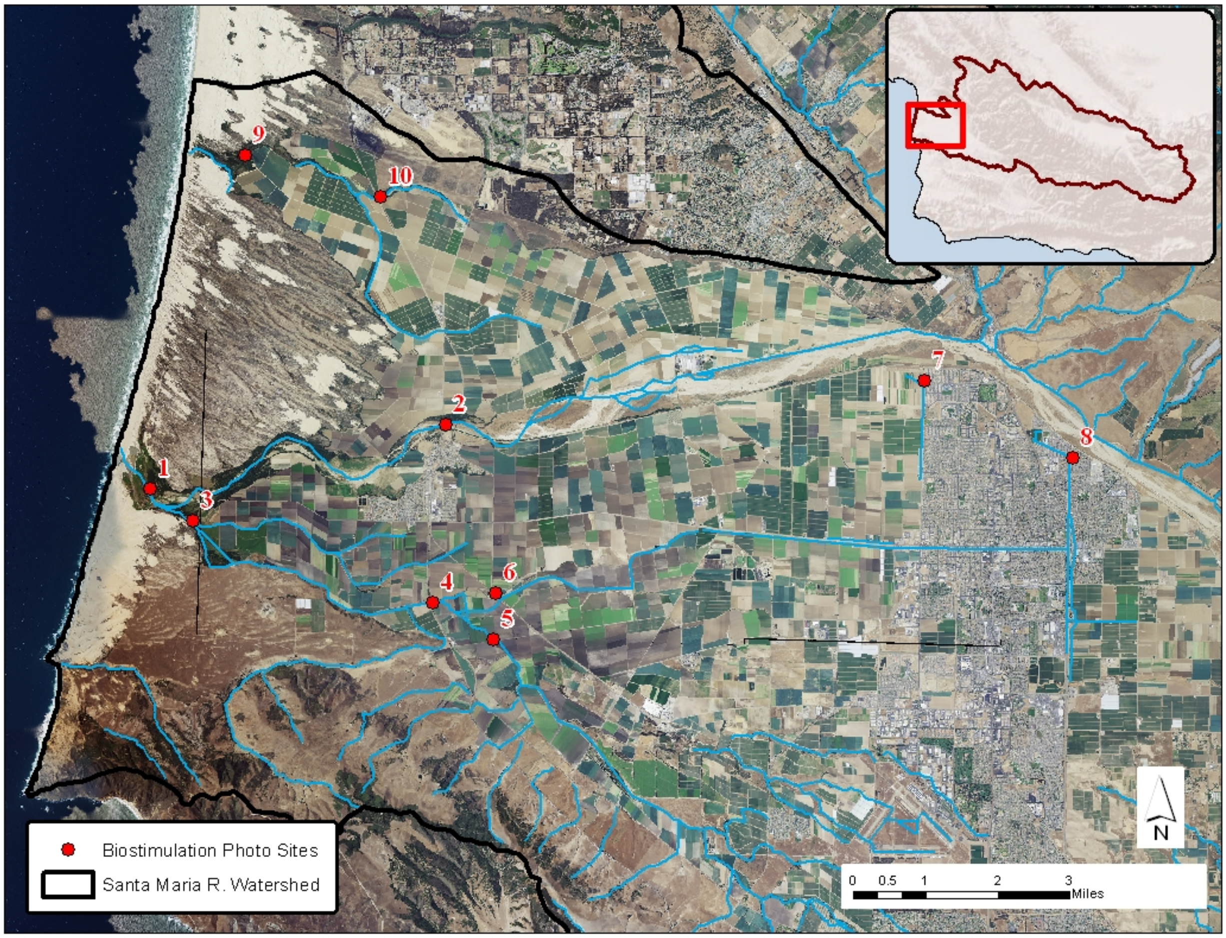


Figure 3-13. Photo documentation of biostimulation.

Photo Documentation	
 Site 1. Lower Santa Maria River 312SMA (July 2009)	 Site 2. Santa Maria River @ HWY 1 312SMI (March 2007)
 Site 3. Orcutt Creek 312ORC (Sept. 2007)	 Site 4. Orcutt Creek @ Hwy 1 312ORI (June 2006)

Photo Documentation

Site 5. Orcutt Creek 312GVT (July 2007)

Site 6. Greene Valley Creek 312GVS (May 2007)

Site 7. Blosser Channel 312BCD (August 2007)

Site 8. Bradley Channel 312BCU (June 2007)

Photo Documentation

Site 9. Oso Flaco Lake 312OFL (Sept. 2007)

Site 10. Little Oso Flaco Creek 312OFN (July 2007)

3.2.3 Total Nitrogen/Total Phosphorus Ratios (Limiting Nutrient)

The term limiting nutrient refers to the nutrient that limits plant growth when it is not available in sufficient quantities. Algal cells require nitrogen and phosphorus in relatively fixed stoichiometric proportions; the limiting nutrient is the nutrient that will become exhausted first, thereby limiting algal cell growth. Therefore, if there is potentially less available phosphorus relative to algal stoichiometric requirements, then phosphorus is the limiting nutrient. Table 3-17. presents published nitrogen:phosphorus ratios (TN:TP) for limiting algal response.

Table 3-17. Published Nutrient Limiting Thresholds (N:P ratio)*

N Limiting Threshold	**Transition - N & P Co-limiting**	**P Limiting Threshold**	**Source[A]**
<10:1	10:1 – 20:1	>20:1	Schanz and Juon (1983)
		> 20:1	Petersen et al. (1993)
		> 20:1	Stockner and Shortreed (1978)
		> 20:1	Pringle (1987)
<10:1			Grimm and Fisher (1986)
<12.6:1			Dodds et al. (1998)
		>17:1	Borchardt (1996)
<12:1			Lohman (1988)
<16:1		>16:1	Tetratech (2004)[B]

A-Sources as reported by Missouri Dept. of Natural Resources in *Total Maximum Daily Load (TMDL) for James River (2001)*
B- *Progress Report – Development of Nutrient Criteria in California: 2003-2004* (TetraTech, 2004)

In general, the published literature indicates that TN:TP ratios above about 20:1 typically imply that phosphorus is the limiting nutrient; TN:TP ratios below about 10:1 can indicate that nitrogen in the limiting nutrient; and TN:TP ranges between about 10:1 and 20:1 indicate a transitional range where N and P can be co-limiting. Figure 3-14 indicates that many paired samples from Santa Maria River and Oso Flaco Lake watershed streams tend for the most part to be phosphorus limited.

It is important to recognize however, that because nutrients occur in such high water column concentrations, it is likely that nutrients do not limit algal productivity (staff communications Brent Hughes, Elkhorn Slough National Estuarine Research Reserve, 9 Aug. 2011; Dr. Ken Johnson, 8 Sept. 2011, and Dr. Jane Caffrey, University of West Florida, 12 Sept. 2011). Therefore, information provided in this section may indicate which nutrient could ultimately become limiting if loading of both nitrogen and phosphorus were progressively reduced at approximately equivalent rates.

Table 3-18 illustrates TN:TP ratios for specific monitoring sites. Generally, streams appear to be below the P-limiting conditions of TN:TP=20, indicating N-limitation or co-limitation. However, waters in the lower portions of the Santa Maria River, Orcutt Creek, and Oso Flaco Lake watersheds appear to be P limited as shown in Figure 3-15.

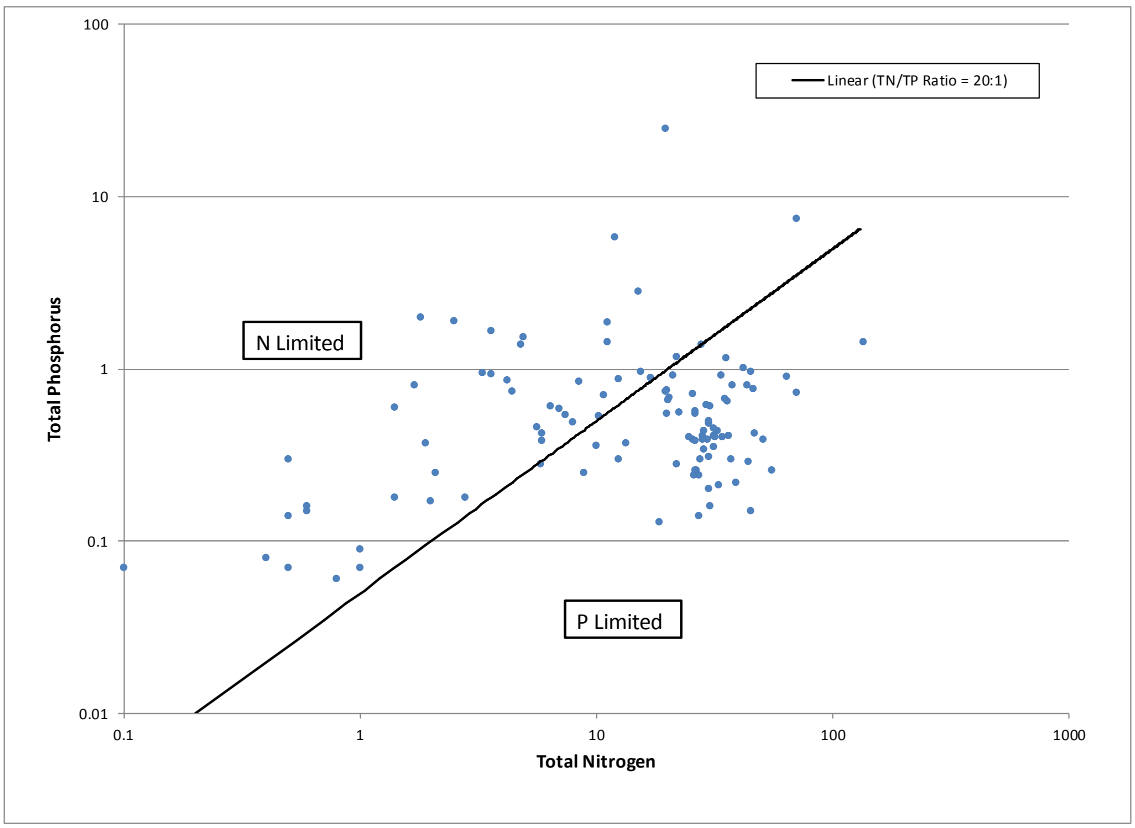


Figure 3-14. TN:TP (mg/L) scatter plot of paired measurements (n=111).

Table 3-18. Nutrient limitation ratios.

Water body	Site	Number of Samples	TN:TP (geomean of samples)	Limiting Nutrient
Santa Maria River	312SMA	11	59.55	P
	312SMI	9	59.16	P
	312SBC	1	1.67	N
Orcutt Creek	312ORC	9	45.72	P
	312ORI	8	63.12	P
	312ORB	7	8.85	N
Main Street Canal	312MSD	7	4.97	N
Blosser Channel	312BCD	6	9.37	N
Bradley Channel	312BCU	7	11.49	Transition range N & P co-limiting
Nipomo Creek	312NIP	6	8.90	N
	312NIT	5	14.63	Transition range N & P co-limiting
Bradley Canyon Creek	312BCF	4	22.37	P
Cuyama River (below res.)	312CUT	1	14.29	Transition range N & P co-limiting
Huasna River	312HUA	1	4.00	N
Alamo Creek	312ALA	3	7.81	N
Cuyama River (above res.)	312CUY	1	1.32	N
	312CAV	2	1.73	N
La Brea Creek	312BRE	1	3.57	N
Oso Flaco Lake	312OFL	7	83.52	P
Little Oso Flaco Creek	312OFN	8	163.99	P
Oso Flaco Creek	312OFC	7	77.56	P

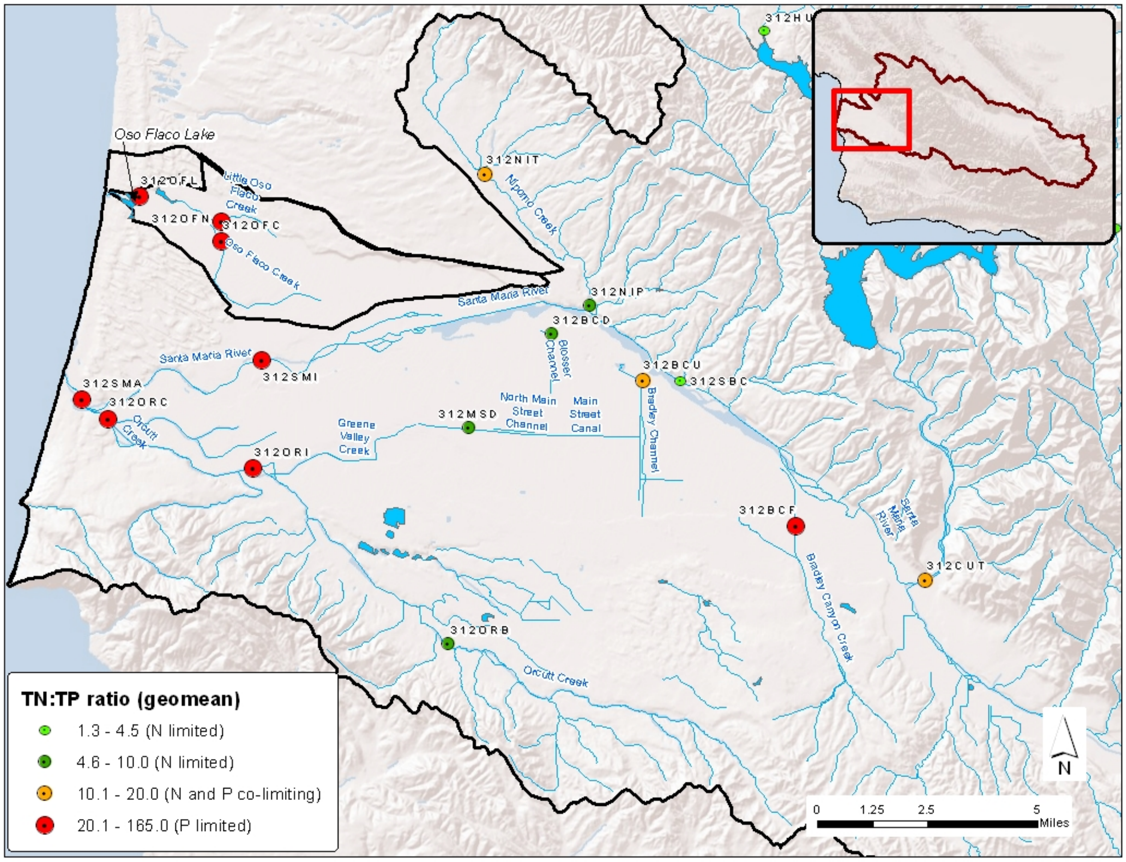


Figure 3-15. Water column TN:TP (mg/L) ratios.
(geomean of individual monitoring site samples, n=111)

3.2.4 Sunlight Availability (Turbidity and Canopy)

Because nutrients occur in such high water column concentrations in the TMDL project area, it is likely that nutrients do not limit biological productivity. Researchers have indicated that when nutrients are as high as they are in this system, sunlight availability is probably what actually limits productivity:

> *"...when nutrients are as high as they are in this system, talking about limiting nutrients probably isn't that relevant. In those cases,* ***light is probably what actually limits production*** *either* ***<u>because of turbidity</u>*** *which keeps overall biomass low or surface blooms which reduce light levels at depth."**
>
> **emphasis added*
> *— Dr. Jane Caffrey[27], estuarine researcher (University of West Florida), personal communication to Water Board staff, Sept. 12, 2011*

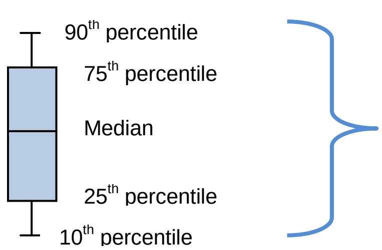
[27] Dr. Caffrey has substantial research experience in Elkhorn Slough water quality issues and has published peer-reviewed literature on water quality issues pertaining to Elkhorn Slough and the lowermost Salinas Valley.

Further, during a presentation to Water Board staff in February 2012, scientists[28] who are currently researching algal response variables and biotic integrity in California central coast inland streams emphasized the “shading” effect water column turbidity has in relation to light availability and algal photosynthesis.

Accordingly, light availability is a response variable that should be considered in developing nutrient water column targets for biostimulatory impairments. Staff used the California Nutrient Numeric Endpoints Approach (Calif. NNE) in developing numeric targets for nutrients for this TMDL (see Section 4.3). It is important to recognize that the Calif. NNE spreadsheet tool is highly sensitive to user inputs for tree canopy shading and turbidity. Shading and turbidity have significant effects on light availability, and consequently photosynthesis and potential biostimulation. The light extinction coefficient is an important input parameter to the NNE spreadsheet tool. This coefficient is calculated in the spreadsheet as a function of turbidity. Higher levels of turbidity can preclude good sunlight penetration. Consequently, staff strongly took into account sunlight availability, and developed plausible approximations of spatial-variations in turbidity and canopy cover in the derivation of nutrient numeric targets (refer to Section 4.3).

3.2.1 Water Quality Seasonal Trends

Staff evaluated seasonal water quality conditions within the Project Area to examine potential seasonal patterns in nutrient concentrations. Figure 3-16 and Figure 3-17 show box and whisker plots of monthly and seasonal nitrate data for the CCAMP monitoring site located in the lower Santa Maria River above the estuary (site 312SMA). Monthly nitrate concentrations during the dry season (May-October) are generally higher than concentrations observed during the wet season (November-April), with a few exceptions. A seasonal effect becomes more apparent when the monthly data is aggregated into wet and dry seasons whereby dry season concentrations are higher and less variable (Figure 3-17).



Explanation of box and whisker plots.

[28] Dr. Scott Rollins (Spokane Falls Community College) and Dr. Marc Los Huertos (Calif. State University at Monterey Bay)

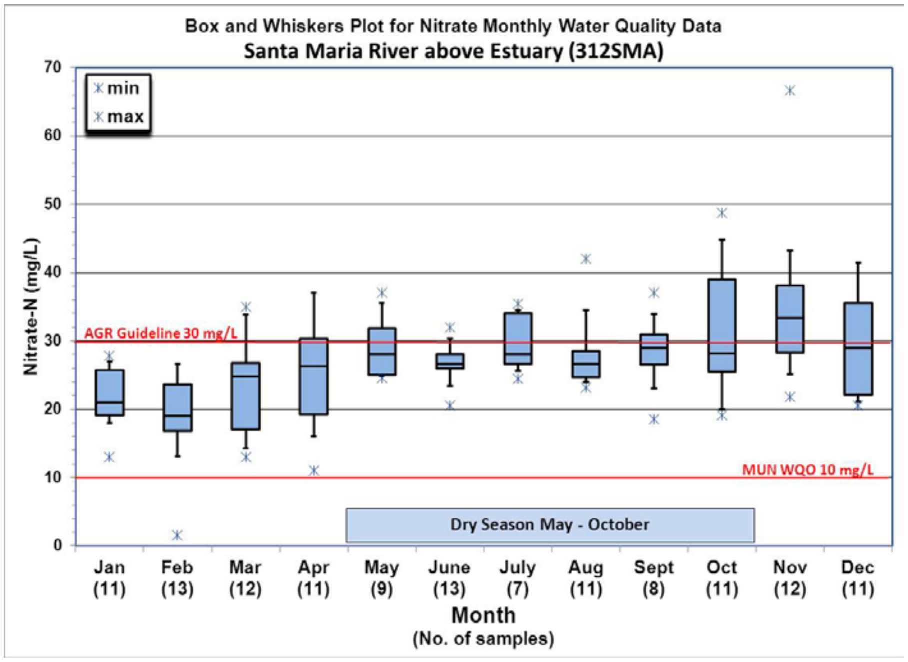


Figure 3-16. Monthly nitrate nitrogen data for Santa Maria River above the Estuary (312SMA)

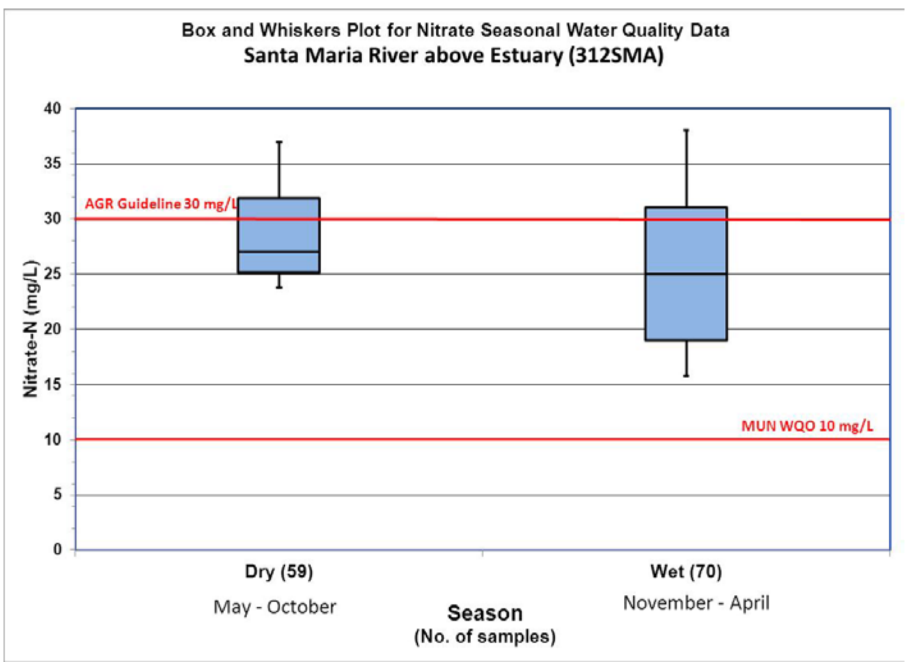


Figure 3-17. Seasonal nitrate nitrogen data for Santa Maria River above the Estuary (312SMA)

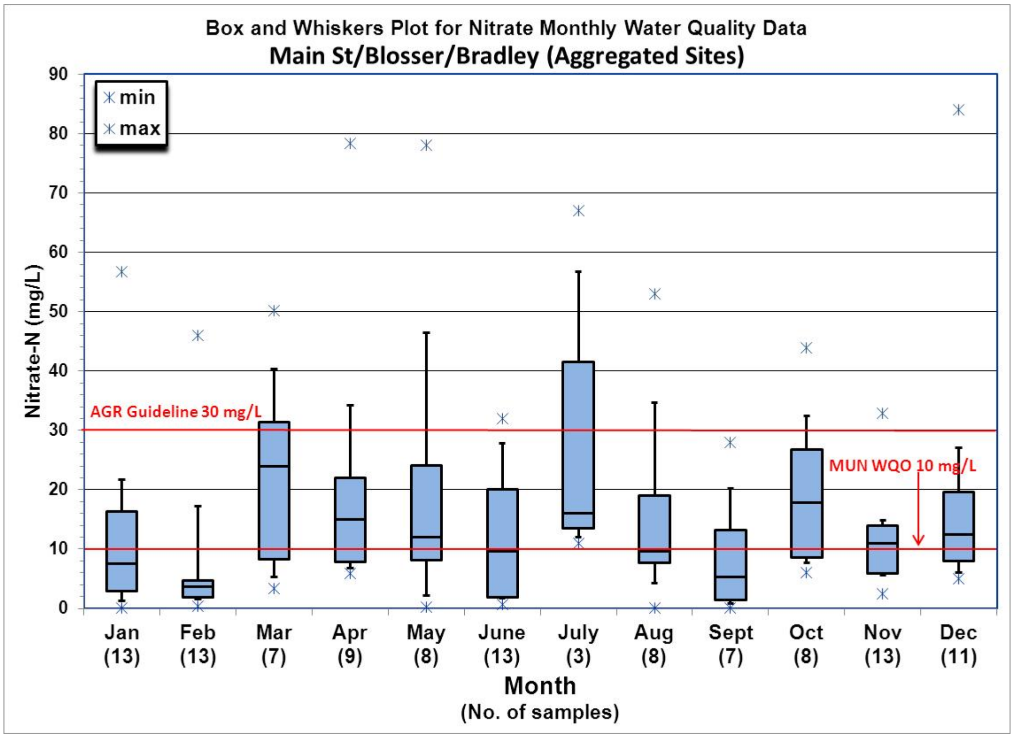


Figure 3-18. Monthly nitrate nitrogen data for Channels and Canals.
Aggregated sites include Blosser Channel (312BCD/312BCJ), Bradley Channel (312BCU), and Main Street Canal (312MSD/312MSS)

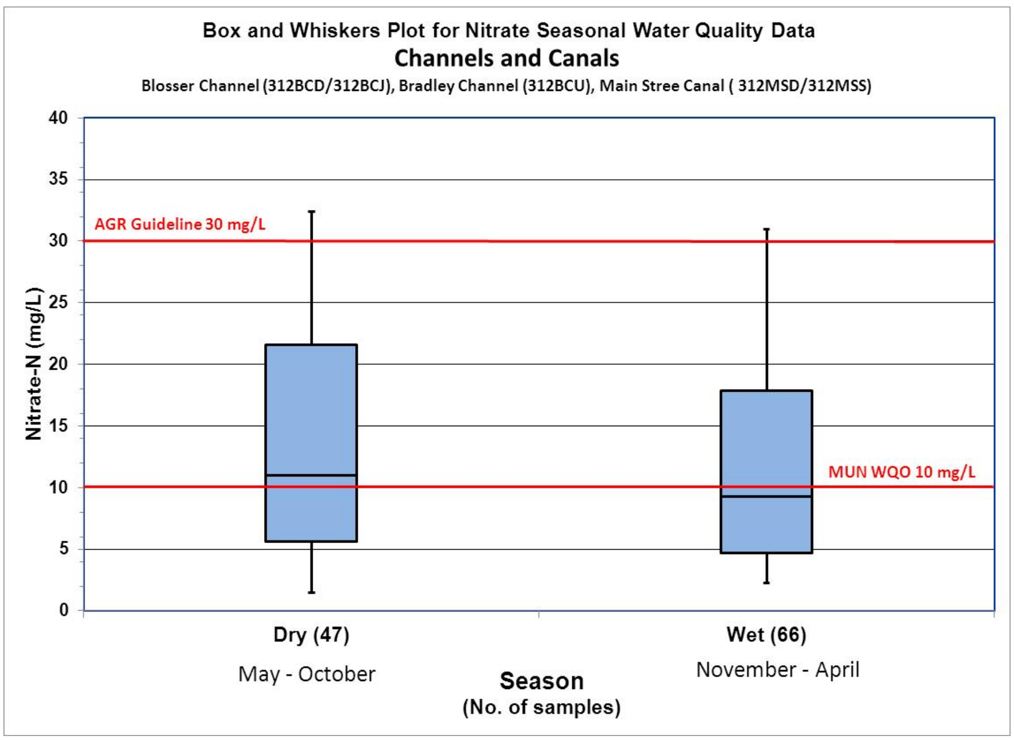


Figure 3-19. Seasonal nitrate nitrogen data for Channels and Canals.
Aggregated sites include Blosser Channel (312BCD/312BCJ), Bradley Channel (312BCU), and Main Street Canal (312MSD/312MSS)

Figure 3-18 and Figure 3-19 above are plots of aggregated monthly and seasonal nitrate data for CCAMP monitoring sites located in Project Area channels and canals. The sites were aggregated to provide an adequate number of data points to develop the plots. A clear trend in monthly nitrate concentrations is not evident; however 75 percentile values during the dry season are typically above 20 mg/L, with the exception of the month of September. The compilation of dry season versus wet season nitrate data (Figure 3-19) shows marginally higher values during the dry season.

In summary, dry season nitrate values appear to be greater than wet season values with a few exceptions. This information, in conjunction with photographic evidence that biostimulatory conditions exist almost exclusively in the dry season (see Section 3.2.2), has led staff to conclude that seasonal characteristics pertaining to numeric targets and nutrient loading should be included in this TMDL.

3.2.2 Groundwater Conditions

The Santa Maria groundwater basin spans approximately 184,000 acres (288 square miles) and underlies and maintains direct hydrologic connectivity with the aquifers of Nipomo and Tri-Cities Mesas, Arroyo Grande Plain, and Nipomo, Arroyo Grande, and Pismo Creek valleys. The groundwater basin is composed of a deep accumulation of marine and non-marine sedimentary units of the Orcutt, Paso Robles, Pismo, and Careaga formations[29] (CDWR 2004). Average total thickness of the water-bearing materials is about 1,000 ft, with a maximum thickness of 2,800 to 3,000 ft (SBCWA 1994[30], Worts 1951[31], as cited in CDWR 2004). Except along the coast where it is confined beneath low-permeable silt and clay strata, groundwater is generally unconfined throughout much of the basin. As a result, there is direct hydrologic connectivity between surface flows in the Santa Maria River and the groundwater table.

Regarding aquifer depth zones, there is a shallow zone consisting of the Quaternary Alluvium, Orcutt formation, and uppermost Paso Robles formation and a deep zone comprising the remaining Paso Robles formation and Careaga Sand. In the eastern portion of the basin where these formations are much thinner and composed of coarser materials, particularly in the Sisquoc Valley, the aquifer system is essentially uniform without distinct aquifer depth zones. In the coastal area where the surficial deposits (upper members of Quaternary Alluvium and Orcutt formation) are extremely fine-grained, the underlying

[29] CDWR. 2004. Santa Maria River Valley groundwater basin. California's Groundwater Bulletin 118. California Department of Water Resources, Sacramento, California.
http://www.water.ca.gov/pubs/groundwater/bulletin_118/basindescriptions/3-12.pdf
[30] SBCWA 1994. Santa Barbara County Water Agency. Santa Maria Valley Water Resources Report.
[31] Worts,, G. F. Jr. 1951. Geology and Ground-Water Resources of the Santa Maria Valley Area, California. U.S. Geological Survey Water-Supply Paper 1000.

formations (lower members of Quaternary Alluvium and Orcutt formation, Paso Robles formation, and Careaga Sand) comprise a confined aquifer[32].

Between 1984 and 1995 the average annual groundwater outflow from the Santa Maria Valley Basin was agriculture extractions (12,300 acre-feet, 57%), City of Santa Maria, City of Guadalupe, Casmalia Community Services, and other urban groundwater extractions (500 acre-feet, 2%), and approximately 6,200 acre-feet (29%) of subsurface outflow to the ocean (CDWR, 2002)[33]. Agriculture has historically been the largest consumer of groundwater, but municipal uses have steadily increased with a growing population in recent decades. Releases from Twitchell Dam to promote groundwater recharge began in 1962. In 1997, importation of water from the State Water Project's Coastal Branch Aqueduct through the City of Santa Maria began to supplement the area's water supply.

As reported in CDWR in 2002, between 1984 and 1995 the average annual groundwater inflow into the Main Santa Maria Groundwater Basin was stream infiltration (11,700 acre-feet, 62%), deep percolation of precipitation (2,600 acre-feet, 14%), agricultural return water (2,700 acre-feet, 14%), and urban return water (100 acre-feet, less than 1%).

Elevated nitrate concentrations in groundwater was reported as early as 1927, with two of 24 water wells reporting a level of 44 mg/L nitrate as nitrate (Worts, 1951), just below the drinking water quality objective of 45 mg/L nitrate as nitrate. Historically, the Santa Maria Valley Groundwater Basin has been subject to high nitrate concentrations, often exceeding the drinking water quality (MUN) objective of 45 mg/L nitrate as nitrate (SBCWA 1999)[34]. Nitrate concentrations have been recorded as high as 240 mg/L nitrate as nitrate (CDWR 2002).

The California Department of Public Health (CDPH) monitors water supply wells. Figure 3-20 shows the location of CDPH water supply wells that were monitored between 1984 and 2010 and indicates the wells that have exceeded the drinking water quality objective of 45 mg/L nitrate as nitrate (10 mg/L nitrate as nitrogen). During this period, 32 of the 88 water supply wells sampled exceeded this threshold. It is important to note that the CDPH dataset represents a range of hydrogeologic conditions, from shallow wells that represent recently recharged groundwater to supply wells that produce from deeper aquifers.

[32] Luhdorff and Scalmaninin Consulting Engineers. 2008. Monitoring Program for the Santa Maria Valley Management Area.
[33] CDWR. 2002. Water resources of the Arroyo Grande-Nipomo Mesa area. Southern District Report.
[34] SBCWA 1999. Santa Barbara County Water Agency. Santa Barbara County 1999 Groundwater Report.

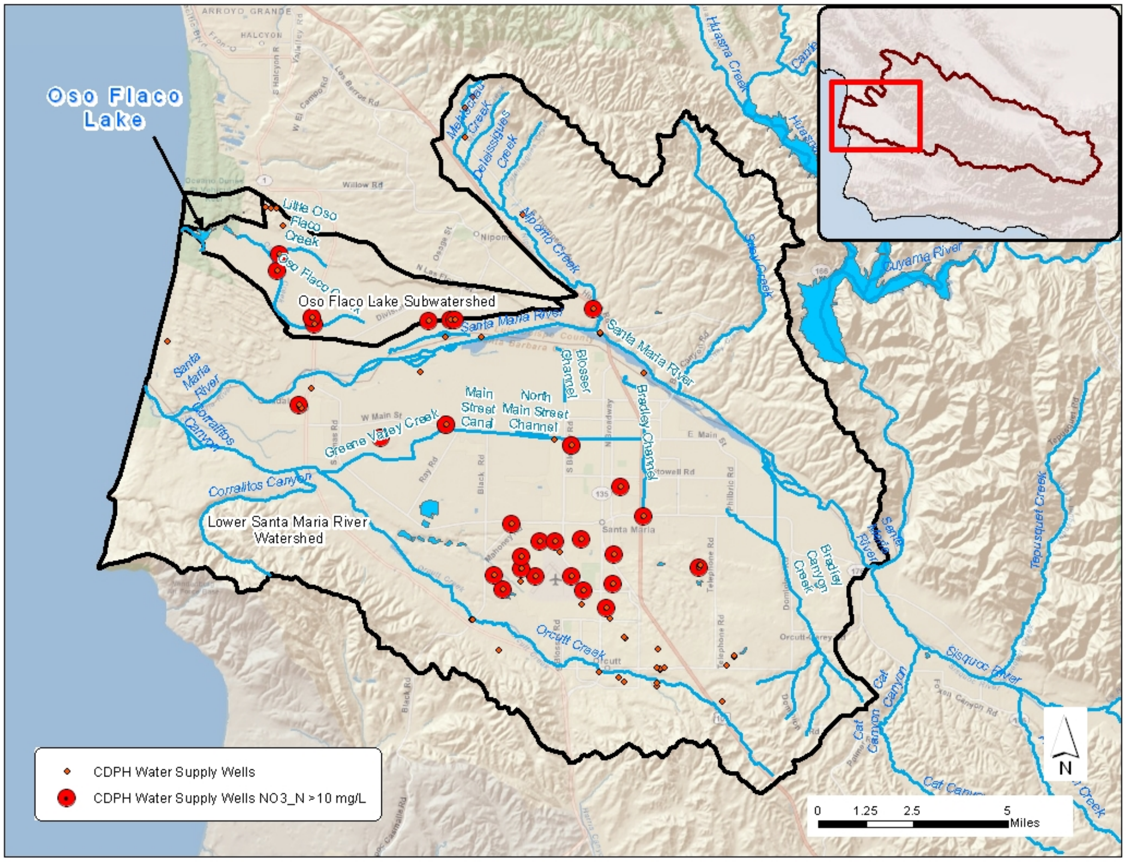


Figure 3-20. CDPH Water Supply Well Nitrate Monitoring.

Groundwater (as baseflow) can be a source of nutrient loads to surface waters (USEPA, 1999). In addition, although TMDLs do not directly address groundwater quality problems, many surface waters are in fact designated for groundwater recharge beneficial use in the Basin Plan. Excessive nutrient concentrations in surface waters can contribute to elevated nitrate concentrations in groundwater under conditions of direct hydrologic connectivity. Figure 3-21 shows estimated nitrate as nitrogen concentrations in shallow (less than 15 feet) groundwater based on the USGS Groundwater Vulnerability Assessment (GWAVA)[35]. The GWAVA model predicted a mean nitrate nitrogen concentrations of 12.7 mg/L in shallow groundwater.

[35] The GWAVA dataset represents predicted nitrate concentration in shallow, recently recharged groundwater in the conterminous United States, and was generated by a national nonlinear regression model based on 16 input parameters. Online linkage: http://water.usgs.gov/GIS/metadata/usgswrd/XML/gwava-s_out.xml

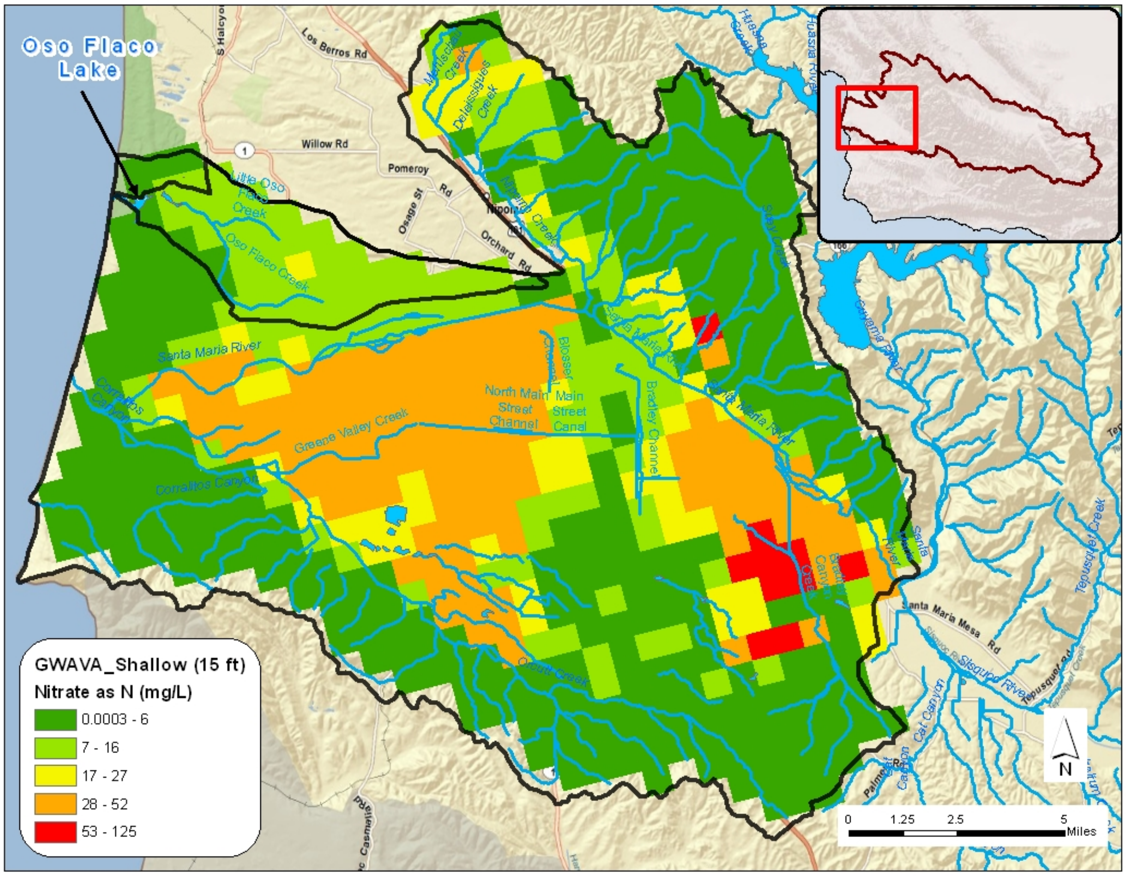


Figure 3-21. GWAVA Predicted Shallow Groundwater Nitrate Concentrations

Groundwater depths become increasingly shallow in the western portion of the Project Area. In a sediment and nutrient study of the Oso Flaco Lake watershed (Cachuma Resource Conservation District, 2004)[36], a perched water table was reported at 4 to 5 feet of depth, seeping from channel banks west of Highway 1 and perched water was often observed at 3 to 4 feet of depth in fields that are west of the railroad tracks. The sediment and nutrient study reported that, further west, near Oso Flaco Lake, water was observed as shallow as 18 to 24 inches and that some farms are equipped with artificial tile drains at 3 to 4 feet of depth. In addition, several fields adjacent to the creek that do not have tile drains are not farmable in the rainy season, due to high water table (CRCD, 2004). The report also mentions that, while current farming operations are responsible for some of the high nitrate concentrations in surface waters, a substantial portion is attributable to groundwater inflow. The average nitrate concentration in irrigation well water was reported as 17 mg/L nitrate as nitrogen (n=15), though the authors cautioned against extending these findings to the entire study area due to the small dataset.

[36] Cachuma Resource Conservation District. 2004. Nitrate and Sediment Assessment, Oso Flaco Lake.

Additionally, in the lower Santa Maria River downstream of Highway 1, flows during the dry season are primarily due to agricultural and urban runoff, as well as the emergence of subsurface flow (SAIC, 2004)[37].

Based on available information referenced above, staff has concluded that surface water flow in portions of the lower Santa Marian River and Oso Flaco Lake watersheds is partially attributable to groundwater inflow.

Using USGS data[38], staff assessed the baseflow mean contact time in the Project Area to estimate the residence time of nitrate in shallow groundwater. For example, if shallow groundwater, or perched groundwater systems have legacy pollution issues and if baseflow is a load contributor to streams, any reasonable implementation strategy or timeline may have to consider that legacy pollution coming from baseflow. Figure 3-22 illustrates that the estimated mean contact time in the Oso Flaco Lake watershed and much of the lower Santa Maria River watershed is generally less than one year, while upper portions in the TMDL Project Area may be greater than 5-years.

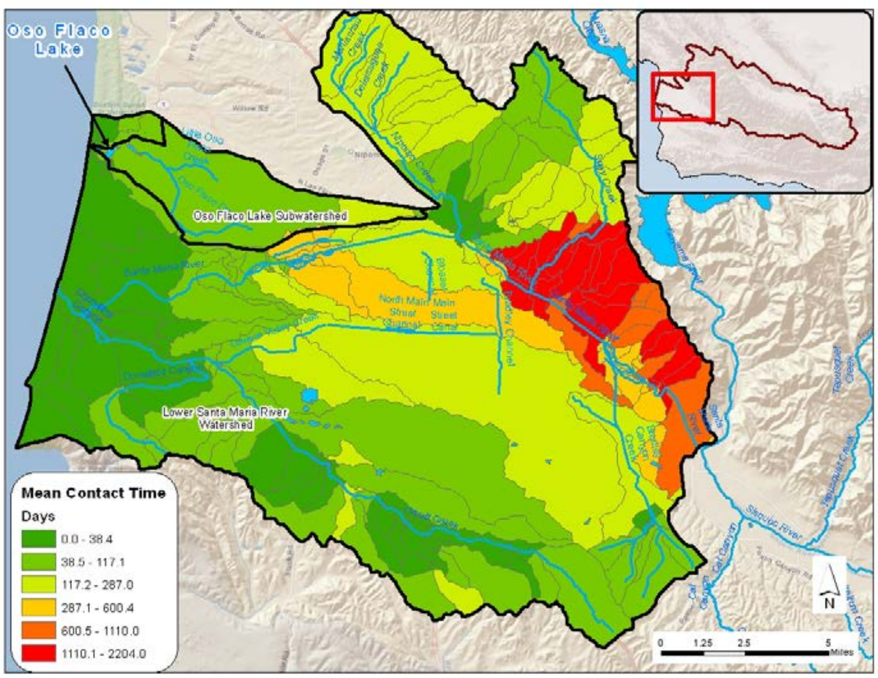


Figure 3-22. Estimated baseflow mean contact time (USGS).

[37] Science Applications International Corporation (SAIC). 2004. Santa Maria River Estuary Enhancement and Management Plan, prepared for the Dunes Center.

[38] Data source: Attributes for NHDplus Catchments, Contact Time, 2002. This dataset was created by the U.S. Geological Survey and represents the average contact time, in units of days, compiled for every catchment of NHDplus for the conterminous United States. Contact time is the baseflow residence time in the subsurface.

3.3 Assessment of Biostimulatory Conditions

Staff used a range of numeric water quality objectives and peer-reviewed biostimulatory numeric screening criteria specific to the Central Coast region (Worcester et al., 2010)[39] to assess TMDL project area waterbodies which are exhibiting a range of indicators of biostimulation. These ranges of indicators collectively constitute a weight-of-evidence approach which demonstrates if and where biostimulatory conditions are impairing beneficial uses.

It is worth reiterating that elevated nutrients, in and of themselves, do not necessarily indicate biostimulation-eutrophication and impairment of beneficial uses. A linkage between elevated nutrients and actual impairment of beneficial uses must be demonstrated; e.g. dissolved oxygen and/or pH imbalances and other water quality-aquatic habitat indicators. Note that the U.S. EPA Science Advisory Board (2010) and Worcester et al. (2010) report that draft numeric targets for biostimulatory impairments may need to be supported with a weight of evidence approach, rather than stand-alone statistical methods. The weight of evidence approach could use other evidence of eutrophication; for example, presence and abundance of floating algal mats, water column chlorophyll *a* concentrations, evidence of oxygen depression and/or supersaturation, and pH over 9.5.

As such, staff used a wide range of Basin Plan numeric water quality objectives and peer-reviewed screening numeric criteria specific to the central coast region (Worcester et al., 2010) to assess the spatial distribution of biostimulatory effects and impairments in order to adequately determine where biostimulatory problems are being expressed in project area surface waters. Consistent with U.S. EPA guidance, staff asserted biostimulatory impairment only where a water body exhibits a range of biostimulatory water quality indicators. Table 3-19 summarizes the range of biostimulatory indicators needed to assert biostimulatory impairment. The range of indicators in Table 3-19 constitute multiple lines of evidence, in a weight-of-evidence approach, to assert biostimulatory impairments.

[39] Worcester, K., D. Paradies, and M. Adams. 2010. Interpreting Narrative Objectives for Biostimulatory Substances for California Central Coast Waters. California Surface Water Ambient Monitoring Technical Report, July 2010.

Table 3-19. Range of Indicators Needed to Assert Biostimulatory Impairment Problems.

1) At least one line of evidence of dissolved oxygen problems – i.e., dissolved oxygen depletion and/or supersaturation (based on basin plan water quality objectives, and peer-reviewed numeric screening values) and/or wide diel swings in DO/pH; 2) At least one line of evidence indicating elevated algal biomass (peer-reviewed numeric screening criteria values for the central coast region, i.e., Worcester et al, 2010); 3) Evidence of elevated water column nutrients concentrations exceeding central coast reference conditions (e.g., Worcester et al., 2010); and 4) At least one additional line of evidence including photo documentation of excessive algal growth and/or evidence of downstream nutrient impacts to a water body that does show multiple indicators of biostimulation problems. 5) For stream reaches that do not exhibit the full range of biostimulatory indicators (bullets 1 through 4, above), but contain nutrient concentrations elevated above reference conditions and are discharging directly into a downstream waterbody that does show a full range of biostimulatory indicators, these stream reaches will be given a numeric target protective against the risk of potential biostimulation, and to protect against downstream impacts (as consistent with USEPA Scientific Advisory Board guidance).

Table 3-20 presents the numeric criteria and screening values used to assess the potential indicators of biostimulation. Table 3-21 presents the biostimulatory assessment matrix for TMDL project area waterbodies.

Table 3-20 . WQOs and Screening Criteria Used as Indicators of Biostimulation.

Water Quality Objectives (Regulatory Standards)		
Constituent Parameter	Source of Water Quality Objective	Numeric Water Quality Objective
Dissolved Oxygen	General Inland Surface Waters numeric objective	Dissolved Oxygen shall not be depressed below 5.0 mg/L Median values should not fall below 85% saturation.
	Basin Plan numeric objective WARM, COLD, SPWN	Dissolved Oxygen shall not be depressed below 5.0 mg/L (WARM) Dissolved Oxygen shall not be depressed below 7.0 mg/L (COLD, SPWN)
pH	General Inland Surface Waters numeric objective	pH value shall not be depressed below 7.0 or raised above 8.5.
	Basin Plan numeric objective MUN, AGR, REC1, REC-2	The pH value shall neither be depressed below 6.5 nor raised above 8.3.
	Basin Plan numeric objective WARM, COLD	pH value shall not be depressed below 7.0 or raised above 8.5
Biostimulatory Substances	Basin Plan General Objected for all Inland Surface Waters, Enclosed Bays, and Estuaries	Basin Plan narrative objective: *"Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses." (Basin Plan, Chapter 3)*
Additional Indicators Supporting Evidence for Biostimulation and Nutrient over-enrichment (Many of these are NOT Regulatory Standards, and should not be used as stand-alone guidelines; but they can provide additional weight of evidence)		
Constituent – Parameter	Source of Screening Criteria	Screening Criteria/Method
Wide diel swings in DO - pH	Wide diel swings widely reported in scientific literature as indicating potential biostimulation	Observational – compare diel swings to reference sites (reference sites show diel DO variation of less than 1 mg/L).
Diel DO crashes	Early morning DO crashes widely reported in scientific literature as indicating potential biostimulation	Early morning DO crashes, depressed below Basin Plan numeric objectives
Low ambient dissolved oxygen and/or oxygen super saturation	Basin Plan Objectives and California Surface Water Ambient Monitoring Program Technical Report[A]	1) Below Basin Plan Objectives: 7.0 mg/L (COLD, SPWN), or 5.0 mg/L (general objective); or below Basin Plan saturation objective of median 85% saturation; – and/or – 2) Exceeding 13 mg/L = evidence of supersaturated conditions and potential nutrient over-enrichment and biostimulation. Low DO or supersaturated DO conditions indicating potential biostimulatory impairments were asserted if exceedances of numeric screening values exceeding sample size and frequencies identified in Table 3.2 of the SWRCB Listing Policy (2004)[C]
Chlorophyll *a*	California Surface Water Ambient Monitoring Program Technical Report[A]	Exceeding 15 mg/L = supporting evidence of potential nutrient over-enrichment and biostimulation.
Evidence of nitrogen enrichment relative to Central Coast reference conditions	California Surface Water Ambient Monitoring Program Technical Report[A]	NO3-N exceeding 1/mg/L = evidence of nutrient enrichment (Assessed using geomean of all samples at monitoring site > 1mg/L).

Evidence of phosphorus enrichment relative to reference conditions	USEPA 25th percentile reference approach for rivers and streams (USEPA, 2000)	Orthophosphate-P exceeding 25th percentile of inland streams for hydrologic unit 312 (Santa Maria Watershed) = 0.108 mg/L (Assessed using geomean of all samples at monitoring site > 0.108 mg/L).
Percent Floating Algal Cover	California Surface Water Ambient Monitoring Program Technical Report[A]	One or more observations of 50% cover or greater = supporting evidence of potential nutrient over-enrichment and biostimulation.
Photo evidence of nuisance algae	-	Photo documentation of nuisance algae and aquatic plant growth, etc.
Downstream Impacts	USEPA Scientific Advisory Board (2010) stressed the importance of recognizing downstream impacts[B]	Observational: assess whether stream reach showing elevated nutrient concentrations (> 1mg/L NO3-N; see nutrient enrichment screening criteria above) has downstream outlet discharging directly into water body which shows evidence of biostimulation problems (as indicated by screening values-weight of evidence in this Table).

[A] Worcester, K., D. M. Paradies, and M. Adams. 2010. Interpreting Narrative Objectives for Biostimulatory Substances for California Central Coast Waters. Surface Water Ambient Monitoring Program (SWAMP) Technical Report, July 2010.
[B] U.S. EPA Science Advisory Board Review of "Empirical Approaches for Nutrient Criteria Derivation". U.S Environmental Protection Agency. April 27, 2010.
[C] State Water Resources Control Board (SWRCB). 2004. Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List.

The importance of downstream impacts cannot be overstated. Excess nutrients in inland streams which drain alluvial or headwater reaches will ultimately end up in a receiving body of water (lakes, estuaries, bays, etc.) where the nutrient concentrations and total load may degrade the water resource. The USEPA Scientific Advisory Board has stressed the importance of recognizing downstream impacts associated with excessive nutrients with respect to developing numeric nutrient concentration criteria for inland streams (USEPA, 2010, Worcester et al., 2010); further downstream impacts must be protected in accordance with federal water quality standards regulations[40]. Numeric targets developed for inland surface streams should generally be applied to also minimize downstream impacts of nutrients in receiving waterbodies, which are exhibiting signs of eutrophication. In other words, tributaries themselves may not exhibit routine or severe signs of biostimulation and eutrophication, but because they contribute to a water body that is showing signs of eutrophication, the downstream effects of the tributaries should be considered.

[40] 40 C.F.R. 131.10(b) states: *"In designating uses of a water body and the appropriate criteria for those uses, the state shall take into consideration the water quality standards of downstream waters and shall ensure that its water quality standards provide for the attainment and maintenance of the water quality standards of downstream waters."*

Table 3-21. Biostimulation assessment matrix.

Stream Reach	DO Problems			Nutrient Enrichment	Elevated Algal Biomass		Other indicators of Biostimulatory problems		Biostimulatory Impairment in Stream Reach?
	Wide Diel DO Swings	Diel DO crashes	Low Ambient DO and/or DO supersaturation	NO3-N exceeding reference conditions; or orthophosphate-P exceeding reference conditions	Chlorophyll a exceeding reference conditions	Excess floating algal cover (≥50% cover)	Downstream nutrient impacts to water body exhibiting biostimulation	Photo documentation of excessive algal biomass	
Santa Maria R. 312SMA	Yes	Yes	No	Yes	Yes	Yes	Yes (Santa Maria River Estuary)	Yes	Yes
Santa Maria R. 312SMI	No data	No data	No	Yes	Yes	No	Yes (Santa Maria River Estuary)	Yes	Yes Although DO problems are not expressed, downstream nutrient impacts to Santa Maria River Estuary are present
Santa Maria R. 12SBC	No data	No data	No	No	No	No Data	No	No	No Based on DO, algal biomass, and nutrient enrichment problems not being expressed
Orcutt Cr. 312ORC	No	No	No	Yes	Yes	No	Yes (Santa Maria River Estuary)	Yes	Yes Although DO problems are not expressed, downstream nutrient impacts to Santa Maria River Estuary are present
Orcutt Cr. 312ORN	No data	No data	No	Yes	No	No Data	Yes (Santa Maria River Estuary)	No	Yes Although DO and algal biomass problems are not expressed, downstream nutrient impacts to Santa Maria River Estuary are present
Orcutt Cr. 312ORI	Yes	Yes	Yes	Yes	Yes	Yes	Yes (Santa Maria River Estuary)	Yes	Yes
Orcutt Cr. 312GVT	Yes	Yes	No	Yes	Yes	No	Yes (Santa Maria River Estuary)	Yes	Yes

Stream Reach	DO Problems			Nutrient Enrichment	Elevated Algal Biomass		Other indicators of Biostimulatory problems		Biostimulatory Impairment in Stream Reach?
	Wide Diel DO Swings	Diel DO crashes	Low Ambient DO and/or DO supersaturation	NO3-N exceeding reference conditions; or orthophosphate-P exceeding reference conditions	Chlorophyll a exceeding reference conditions	Excess floating algal cover (≥50% cover)	Downstream nutrient impacts to water body exhibiting biostimulation	Photo documentation of excessive algal biomass	
Orcutt Cr. 312ORB	No	No	No	Yes	Yes	No	Yes (Santa Maria River Estuary)	No	Yes Although DO problems are not expressed, downstream nutrient impacts to Santa Maria River Estuary are present
Orcutt Creek 312ORS	No data	No data	Yes (below Basin Plan saturation objective of median 85% saturation)	Yes (orthophosphate exceeding reference conditions)	No	No data	Yes (Santa Maria River Estuary)	No	Yes
Greene Valley Cr. 312GVS	Yes	Yes	Yes	Yes	Yes	Yes	Yes (Orcutt Creek)	Yes	Yes
Main St. Canal 312MAB	No data	No data	No	Yes	No	No data	No (biostimulation not present in Santa Maria Riv. above Hwy 1)	No	No Based on DO and algal biomass problems not being expressed
Main St. Canal 312MSD	No data	No data	No	Yes	Yes	Yes	No (biostimulation not present in Santa Maria Riv. above Hwy 1)	No	No Based on DO problems not being expressed
Main St. Canal 312MSS	No data	No data	No	Yes	Yes	No	No (biostimulation not present in Santa Maria Riv. above Hwy 1)	No	No Based on DO problems not being expressed
Blosser Channel 312BCD	No data	No data	Yes (exceeds supersaturation levels > 13 mg/L)	Yes	Yes	Yes	No (biostimulation not present in Santa Maria Riv. above Hwy 1)	Yes	Yes Based on DO, nutrients, and algal biomass problems
Bradley Channel 312BCU	No data	No data	No	Yes	Yes	Yes	No (biostimulation not present in Santa Maria Riv. above Hwy 1)	Yes	No Based on DO problems not being expressed

Stream Reach	DO Problems			Nutrient Enrichment	Elevated Algal Biomass		Other indicators of Biostimulatory problems		Biostimulatory Impairment in Stream Reach?
	Wide Diel DO Swings	Diel DO crashes	Low Ambient DO and/or DO supersaturation	NO3-N exceeding reference conditions; or orthophosphate-P exceeding reference conditions	Chlorophyll a exceeding reference conditions	Excess floating algal cover (≥50% cover)	Downstream nutrient impacts to water body exhibiting biostimulation	Photo documentation of excessive algal biomass	
Bradley Channel 312BCJ	No data	No data	Yes (exceeds supersaturation levels > 13 mg/L)	Yes	Yes	No	No (biostimulation not present in Santa Maria Riv. above Hwy 1)	No	Yes Bbased on DO, and nutrient problems
Nipomo Creek 312NIP	No data	No data	No	Yes (orthophosphate exceeding reference conditions)	Yes	No	No (biostimulation not present in Santa Maria Riv. above Hwy 1)	No	No Based on DO problems not being expressed
Nipomo Creek 312NIT	No data	No data	No	Yes	Yes	Yes	No (biostimulation not present in Santa Maria Riv. above Hwy 1)	No	No Based on DO problems not being expressed
Bradley Canyon Creek 312BCC	No data	No data	Yes	Yes	No	No	No (biostimulation not present in Santa Maria Riv. above Hwy 1))	No	Yes
Bradley Canyon Creek 312BCF	No data	No data	Yes (below Basin Plan saturation objective of median 85% saturation)	Yes	Yes	No	No (biostimulation not present in Santa Maria Riv. above Hwy 1)	No	Yes
Cuyama R (below reservoir) 312CUT	No data	No data	No	No	No	No	No (biostimulation not present in Santa Maria Riv. above Hwy 1)	No	No Based on DO and algal biomass problems not being expressed
Cuyama R (above reservoir) 312CUY	No data	No data	No	No	Yes	No	No	No	No Based on DO problems not being expressed
Cuyama R (above reservoir) 312CCC	No data	No data	No	No	Yes	Yes	No	No	No Based on DO problems not being expressed

Stream Reach	DO Problems			Nutrient Enrichment	Elevated Algal Biomass		Other indicators of Biostimulatory problems		Biostimulatory Impairment in Stream Reach?
	Wide Diel DO Swings	Diel DO crashes	Low Ambient DO and/or DO supersaturation	NO3-N exceeding reference conditions; or orthophosphate-P exceeding reference conditions	Chlorophyll a exceeding reference conditions	Excess floating algal cover (≥50% cover)	Downstream nutrient impacts to water body exhibiting biostimulation	Photo documentation of excessive algal biomass	
Cuyama R (above reservoir) 312CUL	No data	No data	No	No	No	No	No	No	No Based on DO and algal biomass problems not being expressed
Cuyama R (above reservoir) 312CAV	No data	No data	No	No	Yes	No	No	No	No Based on DO problems not being expressed
Oso Flaco Lake 312OFL	Yes	No	Yes	Yes	Yes	No	No	Yes	Yes
Little Oso Flaco Creek 312OFN	Yes	Yes	No	Yes	Yes	Yes	Yes (Oso Flaco Lake)	Yes	Yes
Oso Flaco Creek 312OFC	No	No	No	Yes	Yes	Yes	Yes (Oso Flaco Lake)	No	Yes Although DO problems are not expressed, downstream nutrient impacts to Oso Flaco Lake are present
Oso Flaco Creek 312USC	No data	No data	No	Yes	Yes	No data	Yes (Oso Flaco Lake)	No	Yes Although DO and algal biomass problems are not being expressed, downstream nutrient impacts to Oso Flaco Lake are present
Oso Flaco Creek 312OSR	No data	No data	No	Yes	No	No data	Yes (Oso Flaco Lake)	No	Yes Although DO and algal biomass problems are not being expressed, downstream nutrient impacts to Oso Flaco Lake are present

Stream Reach	DO Problems			Nutrient Enrichment	Elevated Algal Biomass		Other indicators of Biostimulatory problems		Biostimulatory Impairment in Stream Reach?
	Wide Diel DO Swings	Diel DO crashes	Low Ambient DO and/or DO supersaturation	NO3-N exceeding reference conditions; or orthophosphate-P exceeding reference conditions	Chlorophyll a exceeding reference conditions	Excess floating algal cover (≥50% cover)	Downstream nutrient impacts to water body exhibiting biostimulation	Photo documentation of excessive algal biomass	
Oso Flaco Creek 312OLR	No data	No data	No	Yes	No	No data	Yes (Oso Flaco Lake)	No	Yes Although DO and algal biomass problems not being expressed, downstream nutrient impacts to Oso Flaco Lake are present
Oso Flaco Creek 312BSR	No data	No data	No	Yes	Yes	No	Yes (Oso Flaco Lake)	No	Yes Although DO and algal biomass problems not being expressed, downstream nutrient impacts to Oso Flaco Lake are present

Based on the biostimulatory assessment summarized in Table 3-21 above, staff has concluded that the following waterbodies exhibit biostimulatory conditions:

- Santa Maria River Estuary
- Santa Maria River downstream of Highway 1
- Orcutt Creek
- Greene Valley Creek
- Blosser Channel
- Bradley Channel
- Bradley Canyon Creek
- Oso Flaco Creek
- Little Oso Flaco Creek
- Oso Flaco Lake

Although Bradley Channel and Blosser Channel exhibit biostimulatory conditions based on this assessment, staff is not proposing numeric targets, TMDLs, or allocation to protect against biostimulatory conditions in these two waterbodies. Staff is, however, proposing numeric targets, TMDLs, and allocations for nitrogen compounds (e.g., unionized ammonia and nitrate) that are protective of the municipal drinking water (MUN) and groundwater recharge (GWR) beneficial uses. This approach will allow the City of Santa Maria ample latitude to pursue the design, installation, and maintenance of treatment systems to improve water quality within these flood control structures.

3.4 Summary of Water Quality Impairments

Staff identified a total of 36 water body and pollutant combinations that are addressed in this TMDL. The pollutants addressed in this TMDL are nitrate, un-ionized ammonia, and orthophosphate—orthophosphate is included as a pollutant contributing to biostimulatory impairments of surface waters. Geographically, these impairments define the Project Area as all drainages to the Santa Maria River from the Bradley Canyon Creek confluence in the east to the Pacific Ocean in the west, including Orcutt Creek and all tributaries to Oso Flaco Lake. Table 3-22 summarizes the impaired waterbodies and pollutant combinations that are addressed in this TMDL.

As a result of these conditions, beneficial uses are not being protected. The following sections of this Project Report identify the causes of impairment and describe solutions to achieve water quality objectives for the protection of beneficial uses.

Table 3-22. Water body and Pollutant Combinations Addressed in this TMDL.

		Impairment Pollutant			
Water Body Name	SB Water Body ID	Unionized Ammonia	Nitrate	Low Dissolved Oxygen	Biostimulatory Substances
Blosser Channel	CAR3121003020011121135941	X	X		
Bradley Canyon Creek	CAR3121003020011121144840	X	X[1]	X[1]	O
Bradley Channel	CAR3121003020021002233532	X	X		
Greene Valley Creek	CAR3121003020080611165954	X	X[1]	X[1]	O
Little Oso Flaco Creek	CAR3121003020080611165546	--	X[1]		O
Main Street Canal	CAR3121003020020819110803	X	X		
Nipomo Creek	CAR3121001120011129124911	--	X[2]		
North Main Street Channel	CAR3121003020080620111045	--	X		
Orcutt Creek	CAR3121003020011129154708	X	X[1]	O	O
Oso Flaco Creek	CAR3121003020020124122144	X	X[1]		O
Oso Flaco Lake	CAL3121003020011121102545		X[3]	O[3]	
Santa Maria River	CAR3121003020011228103528	--	X[4]		O[5]
Santa Maria River Estuary	CAE3121003020020311125938	--		O	O
	Totals	12	12	5	7
	Total Water Body/Pollutant Combinations	36			

X Included on 2008-2010 303(d) list of impaired waterbodies and addressed in this TMDL.
-- Not listed or impaired, however TMDLs proactively established using targets and allocations consistent with Basin Plan numeric water quality objectives (WQO's) for associated pollutant (0.025 mg/L unionized ammonia, 10 mg/L nitrate as nitrogen).
O Not included on 2008-2010 303(d) list of impaired waterbodies, however impairment asserted due to exceedance of WQO's and addressed in this TMDL using more restrictive biostimulatory nitrate and orthophosphate targets and allocations.
1 Nitrate and/or low dissolved oxygen impairment addressed in this TMDL using more restrictive biostimulatory nitrate and orthophosphate targets and allocations.
2 Listed but not exceeding WQO's. TMDL proactively established using targets and allocations consistent with Basin Plan nitrate numeric WQO of 10 mg/L nitrate as nitrogen.
3 Oso Flaco Lake impairments will be addressed in a future, separate, lake-specific TMDL
4 Santa Maria River (upstream of Highway-1) nitrate TMDL established using targets and allocations consistent with Basin Plan nitrate WQO of 10 mg/L nitrate as nitrogen
5 Lower Santa Maria River (downstream of Highway-1 to the Pacific Ocean) impairment addressed in this TMDL using more restrictive biostimulatory nitrate and orthophosphate targets and allocations.

3.5 Problem Statement

Discharges of nitrogen compounds and orthophosphate are occurring at levels in surface waters which are impairing a wide spectrum of beneficial uses and, therefore, constitute a serious water quality problem. The municipal and domestic drinking water supply (MUN, GWR) beneficial uses and the range of aquatic habitat beneficial uses are currently impaired; additionally, locally some waterbodies do not meet non-regulatory recommended guidelines for nitrate in agricultural supply water for sensitive crops indicating that potential or future designated agricultural supply beneficial uses may be detrimentally impacted (refer back to Basin Plan water quality objectives in Section 2.3). A total of 30 waterbody/pollutant combinations are impaired due to exceedances of water quality objectives. The pollutants addressed in this TMDL are nitrate, un-ionized ammonia, and orthophosphate – orthophosphate is included as a pollutant due to biostimulatory impairments of surface waters. Reducing these pollutants is also anticipated to address several 303(d)-listed dissolved oxygen and chlorophyll *a* impairments in the TMDL project area.

As a result of these conditions, beneficial uses are not being protected. By developing TMDLs for the aforementioned pollutants, the water quality standards violations being addressed in this TMDL include:

- Violations of drinking water standard for nitrate
- Violations of the Basin Plan general toxicity objective for inland surface waters and estuaries (violations of un-ionized ammonia objective)
- Violations of the Basin Plan narrative general objective for biostimulatory substances in inland surface waters and estuaries (as expressed by excessive nutrients, chlorophyll a, algal biomass, and low dissolved oxygen)

The proposed TMDLs would protect and restore the municipal and domestic water supply beneficial use (MUN) and aquatic habitat beneficial uses currently being degraded by violations of the toxicity objective, and the biostimulatory substances objective including the following beneficial uses: wildlife habitat (WILD), cold fresh water habitat (COLD), warm fresh water habitat (WARM), migration of aquatic organisms (MIGR), spawning, reproduction, and/or early development (SPWN), preservation of biological habitats of special significance (BIOL), and rare, threatened, or endangered species (RARE). In addition, current or potential future beneficial uses of the agricultural water supply beneficial use (AGR) are not being supported. Nitrates can create problems not only for water supplies and aquatic habitat, but also potentially for nitrogen sensitive crops (grapes, avocado, citrus[41]) by detrimentally impacting crop yield or quality. Basin Plan water quality guidelines protective of nitrogen sensitive crops and the AGR beneficial use were previously identified in Section 3.2.1.2.

For waterbodies that are not expressing biostimulatory impairments, the most stringent relevant water quality objective for nitrate (and therefore the one that is protective of the full range of all nitrate-impaired designated beneficial uses) is

[41] Source: Natural Resources Conservation Service, U.S. Department of Agriculture. "Irrigation Water Quality" http://www.nm.nrcs.usda.gov/technical/fotg/section-1/irrigation-guide/irrigation-water-quality.pdf and Ayers and Scott (1994). Water Quality for Agriculture. In: United Nations Food and Agriculture Program. http://www.fao.org/DOCREP/003/T0234E/T0234E06.htm

the numeric Basin Plan objective for nitrate in municipal and domestic water supply. Reducing nitrate pollution and ultimately achieving the nitrate drinking water quality standard in these waterbodies will therefore restore and be protective of the full range of MUN, GWR and/or AGR designated beneficial uses of the surface waters which are being currently impaired by excess nitrate.

All waterbodies are required to attain the Basin Plan general toxicity objective for unionized ammonia in inland surface waters and estuaries.

For waterbodies that are expressing biostimulatory impairments, the most stringent relevant water quality objective for nitrate-nutrients (and therefore the one that is protective of the full range of all nutrient-impaired designated beneficial uses) is the Basin Plan narrative general objective for biostimulatory substances in inland surface waters and estuaries. These waterbodies must achieve concentration-based wasteload and load allocations for nitrate and orthophosphate as identified in Section 6.5. Reducing nutrient pollution and ultimately achieving the load allocations for nutrients in these waterbodies will therefore restore and be protective of the full range of Aquatic Habitat, MUN, GWR, and/or AGR designated beneficial uses of the surface waters which are being currently impaired by excess nutrients.

4 NUMERIC TARGETS

4.1 Target for Unionized Ammonia

The Basin Plan contains numeric water quality objectives for un-ionized ammonia protective of the general toxicity objective is as follows:

- *The discharge of wastes shall not cause concentrations of unionized ammonia (NH3) to exceed 0.025 mg/l (as N) in receiving waters.*

4.2 Target for Nitrate (MUN Standard)

The purpose of this target is to meet the water quality objective for nitrates in municipal and domestic drinking water sources (MUN: Municipal/Domestic Supply; GWR: Groundwater Recharge). The Basin Plan numeric water quality objective for nitrate (as nitrogen) is 10 mg/L NO3 as N, therefore the nitrate target is set at the Basin Plan water quality objective as follows:

- *10 mg/L nitrate as nitrogen to ensure that these surface waters are protected as drinking water sources and to assure compliance with the numeric water quality objective at all times.*

4.3 Targets for Biostimulatory Substances (Nitrate and Orthophosphate)

This section provides a summary of the information contained in Appendix C – Nutrient Numeric Target Development for Streams (see appendix C for details). It is important to note that the information necessary to develop a nutrient TMDL for Oso Flaco Lake is not currently available; however, additional background information and a proposed approach is contained in Appendix D.

The Basin Plan contains the following narrative water quality objectives for biostimulatory substances:

- *Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses.*

Under most circumstances, compliance with all applicable water quality objectives, including narrative objectives is required (SWRCB, 2011a). Further, according to USEPA guidance, a TMDL and associated waste load allocations and load allocations must be set at levels necessary to result in attainment of all applicable water quality standards, including narrative water quality objectives (USEPA, 2000b). A narrative objective may be interpreted with respect to a specific pollutant or parameter by selecting an appropriate numeric threshold that meets the conditions of the narrative objective (SWRCB, 2011a). Therefore, in order to implement the Basin Plan's narrative objective for biostimulatory substances the Water Board is required to develop technically defensible numeric water quality criteria to assess attainment or non-attainment of the narrative water quality objective:

*"For waterbodies listed because of failure to meet a narrative water quality objective, **the numeric target will be a quantitative interpretation of the narrative objective***. For example, if a water body fails to achieve a narrative objective for settleable solids, the TMDL could include targets for annual mass sediment loading." (SWRCB, 1999)*

-State Water Resources Control Board, Office of Chief Counsel (1999)

*"In situations where applicable water quality standards are expressed in narrative terms or where 303(d) listings were prompted primarily by beneficial use or antidegradation concerns**, it is necessary to develop a quantitative interpretation of narrative standards***. "*

-U.S. Environmental Protection Agency (2000b)

***** emphasis added

To implement this narrative objective, staff evaluated available data, studies, established methodologies, technical guidance, peer-reviewed numeric criterion, and other information to estimate the levels of nitrogen and phosphorus that can be present without causing violations of this objective. It is important to recognize that definitive and unequivocal scientific certainty is not necessary in a TMDL process with regard to development of nutrient water quality targets protective against biostimulation. Numeric targets should be scientifically defensible, but are not required to be definitive. Eutrophication is an ongoing and active area of research. If the water quality objectives and numeric targets for biostimulatory substances are changed in the future, then any TMDLs and allocations that are potentially adopted for biostimulatory substances pursuant to this project may sunset and be superseded by revised water quality objectives.

Recent research on biostimulation on inland surface waters from agricultural watersheds in the California central coast region indicates that the existing nutrient numeric water quality objectives to protect drinking water standards found in the Basin Plan (i.e., the 10 mg/L nitrate-nitrogen MUN objective) is unlikely to reduce benthic algal growth below even the highest water quality benchmarks. This is because aquatic organisms respond to nutrients at lower concentrations[42,43]. Therefore, the 10 mg/L nitrate-nitrogen objective is insufficiently protective against biostimulatory impairments. Consequently, it is typically necessary to set biostimulatory numeric water quality targets at more stringent levels than the existing numeric objectives found for nitrate in the Basin Plan (i.e., the 10 mg/L MUN objective).

Proposed numeric targets for biostimulatory substances are presented in Table 4-1. Appendix C contains all the data, assessments, and information used to derive numeric targets for biostimulatory substances. Staff followed USEPA guidance in developing draft target with the goal being to account for physical and hydrologic variation within the TMDL project area (see *Nutrient Criteria Technical Guidance Manual, River and Streams* - USEPA July 2000). The USEPA nutrient criteria guidance manual recommends that nutrient criteria need to be developed to account for natural variation existing at the regional and basin level-scale.

Additionally, different water body processes and responses dictate that nutrient criteria be specific to water body type. No single criterion will be sufficient for each water body type. USEPA recommends classifying and group streams by type or comparable characteristics (e.g., fluvial morphology, hydraulics, physical, biological or water quality attributes). Classification will allow criteria to be identified on a broader scale rather than a site-specific scale. The aforementioned stream classification recommendation by USEPA is supported by recent research published for California's central coast region, as illustrated below:

[42] University of California, Santa Cruz. 2010. Final Report: Long-term, high resolution nutrient and sediment monitoring and characterizing in-stream primary production. Proposition 40 Agricultural Water Quality Grant Program. Dr. Marc Los Huuertos, Ph.D., project director.

[43] Rollins, S., M. Los Huertos, P. Krone-Davis, and C. Ritz. 2012. Algae Biomonitoring and Assessment for Streams and Rivers of California's Central Coast. Final Report for Proposition 50 Grant Agreement No. 06-349-553-2

"*Sections of the Pajaro River watershed have been listed by the State of California as impaired for nutrient and sediment violations under the Clean Water Act ……**The best evidence linking elevated nutrient concentrations to algae growth was shown when the stream physiography, geomorphology, and water chemistry were incorporated into the survey and analysis."****

***emphasis added*

From: University of California, Santa Cruz (2009). Final Report: Long-Term, High Resolution Nutrient and Sediment Monitoring and Characterizing In-stream Primary Production. Proposition 40 Agricultural Water Quality Grant Program (Project Lead: Dr. Marc Los Huertos).

Further, numeric target development in this TMDL is consistent with policy recommendations outlined in the draft State Water Resources Control Board's Statewide Nutrient Policy (SWRCB, 2011b). The draft Statewide Nutrient Policy recognizes both the California Nutrient Numeric Endpoints (CA NNE) approach and the USEPA percentile-approach as the two valid alternatives under consideration for a statewide policy for nutrient policy. Staff evaluated and utilized both the CA NNE and the USEPA percentile approach in development of numeric targets. Further background on development of numeric targets are presented in Section 4.3.1 and Section 4.3.2. As noted previously, Appendix C presents detailed information and the full scope of data and methods used for the evaluation and development of nutrient numeric targets. A brief summary of technical guidance used by staff in nutrient target development is presented below:

Summary of published technical guidance used by staff in nutrient target development:

Using a combination of recognized approaches (i.e., literature values, statistical approaches, predictive modeling approaches) result in criteria of greater scientific validity *(guidance source: USEPA, 2000a. Nutrient Criteria Guidance Manual*);

Classify and group streams needing nutrient targets, based on similar characteristics *(guidance source: USEPA, 2000a. Nutrient Criteria Guidance Manual);*

Targets should not be lower than expected concentrations found in background/natural conditions *(guidance source: California NNE Approach guidance – TetraTech, 2006).*

Table 4-1. Numeric Targets for Biostimulatory Substances.

Water body Type	Geomorphology & Stream Characteristics	Project Area Stream Reaches	Allowable Nitrate-N (mg/L)	Allowable Orthophosphate-P (mg/L)	Methodology for Developing Numeric Target	Notes Pertaining to Development of Targets
Alluvial Valley River – flood plain	Alluvial valley river. Alluvial flood plain, channels, drainageways. Moderate ambient turbidity; sandy substrate; <10 average canopy cover;	Lower Santa Maria River from Highway 1 to Pacific Ocean (including Santa Maria River Estuary), Orcutt Creek, Greene Valley Creek	**4.3** **Dry Season Samples (May 1-Oct31)** **8.0** **Wet Season Samples (Nov. 1-Apr. 30)**	**0.19** **Dry Season Samples (May 1-Oct. 31)** **0.3** **Wet Season Samples (Nov. 1-Apr. 30)**	Statistical Analysis (USEPA percentile-based approaches) Supported by Calif. NNE approach (NNE benthic biomass model tool) Wet-season targets based on Central Coast Basin Plan nitrate objectives and State of Nevada phosphate criteria for streams	Moderately high ambient turbidity (17 NTU-25th percentile), sandy substrate, poor sunlight penetration, low to moderate canopy cover indicates risk of biostimulation at relatively low concentrations of nutrients.
Oso Flaco Lake Tributaries	Alluvial fan, alluvial flats; Relatively high ambient turbidity; Loamy sand substrates; almost no canopy cover	Oso Flaco Creek, Little Oso Flaco Creek.	**5.7** **Year Round Samples**	**0.08** **Year Round Samples**	Statistical Analysis (USEPA percentile-based approaches) Supported by Calif. NNE approach (NNE benthic biomass model tool)	Loam, sandy loams, and sand. Relatively high ambient turbidity (20 NTU – 25th percentile) which precludes good sunlight penetration of water column; risk of biostimulation occurs at relatively higher nutrient concentrations.
Oso Flaco Lake	**In Development**					

4.3.1 Background Information on Numeric Targets for Biostimulatory Substances

Water Board staff are required to develop scientifically-valid numeric nutrient water quality targets that are protective of the Basin Plan's narrative biostimulatory water quality objective. Table 4-2 summarizes the USEPA-recommended approaches for assessing and developing numeric nutrient criteria that will be protective of the Basin Plan's narrative biostimulatory water quality standard. USEPA (2000) reports that a weight of evidence approach to developing nutrient criteria that ***"combines any or all of the three recommended of the approaches will produce criteria of greater scientific validity."*** Consistent with this USEPA guidance, staff evaluated and utilized multiple USEPA-recognized methodologies in the evaluation and development of nutrient numeric targets (see Appendix C)

Table 4-2 . USEPA-recommended approaches for developing nutrient criteria.

USEPA-Recommended Approaches	**Approach Assessed in this TMDL project?**	**Methodology**	**Staff Notes**
Use of **Predictive Relationships** (modeling; biocriteria)	☑	California NNE Approach	Staff used NNE benthic biomass model tool to supplement and validate USEPA-25th percentile draft targets for reasonableness.
Statistical Analysis of Data	☑	USEPA-recommended statistical analysis: 25th percentile of nutrient data for stream population	Staff used USEPA 25th percentile approach to develop numeric targets in this TMDL project. – targets were supplemented and refined using the NNE biomass model tool.
Use of established concentration **thresholds from published literature**	☑	USEPA published nutrient criteria for Ecoregion III, Subecoregion 6	Staff evaluated USEPA ecoregional criteria. Staff finds ecoregion 6 criteria are inappropriate for the TMDL project area – ecoregional approach lumps together streams of with significantly different characteristics: headwater streams, alluvial valley streams, coastal confluence streams, etc. USEPA itself recognizes ecoregional criteria may not sufficiently address local variation.

Further, biostimulatory numeric target development in this TMDL is consistent with policy recommendations outlined in the draft State Water Resource Control Board's Statewide Nutrient Policy (SWRCB, 2011). The draft Statewide Nutrient Policy recognizes both the California Nutrient Numeric Endpoints (CA NNE) approach and the USEPA percentile-approach as the two valid alternatives under consideration for a statewide policy for nutrient policy. Consistent with this draft policy staff evaluated and utilized both the CA NNE and the USEPA percentile approach in development and refinement of numeric targets.

While USEPA generally recommends total nitrogen and total phosphorus as targets protective against biostimulation, USEPA also states that ***other factors should be considered in selecting targets***; for example consistency with already available data. In many cases, many existing project area monitoring programs do not collect or report total kjeldahl nitrogen (TKN) or total phosphorus (TP), and only report nitrate and nitrite, and orthophosphate. Particularly problematic is that, many of the major monitoring programs that are active in the TMDL project area have only been collection orthophosphate data and not total phosphorus data (e.g., Cooperative Monitoring Program, etc.). The relatively limited amounts of total phosphorus data that has been collected (Central Coast Ambient Monitoring Program - CCAMP) is episodic and does not have adequate temporal and spatial representation for purposes of TMDL development. Of all forms of phosphorus water column data collected in the TMDL project area since 2000, only about 13% of those samples are for total phosphorus. Also, to the extent there is data for total phosphorus, most of the total phosphorus data was collected in years 2000-2002 which is inadequate for temporal representation. As such total nitrogen and total phosphorus values are generally not widely or consistently available. USEPA guidance on selecting numeric targets is reproduced below:

> *Various factors will affect the selection of an appropriate TMDL indicator. These factors include issues associated with the indicator's scientific and technical validity, as well as practical management considerations. The importance of these factors will vary for each waterbody, depending, for instance, on the time and resources available to develop the TMDL, the availability of already existing data, and the water's designated uses. Final selection of the indicator should depend on site-specific requirements. The following sections identify some factors to keep in mind during indicator selection.*
>
> *Practical considerations:*
> *Measurement of the indicator should cost as little as possible, while still meeting other requirements. Indicators that can be suitably monitored through volunteer monitoring programs or other cost-effective means should be evaluated for adequate quality control and assurance of sample collection, preservation, laboratory analysis, data entry, and final reporting. Monitoring should introduce as little stress as possible on the designated uses of concern.*
>
> *It is advantageous to select an indicator **consistent with already available data**. Choice of an indicator also should take into account how "obvious" it is to the public that the target value must be met to ensure the desired level of water quality. (For example, the public understands Secchi depth and chlorophyll indicators fairly well.)*
>
> ***Recommendation: Scientific and technical issues should be balanced against practical considerations when deciding upon a water quality indicator**.*
>
> *From: USEPA Protocol for Developing Nutrient TMDLs, 1999 (emphasis added)*

It should be noted that in inland rivers and streams, nitrate and orthophosphate are generally the bioavailable forms of nutrients. In static or stagnant receiving waterbodies, such as lakes and reservoirs, other forms of nitrogen and phosphorus tend to accumulate and ultimately contribute to internal loading due to the nitrogen and phosphorus cycle. However, in rivers and streams, this internal loading and cycling affect typically is less pronounced. Furthermore, nitrate typically comprises over 90% total water column nitrogen in agricultural inland surface streams of the lower Santa Maria River valley (see Table 4-3).

Table 4-3. Proportion of Nitrate Nitrogen in Total Nitrogen for Project Area Waterbodies.

Water body	Site ID	Paired Sample Count	Geomean	Median	Mean
Santa Maria River	312SMA	83	92.21	93.33	92.65
	312SMI	12	97.79	100.00	97.85
	312SBC	1	100.00	100.00	100.00
Orcutt Creek	312ORC	23	93.15	93.94	93.27
	312ORI	22	94.65	96.05	94.75
	312GVT	12	88.60	90.85	88.95
	312ORB	20	72.00	87.78	76.17
	312ORS	1	16.40	16.40	16.40
Green Valley Creek	312GVS	12	95.69	98.17	95.83
Main street Canal	312MSD	20	62.12	68.78	65.28
	312MSS	10	55.47	58.33	60.48
Blosser Channel	312BCD	18	52.67	67.98	64.68
Bradley Channel	312BCU	20	78.07	86.40	81.71
Nipomo Creek	312NIP	14	50.47	56.35	53.54
	312NIT	12	72.39	84.96	79.38
Bradley Canyon Creek	312BCF	9	78.50	82.76	79.93
Oso Flaco Lake	312OFL	22	97.11	96.87	97.15
Little Oso Flaco Creek	312OFN	19	99.15	100.00	99.17
Oso Flaco Creek	312OFC	18	89.43	94.42	90.35
	312BSR	6	96.88	98.35	96.91

Proportion based on percent of nitrate (as N) in total nitrogen for paired samples

Table 4-4. Proportion of orthophosphate as phosphorus in total phosphorus for Project Area Waterbodies.

Water body	Site	Paired Sample Count	Geomean	Median	Mean
Santa Maria River	312SMA	15	53.27	71.43	65.46
	312SMI	9	69.70	85.07	83.42
	312SBC	2	34.47	51.60	51.60
Orcutt Creek	312ORC	9	47.83	80.33	65.97
	312ORI	8	38.19	61.68	53.86
	312ORB	7	38.80	86.67	61.64
Main Street Canal	312MSD	7	68.92	84.40	73.32
Blosser Channel	312BCD	6	52.12	72.67	60.68
Bradley Channel	312BCU	7	59.05	66.18	66.03
Nipomo Creek	312NIP	7	54.87	66.67	60.02
	312NIT	5	58.49	82.61	67.07
	312BCF	4	76.64	82.86	79.53
Oso Flaco Lake	312OFL	7	38.07	38.64	50.54
Little Oso Flaco Creek	312OFN	6	60.37	75.60	67.19
Oso Flaco Creek	312OFC	7	62.39	75.26	67.53

Proportion based on percent of orthophosphate (as P) in total phosphorus for paired samples.

Based on the above information and consistent with USEPA guidance for practical monitoring considerations, staff proposes that nutrient targets for this TMDL project shall be based on nitrate and orthophosphate because:

(1) nitrate is the overwhelming fraction of total water column nitrogen in the lower Santa Maria Valley inland streams;

(2) the limited amount of available total nitrogen data are inadequate to represent spatial and temporal variation

(3) the limited amount of available total phosphorus data are completely inadequate to represent spatial and temporal variation; and

(4) nitrate and orthophosphate are the generally bioavailable forms of nitrogen and phosphorus in inland surface streams.

With regard to statistical approaches to developing nutrient targets, USEPA's Technical Guidance Manual for Developing Nutrient Criteria for Rivers and Streams (2000) describes two ways of establishing a reference condition. One method is to choose the upper 75th percentile of a reference population of streams. The 75th percentile was chosen by EPA since it is likely associated with minimally impacted conditions, will be protective of designated uses, and provides management flexibility. With regard to identifying reference streams USEPA defines a reference stream "as a least impacted water body within an ecoregion that can be monitored to establish a baseline to which other waters can be compared. Reference streams are not necessarily pristine or undisturbed by humans."

USEPA proposed that the 75th percentiles of all nutrient data of these reference stream(s) could be assumed to represent unimpacted reference conditions for each aggregate ecoregion, and also provided a comparison of reference condition for the aggregate ecoregion versus the subecoregions.

Alternatively, when reference streams are not identified, the second method USEPA recommends is to determine the lower 25th percentile of the population of all streams within a region. The 25th percentile of the entire population was chosen by EPA to represent a surrogate for an actual reference population. To further clarify this point, USEPA (2000) reports that "(d)ata analyses to date indicate that the lower 25th percentile from an entire population roughly approximates the 75th percentile for a reference population (see case studies for Minnesota lakes in the Lakes and Reservoirs Nutrient Criteria Technical Guidance Document [U.S. EPA, 2000a], the case study for Tennessee streams in the Rivers and Streams Nutrient Criteria Technical Guidance Document [U.S. EPA, 2000b], and the letter from Tennessee Department of Environment and Conservation to Geoffrey Grubbs [TNDEC, 2000]). New York State has also presented evidence that the 25th percentile and the 75th percentile compare well based on user perceptions of water resources (NYSDEC, 2000)."

These 25th percentile values are thus characterized as criteria recommendations that could be used to protect waters against nutrient over-enrichment (USEPA, 2000). This is because the 25^{th} percentile of the entire population was chosen by EPA to represent a surrogate for an actual reference population.

It is important to note that the USEPA Science Advisory Board (2010) and Worcester et al. (2010) report that draft numeric targets for nutrients may need to be supported with a weight of evidence approach, rather than stand-alone statistical methods. The weight of evidence approach could use other evidence of eutrophication; for example, presence and abundance of floating algal mats, water column chlorophyll a concentrations, evidence of oxygen depression and/or supersaturation, and pH over 9.5.

Accordingly, staff finds that it is not warranted to apply the USEPA 25^{th} percentile approach to all project area waterbodies with elevated nutrients absent a demonstrable beneficial use impairment that can be linked to nutrients. It is worth reiterating that elevated nutrients, in and of themselves, do not necessarily indicate biostimulation-eutrophication and impairment of beneficial uses (refer back to Section 3.3). A linkage between elevated nutrients and actual impairment of beneficial uses must be demonstrated; e.g. dissolved oxygen and/or pH imbalances and other water quality-aquatic habitat indicators. As such, staff used a range of Basin Plan numeric water quality objectives and peer-reviewed screening criteria to assess the spatial distribution of biostimulatory effects and impairments in order to adequately determine where a nutrient numeric target based on USEPA-recommended statistical criteria is warranted (for example, refer back to Table 3-21).

Also, because nutrient loads, and nutrient effects can vary substantially in different seasons, refinements may include developing a temporal, seasonal (e.g., summer versus winter targets), or statistical component (e.g., annual or seasonal mean value of a suite of water quality samples) that may be embedded in the final numeric targets.

4.3.2 Nutrient Numeric Endpoint Analysis

An additional line of evidence for establishing nutrient water quality targets in the TMDL project area was provided by an application of the California Nutrient Numeric Endpoint (California NNE) approach (Tetra Tech 2006). The California nutrient numeric endpoints (NNE) approach (see Appendix C of this report) was developed as a methodology for the development of nutrient (nitrogen and phosphorus) numeric endpoints for use in the water quality programs of the California's State Water Resources Control Board (State Water Board) and Regional Water Quality Control Boards (Regional Water Boards).

The California NNE approach is a risk-based approach in which algae and nutrient targets can be evaluated based on multiple lines of evidence; the intention of the NNE approach is to use nutrient response indicators to develop potential nutrient water quality criteria. The California NNE approach also includes a spreadsheet scoping tool for application in river systems to assist in evaluating the translation between response indicators (e.g. algal biomass) and nutrient concentrations. It is noteworthy that another important tenet of the CA NNE approach (Tetra Tech 2006) is that targets should not be set lower than the value expected under natural conditions. The models used in the spreadsheet tool and their application are described extensively in Appendix 3 of the California NNE Approach (Creager, 2006). They include empirical models (Dodds, 1997 and 2002) and the QUAL2K simulation models (Chapra and Pelletier, 2003), including the standard model, a revised model that provides a better fit to Dodd's empirical data, and a revised model that adjusts for algae accrual time between scour events. The revised QUAL2K simulation model also predicts the anticipated maximum algal contribution to oxygen deficit. This is the maximum amount of dissolved oxygen expected to be removed from the water as a result of predicted benthic algal growth. The outputs can then be evaluated using the numeric targets for secondary indicators, established by the California NNE Approach to determine the risk of impairment at a given site from nutrient over-enrichment.

As part of the development of biostimulatory nutrient targets for this TMDL project, multiple lines of evidence including the use of the California NNE scoping tools were used. Consequently, the California NNE approach scoping spreadsheet tool is used in this TMDL project to evaluate and support the appropriateness of targets staff developed based on the USEPA 25th percentile statistical approach. Reasonably close agreement between California NNE spreadsheet tool nutrient targets with USEPA 25th percentile approach nutrient targets is taken to indicate a higher level of scientific validity and confidence in the proposed targets, consistent with nutrient criteria guidance provided by USEPA.

It is noteworthy that the draft SWRCB Statewide Nutrient Policy (SWRCB, 2011) recognizes both the CA NNE approach and the USEPA percentile-approach as the two alternatives under consideration for a statewide policy for development numeric targets. As such, the methodologies used to develop nutrient numeric targets in this project report, as outlined above, are consistent with the recognized methodologies currently under consideration by SWRCB for statewide application.

4.4 Targets for Nutrient-Response Indicators (DO, Chlorophyll a, and Microcystins)

Low dissolved oxygen, chlorophyll *a.* and algal toxins (microcystins) are nutrient-response indicators and represent a primary biological response to excessive nutrient loading in waterbodies which exhibit biostimulatory conditions. Current 303(d)-listed dissolved oxygen (DO) impairments in the TMDL project area are not directly addressed in the TMDL implementation plan in terms of calculating loads (TMDLs) or setting wasteload or load allocations. However reductions in nutrient loading are anticipated to be beneficial in attainment of water quality standards for DO and restoring the waterbodies to a desired condition. Note that this approach regarding nutrient pollution and dissolved oxygen has similarly been used in previous USEPA-approved TMDLs[44]. Therefore, the current 303(d) listings for dissolved oxygen that are associated with identified biostimulatory problems (refer to Section 3.2.1.3) are addressed by the TMDLs established herein. It is important to reiterate that nutrient concentrations by themselves constitute indirect indicators of biostimulatory conditions and there is an interrelationship between high nutrient loads, excessive algal growth, and the subsequent impacts of excessive algae on dissolved oxygen and aquatic habitat. Accordingly staff is also proposing dissolved oxygen and chlorophyll a numeric targets to ensure that streams do not show evidence of biostimulatory conditions; additionally numeric targets identified for DO and chlorophyll *a* in this TMDL will be used as indicator metrics to assess primary biological response to future nutrient water column concentration reductions, and compliance with the Basin Plan's biostimulatory substances objective.

[44] For example: Wabash River Nutrient and Pathogen TMDL, Final Report. Indiana Dept. of Environmental Management, 2006. Approved by USEPA under Section 303(d) of the Clean Water Act on Sept. 22, 2006.

4.4.1 Dissolved Oxygen

The Basin Plan contains the following water quality objectives for dissolved oxygen (DO):

- *For warm beneficial uses and for waters not mentioned by a specific beneficial use, dissolved oxygen concentrations shall not be reduced below 5.0 mg/L at any time.*
- *For cold and spawning beneficial uses, dissolved oxygen concentrations shall not be reduced below 7.0 mg/L at any time.*
- *Median values for dissolved oxygen should not fall below 85% saturation as a result of controllable conditions.*

In addition, due to the nature of algal respiration and photosynthesis (refer back to Section 3.2.1) and since daytime monitoring programs are unlikely to capture most low DO crashes, it is prudent to identify a numeric guideline that can measure daytime biostimulatory problems on the basis of DO supersaturation. Peer-reviewed research in California's central coast region (Worcester et al., 2010) has established an upper limit of 13 mg/L for DO to screen for excessive DO saturation. Of monitoring sites evaluated in the central coast region that are supporting designated aquatic habitat beneficial uses and do not show signs of biostimulation, DO virtually never exceeded 13 mg/L at any time[45]). Note that the 13 mg/L DO saturation target is not a regulatory standard, but can be used as a TMDL nutrient-response indicator target to assess primary biological response to nutrient pollution reduction. Accordingly, staff proposes the numeric target for DO supersaturation indicative of biostimulatory conditions as follows:

- *Dissolved oxygen concentrations not to exceed 13 mg/L.*

Note that this TMDL is addressing biostimulatory impairments; as such only dissolved oxygen impairments that are credibly linked to biostimulation problems (i.e., elevated algal biomass, wide diel swings in DO/pH, and elevated nutrients) will be addressed in this TMDL. It is important to recognize that there are other factors that affect the concentration of dissolved oxygen in a waterbody. Oxygen can be introduced by additions of higher DO water (e.g., from tributaries); additions of lower DO water (groundwater baseflow), temperature (warm water holds less oxygen than cold water), and reductions in oxygen due to organic decomposition. Dissolved oxygen impairments that are not credibly linked to biostimulation impairments will potentially be addressed in another TMDL process, or in a future water quality standards action.

4.4.2 Chlorophyll a

Chlorophyll *a* is an algal biomass indicator. The Basin Plan does not include numeric water quality objectives or criteria for chlorophyll *a*. Staff considered a

[45] Of 2,399 samples at these reference sites, only about 1% of the samples ever exceeded 13 mg/L DO.

range of published numeric criteria. The State of Oregon uses an average chlorophyll a concentration of > 15 μg/L as a criterion for nuisance phytoplankton growth in lakes and rivers[46]. The state of North Carolina has set a maximum acceptable chlorophyll *a* standard of 15 μg/L for cold water (lakes, reservoir, and other waters subject to growths of macroscopic or microscopic vegetation designated as trout waters), and 40 μg/L for warm water (lakes, reservoir, and other waters subject to growths of macroscopic or microscopic vegetation not designated as trout waters)[47]. A chlorophyll *a* concentration of 8 μg/L is recommended as a threshold of eutrophy for plankton in EPA's Nutrient Criteria Technical Guidance Manual for Rivers and Streams (USEPA, 2000a). The Central Coast Region has used 40 μg/L as stand-alone evidence to support chlorophyll *a* listing recommendations for the 303(d) Impaired Water Bodies list.

A recent peer-reviewed study conducted by CCAMP reports that in the California central coast region inland streams that do not show evidence of eutrophication all remained below the chlorophyll *a* threshold of 15 μg/L (Worcester et al., 2010). As this value is consistent with several values reported in published literature and regulations shown above, and as the CCAMP study by Worcester et al. is central coast-specific, staff proposes the numeric target for chlorophyll *a* indicating biostimulatory conditions as follows:

- *Water column chlorophyll a concentrations not to exceed 15 μg/L.*

4.4.3 Microcystins

Microcystins are toxins produced by cyanobacteria (blue-green algae) and are associated with algal blooms and biostimulation in surface waterbodies[48]. The Basin Plan does not contain numeric water quality objectives for microcystins. However, the California Office of Environmental Health Hazard Assessment has published final microcystin public health action levels[49] for human recreational uses of surface waters. These are not regulatory standards, but are suggested public health action levels. This public health action level is 0.8 μg/L for human recreational uses of water. Therefore, staff proposes the numeric water quality target for microcystins[50] as follows:

- *Microcystins concentrations not to exceed 0.8 μg/L.*

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[46] Oregon Adminstrative Rules (OAR). 2000. Nuisance Phytoplankton Growth. Water Quality Program Rules, 340-041-0150.
[47] North Carolina Administrative Code 15A NCAC 02B .0211(3)(a).
[48] See: U.S. Environmental Protection Agency. Drinking Water Treatability Database.
[49] California Office of Environmental Health Hazard Assessment. 2012. *Toxicological Summary and Suggested Action Levels to Reduce Potential Adverse Health Effects of Six Cyanotoxins* (Final, May 2012).
[50] Includes microcystins LA, LR, RR, and YR

These targets are therefore protective of the REC-1 designated beneficial uses of surface waters. Currently, there are no identified impairments in the TMDL Project Area on the basis of algal toxins. However, numeric targets identified for microcystins in the TMDL will be used as an indicator metric to assess primary biological response to future nutrient water column concentration reductions and to ensure compliance with the Basin Plan's biostimulatory substances objective and designated REC-1 beneficial uses.

It should be noted that implementing parties are not required to collect microcystin data, unless they choose to do so voluntarily. At this time, the Water Board is currently funding microcystin data collection which may be used for future assessments of biostimulatory problems in waterbodies of the TMDL project area.

5 SOURCE ANALYSIS

5.1 Introduction: Source Assessment Using STEPL Model

Both nitrogen and phosphorus reach surface waters at an elevated rate 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[51].

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/.

[51] 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.

STEPL input parameters used in this TMDL project are shown in Table 5-1 and the spreadsheet results are presented in Appendix D. It should be emphasized that nutrient load estimates calculated by STEPL are estimates and subject to uncertainties; actual loading at the stream-reach scale can vary substantially due to numerous factors over various temporal and spatial scales.

Staff ran the STEPL model for all Project Area subwatersheds that are shown in Figure 1-4.

Table 5-1. 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	See STEPL spreadsheets (Appendix E)	Farmland Mapping and Monitoring Program data (see Section 1)
Urban Land Use Distributions (impervious surfaces categories)	STEPL default values	STEPL
Agricultural Animals	See STEPL spreadsheets (Appendix E)	Agricultural Census statistics, as reported in Santa Maria River Fecal Coliform TMDL, Central Coast Water Board, 2012
Septic system discharge and failure rate data	See STEPL spreadsheets (Appendix E)	Septic System (OSDS) data as reported in Santa Maria River Watershed Fecal Coliform TMDL, Central Coast Water Board, 2012
Hydrologic Soil Group (HSG)	HSG "B"	Median HSG based on soil distribution for TMDL project area – see
Soil N and P concentrations (%)	N = 0.10% P = 0.031%	• 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). • P (%) – STEPL default values
NRCS reference runoff curve numbers	STEPL default values	NRCS default curve numbers provided in STEPL
Nutrient concentration in runoff (mg/L)	Agricultural Lands N = 11.4 mg/L P = 0.64 mg/L Urban Lands N = 1.5-2.5 mg/L P = 0.15-0.4 mg/L Grazing Lands (range) N = 0.25 mg/L P = 0.27 mg/L Forest N = 0.2 mg/L P = 0.1 mg/L	• Agricultural lands mean N runoff concentration data from Southern California Coastal Water Research Project, Technical Report 335 (Nov. 2000), Appendix C, and U.S. Dept. of Agriculture MANAGE database • Agricultural lands mean P runoff concentration data from Southern California Coastal Water Research Project, Technical Report 335 (Nov. 2000), Appendix C • Urban lands –Used STEPL default values that contain a range of N and P runoff concentrations based on specific urban land use type (e.g., commercial, industrial, residential. Transportation, etc.). • Grazing lands mean N runoff concentration. from California Rangeland Watershed Laboratory rangeland presentation for stream water quality (average of the concentrations given for moderate grazing intensity and no grazing categories) http://rangelandwatersheds.ucdavis.edu/Recent%20Outreach/tate%20oakdale%20mar%202012.pdf • Grazing lands mean P runoff concentration. from U.S. Dept. of Agriculture MANAGE database, average of values for no grazing-light grazing-moderate grazing land uses. • Forest N and P runoff concentration: used STEPL default values
Nutrient concentration in shallow groundwater (mg/L).	Valley floor (ag and urban) NO3-N = 12.7 P = 0.127 Grazing Lands (range) NO3-N = 1.44 P = 0.063 Forest NO3-N = 0.11 P = 0.009	• NO3-N (ag and urban) – mean value for project area using USGS GWAVA model dataset • P – (ag and urban) mean value of project area data from USGS NURE dataset • Grazing Lands (range) and Forest N and P default values from STEPL

5.1.1 Urban Runoff

Urban runoff can be a contributor of nutrients to waterbodies. USEPA policy explicitly specifies NPDES-regulated urban stormwater discharges are point source discharges and, therefore, must be addressed by the WLA component of a TMDL.[52] 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, grass clippings, organic debris from gardens and other greenwaste, 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 is a wealth of data, both nationwide and from the central coast region, that have characterized nitrate-nitrogen concentrations in urban runoff (see Figure 5-1). These data (438 total samples) illustrate that nitrate concentrations in urban runoff virtually never exceed the 10 mg/L MUN regulatory standard[53] and rarely exceed the proposed 8.0 mg/L (wet season) nitrate water quality targets proposed TMDL project area waterbodies. In fact, the central coast-specific urban runoff data (Santa Cruz and Monterey County) shown in Figure 5-1 infrequently exceed nitrate-N concentrations of 2 mg/L.

[52] See 40CFR 130.2(g) & (h) and USEPA Office of Water Memorandum (Nov. 2002) *"Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water Sources and NPDES Permit Requirements Based on Those WLAs"*

[53] Elevated nitrogen levels in urban runoff can, however, locally contribute to biostimulatory impairments of receiving waters where eutrophication has been identified as a water quality problem.

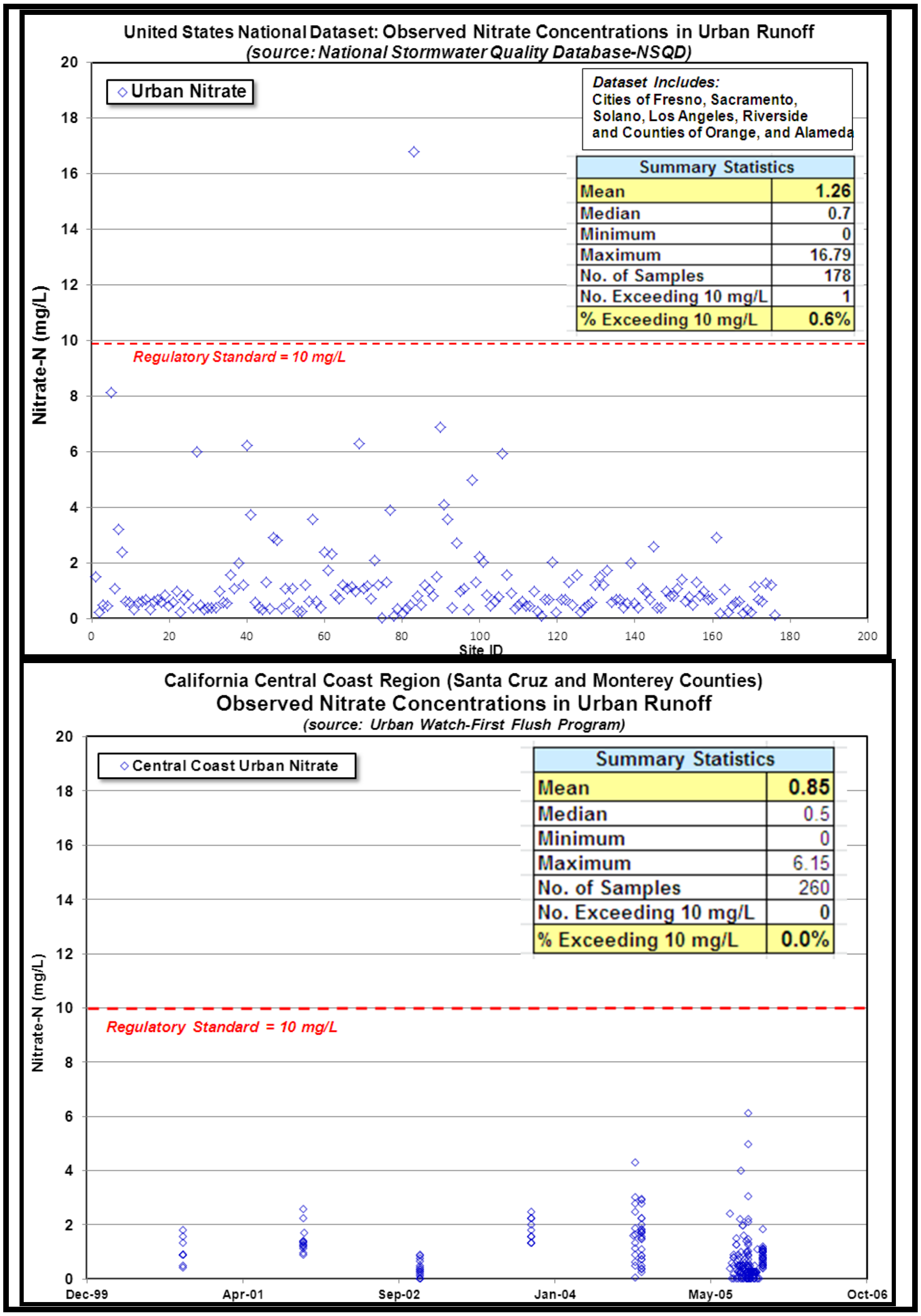


Figure 5-1. Nitrate concentration in urban runoff: national, California, and central coast regional data.

Figure 5-2 shows event mean concentration data for dissolved phosphorus from various municipal land use categories[54]. Dissolved phosphorus levels are elevated well above USEPA ecoregional ambient criteria of 0.03 mg/L total phosphorus (see Appendix A, Table A-4) and are also above the proposed dry season orthophosphate target of 0.19 mg/L (see Table 4-1) for Santa Maria River waterbodies. In particular, for this Los Angeles county dataset, transportation and single-family residential land use categories are typically the highest sources of phosphorus loads.

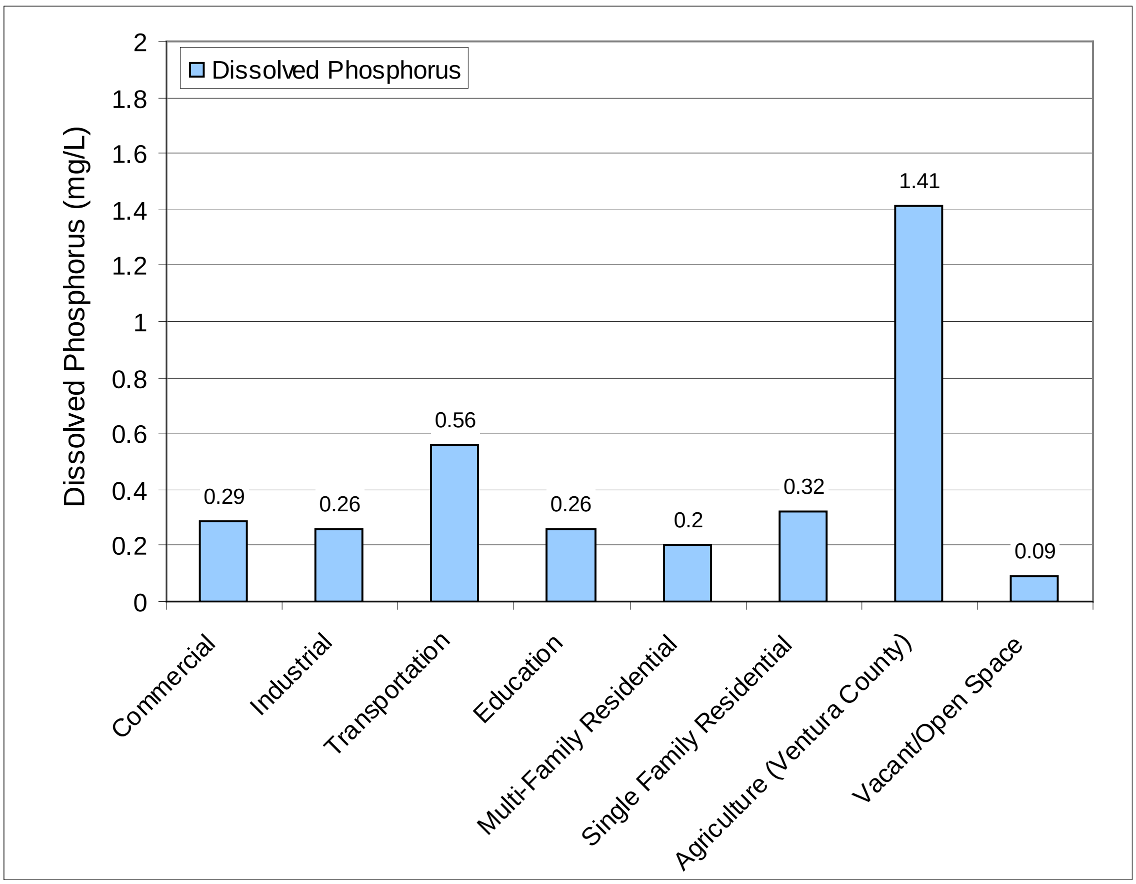


Figure 5-2. Dissolved phosphorus runoff event mean concentration data for municipal land use categories, Los Angeles and Ventura counties.
Source: Geosyntec Consultants, 2008. Technical Appendix C

In summary, this preceding information indicates that nitrate concentrations in urban runoff are generally below applicable Basin Plan nitrate water quality criteria (10 mg/L), as well as the proposed dry season nitrate target of 4.3 mg/L (see Figure 5-1). On the other hand, event mean concentration data for dissolved phosphorus indicated that discharges from urban runoff may exceed proposed dry season numeric targets.

[54] Geosyntec Consultants, 2008. Structural BMP Prioritization and Analysis Tool, Appendix C.

Using the average concentration of nitrogen in urban runoff used in this project report was derived from Shaver et al. (2007) taking a mean of nitrogen-N in runoff from the cities of San Diego, Phoenix, Boise, and Denver = 4.0 mg/L nitrogen-N. Average concentration of phosphorus-P in urban runoff used in this project report is taken from SCCWRP (2000) = 0.53 mg/L phosphate-P.

Using the parameter inputs identified in Section 5.1 the estimated annual nutrient load from urban runoff in the project area as calculated by STEPL is shown in Table 5-2.

Table 5-2. Urban Annual Load (lbs./year)

	Oso Flaco Lake Subwatershed		**Lower Santa Maria River Subwatershed**	
Source	**N Load (lb/yr)**	**P Load (lb/yr)**	**N Load (lb/yr)**	**P Load (lb/yr)**
Urban	3,343	516	165,003	25,450

5.1.2 Cropland

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 5-3 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[55].

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

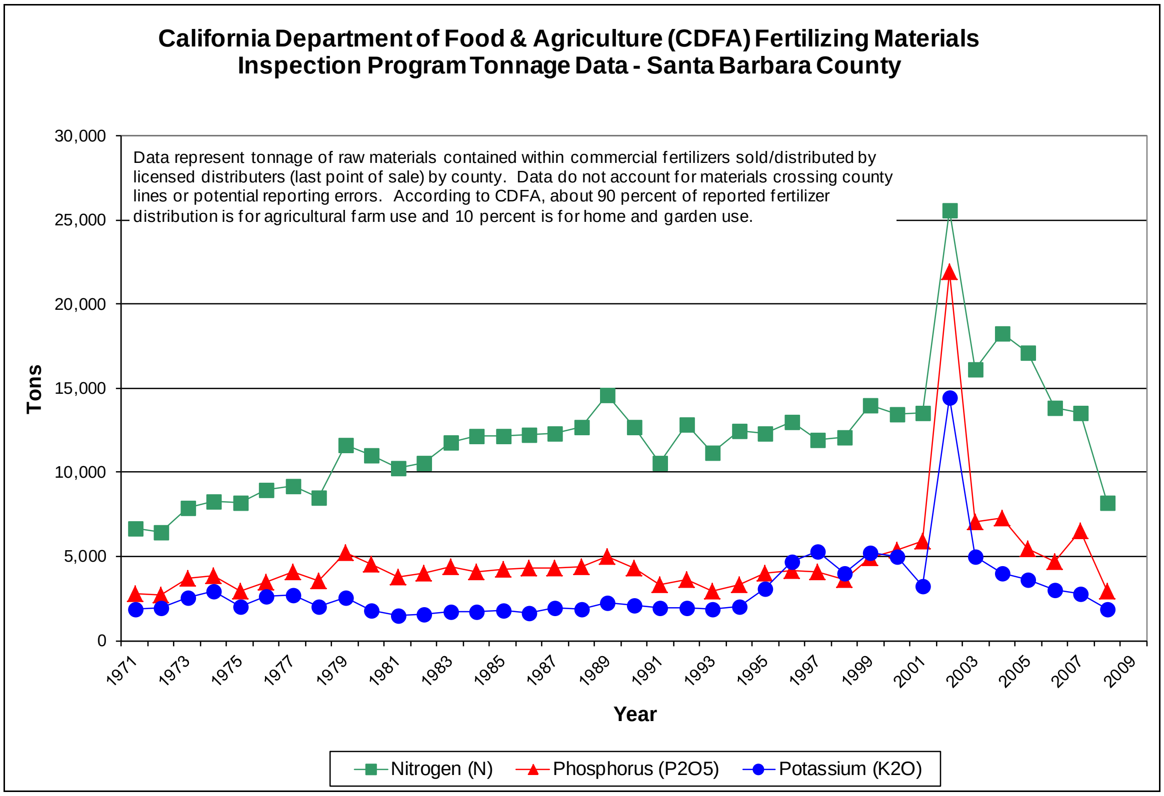


Figure 5-3. Fertilizer sales in Santa Barbara County.

California fertilizer application rates on specific crop types are available from the U.S. Department of Agriculture, National Agricultural Statistics Service, as shown in Table 5-3 and Figure 5-4.

Table 5-3. 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
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

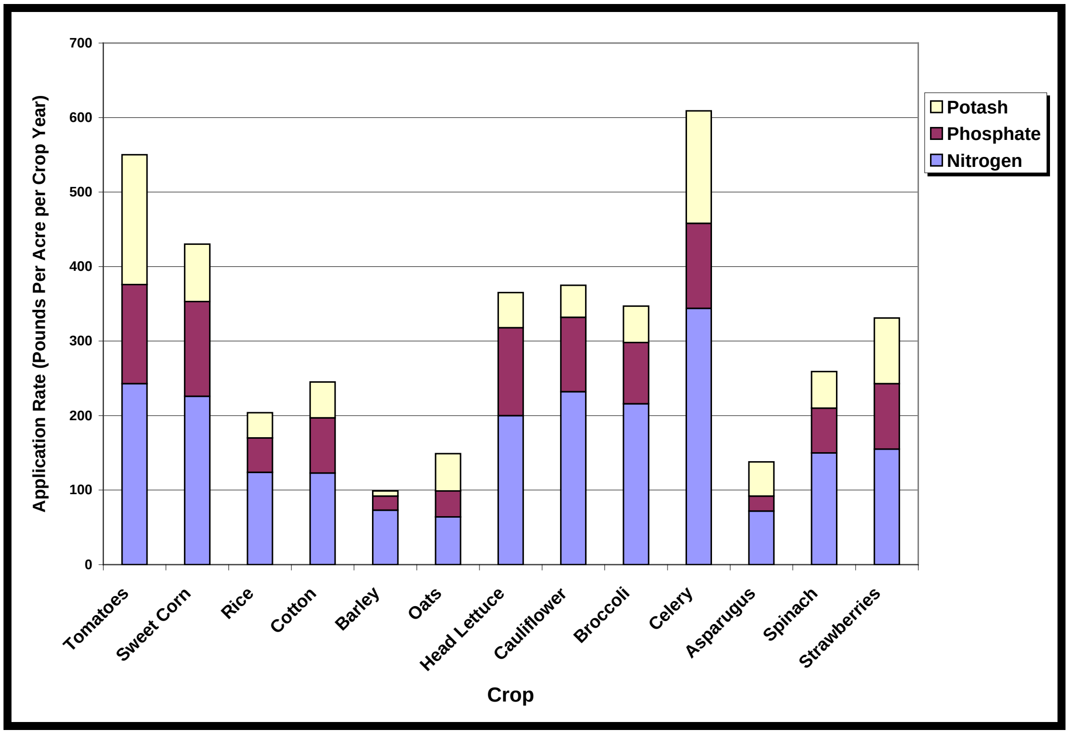


Figure 5-4. California fertilizer application rates on crops (source: USDA-NASS, 2004-2008).

Based on staff observations in the project area, cropland the lower Santa Maria valley is largely comprised of lettuce, broccoli, cole crops, and strawberries. These types of crops typically require the application of relatively larger amounts of fertilizer relative to other types of crops (e.g., grain and field crops), as previously shown in Figure 5-4.

Estimates for the average concentration of nitrogen in agricultural runoff used in this project report was derived using two data sources: SCCWRP (2000) and the U.S. Department of Agricultural-Agricultural Research Service's MANAGE database.[56] An average of the SCCWRP nitrogen runoff concentration estimate (13.8 mg/L) and the MANAGE database runoff mean (9.0 mg/L) for vegetable crops[57] is equivalent to 11.4 mg/L nitrogen-N, as illustrated in Figure 5-5. Average concentration of phosphorus-P in agricultural runoff used in this project report is taken from the aforementioned SCCWRP (2000) report = 0.64 mg/L phosphate-P.

[56] Manage Nutrient Database - Nutrient Loss Database for Agricultural Fields in the US. The primary objective of this effort was to compile measured annual nitrogen (N) and phosphorus (P) load and concentration data representing field-scale transport from agricultural land uses. http://www.ars.usda.gov/Research/docs.htm?docid=11079

[57] Vegetable crops are the dominant type of crop cover in the TMDL project area.

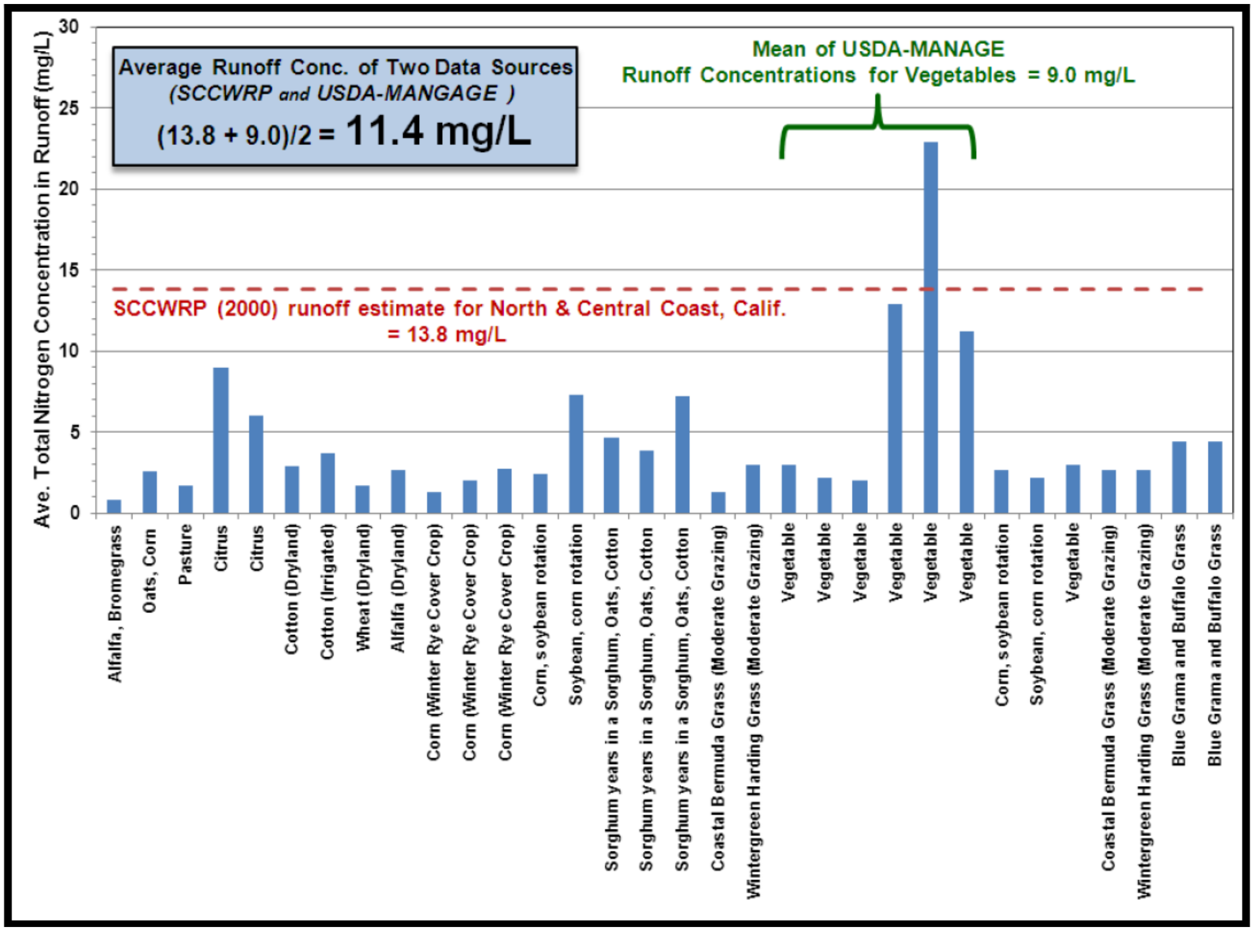


Figure 5-5. Average nitrogen-N concentrations in agricultural lands runoff.

The estimated annual nutrient load from cropland in the project area as calculated by STEPL is shown in Table 5-4.

Table 5-4. Cropland annual load (lbs./year).

	Oso Flaco Lake Subwatershed		**Lower Santa Maria River Subwatershed**	
Source	**N Load (lb/yr)**	**P Load (lb/yr)**	**N Load (lb/yr)**	**P Load (lb/yr)**
Cropland	325,455	21,128	2,254,167	146,334

5.1.3 Grazing Lands

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). Also, animal waste associated with confined animals (feedlots, dairies, etc.) can constitute a potential significant source of nutrient loads to surface waters. Unregulated or poorly managed confined animal facilities on a unit area basis (e.g., per acre) can typically be a higher pollutant loading risk than lightly grazed rangeland. It is important to recognize that many of these confined animal facilities will be located on the valley floor in the farmland land-use category. As such, nitrogen loading from domestic animal manure is also a component of the "cropland" load fraction in Section 5.1.2.

The estimated annual nutrient load from grazing lands in the project area as calculated by STEPL is shown in Table 5-5.

Table 5-5. Grazing lands annual load (lbs./year).

	Oso Flaco Lake Subwatershed		**Lower Santa Maria River Subwatershed**	
Source	**N Load (lb/yr)**	**P Load (lb/yr)**	**N Load (lb/yr)**	**P Load (lb/yr)**
Grazing Lands	9	8	38,395	34,599

5.1.4 Forest and Undeveloped Lands

The estimated annual nutrient load from forest in the project area as calculated by STEPL is shown in Table 5-6.

Table 5-6. Forest annual load (lbs./year).

	Oso Flaco Lake Subwatershed		**Lower Santa Maria River Subwatershed**	
Source	**N Load (lb/yr)**	**P Load (lb/yr)**	**N Load (lb/yr)**	**P Load (lb/yr)**
Forest	429	212	8,821	4,368

5.1.5 Onsite Disposal Systems (OSDS)

The estimated annual nutrient load from OSDS (i.e., septic systems) to surface waters in the project area as calculated by STEPL is shown in Table 5-7. This estimate is based on data contained data as reported in Santa Maria River Watershed Fecal Coliform TMDL, which estimates approximately 28 OSDS within the Nipomo Creek subwatershed. 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 relatively insignificant as compared to agricultural fertilizer impacts (University of California-Davis, 2012).

Table 5-7. OSDS annual load (lbs./year).

	Oso Flaco Lake Subwatershed		Lower Santa Maria River Subwatershed	
Source	**N Load (lb/yr)**	**P Load (lb/yr)**	**N Load (lb/yr)**	**P Load (lb/yr)**
OSDS	0	0	17	7

5.1.6 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 nutrient sources during dry periods. Ground water contamination from nutrients can occur from various sources, including septic systems, fertilizer application, animal waste, waste-lagoon sludge, and soil mineralization (USEPA, 1999). In addition, groundwater has a natural, ambient background load of nitrogen and phosphorus. Note that controllable phosphorus leaching to groundwater is presumed to be negligible in this project report; phosphorus readily binds to sediment, is relatively insoluble, and is generally not expected to be leached to groundwater from surface sources in significant amounts. Phosphorus in groundwater is generally expected to result from leaching of aquifer minerals in the subsurface.

The estimated annual nutrient load from groundwater to surface waters in the project area as calculated by STEPL is shown in Table 5-8.

Table 5-8. Groundwater annual load (lbs./year).

	Oso Flaco Lake Subwatershed		Lower Santa Maria River Subwatershed	
Source	**N Load (lb/yr)**	**P Load (lb/yr)**	**N Load (lb/yr)**	**P Load (lb/yr)**
Groundwater	308,054	3,108	2,521,119	32,353

5.1.7 Atmospheric Deposition

Input of nutrients in rainfall may be a significant source of loading. Because nitrogen can exist as a gaseous phase (while phosphorus cannot), nitrogen is more prone to atmospheric transport and deposition. It is important to recognize however that atmospheric deposition of nutrients is typically more significant in lakes and reservoirs, than in creeks or streams (USEPA, 1999). This is because the surface area of a stream is typically small compared to the area of a watershed. Atmospheric deposition of nutrients to project area surface waterbodies was estimated using estimates of the surface area of all surface waterbodies in the project area (estimated from NHDplus flowline data); wet deposition of inorganic nitrogen from USGS raster datasets available in NHDplus; and literature values of dry atmospheric deposition of nitrate-N (Rast and Lee, 1983). Atmospheric deposition rates are illustrated in Figure 5-6 and enumerated in Table 5-9.

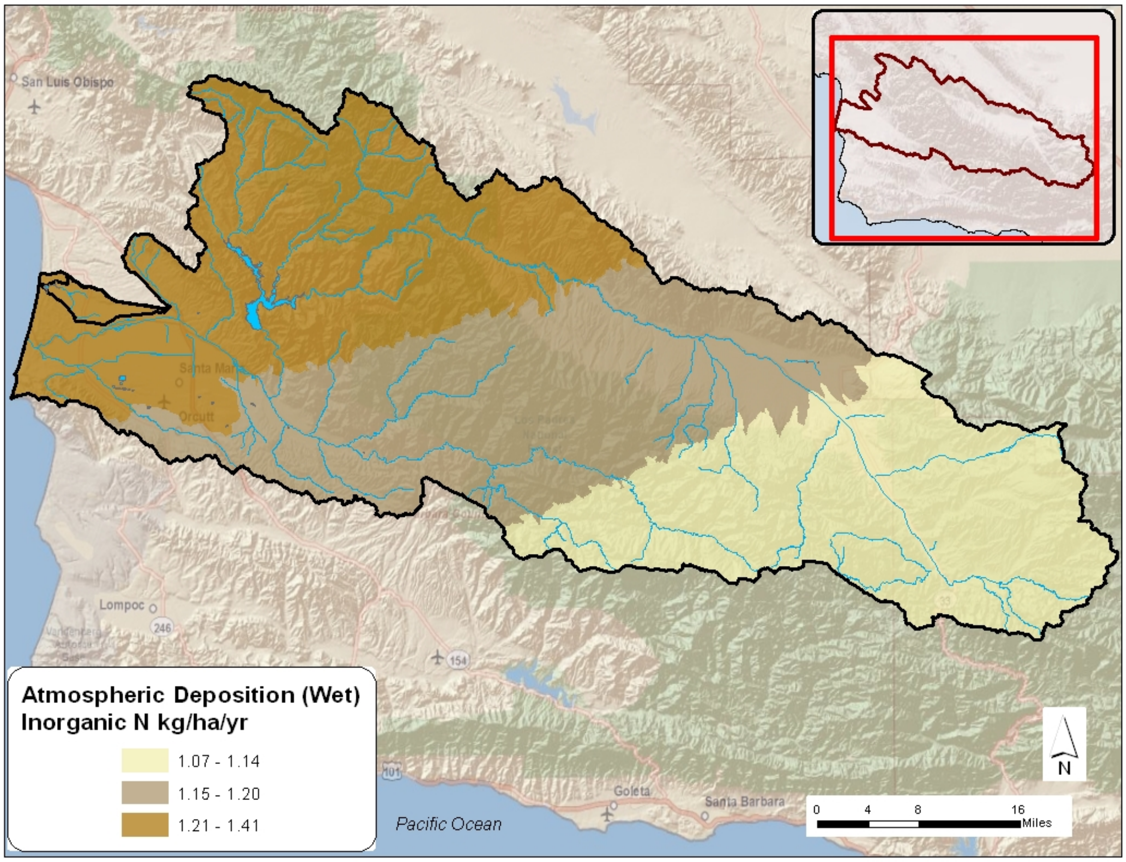


Figure 5-6. Atmospheric Deposition (Wet) Inorganic Nitrogen

Table 5-9. Atmospheric deposition rates for nitrogen (kg/ha/yr)

Atmospheric Deposition (Wet) Statistics from NHDplus GIS Database	
Mean:	1.166
Count:	2958
Range	1.07 - 1.41
Standard Deviation:	0.054
Atmospheric Deposition (Dry) from Rast and Lee (1983)	
	0.93
Atmospheric Deposition Total	
	2.1

The length of all NHDplus surface water flowlines with the Oso Flaco Lake and Lower Santa Maria River watersheds is approximately 3.71E+04 feet and 1.35E+06 feet, respectively. Assuming an average width of 5 feet, the total surface area for Oso Flaco streams is approximately 1.85E+05 square feet (1.7 hectares), while the Lower Santa Maria River watershed is approximately 6.73E+06 square feet (62.5 hectares). With an estimated combined dry and wet atmospheric deposition rate of 2.1 kg N/ha/yr, the typical annual load from atmospheric deposition would be approximately 3.6 kg N/year (8 pounds N/year) for Oso Flaco waterbodies and 131 kg N/year (289 pounds N/year) for the Santa Maria River/Sisquoc River watershed.

Atmospheric phosphorus can be found in organic and inorganic dust particles. The general atmospheric deposition rate for total phosphorus is 0.6 kg P/ha/yr (USEPA 1994, as reported in San Diego Regional Water Quality Control Board, 2006). Accordingly, using the stream surface areas presented above, the typical annual load of phosphorus would be approximately 1 kg/year (2.3 pounds P/yr) for Oso Flaco waterbodies and 37 kg/yr (83 pounds P/yr) for Santa Maria River/Sisquoc River waters (see Table 5-10).

Table 5-10. Atmospheric Deposition (lbs./year).

	Oso Flaco Lake Subwatershed		**Lower Santa Maria River Subwatershed**	
Source	**N Load (lb/yr)**	**P Load (lb/yr)**	**N Load (lb/yr)**	**P Load (lb/yr)**
Atmospheric Deposition	8	2	289	83

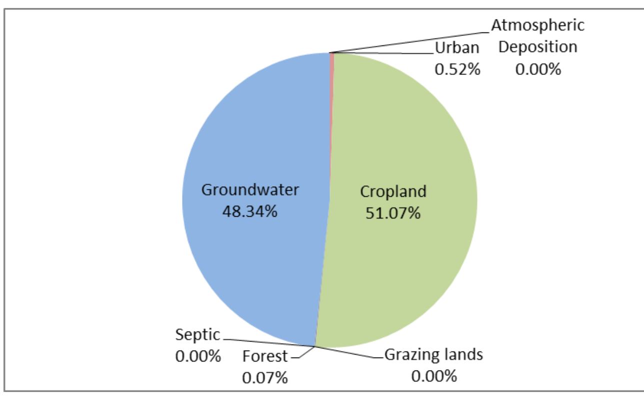
5.2 Summary of Sources

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 nutrients. It is important to recognize also that annual nutrient load estimates at the basin scale do not adequately capture the variability, magnitude, seasonality, or flow-based nature of nutrient-related impairments that occur locally.

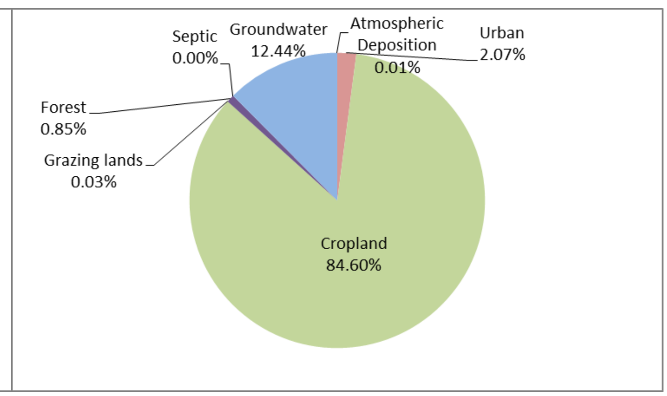
Table 5-11 and Figure 5-7 summarize estimated loads of nitrogen and phosphorus based on the information provided in Section 5 Source Analysis.

Table 5-11. Summary of Estimated Loads

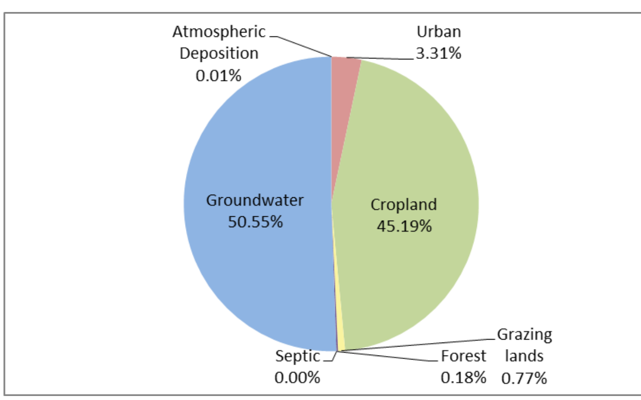
	Oso Flaco Lake Subwatershed		Lower Santa Maria River Subwatershed	
Sources	N Load (lb/yr)	P Load (lb/yr)	N Load (lb/yr)	P Load (lb/yr)
Urban	3,343	516	165,003	25,450
Cropland	325,455	21,128	2,254,167	146,334
Grazing lands	9	8	38,395	34,599
Forest	429	212	8,821	4,368
Septic	0	0	17	7
Groundwater	308,054	3,108	2,521,119	32,353
Atmospheric Deposition	8	2	289	83
Total	637,298	24,974	4,987,811	243,194



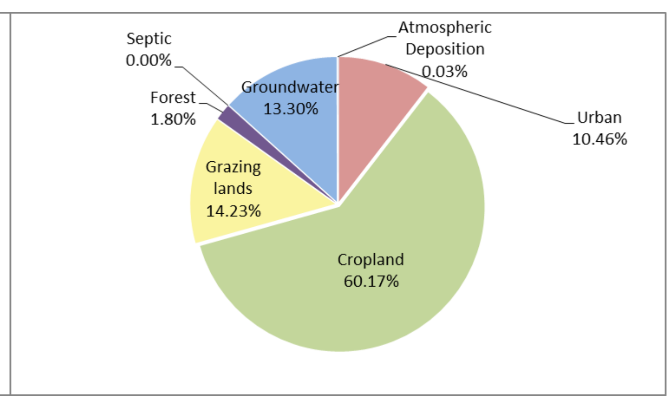
Oso Flaco Nitrate Loads



Oso Flaco Phosphorus Loads



Lower Santa Maria Nitrate Loads



Lower Santa Maria Phosphorus Loads

Figure 5-7. Summary of estimated nitrate and phosphorus loads (%)

Overall, cropland and groundwater sources are estimated to be the dominant sources of nutrient loading in the TMDL project area. It is worth reiterating that these are estimates for the TMDL project area and it is understood there will be substantial variation due to real-time conditions, as well as local and site specific conditions. It is also important to recognize that "annual" nitrate load estimates at the basin-scale do not adequately capture the variability, magnitude, or the seasonal and flow-based nature of nutrient-related impairments that may exist locally. For example, the Santa Maria River is considered a losing stream with no flow during most of the year; therefore, surface water nutrient loads originating upstream from this recharge zone (approximately between Bonita School Road and Suey Creek) are transferred as groundwater loads. As a result, these upstream nutrient loads are essentially lost to the aquifer and not readily expressed as surface water nutrient loads that may be observed or quantified at locations further downstream. Table 5-12 summarizes estimated annual nutrient loads and yields by subwatershed based on the STEPL results.

Table 5-12. Estimated average annual nutrient loads and yields by subwatershed.

	Land Cover (acres)				Predicted Nutrient Loads (lbs./yr)		Predicted Nutrient Yields (lbs./acre/yr)	
Subwatershed	Urban	Cropland	Grazing Lands	Forest-Undev.	Predicted N Load	Predicted P Load	Predicted Annual N Yield	Predicted Annual P Yield
Betteravia Area	5,197	2,733	1,569	703	343,930	18,703	33.7	1.8
Blosser Street	1,900	0	0	66	45,514	3,296	23.1	1.7
Bradley Channel	913	5,723	390	379	466,362	19,018	63.0	2.6
Bradley Cyn	0	3,712	2,652	1,318	301,208	13,779	39.2	1.8
Corralitos Cyn	0	184	2,751	0	28,139	3,112	9.6	1.1
Greene Cyn	2,622	11,100	1,020	552	926,071	38,562	60.5	2.5
Guadalupe Area	166	1,694	0	0	134,882	5,317	72.5	2.9
Guadalupe Dunes	0	29	1,252	9,896	15,542	3,368	1.4	0.3
Ineffective WA	4	899	2,869	409	84,322	5,438	20.2	1.3
Main Street	1,057	2,515	0	33	219,695	9,302	60.9	2.6
Nipomo Cr	578	7,620	4,674	516	626,681	28,102	46.8	2.1
Oso Flaco	324	8,135	11	1,134	637,289	24,972	66.3	2.6
Orcutt Cr	2,051	4,567	15,417	1,643	481,080	31,831	20.3	1.3
Santa Maria R	1,451	14,945	13,019	3,550	1,257,938	59,787	38.2	1.8
Santa Maria R Channel	59	626	667	4,276	56,159	3,496	10.0	0.6

5.2.1 Comparison of STEPL Predicted Loads to Observed Loads

As a preliminary validation of the STEPL annual load calculations, staff estimated annual loads from water quality monitoring data.

Monitoring site 312SMA (Santa Maria River above Estuary) represents the downstream drainage outlet of the TMDL project area as it drains into Santa Maria River Estuary. Water quality data and flow data are available for this site to approximate average annual loads for comparison with STEPL load estimates. It is important to note that while nitrogen as nitrate is not directly comparable to total nitrogen (total N as calculated by STEPL); nonetheless nitrate is generally the largest fraction of nitrogen species in aquatic environments[58] and presents an opportunity for a screening assessment of the reasonableness of total nitrogen loads as estimated by STEPL.

Mean annual loads were estimated using a simple averaging technique where the annual load is calculated as the average concentration of samples multiplied by the mean annual flow. For this screening assessment, the mean annual flow at 312SMA is estimated using USGS NHDPlus mean annual flow value (see Section 6.2.1). Using appropriate conversion factors the estimated mean annual nitrogen as nitrate load at the Santa Maria River outlet is:

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

Nitrate Load (lbs/day) = 61.98 * 5.394 * 28.3
= 9,461

Nitrate Load (lbs/yr) = 9,461 * 365
= 3,453,121

Table 5-13. Estimated mean annual flows and mean concentrations at Santa Maria River outlet.

Water body	Mean Annual Flow (cfs) *source: USGS* 11141000	Number of NO3-N Samples	Mean NO3-N Concentration (mg/L)
Santa Maria River above Estuary (312SMA)	62	129	28.3

Using the sum of STEPL predicted loads for project area watersheds (except for Guadalupe Dunes and Ineffective Watershed Area subwatersheds, as these do not drain to 312SMA) shown in Table 5-13, a comparison of STEPL estimated mean annual load to the estimated annual load for nitrate is shown in Figure 5-8, suggesting that the project area nitrate loads calculated by STEPL are approximate to observed water quality monitoring data loads in Lower Santa Maria River. As noted earlier, it can be expected that STEPL estimated annual

[58] A cursory evaluation of CCAMP data (through 2006) for the entire central coast region indicates that for water quality samples having >0.5 mg/L total nitrogen, the nitrate (as N) component constitutes on average (median value) 76.2% of the total nitrogen in the water quality sample. Also, in approximately 30% of water quality samples the nitrogen as nitrate component constitutes 90% or greater of the total nitrogen in the sample.

loads may not be expressed at downstream locations due to losses to groundwater.

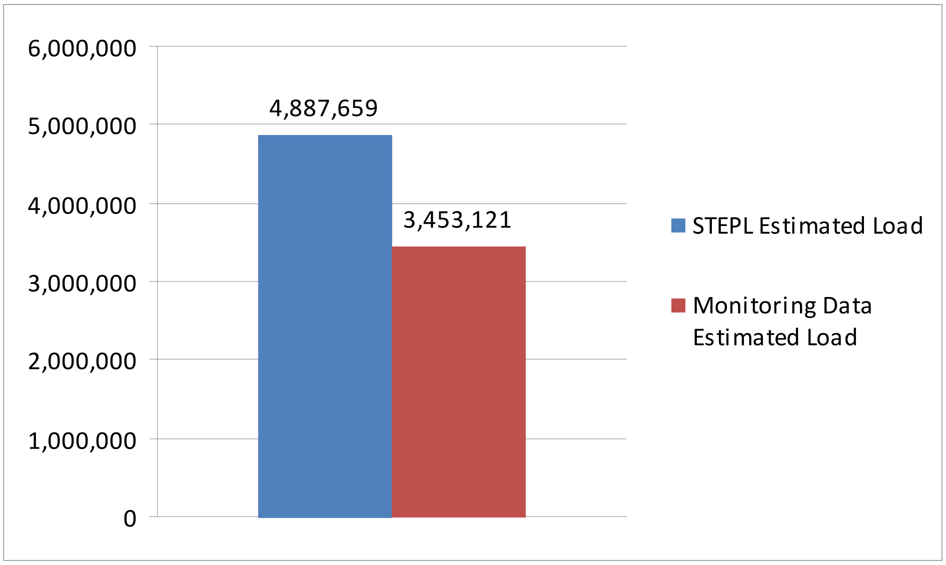


Figure 5-8. Comparison of STEPL predicted nitrogen loads (lbs/yr) to 312SMA monitoring data loads.

Staff performed an additional comparison of STEPL predicted loads using data for the Oso Flaco Lake watershed. The California Department of Parks and Recreation (State Parks) funded a sediment and turbidity study of Oso Flaco Lake and Oso Flaco Creek (report pending). The study began in April 2010 and will conclude in late 2012. Staff obtained preliminary provisional data that included hourly flow data and periodic nitrate grab sample results. Using this flow and nutrient data staff used the FLUX computer program[59] to estimate annual flow into Oso Flaco Lake and annual nitrate loads for a one year period beginning October 2010 (see Appendix D). For this one-year period the total inflow into Oso Flaco Lake was calculated as 9.09 hm^3 (cubic hectometers) or 7,369 acre feet. Using nitrate nitrogen grab sample data collected during the study (n=51), FLUX estimated a nitrogen load of 224,624 kg/yr (495,211 lbs/yr).

A comparison of the estimated mean annual load to the estimated annual load for total nitrogen is shown in Figure 5-9, suggesting that the project area nitrogen loads calculated by STEPL appear to approximate the estimated loads derived using the Oso Flaco Lake FLUX model.

[59] Walker, William, W., "Empirical Methods for Predicting Eutrophication in Impoundments - Report 2: Model Testing", prepared for Office, Chief of Engineers, U.S. Army, Washington, D.C., Technical Report E-81-9, U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi, September 1982.

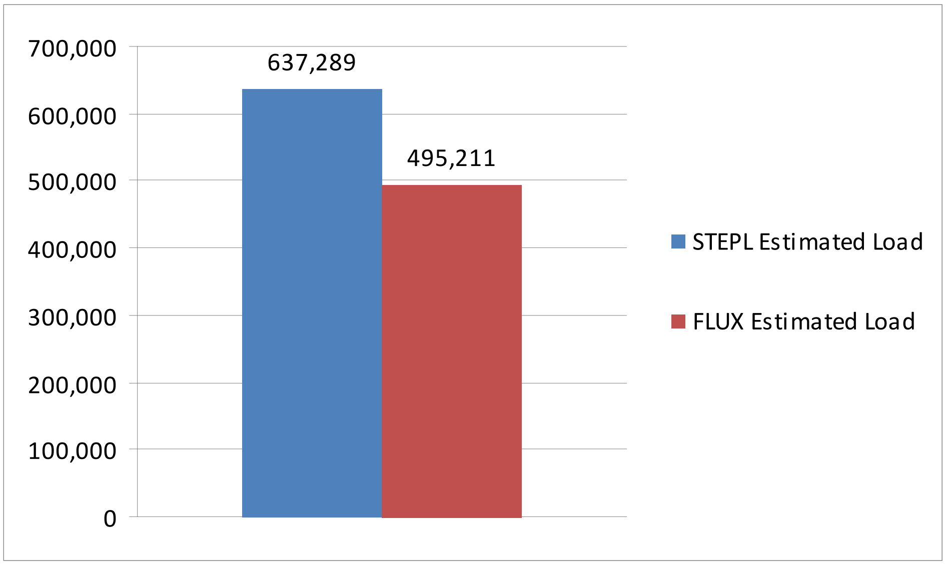


Figure 5-9. Comparison of STEPL predicted nitrogen loads (lbs/yr) to Oso Flaco Lake FLUX estimated loads.

6 TOTAL MAXIMUM DAILY LOAD AND ALLOCATIONS

6.1 Introduction

The TMDL represents the loading capacity of a water body—the amount of a pollutant that the water body can assimilate and still support beneficial uses. The TMDL is the sum of allocations for nonpoint and point sources and any allocations for a margin of safety. TMDLs are often expressed as a mass load of the pollutant but can also be expressed as a unit of concentration (40 CFR 130.2(i)).

The TMDLs for nitrate, orthophosphate, and unionized ammonia for project areas waterbodies are set at a maximum concentrations (numeric targets) in receiving water as previously presented in Section 4. The TMDL allocations, which include background levels, are also equal to the numeric targets. Expressing the TMDL as a nitrate concentration equal to the water quality objectives and numeric targets provides a direct measure of the nitrogen compounds and orthophosphate levels in the watershed to compare with water quality objectives and provides a measurable target for sources to monitor and with which to comply. Requiring the responsible parties for nitrogen compounds and orthophosphate loading to reduce nitrate discharges to the numeric water quality objectives and targets will establish a direct link between the TMDL target and sources.

Load allocations for nitrogen compounds and orthophosphate are assigned to each source, including background. This allocation will require a reduction of existing loads by cropland landowners and operators, and MS4 stormwater entities.

Owners/operators of domestic animals and grazing animals are given an allocation, which is presumed to be equal to the existing load from this source category. At this time, this source category appears to be in compliance with their load allocation, consequently there are no additional requirements for owners/operators of domestic animals. It is important to note that Santa Maria River Watershed is in fact subject to the Domestic Animal Waste Discharge Prohibition (Water Quality Control Plan for the Central Coast Basin, Chapter 5. IV. Discharge Prohibitions), and owners/operators of domestic animals are subject to compliance with an approved indicator bacteria TMDL load allocation. Implementation efforts by responsible parties to comply with this prohibition and indicator bacteria load allocation will, as a practical matter, also reduce the risk of nitrogen and phosphorus loading to surface waters from domestic animal waste.

6.2 Existing Loading and Loading Capacity

6.2.1 Estimates of Existing Loading

Existing mean annual and dry season (May 1 – Oct 31) loads were estimated using a simple averaging technique where the load is calculated as the average concentration of samples multiplied by the mean flow. Staff used the following flow data to estimate mean annual and mean dry season flows for streams within the project area:

- USGS gage station data.
- Continuous flow data as reported in *Final Follow-Up Water Quality Monitoring Report: Continuous Monitoring of Flows,* Cooperative Monitoring Program (CMP), dated August 14, 2009. Flow data from April to December 2008.
- Mean annual flow estimates from USGS's high resolution National Hydrography Dataset Plus (NHDplus) [60].
- Instantaneous flow data from the Central Coast Ambient Monitoring Program (CCAMP) and Cooperative Monitoring Program (CMP). Flow data period varies, but generally from 2005 to 2008.

Estimated annual and dry season (May 1 to October 31) mean flows are summarized in Table 6-1 and depicted in Figure 6-1 and Figure 6-2, respectively.

[60] The NHDPlus Version 1.0 is (2005) was created by the U.S. Environmental Protection Agency and the U.S. Geological Survey as an integrated suite of application-ready geospatial data sets that incorporate many of the best features of the National Hydrography Dataset (NHD) and the National Elevation Dataset (NED). The NHDPlus includes a stream network (based on the 1:100,000-scale NHD), improved networking, naming, and "value-added attributes" (VAA's).

Table 6-1. Summary of Estimated Mean Flows (cfs) for Project Area streams.

		CCAMP/CMP Flow Data [A]				CMP Flow Study [B]	NHDPlus [C]	USGS [D]	
Water body	Site ID	Sample Count	Mean Flow (cfs)	Dry Season Count	Dry Season Mean Flow (cfs)	Mean Flow (cfs)	Mean Annual Flow (cfs)	Mean Annual Flow (cfs)	Dry Season Mean Flow (cfs)
Santa Maria River	312SMA	133	22.90	61	**9.95**		**61.98**		
	312SMI	31	71.01	13	0.17		53.25	**29.90**	**0.54**
Orcutt Creek	312ORC	82	12.76	39	**7.72**	**7.2**	7.21		
	312GVT	15	1.04	5	**1.36**		**4.08**		
	312ORB	29	1.31	11	0.33			**2.35**	**0.21**
Green Valley Creek	312GVS	95	1.78	44	**1.10**	**0.89**	1.58		
Main Street Canal	312MSD	82	**3.86**	37	**0.69**				
Blosser Channel	312BCD	14	**1.44**	4	**0.41**				
Bradley Channel	312BCU	14	**0.49**	5	**0.20**				
	312BCJ	75	**4.20**	38	**0.78**				
Nipomo Creek	312NIP	10	0.70	2	**0.0015**		**0.36**		
Bradley Canyon Creek	312BCC	38	0.97	20	**0.19**		**0.17**		
Little Oso Flaco Creek	312OFN	88	**1.68**	43	**0.87**				
Oso Flaco Creek	312OFC	88	4.09	44	**2.63**	**2.44**			

Note: Values indicated in **bold** are used to estimate mean annual and mean dry season nitrate loads, loading capacities under TMDL conditions, and percent reduction goals as presented in this Section.

[A] Monitoring program instantaneous measurements (Central Coast Ambient Monitoring Program/Cooperative Monitoring Program).
[B] Continuous Monitoring of Flows, CMP 2009.
[C] NHDPlus mean annual flow using Unit Runoff Method.
[D] USGS gage data for Santa Maria River at Guadalupe [USGS 11141000 (1940-1980), same location as CCAMP 312SMI] and Orcutt Creek near Orcutt [USGS 11141050 (1983-2011), same location as CCAMP 312ORB].

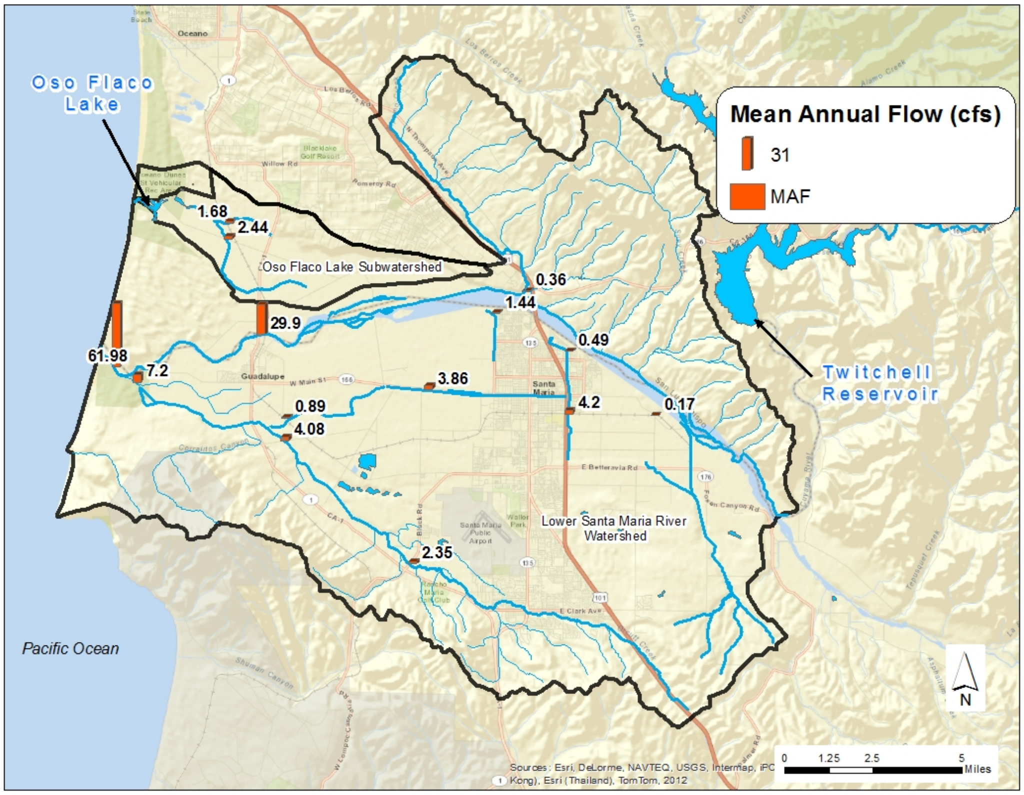


Figure 6-1. Estimated mean annual flow (cfs).

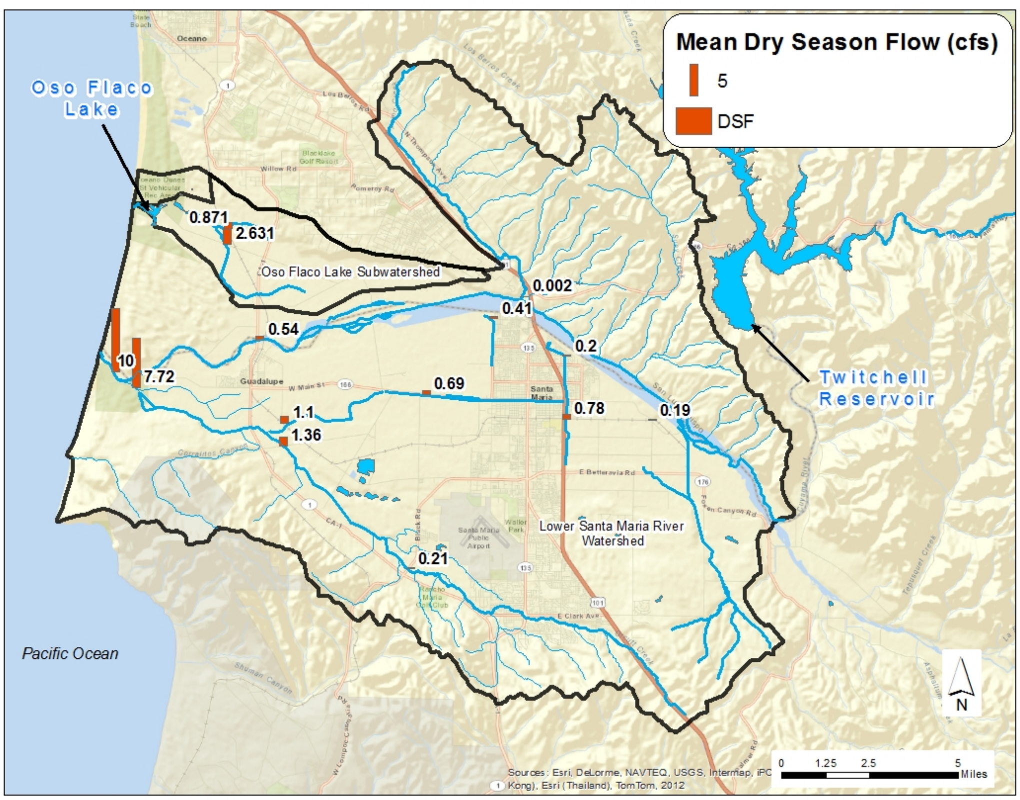


Figure 6-2. Estimated mean dry season (May-Oct) flow (cfs).

Based on the estimated flow data presented above, staff has concluded that a majority of mean annual flow observed above the Santa Maria River Estuary (61.98 cfs at 312SMA) are attributable to inflow from the Santa Maria River (30 cfs at 312SMI). However, during the dry season (May 1 to Oct. 31), mean flow observed above the Santa Maria River Estuary (10 cfs at 312SMA) is almost exclusively derived from Orcutt Creek inflows (7.7 cfs at 312ORC).

Staff used CCAMP/CMP water quality monitoring data and the flow data presented above to calculate mean concentrations and derive the estimated loads. Table 6-2 presents a tabulation of estimated mean annual nitrate-N loads, loading capacity under TMDL conditions, and percent reduction goals for project area waterbodies. Figure 6-3 graphically portrays the estimated mean annual nitrate loads.

Table 6-2. 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)
Santa Maria River	312SMA	61.98	28.3	3,453,121	976,147	72%	Wet Season Biostim (8.0)
	312SMI	29.90	30.8	1,813,117	588,674	68%	MUN (10)
Orcutt Creek	312ORC	7.20	35.5	503,228	113,403	77%	Wet Season Biostim (8.0)
	312GVT	4.08	36.4	292,726	64,335	78%	Wet Season Biostim (8.0)
	312ORB	2.35	13.5	62,574	37,081	41%	Wet Season Biostim (8.0)
Green Valley Creek	312GVS	0.89	54.7	95,848	14,018	85%	Wet Season Biostim (8.0)
Main Street Canal	312MSD	3.86	21.6	164,303	76,066	54%	MUN (10)
Blosser Channel	312BCD	1.44	5.4	15,308	28,348	0%	MUN (10)
Bradley Channel	312BCU	0.49	11.9	11,460	9,630	16%	MUN (10)
	312BCJ	4.20	19.6	162,181	82,746	49%	MUN (10)
Nipomo Creek	312NIP	0.36	1.2	850	7,082	0%	MUN (10)
Bradley Canyon Creek	312BCC	0.17	11.0	3,602	2,620	27%	Wet Season Biostim (8.0)
Little Oso Flaco Creek	312OFN	1.68	41.0	135,853	18,887	86%	Year-Round (5.7)
Oso Flaco Creek	312OFC	2.44	38.6	185,430	27,382	85%	Year-Round (5.7)

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

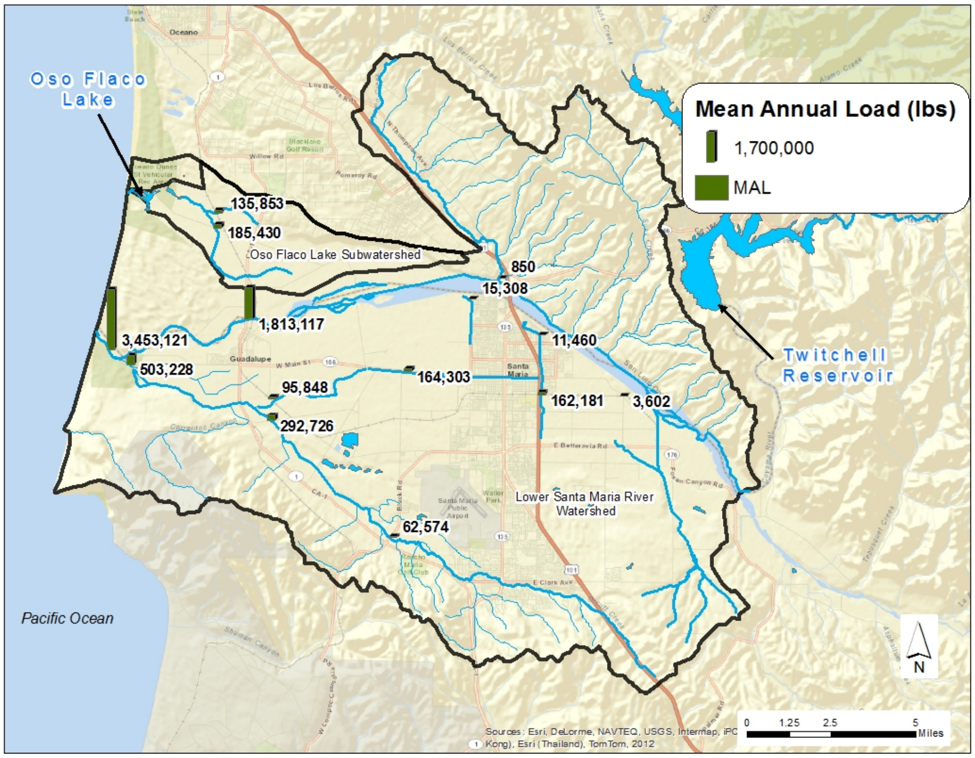


Figure 6-3. Estimated mean annual nitrate-N load (lbs.).

Table 6-3 is a tabulation of estimated mean dry season (May 1 to Oct. 31) nitrate-N loads, loading capacity under dry season TMDL conditions, and percent reduction goals. Figure 6-4 graphically portrays the estimated mean dry season nitrate-N loads.

Table 6-3. Estimated mean dry season nitrate-N loads, loading capacities, and percent reduction goals.

Water body	Site ID	Estimated Mean Dry Flow (cfs)	Mean Dry Season Conc. (mg/L)	Est. Existing Mean Dry Load (lbs.)	Mean Dry Loading Capacity (lbs.)	% Reduction Goal [A]	NO3-N Numeric Target Used for Loading Capacity (mg/L)
Santa Maria River	312SMA	10.00	28.84	567,709	84,659	85%	Dry Season Biostim (4.3)
	312SMI	0.54	34.42	36,589	10,632	71%	MUN (10)
Orcutt Creek	312ORC	7.72	32.8	497,833	65,357	87%	Dry Season Biostim (4.3)
	312GVT	1.36	41.00	109,781	11,514	90%	Dry Season Biostim (4.3)
	312ORB	0.21	16.0	6,600	1,778	73%	Dry Season Biostim (4.3)
Green Valley Creek	312GVS	1.10	54.43	117,873	9,312	92%	Dry Season Biostim (4.3)
Main Street Canal	312MSD	0.69	18.82	25,560	13,585	47%	MUN (10)
Blosser Channel	312BCD	0.41	2.60	2,096	8,072	0%	MUN (10)
Bradley Channel	312BCU	0.20	15.93	6,273	3,938	37%	MUN (10)
	312BCJ	0.78	33.26	51,079	15,357	70%	MUN (10)
Nipomo Creek	312NIP	0.002	0.35	1	39	0%	MUN (10)
Bradley Canyon Creek	312BCC	0.19	6.66	2,491	1,609	0%	Dry Season Biostim (4.3)
Little Oso Flaco Creek	312OFN	0.87	36.39	62,378	9,772	84%	Year-Round (5.7)
Oso Flaco Creek	312OFC	2.63	33.32	172,622	29,530	83%	Year-Round (5.7)

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

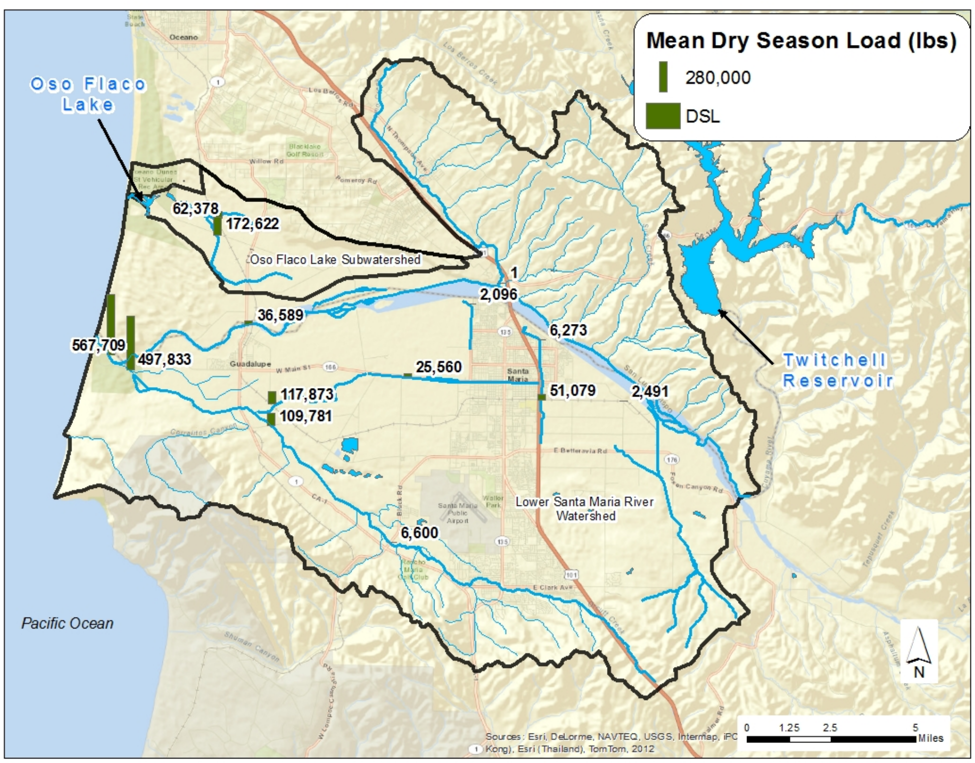


Figure 6-4. Estimated mean dry season (May-Oct) nitrate-N loads.

Staff also estimated mean annual and mean dry season orthophosphate-P loads, loading capacities under TMDL conditions, and percent reduction goals as tabulated in Table 6-4 and Table 6-5, respectively.

Table 6-4. Estimated mean annual orthophosphate-P loads, loading capacities, and percent reduction goals.

Water body	SiteID	Estimated Mean Annual Flow (cfs)	Mean Annual Conc. (mg/L)	Est. Existing Mean Annual Load (lbs.)	Mean Annual Loading Capacity (lbs.)	% Reduction Goal	Orthophosphate-P Numeric Target Used for Loading Capacity (mg/L)
Santa Maria River	312SMA	61.98	0.295	35,995	36,606	0%	Wet Season Biostim (0.3)
	312SMI	29.90	0.284	16,737	17,660	0%	Wet Season Biostim (0.3)
Orcutt Creek	312ORC	7.20	0.344	4,876	4,253	13%	Wet Season Biostim (0.3)
	312GVT	4.08	0.306	2,461	2,413	2%	Wet Season Biostim(0.3)
	312ORB	2.35	0.648	3,004	1,391	54%	Wet Season Biostim (0.3)
Green Valley Creek	312GVS	0.89	0.195	342	526	0%	Wet Season Biostim(0.3)
Bradley Canyon Creek	312BCC	0.17	1.474	483	98	80%	Wet Season Biostim (0.3)
Little Oso Flaco Creek	312OFN	1.68	0.139	461	265	42%	Year-Round (0.08)
Oso Flaco Creek	312OFC	2.44	0.257	1,235	384	69%	Year-Round (0.08)

Table 6-5. Estimated mean dry season orthophosphate-P loads, loading capacities, and percent reduction goals.

Water body	SiteID	Estimated Mean Dry Flow (cfs)	Mean Dry Season Conc. (mg/L)	Est. Existing Mean Dry Load (lbs.)	Mean Dry Loading Capacity (lbs.)	% Reduction Goal	Orthophosphate-P Numeric Target Used for Loading Capacity (mg/L)
Santa Maria River	312SMA	10.00	0.310	6,106	3,741	39%	Dry Season Biostim (0.19)
	312SMI*	0.54	0.358	380	202	47%	Dry Season Biostim (0.19)
Orcutt Creek	312ORC	7.72	0.357	5,428	2,888	47%	Dry Season Biostim (0.19)
	312GVT	1.36	0.218	584	509	13%	Dry Season Biostim (0.19)
	312ORB*	0.21	0.743	307	79	74%	Dry Season Biostim (0.19)
Green Valley Creek	312GVS	1.10	0.140	302	411	0%	Dry Season Biostim (0.19)
Bradley Canyon Creek	312BCC	0.19	1.558	583	71	0%	Dry Season Biostim (0.19)
Little Oso Flaco Creek	312OFN	0.87	0.116	199	137	31%	Year-Round (0.08)
Oso Flaco Creek	312OFC	2.63	0.227	1,174	414	65%	Year-Round (0.08)

6.3 TMDLs

The TMDLs (loading capacity) for water body segments in the TMDL project area is the amount of nitrate, unionized ammonia, and/or orthophosphate that can be assimilated without exceeding the water quality objectives. The Basin Plan contains water quality objectives for nitrate, unionized ammonia, and narrative water quality objectives for biostimulatory substances and thus the loading capacities for the waterbodies are:

For waterbodies designated with the Municipal and Domestic Supply (MUN) beneficial use in the project area:

Including, but not limited to:

- Blosser Channel
- Bradley Channel
- Main Street Canal
- North Main Street Channel
- Nipomo Creek
- Santa Maria River (upstream of Highway 1)

Waters shall not contain concentrations of nitrate as nitrogen in excess of 10 mg/L nitrate as nitrogen.

For all inland surface waters and estuaries in the project area:

Including but not limited to:

- Santa Maria River
- Bradley Canyon Creek
- Blosser Channel
- Bradley Channel
- Greene Valley Creek
- Little Oso Flaco Creek
- Main Street Canal
- North Main Street Channel
- Nipomo Creek
- Orcutt Creek
- Oso Flaco Creek
- Santa Maria River Estuary

The discharge of wastes shall not cause concentrations of unionized ammonia (NH3) to exceed 0.025 mg/l (as N) in receiving waters.

For waterbodies required to meet the Water Quality Objective for Biostimulatory Substances

Receiving waters shall not contain concentrations of nitrate (as N) or orthophosphate (as P) in accordance with the stream reach/water column concentration pairs presented in Table 6-6. [61]

Table 6-6. Loading capacity for biostimulatory substances.

Project Area Stream Reaches	Allowable Nitrate-N (mg/L)	Allowable Orthophosphate-P (mg/L)
• Lower Santa Maria River from Highway 1 to the Pacific Ocean (including Santa Maria River Estuary) • Orcutt Creek all reaches • Greene Valley Creek all reaches • Bradley Canyon Creek	**4.3** **Dry Season Samples (May 1-Oct31)** **8.0** **Wet Season Samples (Nov. 1-Apr. 30)**	**0.19** **Dry Season Samples (May 1-Oct. 31)** **0.3** **Maximum** **Wet Season Samples (Nov. 1-Apr. 30)**
• Oso Flaco Creek all reaches • Little Oso Flaco Creek all reaches	**5.7** **Year round samples**	**0.08** **Year round samples**

6.3.1 USEPA Guidance on Daily Load Expressions

In light of a court decision (Friends of the Earth, Inc. v. EPA, et al., No. 05-5015, D.C. Cir. 2006), USEPA recommends incorporating a daily load expression for certain types of TMDLs which are based on a concentration-based loading capacity (USEPA, 2007); e.g., when the concentration-based numeric loading capacity has a time-step, or temporal component embedded in the numeric target (for example, the 30-day geometric mean Basin Plan numeric objective for fecal coliform). In other words, a loading capacity based on a 30-day average, a seasonal mean, or a mean annual numeric target does not represent a “daily load.” However, the loading capacities for this TMDL are based on the Basin Plan nitrate water quality objective, the Basin Plan unionized ammonia objective, and single sample numeric water quality targets for biostimulatory substances. These are instantaneous water quality targets. USEPA considers an instantaneous water quality numeric target to be equivalent to daily-time step measurement and therefore representative of a daily load expression (USEPA, 2007a). Therefore mass-based daily load expressions are not warranted for this concentration-based TMDL. To facilitate implementation of the concentration-based allocations, non-daily and alternative load expressions are provided as Appendix F.

[61] Refer back to Section 4.3 for a description of the development of numeric targets for biostimulatory substances.

6.4 Linkage Analysis

The goal of the linkage analysis is to establish a link between pollutant loads and water quality. This, in turn, supports that the loading capacity specified in the TMDLs will result in attaining the numeric target. The Linkage Analysis therefore represents the critical quantitative link between the TMDL and attainment of the water quality standards.

The proposed TMDLs will result in the attainment of the biostimulatory substances water quality objective, the water quality objective for unionized ammonia, and the water quality objective for municipal and domestic water supply, and therefore the restoration of beneficial uses of waterbodies in the TMDL project area. This is because the numeric targets are set equal to the nutrient water quality objectives as concentrations of nutrients that will prevent plant nuisance in flowing waters. The numeric targets are used directly to calculate the loading capacity (TMDLs). Requiring the responsible parties for nitrogen compounds and orthophosphate loading to reduce nitrate discharges to the numeric water quality objectives and targets will establish a direct link between the TMDL target and sources.

If the Biostimulatory Substances water quality objectives change in the future, the numeric targets would be equal to the new water quality objectives, and a new loading capacity would be calculated to meet the new numeric targets.

6.5 TMDL Allocations

Table 6-7 presents a summary tabulation of final waste load allocations (WLAs) and load allocations (LAs) for pollutant source categories associated with relevant stream reaches. A description of the numeric value of each type of allocation is presented in Table 6-8.

Table 6-7. Final Waste Load Allocation and Load Allocations.

FINAL WASTE LOAD ALLOCATIONS (WLAs)				
Water body [1]	**Party Responsible for Allocation & NPDES/WDR number**	**Receiving Water Nitrate as N WLA (mg/L)**	**Receiving Water Orthophosphate as P WLA (mg/L)**	**Receiving Water Unionized Ammonia as N WLA (mg/L)**
Santa Maria River (upstream from Highway 1), Blosser Channel, Bradley Channel, Main Street Canal, North Main Street Channel	City of Santa Maria (Storm drain discharges to MS4s) NPDES No. CAS000004 City of Guadalupe (Storm drain discharges to MS4s) (NPDES Permit Pending)	Allocation-4 *(see descriptions of allocations in* Table 6-8 *)*	Not Applicable	Allocation-3
Santa Maria River (downstream of Highway 1	City of Guadalupe (Storm drain discharges to MS4s) (NPDES Permit Pending)	Allocation-1	Allocation-2	Allocation-3
Nipomo Creek	County of San Luis Obispo (Storm drain discharges to MS4s) (NPDES No. CAS000004)	Allocation-4	Not Applicable	Allocation-3
Orcutt Creek	County of Santa Barbara (Storm drain discharges to MS4s) (NPDES No. CAS000004)	Allocation-1	Allocation-2	Allocation-3

(Continued next page)

FINAL LOAD ALLOCATIONS (LAs)				
Water body[1]	**Party Responsible for Allocation**	**Receiving Water Nitrate as N LA (mg/L)**	**Receiving Water Orthophosphate as P LA (mg/L)**	**Receiving Water Unionized Ammonia as N LA (mg/L)**
Santa Maria River (upstream from Highway 1), Blosser Channel, Bradley Channel, Main Street Canal, North Main Street Channel, Nipomo Creek	Owners/operators of irrigated agricultural lands (Discharges from irrigated lands)	Allocation-4	Not Applicable	Allocation-3
	Owners/operators of land used for/containing domestic animals/livestock (Domestic animals/livestock waste not draining to MS4s)			
	No responsible party (Natural sources)			
Santa Maria River (downstream of Highway 1), Santa Maria River Estuary, Bradley Canyon Creek, Orcutt Creek, Greene Valley Creek	Owners/operators of irrigated agricultural lands (Discharges from irrigated lands)	Allocation-1	Allocation-2	Allocation-3
	Owners/operators of land used for/containing domestic animals/livestock (Domestic animals/livestock waste not draining to MS4s)			
	No responsible party (Natural sources)			
Oso Flaco Creek, Little Oso Flaco Creek,	Owners/operators of irrigated agricultural lands (Discharges from irrigated lands)	Allocation-5	Allocation-6	Allocation-3
	Owners/operators of land used for/containing domestic animals/livestock (Domestic animals/livestock waste not draining to MS4s)			
	No responsible party (Natural sources)			

[1] All reaches and tributaries unless otherwise noted.

Table 6-8. Numeric concentration value of allocations

ALLOCATION [A]	COMPOUND	CONCENTRATION (mg/L) [B]
Allocation 1	Nitrate as N	Dry Season (May 1-Oct. 31): **4.3** Wet Season (Nov. 1-Apr. 30): **8.0**
Allocation 2	Orthophosphate as P	Dry Season (May 1-Oct. 31): **0.19** Wet Season (Nov. 1-Apr. 30): **0.3**
Allocation 3	Unionized Ammonia as N	Year-round: **0.025**
Allocation 4	Nitrate as N	Year-round: **10**
Allocation 5	Nitrate as N	Year-round: **5.7**
Allocation 6	Orthophosphate as P	Year-round: **0.08**

[A] Federal and State anti-degradation requirements apply to all waste load and load allocations.
[B] Achievement of final wasteload and load allocations to be determined on the basis of the number of measured exceedances and/or other criteria set forth in Section 4 of the *Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List* (Listing Policy - State Water Resources Control Board, Resolution No. 2004-0063, adopted September 2004). or as consistent with any relevant revisions of the Listing Policy promulgated in the future.

Recognizing that achievement of the more stringent dry season biostimulatory target allocation embedded in Table 6-7 may locally require a significant amount of time to achieve, Table 6-9 therefore presents interim allocations which will be used as benchmarks in assessing progress and gauging ultimate achievement of the final allocations

Table 6-9. Interim Wasteload Allocations and Load Allocations.

INTERIM WASTE LOAD ALLOCATIONS (WLAs)			
Water body	**Party Responsible for Allocation (Source)**	**First Interim WLA**	**Second Interim WLA**
All waterbodies given wasteload allocations (WLAs) in Table 6-7	City of Santa Maria (Storm drain discharges to MS4s) Storm Water Permit NPDES No. CA00049981 City of Guadalupe (Storm drain discharges to MS4s) (NPDES Permit Pending) County of San Luis Obispo (Storm drain discharges to MS4s) (NPDES No. CAS000004) County of Santa Barbara (Storm drain discharges to MS4s) (NPDES No. CAS000004)	Achieve **MUN standard-based** and **Unionized Ammonia objective-based** allocations: Allocation-3 Allocation-4 **12 years after effective date of TMDL**	Achieve **Wet Season** (Nov. 1 to Apr. 30) or Year-round **Biostimulatory target-based** TMDL allocations: Allocation-1 Allocation-2 **20 years after effective date of TMDL**
INTERIM LOAD ALLOCATIONS (LAs)			
Water body	**Party Responsible for Allocation (Source)**	**First Interim LA**	**Second Interim LA**
All waterbodies given load allocations (LAs) in Table 6-7	Owners/operators of irrigated agricultural lands (Discharges from irrigated lands) Owners/operators of land used for/containing domestic animals/livestock (Domestic animals/livestock waste not draining to MS4s) No responsible party (Natural sources)	Achieve **MUN standard-based** and **Unionized Ammonia objective-based** allocations: Allocation-3 Allocation-4 **12 years after effective date of TMDL**	Achieve **Wet Season** (Nov. 1 to Apr. 30) or Year-round **Biostimulatory target-based** TMDL allocations: Allocation-1 Allocation-2 Allocation-5 Allocation-6 **20 years after effective date of TMDL**

6.5.1 Antidegradation Requirements

It is important to emphasize that state water quality standards, and thus the receiving water-based allocations identified in Table 6-7, are subject to antidegradation requirements. Recall that beneficial uses of waterbodies, water quality objectives, and antidegradation policies collectively constitute water quality standards. For a discussion of antidegradation policies, refer to Section 7.2.3. State and federal antidegradation policies require, in part, that where surface waters are of higher quality than necessary to protect beneficial uses, the high quality of those waters must be maintained unless otherwise provided by the policies. Therefore, antidegradation requirements are a component of every water quality standard. Accordingly, antidegradation requirements apply to the nutrient water quality criteria, and hence to the proposed waste load and load allocations, and can be characterized as follows:

> Wherever the existing quality of water in a stream reach or water body is better than necessary***** to support the designated beneficial uses, that water quality shall be maintained and protected, unless and until warranted pursuant to provisions in federal and state antidegradation policies *(See Section II.A, Anti-degradation Policy in the Central Coast Basin Plan)*
> ***** *i.e., better-lower than the numeric water quality objective/criteria/allocation*

Practically speaking, this means that, for example, stream reaches or waterbodies that have a concentration-based TMDL allocation of 10 mg/L nitrate-N, and if current or future identified water quality in the stream reach is in fact *well under* 10 mg/L nitrate-N, the allocation does not give license for controllable nitrogen sources to degrade the water resources all the way up to the maximum allocation = 10 mg/L nitrate-N. This is because antidegradation requirements are a part of every water quality standard.

Non-compliance with antidegradation requirements may be determined on the basis of trends in declining water quality consistent with the methodologies provided in Section 3.10 of the California 303(d) Listing Policy (SWRCB, 2004).

6.6 Margin of Safety

The Clean Water Act and federal regulations require that TMDLs provide a margin of safety to account for uncertainty concerning the relationship between pollution controls and water quality responses (see 40 CFR 130.7(c)(1)). The Santa Maria River Oso Flaco Lake watershed nutrient TMDLs provide both implicit and explicit margins of safety to account for several types of uncertainty in the analysis. This section discusses analytical factors that are uncertain and describes how the TMDL provides the requisite margin of safety.

<u>Relationship between algae growth and nutrient loading</u>. Although there is photographic evidence of excessive algal growth in summer and some evidence of excessive algal growth in winter, the degree of algae-related impairment in winter and the degree to which nitrogen, phosphorus, or both are limiting factors in algae production throughout the year are uncertain.

The dry season TMDLs and allocations account for this uncertainty by setting conservative numeric target values for total nitrogen and total phosphorus. Staff review of the available data suggests that there is a closer relationship between nutrient levels and algae production in summer than was observed in the winter. Attainment of these conservative summer target values should ensure that nitrogen and phosphorus are not critical limiting factors in algae production and should result in reductions in algae growth.

The wet season numeric targets, associated TMDLs and allocation are less stringent than the dry season targets because available data and research studies do not clearly demonstrate that nutrient levels are likely to cause excessive algae growth. The wet season targets and allocations are designed to ensure implementation of the Basin Plan numeric objective for nitrate while acknowledging uncertainty concerning winter algae problems and associated attainment of the narrative objective for biostimulatory effects. The TMDLs account for this winter period uncertainty by incorporating a 20% margin of safety (setting the nitrogen numeric target at 8 mg/l instead of 10 mg/l, which is the applicable numeric objective).

Nutrient loading during the wet season period, stream flows, and nutrient loading capacity vary more during the winter period than the summer period because most precipitation related changes in runoff, loads, and flows occurs during the winter period. Wet season period loads and flows change quickly in response to unpredictable precipitation events. High velocity stream flows are likely to scour filamentous algae and carry it out of the watershed; these high flows also flush nutrient compounds through the watershed and into the ocean. Staff has accounted for the uncertainty associated with winter season variability in loads, flows, and loading capacity by setting the winter season TMDLs and allocations on a concentration basis instead of a mass-loading basis.

Staff has concluded that data is not sufficient to support less stringent year-round nitrate and orthophosphate numeric targets, allocations, and TMDLs for Oso Flaco Lake tributaries. Therefore, due to an uncertainty of seasonal biostimulatory effects upon the lentic (lake) system, staff has proposed year-round targets, allocations, and TMDLs for Oso Flaco Lake tributaries.

Staff has designed a monitoring plan (see Section 7.9) to evaluate the effectiveness of implemented management practices, source load reductions, as well as to gain sufficient data to develop TMDLs for Oso Flaco Lake. Existing monitoring programs in conjunction with proposed monitoring requirements in this TMDL can be used in tandem to provide for long-term water quality monitoring and improve our understanding of the relationship between nutrient levels in the watershed and algal growth. Based on results from these data and studies, staff will review and, if necessary, revise the TMDLs, allocations, and/or implementation provisions.

Additional studies of loadings from nonpoint sources would be warranted in the future to better characterize loadings during wet weather periods from polluted runoff as well as loads associated with septic system operation.

6.7 Critical Conditions and Seasonal Variation

Critical conditions refer to a combination of environmental factors (e.g., flow, temperature, etc.) during which the waterbody is most vulnerable and has the lowest pollutant assimilative capacity. The condition is considered critical because any unknown factor regarding environmental conditions or the calculation of the load allocation could result in not achieving the water quality standard. Therefore, critical conditions are particularly important with load-based allocations and TMDLs. However, this TMDL is a concentration-based TMDL. As such, the numeric targets and allocations are the concentrations equal to the water quality objectives. While critical conditions shall be considered even in concentration-based TMDLs, once the concentration-based allocations are met over all flow conditions, seasonal conditions, or other critical conditions, then there exists no uncertainty as to whether the allocations and TMDLs will result in achieving water quality objectives.

Staff determined there are patterns of seasonal variation based on review of the monitoring data. While exceedances were found at monitoring sites year round, temporal and seasonal analysis suggests that many project area waterbodies are subject to higher nitrate concentrations during the dry season months (May 1 to Oct. 31) as presented in Section 3.2.1. Seasonal or flow-based variability is accounted for and addressed by use of the allocations equal to the water quality objectives and concentration-based allocations which assures the loading capacity of the water body be met under all flow and seasonal conditions.

7 IMPLEMENTATION AND MONITORING

7.1 Introduction

The purpose of the proposed TMDL Implementation Plan is to describe the steps necessary to reduce nutrient loads and to achieve these TMDLs. The TMDL Implementation Plan provides a series of actions and schedules for implementing parties to implement management practices to comply with the TMDL. The TMDL Implementation Plan is designed to provide implementing parties flexibility to implement appropriate management practices and strategies to address nitrate, unionized ammonia and biostimulatory impairments. Implementation consists of 1) identification of parties responsible for taking these actions 2) development of management/monitoring plans to reduce controllable sources of nitrogen compounds and orthophosphate in surface waters; 3) mechanisms by which the Central Coast Water Board will assure these actions are taken; 4) reporting and evaluation requirements that will indicate progress toward completing the actions; 5) and a timeline for completion of implementation actions.

7.2 Legal Authority and Regulatory Framework

This section presents information on the legal authority and regulatory framework which provides the basis for assigning specific responsibilities and accountability to implementing parties for implementation and monitoring actions. The laws and policies pertaining to point sources and nonpoint sources are identified. The legal authority and regulatory framework are described in terms of the following:

- Controllable Water Quality Conditions
- Manner of Compliance
- Point Source Discharges (MS4 entities)
- Nonpoint Source Discharges

7.2.1 Controllable Water Quality Conditions

In accordance with the Water Quality Control Plan for the Central Coast Basin (Basin Plan) Controllable water quality shall be managed to conform or to achieve the water quality objectives and load allocations contained in this TMDL. The Basin Plan defines controllable water quality conditions as follows:

> *"Controllable water quality conditions are those actions or circumstances resulting from man's activities that may influence the quality of the waters of the State and that may be reasonably controlled."*
>
> Source: Water Quality Control Plan for the Central Coast Basin, Chapter 3. Water Quality Objectives, page III-2.

Examples of non-controllable water quality conditions may include atmospheric deposition of nitrogen and phosphorus, and non-controllable natural sources of nutrient compounds.

7.2.2 Manner of Compliance

In accordance with Section 13360 of the Porter-Cologne Water Quality Control Act (California Water Code, Division 7) the Water Board cannot specify or mandate the specific type, manner, or design of on-site actions necessary to reduce nutrient loading, or to meet allocations by the various responsible parties. Specific types of potential management practices identified in this TMDL project report constitute examples or suggestions of management practices known to mitigate or reduce nutrient loading to waterbodies. Stakeholders, local public entities, property owners, and/or resource professionals are in the best position to identify appropriate management measures, where needed, to reduce nutrient loading based on site-specific conditions, with the Water Board providing an oversight role in accordance with adopted permits, waivers, or prohibitions.

7.2.3 Anti-degradation Policies

State and federal antidegradation policies require, in part, that where surface waters are of higher quality than necessary to protect designated beneficial uses, the high quality of those waters must be maintained unless otherwise provided by the policies. The beneficial uses of waterbodies, water quality objectives, and anti-degradation policies collectively constitute water quality standards. Therefore, anti-degradation requirements are a component of every water quality standard. High quality waters are determined on a "pollutant-by-pollutant"/"parameter-by-parameter" basis, by determining whether water quality is better than the criterion for each parameter using chemical or biological data[62].

Both the U.S. Environmental Protection Agency (40 CFR 131.12) and the State of California (State Board Resolution 68-16) have adopted antidegradation policies as part of their approach to regulating water quality. Both state and federal anti-degradation policies apply to point source and nonpoint source discharges that could lower water quality (refer to footnote 62). Although there are some differences, where the federal and state policies overlap they are consistent with each other. Further, state anti-degradation policy incorporates the federal policy where applicable. The Central Coast Water Board must ensure that its actions do not violate the federal or State antidegradation policies. These policies acknowledge that minor, or repeated activities, even if individually small, can result in violation of antidegradation policies through cumulative effects.

[62] See: State Water Resources Control Board (2008), *Water Quality Standards Academy, Basic Course, Module 14*. Presented by U.S. Environmental Protection Agency, Region 9 – Office of Science and Technology (May 12, 2008).

<u>Federal Antidegradation Policy</u>

The federal antidegradation policy, 40 CFR 131.12(a), states in part:

> (1) Existing instream water uses and the level of water quality necessary to protect the
> existing uses shall be maintained and protected.
>
> (2) …Where the quality of waters exceed levels necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water, that quality shall be maintained and protected unless the State finds, after full satisfaction of the intergovernmental coordination and public participation provisions of the State's continuing planning process, that allowing lower water quality is necessary to accommodate important economic or social development in the area in which the waters are located…
>
> (3) Where high quality waters constitute an outstanding National resource, such as waters of National and State parks and wildlife refuges and waters of exceptional recreational or ecological significance, that water quality shall be maintained and protected.

<u>State Antidegradation Policy</u>

Antidegradation provisions of State Water Board Resolution No. 68-16 ("Statement of Policy With Respect to Maintaining High Quality Waters in California") state, in part:

> (1) Whenever the existing quality of water is better than the quality established in policies
> as of the date on which such policies become effective, such existing high quality will be maintained until it has been demonstrated to the State that any change will be consistent with maximum benefit to the people of the State, will not unreasonably affect present and anticipated beneficial use of such

Also noteworthy, Section II.A. of the Central Coast Basin Plan explicitly references anti-degradation requirements, and states:

> II.A. Anti-degradation Policy
>
> "Wherever the existing quality of water is **better than the quality of water established herein as objectives**, **<u>such existing quality shall be maintained</u>*** unless otherwise provided by the provisions of the State Water Resources Control Board Resolution No. 68-16, "Statement of Policy with Respect to Maintaining High Quality of Waters in California," including any revisions thereto."
>
> ***** *emphasis added*

Accordingly, antidegradation policies pertain to the proposed concentration-based wasteload and load allocations in this TMDL, and can be summarized as follows:

Summary of TMDL Anti-degradation Requirments

Where the quality of water in a stream reach or water body is better than necessary (i.e., lower/better than the water quality objective/critera/allocation) to support the designated beneficial uses, that existing water quality shall be maintained and protected, unless and until a lowering of water quality is warranted pursuant to provisions in federal and state antidegradation policies.

During TMDL implementation, compliance with anti-degradation requirements may be determined on the basis of trends in declining water quality in applicable waterbodies, consistent with the methodologies and criteria provided in Section 3.10 of the California 303(d) Listing Policy (adopted, Sept. 20, 2004, SWRCB Resolution No. 2004-0063). Section 3.10 of the California 303(d) Listing Policy explicitly addresses the anti-degradation component of water quality standards as defined in 40 CFR 130.2(j), and provides for identifying trends of declining water quality as a metric for assessing compliance with anti-degradation requirements.

Section 3.10 of the California 303(d) Listing Policy states that pollutant-specific water quality objectives need not be exceeded to be considered non-compliance with anti-degradation requirements *"if the water segment exhibits concentrations of pollutants or water body conditions for any listing factor that shows a trend of declining water quality standards attainment"*[63] (SWRCB, 2004).

Practically speaking, this means that, for example, stream reaches or waterbodies that have a concentration-based TMDL allocation of 10 mg/L nitrate-N, and if current water quality data or future water quality assessments in the stream reach indicate nitrate-N concentrations in fact well under 10 mg/L nitrate-N, the allocation does not give license for controllable nitrogen sources to degrade the water resource all the way up to the maximum allocation = 10 mg/L nitrate-N. Data demonstrating trends of declining water quality in these reaches may constitute non-compliance with anti-degradation requirements, where applicable.

7.2.4 Point Sources

The National Pollutant Discharge Elimination System (NPDES) permit is the mechanism for translating wasteload allocations (WLAs) into enforceable

[63] Section 3.10 of the California Impaired Waters 303(d) Listing Policy (adopted, Sept. 20, 2004, SWRCB Resolution No. 2004-0063)

requirements for point sources. Under Clean Water Act § 402, discharges of pollutants to waters of the United States are authorized by obtaining and complying with the terms of an NPDES permit.

USEPA regulations require that a TMDL include wasteload allocations (WLAs) which identify the portion of the loading capacity allocated to existing and future point sources. Thus, the WLA is the maximum amount of a pollutant that may be contributed to a water body by point source discharges[64] of the pollutant in order to attain and maintain water quality objectives and restore beneficial uses. 40 CFR 122.44(d)(1)(vii)(B) requires effluent limits to be consistent with the WLAs in an approved TMDL. USEPA policy explicitly specifies NPDES-regulated stormwater discharges are point source discharges and, therefore, must be addressed by the WLA component of a TMDL.[65] The Water Board is the permitting authority for NPDES stormwater permits in the Central Coast region.

7.2.5 Nonpoint Sources

Nonpoint sources (NPS) refer to pollution that is not released through pipes but rather originates from multiple sources over a relatively large area. Nonpoint sources are assigned the load allocation (LA) component of a TMDL. The LA is the portion of the receiving water's pollutant loading capacity attributed to (1) the existing or future nonpoint sources of pollution and (2) natural background sources. While point source discharges are not controlled directly by the federal Clean Water Act's NPDES permit program, direct control of nonpoint source pollution is left to state programs developed under state law. . California's Porter- Cologne Water Quality Control Act applies to both point and nonpoint sources of pollution and serves as the principle legal authority in California for the application and enforcement of TMDL load allocations for nonpoint sources.

In July 2000 the State Water Resources Control Board and the California Coastal Commission developed the Plan for California's Nonpoint Source Pollution Control Program to reduce and prevent nonpoint source pollution in California, expanding the State's nonpoint source pollution control efforts. The NPS Program's long-term goal is to "improve water quality by implementing the management measures identified in the California Management Measures for Polluted Runoff Report (CAMMPR) by 2013. Under the California NPS Program Pollution Control Plan, TMDLs are considered one type of implementation planning tool that will enhance the State's ability to foster implementation of appropriate NPS management measures.

[64] See 40 CFR 130.2(h). A wasteload allocation is the portion of the receiving water's loading capacity that is allocated to its point sources of pollution.
[65] See 40CFR 130.2(g) & (h) and USEPA Office of Water Memorandum (Nov. 2002) *"Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water Sources and NPDES Permit Requirements Based on Those WLAs"*

The Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program adopted in August 2004, explains how Water Board authorities granted by the Porter-Cologne Water Quality Control Act will be used to implement the California NPS Program Plan The Nonpoint Source Implementation and Enforcement Policy requires the Regional Water Boards to regulate all nonpoint sources (NPS) of pollution using the administrative permitting authorities provided by the Porter-Cologne Act. Nonpoint source dischargers must comply with Waste Discharge Requirements (WDRs), waivers of WDRs, or Basin Plan Prohibitions by participating in the development and implementation of Nonpoint Source Pollution Control Implementation Programs. NPS dischargers can comply either individually or collectively as participants in third-party coalitions. (The "third-party" Programs are restricted to entities that are not actual discharges under Regional Water Board permitting and enforcement jurisdiction. These may include Non-Governmental Organizations, citizen groups, industry groups, watershed coalitions, government agencies, or any mix of the these.) All Programs must meet the requirements of the following five key elements described in the NPS Implementation and Enforcement Policy. Each Program must be endorsed or approved by the Regional Water Board or the Executive Officer (if the Water Board has delegated authority to the Executive Officer).

Key Element 1: A Nonpoint Source Pollution Control Implementation Program's ultimate purpose must be explicitly stated and at a minimum address NPS pollution control in a manner that achieves and maintains water quality objectives.

Key Element 2: The Program shall include a description of the management practices (MPs) and other program elements dischargers expect to implement, along with an evaluation program that ensures proper implementation and verification.

Key Element 3: The Program shall include a time schedule and quantifiable milestones, should the Regional Water Board require these.

Key Element 4: The Program shall include sufficient feedback mechanisms so that the Regional Water Board, dischargers, and the public can determine if the implementation program is achieving its stated purpose(s), or whether additional or different MPs or other actions are required (See Section 12, Monitoring Program).

Key Element 5: Each Regional Water Board shall make clear, in advance, the potential consequences for failure to achieve a Program's objectives, emphasizing that it is the responsibility of individual dischargers to take all necessary implementation actions to meet water quality requirements.

7.3 Implementation for Discharges from Irrigated Lands

The Conditional Waiver of Waste Discharge Requirements for Irrigated Lands (Order R3-2012-0011) requires dischargers from irrigated lands to implement practices to achieve water quality objectives. Executive Officer Order R3-2012-0011 (Agricultural Order) also requires dischargers to implement Monitoring and Reporting Programs in accordance with Orders R3-2012-0011-01, R3-2012-0011-02, and R3-2012-0011-03. 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. Implementing parties will comply with the Agricultural Order, and if/where appropriate, consistent with the current Agricultural Order, renewals or replacements of the Agricultural Order, and this TMDL.

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.

Note that 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 the 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.

7.3.1 Implementing Parties

Table 7-1 presents the implementing parties responsible for implementation load allocations for discharges of agricultural fertilizer.

Table 7-1. Implementing Parties for Discharges of Agricultural Fertilizer

Source Category	Implementing Parties	Land Use Category
Irrigated Agricultural Lands	Owners/operators of irrigated lands	Farmland – cultivated crops

7.3.2 Priority Areas

The Agricultural Order should prioritize implementation and monitoring efforts in impaired subwatersheds, 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 aquatic habitat and/or human health in receiving waters and also with consideration to mitigation of downstream impacts (e.g., Oso Flaco Lake and Santa Maria River Estuary);
3) Crops that are grown that require high fertilizer inputs (see for example Table 5-3);
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 nutrient and/or biostimulatory impacts to receiving waters.

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

- Orcutt Creek, including Greene Valley Creek tributary
- Oso Flaco Creek and Little Oso Flaco Creek
- Santa Maria River

7.3.3 Proposed Implementation Actions

Consistent with the Agricultural Order, owners/operators of irrigated lands in the TMDL project area should implement management measures as identified:

A. Implement, and update as necessary, management practices to achieve compliance with the Agricultural Order and to make progress towards achieving Load Allocations.
B. Maintain existing, naturally occurring, riparian vegetative cover in aquatic habitat areas to prevent/mitigate nutrient loading to receiving waters.

C. Develop/update and implement Farm Plans.
D. Properly destroy abandoned groundwater wells.
E. 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.

7.3.4 Determination of Compliance with Load Allocations

Load allocations will be achieved through a combination of implementation of management practices and strategies to reduce nitrogen compound and orthophosphate loading, and water quality monitoring. Flexibility to allow owners/operators from 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 a surface water impairment. However, it is important to recognize that impacting shallow groundwater with nutrient pollution may also impact surface water quality via baseflow loading contributions to the creek.

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. Attaining receiving water TMDL numeric targets for nutrient-response indicators (i.e., dissolved oxygen water quality objectives, chlorophyll *a* targets and microcystin targets) may constitute a demonstration of attainment of the nitrate, nitrogen and orthophosphate-based seasonal biostimulatory load allocations. Note that implementing parties are strongly encouraged to maximize overhead riparian canopy, where and if appropriate, using riparian vegetation, because doing so could result in achieving nutrient-response indicator targets before allocations are achieved (resulting in a less stringent allocation);
C. Implementing management practices that are capable of achieving interim and final load allocations identified in this TMDL;
D. Demonstrating quantifiable receiving water mass load reductions.
E. 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.

7.4 Implementation for Discharges from MS4 Stormwater Entities

The Central Coast Water Board will require the MS4 entities to develop and submit for Executive Officer approval a Wasteload Allocation Attainment Program (WAAP). The WAAP shall be submitted within one year of approval of the TMDL by the Office of Administrative Law, or within one year of a storm water permit renewal, whichever occurs first. The WAAP shall include descriptions of the actions that will be taken by the MS4 entity to attain the TMDL wasteload allocations, and specifically address:

A. Development of an implementation and assessment strategy;
B. Source identification and prioritization;
C. Best management practice identification, prioritization, implementation schedule, analysis, and effectiveness assessment;
D. Monitoring and reporting program development and implementation. Monitoring program goals shall include:
    1. assessment of storm water discharge and receiving water discharge quality
    2. assessment of best management effectiveness, and
    3. demonstration of progress towards achieving interim targets and wasteload allocations.
E. Coordination with stakeholders; and ,
F. Other pertinent factors

7.4.1 Implementing Parties

Table 7-2 presents the implementing parties responsible for implementation load allocations for discharges of agricultural fertilizer.

Table 7-2. Implementing Parties for Discharges from MS4 Entities.

Source Category & Potential Contributing Controllable Sources	**Implementing Parties (MS4 Entities)**	**Land Use Category**
MS4 Discharges: Residential fertilizer application Commercial fertilizer application and service facilities Grass clippings and green waste Domestic Animal/Pet waste	City of Santa Maria City of Guadalupe (pending) County of Santa Barbara County of San Luis Obispo	Urban-Developed (areas draining to MS4 system)

7.4.1 Priority Areas

Municipal stormwater entities and local resource professionals are in the best position to ultimately assess priorities and problem areas. Based on the City of Santa Maria Annual Storm Water Reports (2009, 2010, 2011), concentrations of nitrate-N never exceeded 3.3 mg/L and rarely exceeded 1.0 mg/L. Stormwater from the City of Santa Maria, the largest municipality in the project area, appears to be easily achieving proposed wasteload allocations. Stormwater quality data is not available for the City of Guadalupe and the counties of Santa Barbara and San Luis Obispo; however, impacts to adjacent waterbodies is presumed to be minimal due to lower population densities.

7.4.2 Implementation Actions

The overall goal of developing a Wasteload Allocation Attainment Program is to Implement management practices capable of achieving interim and final Wasteload Allocations identified in this TMDL. The Central Coast Water Board will require the Wasteload Allocation Attainment Program to include descriptions of the actions that will be taken by the MS4 entity to attain the TMDL wasteload allocations, and specifically address:

1. Development of an implementation and assessment strategy;
2. Source identification and prioritization;
3. Best management practice identification, prioritization, implementation schedule, analysis, and effectiveness assessment;
4. Monitoring program development and implementation;
5. Reporting; including evaluation whether current best management practices are progressing towards achieving the wasteload allocations within thirteen years of the date that the TMDLs are approved by the Office of Administrative Law;
6. Coordination with stakeholders; and
7. Other pertinent factors.

The Wasteload Allocation Attainment Program will be required by the Central Coast Water Board to address each of these TMDLs that occur within the MS4 entities' jurisdictions. The Central Coast Water Board will require the Wasteload Allocation Attainment Program to be submitted at one of the following milestones, whichever occurs first:

1. Within one year of approval of the TMDLs by the Office of Administrative Law;
2. When required by any other Water Board-issued storm water requirements (e.g., when the Phase II Municipal Storm Water Permit is renewed).

In accordance with the milestones listed above, the Cities of Santa Maria and Guadalupe and the counties of Santa Barbara and San Luis Obispo shall each develop, submit, and begin implementation of a Wasteload Allocation Attainment Program that identifies the actions they will take to attain their wasteload allocations. The Wasteload Allocation Attainment Programs shall include the elements identified in Table 7-3.

Table 7-3. Proposed TMDL implementation action plan for MS4 Entities, and required components of Wasteload Allocation Attainment Programs.

<table>
<tr><th>Proposed Actions & Proposed Wasteload Allocation Attainment Program Requirements</th><th>Regional Board Authority</th></tr>
<tr><td colspan="2">Pollutant Source Category: MS4 Entities</td></tr>
<tr><td>PROPOSED ACTIONS

<u>Implementing Parties</u>: Implement a strategy and management practices consistent with NPDES permit conditions and an approved Wasteload Allocation Attainment Program, capable of achieving interim and final Wasteload Allocations.

<u>Water Board Actions</u>: The Water Board will require the Wasteload Allocation Attainment Program to be submitted at one of the following milestones, whichever occurs first:
1. Within one year of approval of the TMDLs by the Office of Administrative Law;
2. When required by any other Water Board-issued storm water requirements</td><td rowspan="2">Storm Water General Permit
NPDES No. CAS000004</td></tr>
<tr><td>WASTELOAD ALLOCATION ATTAINMENT PROGRAM REQUIRED ELEMENTS:

1. A detailed description of the strategy the MS4 will use to guide BMP selection, assessment, and implementation, to ensure that BMPs implemented will be effective at abating pollutant sources, reducing pollutant discharges, and achieving wasteload allocations.

2. Identification of sources of the impairment within the MS4's jurisdiction, including specific information on various source locations and their magnitude within the jurisdiction.

3. Prioritization of sources within the MS4's jurisdiction, based on suspected contribution to the impairment, ability to control the source, and other pertinent factors.

4. Identification of BMPs that will address the sources of impairing pollutants and reduce the discharge of impairing pollutants.

5. Prioritization of BMPs, based on suspected effectiveness at abating sources and reducing impairing pollutant discharges, as well as other pertinent factors.

6. Identification of BMPs the MS4 will implement, including a detailed implementation schedule. For each BMP, identify milestones the MS4 will use for tracking implementation, measurable goals the MS4 will use to assess implementation efforts, and measures and targets the MS4 will use to assess effectiveness. MS4s shall include expected BMP implementation for future implementation years, with the understanding that future BMP implementation plans may change as new information is obtained.

7. A quantifiable numeric analysis demonstrating the BMPs selected for implementation will result in the MS4's attainment of its wasteload allocation. This analysis will most likely incorporate modeling efforts. The MS4 shall conduct repeat numeric analyses as the BMP implementation plans evolve and information on BMP effectiveness is generated. Once the MS4 has water quality data from its monitoring program, the MS4 shall incorporate water quality data into the numeric analyses to validate BMP implementation plans.

8. A detailed description of a monitoring program the MS4 will implement to assess discharge and receiving water quality and BMP effectiveness, including a schedule for implementation of the monitoring program. The monitoring program shall be designed to validate BMP implementation efforts and demonstrate attainment of wasteload allocations.

9. A detailed description of how the MS4 will assess BMP and program effectiveness. The description</td></tr>
</table>

Proposed Actions & Proposed Wasteload Allocation Attainment Program Requirements	Regional Board Authority
shall incorporate the assessment methods described in the CASQA Municipal Storm water Program Effectiveness Assessment Guide. 10. A detailed description of how the MS4 will modify the program to improve upon BMPs determined to be ineffective during the effectiveness assessment. 11. A detailed description of information the MS4 will include in annual reports to demonstrate adequate progress towards attainment of wasteload allocations. 12. A detailed description of how the municipality will collaborate with other agencies, stakeholders, and the public to develop and implement the Wasteload Allocation Attainment Program. 13. Any other items identified by Integrated Report fact sheets, TMDL Project Reports, TMDL Resolutions, or that are currently being implemented by the MS4 to control its contribution to the impairment.	

[1] Indicators of progress towards milestones in achieving wasteload allocations include, but are not limited to data and information related to: 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.

7.4.3 Determination of Compliance with Wasteload Allocations

Waste load allocations will be achieved through a combination of implementation of management practices and strategies to reduce nitrogen compound and orthophosphate loading. Water quality monitoring will be included as well.

To be consistent with waste load allocations, Water Board staff will evaluate compliance with waste load allocations using one or a combination of the following:

A. attaining the waste load allocations in the receiving water;
B. attaining receiving water TMDL numeric targets for nutrient-response indicators (i.e., dissolved oxygen water quality objectives, chlorophyll a targets and microcystin targets) may constitute a demonstration of the attainment of the nitrate, nitrogen and orthophosphate-based seasonal biostimulatory waste load allocations. Note that implementing parties are strongly encouraged to maximize overhead riparian canopy using riparian vegetation, as appropriate, because doing so could result in achieving nutrient-response indicator targets before allocations are achieved (resulting in a less stringent allocation);
C. demonstrate reduction of nutrient concentrations in storm water outfalls. Optionally, where storm water is conveyed through managed flood protection facilities that also serve to treat and improve water quality (e.g., treatment wetlands, bioreactors, etc.), compliance may be demonstrated by measuring storm water quality before entering the receiving water body.

In order to achieve attainment of waste load allocations, Water Board staff may additionally consider:

D. Load reductions demonstrations on mass basis at storm drain outfalls and/or downstream of treatment systems;

E. Implementation and assessment of pollutant loading reduction projects (BMPs), capable of achieving interim and final waste load allocations identified in this TMDL in combination with water quality monitoring for a balanced approach to determining program effectiveness;
F. Any other effluent limitations and conditions which are consistent with the assumptions and requirements of the waste load allocations.

7.5 Implementation for Discharges from Domestic Animals

The water quality data available to staff from stream reaches that exclusively drain grazing lands, or lands where grazed animals and farm animals can be expected to occur[66], indicate the nitrogen compounds and orthophosphate proposed water quality targets, and thus load allocations, are evidently being met in these reaches. Nitrogen compounds and orthophosphate appear to be marginally elevated relative to undisturbed or natural background conditions found elsewhere in the Santa Maria River Basin, potentially indicating an incremental amount of degradation by livestock activities. However, pending the acquisition of more data, this source category appears to be meeting their load allocation. As such no new regulatory requirements are deemed necessary or are being proposed.

It is important to note that the Santa Maria River Watershed (including Oso Flaco Creek subwatershed) is subject to a Domestic Animal Waste Discharge Prohibition in association with an approved Fecal Indicator Bacteria TMDL for the Santa Maria River watershed. Therefore owners and operators of lands used for/containing domestic animals are subject to compliance with TMDL load allocations[67].

Implementation efforts by responsible parties to comply with this prohibition and with indicator bacteria load allocations will, as a practical matter, also reduce the risk of nitrogen and phosphorus loading to surface waters from domestic animal waste. It should be noted that information developed in this project report does not conclusively demonstrate that all domestic animal operations are currently meeting load allocations; there are potentially unpermitted confined animal facilities, equestrian facilities, or grazing animal operations that do not meet load allocations. More information will be obtained during the implementation phase of the TMDL to further assess the level of nutrient contribution from these source categories, and to identify any actions if necessary to reduce loading. Additional information will include water quality monitoring data obtained through the Agricultural Order, CCAMP, or during implementation of the Santa Maria River Watershed Fecal Indicator Bacteria TMDLs to demonstrate compliance with the Domestic Animal Waste Discharge Prohibition.

[66] Orcutt Creek, Lower Santa Maria River and Estuary.
[67] Central Coast Water Board Resolution No. R3-2012-0002, approved March 15, 2012.

7.6 Metrics to Assess Interim Progress towards TMDL Achievement

Recognizing there are uncertainties including, but not limited to, extreme inter-annual variability in pollutant loading to surface waters based on climatic conditions, flows, water management practices, uncertainties about the nexus between receiving water pollutant concentrations and leachate concentrations[68], etc., measures of TMDL implementation progress will not necessarily be limited to receiving water column concentration-based metrics and/or time-weighted average concentrations of water column pollutants.

Other metrics that can provide insight on interim progress to reduce nutrient pollution may be utilized, for example:

- assessments of mass-based load reductions;
- improvements in flow-weighted concentrations;
- estimates of the percent/scope/degree of implementation of management practices capable of ultimately achieving load allocations;
- improvements in receiving water nutrient-response indicators (i.e., dissolved oxygen, chlorophyll *a*, microcystins), etc.

In addition, while the waste load and load allocations are based on the MUN water quality standard of 10 mg/L, or biostimulatory numeric criteria, restoration of the AGR beneficial use (based on the 30 mg/L nitrate-N Basin Plan guideline value) during TMDL implementation can be used as an indication of interim progress.

7.7 Suggested Management Measures

7.7.1 Potential Management Measures for Agricultural Sources

The SWRCB, California Coastal Commission and other State agencies have identified management measures (MMs) to address agricultural sources of nutrient pollution that affect State waters. The agricultural MMs include practices and plans installed under various NPS programs in California, including systems of practices commonly used and recommended by the U.S. Department of Agriculture as components of Resource Management Systems (RMS), Water Quality Management Plans and Agricultural Waste Management Systems. These RMSs are planned by individual farmers and ranchers using an objective-driven planning process outlined in the NRCS National Planning Procedures Handbook.

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[68] Pilot-scale field trials in Monterey County suggests that while substantial reduction in nitrogen loss from cropland are achievable with BMPs, there was not a corresponding reduction in nitrate leachate on a concentration (ppm) basis. Source: Michael Cahn, 2010, University of California Cooperative Extension, Monterey County, *Optimizing Irrigation and Nitrogen Management in Lettuce for Improving Farm Water Quality, Northern Monterey County*, Grant No. 20080408 project report.

As described in Section 7.2.2, the Water Board cannot specify the specific type or design of onsite actions necessary to reduce nutrient loading to waterbodies; however the California Nonpoint Source Pollution Control Program contains information on the general expectations and types of MMs (see Management Measure 1C – Nutrient Management) that will reduce nutrient loading; this information may be viewed at the following link:

http://www.swrcb.ca.gov/water_issues/programs/nps/docs/cammpr/cammpr_agr.pdf

Further, the State Water Resources Control Board's (SWRCB) Nonpoint Source Management Program provides an on-line reference guide designed to facilitate a basic understanding of nonpoint source (NPS) pollution control and to provide quick access to essential information from a variety of sources The purpose of this on-line resource guide is to support the implementation and development of NPS total maximum daily loads (TMDLs) and watershed (action) plans with a goal of protecting high-quality waters and restoring impaired waters. Relevant information from the SWRCB Nonpoint Source (NPS) – Encyclopedia for nutrient management is available online at:

http://www.swrcb.ca.gov/water_issues/programs/nps/encyclopedia.shtml

The California Department of Food and Agricultural Fertilizer Research and Education Program (FREP) funds and coordinates research to advance the environmentally safe and agronomically sound use and handling of fertilizer materials. FREP serves growers, agricultural supply and service professionals, extension personnel, public agencies, consultants, and other interested parties. FREP is guided by the Technical Advisory Subcommittee (TASC) of the Fertilizer Inspection Advisory Board (FIAB). This subcommittee includes growers, fertilizer industry professionals, and state government and university scientists. The TASC directs FREP activities, and reviews, selects and (after peer review) recommends to the FIAB funding for FREP research and education projects. Information on FREP and nutrient management research and education can be found at: http://www.cdfa.ca.gov/is/ffldrs/frep.html

Legacy nitrate concentrations in groundwater should be treated as a resource and long-term remediation by "pump-and-fertilize" would use existing agricultural wells to gradually remove nitrate-contaminated groundwater and treat the water by ensuring nitrate uptake by crops through appropriate nutrient and irrigation water management. [69]

[69] Assessing Nitrate in California's Drinking Water (SBX2 1), 2012. Center for Watershed Sciences, University of California, Davis.

Nutrient Management Plans

The Agricultural Order, or its revision, may require nutrient management plan (NMP) implementation, which may be voluntary in some cases. Where needed and appropriate, NMPs may be an effective management option to reduce nitrate loads to waters of the State. The California Nonpoint Source Pollution Control Program states that development and implementation of a nutrient management plan should include the following goals:

1) Apply nutrients at rates necessary to achieve realistic crop yields,
2) Improve the timing of nutrient application, and
3) Use agronomic crop production technology to increase nutrient use efficiency.

The California Nonpoint Source Pollution Control Program states that core components of a nutrient management plan should include:

- Farm and field maps with identified and labeled: acreage and type of crops, soil surveys, location of any environmental sensitive areas including any nearby water bodies and endangered species habitats.
- Realistic yield expectations for the crop(s) to be grown based primarily on the producer's yield history, State Land Grant University yield expectations for the soil series, or USDA NRCS Soils-5 information for the soil series.
- A summary of the nutrient resources available to the producer, which (at a minimum) include (a) soil test results for pH, phosphorus, nitrogen, and potassium; (b) nutrient analysis of manure, sludge, mortality compost (birds, pigs, etc.), or effluent (if applicable); (c) nitrogen contribution to the soil from legumes grown in rotation (if applicable); and (d) other significant nutrient sources (e.g., irrigation water).
- An evaluation of the field limitations and development of appropriate buffer areas, based on environmental hazards or concerns such as (a) sinkholes, shallow soils over fractured bedrock, and soils with high leaching potential; (b) lands near or draining into surface water; (c) highly erodible soils; and (d) shallow aquifers.
- Use of the limiting nutrient concept to establish a mix of nutrient sources and requirements for the crop based on realistic yield expectations.
- Identification of timing and application methods for nutrients to (a) provide nutrients at rates necessary to achieve realistic yields, (b) reduce losses to the environment, and (c) avoid applications as much as possible to frozen soil and during periods of leaching or runoff.
- Provisions for the proper calibration and operation of nutrient application equipment.
- Provisions to ensure that, when manure from confined animal facilities (excluding CAFOs) is to be used as a soil amendment or is disposed

of on land, subsequent irrigation of the land does not leach excess nutrients to surface or ground waters.

- Vegetated Treatment Systems which are discussed in Management Measure 6C of the NPS Encyclopedia.[70]

7.7.2 Potential Management Measures for Urban Sources

As described in Section 7.2.2, the Water Board cannot specify or mandate the specific type or design of onsite actions (e.g., BMPs) necessary to reduce nutrient loading to waterbodies; however the California Nonpoint Source Pollution Control Program[71] contains information on the general expectations and types of MMs that will reduce urban nutrient loading; this information may be viewed at the following link:

http://www.swrcb.ca.gov/water_issues/programs/nps/docs/cammpr/cammpr_urb.pdf

Further, the State Water Resources Control Board's (SWRCB) Nonpoint Source Management Program provides an on-line reference guide designed to facilitate a basic understanding of nonpoint source (NPS) pollution control and to provide quick access to essential information from a variety of sources The purpose of this on-line resource guide is to support the implementation and development of NPS total maximum daily loads (TMDLs) and watershed (action) plans with a goal of protecting high-quality waters and restoring impaired waters. Relevant information from the SWRCB Nonpoint Source (NPS) – Encyclopedia for nutrient management is available online at:

http://www.swrcb.ca.gov/water_issues/programs/nps/encyclopedia/3_0_urb.shtml.

The International Stormwater BMP Database is a comprehensive source of BMP performance information. The BMP Database is comprised of carefully examined data from a peer reviewed collection of studies that have monitored the effectiveness of a variety of BMPs in treating water quality pollutants for a variety of land use types. The Stormwater BMP Database is available online at:

http://www.bmpdatabase.org/

7.8 Proposed Monitoring Requirements

For irrigated agricultural sources, in accordance with the Agricultural Order, owners and operators of irrigated agricultural lands will perform monitoring and

[70] http://www.swrcb.ca.gov/water_issues/programs/nps/encyclopedia/6c_vts.shtml

[71] While MS4 permitted municipal stormwater is considered a "point source" requiring WLAs under EPA regulation, urban runoff management measures are identified in California's Nonpoint Source Pollution Plan.

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.

For urban sources, the City of Santa Maria, City of Guadalupe, County of San Luis Obispo (Nipomo), and County of Santa Barbara (Orcutt) are required to develop and submit monitoring programs as part of their WAAP. The goals of the monitoring programs are described in the requirements of the WAAP. Staff encourages the City of Santa Maria, City of Guadalupe, County of San Luis Obispo (Nipomo), County of Santa Barbara (Orcutt) to develop and submit creative and meaningful monitoring programs. Monitoring strategies can use a phased approach, for example, whereby outfall or receiving water monitoring is phased in after best management practices have been implemented and assessed for effectiveness. Pilot projects where best management practices are implemented in well-defined areas covering a fraction of the MS4 that facilitates accurate assessment of how well the best management practices control pollution sources, is acceptable, with the intent of successful practices then being implemented in other or larger parts of the MS4.

The monitoring frequency required at a receiving water site must satisfy a sufficient number of samples needed to evaluate progress towards, and achievement of both the wet-season and dry-season targets for nitrate and orthophosphate, and evaluation of the single sample maximum water quality objective for unionized ammonia. As this TMDL is addressing biostimulatory impairments by setting allocations for nitrate and orthophosphate, staff anticipates that chlorophyll impairments and dissolved oxygen impairments that are related to biostimulation will be evaluated with data from existing and ongoing monitoring programs (CCAMP, CMP), thus chlorophyll and dissolved oxygen monitoring requirements are not being proposed for this TMDL at this time.

Monitoring and reporting requirements should include:

<u>Receiving Waters</u>

1. Subwatershed scale receiving water monitoring for all the impaired waterbodies assigned TMDLs (see Table 7-5).
   a) <u>Waterbodies with Biostimulatory Impairments</u>: This TMDL established seasonal targets for nitrate and orthophosphate in reaches identified as having biostimulatory impairments
      - ✓ Wet Season: Nov. 1 through May 31: Two samples from receiving waters to establish progress and achievement of the wet-season single-sample maximum target for nutrients..
      - ✓ Dry Season: June 1 through October 31: Monthly sampling to establish progress and achievement of the dry-season geomean target for nutrients.

   b) <u>Waterbodies with Drinking Water (Nitrate) Impairments</u>
      - ✓ Quarterly: One receiving water sample, quarterly.

c) <u>Waterbodies with Unionized Ammonia Impairments</u>
   ✓ Quarterly: One receiving water sample, quarterly.

2. Dissolved oxygen and chlorophyll samples for waterbodies exhibiting biostimulatory impairments are recommended for use as supplementary or proxy indicators of attainment or non-attainment of biostimulatory water quality objectives, consistent with numeric targets identified for these constituents in this TMDL (see Section 4.4).
3. Laboratory analytical methods rigorous enough for data comparison with the numeric targets.
4. If samples are not collected or available for the recommended frequencies recommended above, the available data shall be evaluated consistent with Section 6.1.5.6 of the SWRCB Listing Policy (*Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List*, SWRCB 2004)

Receiving water monitoring sites in subwatersheds should be located in the lower portions of the watershed, whenever feasible. Use of previously established monitoring sites would be useful for showing trends. Recommended watershed monitoring sites are listed in Table 7-4. These or similar sites should be used to assess progress toward achieving the TMDLs assigned to the impaired waterbodies.

Table 7-4. Recommended receiving water monitoring sites for TMDL progress assessment for discharges from irrigated lands.

Impaired Water body	Impairment(s) / Water Quality Objective	Recommended Monitoring Site
Santa Maria River Estuary	Nutrients (biostimulatory substances objective)	312SMA
Santa Maria River	Nutrients (biostimulatory substances objective)	312SMI
Orcutt Creek	Nutrients (biostimulatory substances objective) Unionized Ammonia (toxicity objective)	312ORC
Greene Valley Creek	Nutrients (biostimulatory substances objective) Unionized Ammonia (toxicity objective)	312GVS
Main Street Canal	Nitrate (Drinking water standard) Unionized Ammonia (toxicity objective)	312MAB
Blosser Channel	Nutrients (biostimulatory substances objective) Unionized Ammonia (toxicity objective)	312BCD
Bradley Channel	Nutrients (biostimulatory substances objective) Unionized Ammonia (toxicity objective)	312BCU
Bradley Canyon Creek	Nutrients (biostimulatory substances objective) Unionized Ammonia (toxicity objective)	312BCC
Nipomo Creek	Nitrate (Drinking water standard)	312NIP
Oso Flaco Creek	Nutrients (biostimulatory substances objective) Unionized Ammonia (toxicity objective)	312OFC
Little Oso Flaco Creek	Nutrients (biostimulatory substances objective) Unionized Ammonia (toxicity objective)	312OFN

While microcystin water quality targets have been identified in this project report, to limit the burden of monitoring staff are not recommending that responsible parties conduct microcystin monitoring. Responsible parties may voluntarily collect microcystin data if they choose to do so. Currently, the Water Board is funding the collection of baseline microcystin data for the central coast region, which may be used to assess water quality conditions and attainment of water quality standards.

In addition to the stream monitoring stations referenced above, staff recommends the sampling of Oso Flaco Lake from the pedestrian bridge that transects the lake. Staff conducted one sampling event from this location (site 312OFL_Br) and has concluded that this is the preferred site for representing lake conditions, as opposed to existing CCAMP monitoring site 312OFL (see Appendix D for a discussion of the lake monitoring site and preliminary sampling results). Staff proposes monthly sampling at site 312OFL_Br for the following parameters:

- Dissolved oxygen concentration
- Dissolved oxygen percent saturation
- Total nitrogen
- Nitrate as nitrogen
- Nitrite as nitrogen
- Ammonia as nitrogen
- Total Kjeldahl nitrogen
- Total phosphorus
- Orthophosphate as phosphorus
- Chlorophyll a
- Secchi depth (transparency)
- Temperature
- pH
- Conductivity

The parameters above for Oso Flaco Lake will provide staff with the information necessary to assess biostimulatory conditions and develop a Nutrient TMDL for the lake based on lake response to nutrient loading from Oso Flaco Creek and Little Oso Flaco Creek (see Appendix D).

7.9 Timeline and Milestones

7.9.1 Timeline to Achieve Loading Capacity

Discharges of nitrogen compounds and orthophosphate are occurring at levels which are impairing a wide spectrum of beneficial uses and, therefore, constitute a serious water quality problem. As such, implementation should occur at a pace to achieve the allocations and TMDL in the shortest time-frame feasible. Staff recognizes that immediate compliance with water quality standards is not feasible, and therefore proposing the following milestones.

Table 7-5 presents temporal bench marks to establish progress towards achievement of the final wasteload allocations and load allocations previously presented in Table 6-9. These benchmarks can be summarized as follows:

- First Interim Waste Load and Load Allocations : Achieve the nitrate MUN standard-based and unionized ammonia water quality objective-based allocations within 12 years of the effective date of the TMDL (which is upon approval by the Office of Administrative Law);
- Second Interim Waste Load and Load Allocations: Achieve the less stringent wet-season (Nov. 1 to Apr. 30) biostimulatory target-based allocations within 20 years of the effective date of the TMDL;
- Final Interim Waste Load and Load Allocations: Achieve the more stringent dry-season (May 1 to Oct. 31) biostimulatory target-based allocations within 30 years of the effective date of the TMDL;

The 12 year timeframe to achieve the MUN nitrate standard and the Basin Plan objective for unionized ammonia is based primarily on the expectation that nearly all landowners and operators of irrigated agricultural activities will have completed Farm Water Quality Plans and be implementing management practices by the end of the first waiver cycle (5 years). Water quality benefits resulting from implementing nutrient-control management measures may take a few years to be realized. Water Board staff believes 12 years for the first interim waste load and load allocations is a reasonable timeframe to implement management measures and reduce nitrate levels consistent with the allocations and the numeric target. The 12 year benchmark is also consistent with the Water Board's vision for the central coast region of healthy, functioning watersheds by the year 2025.

The 20 year timeframe to achieve the second interim waste load and load allocations (which are based on the less stringent wet-season biostimulatory targets) was identified as a reasonable time frame and intermediate benchmark prior to achieving the final, more-stringent final allocations. The basis for this timeline is that source controls (nutrient and irrigation efficiency improvements) and surface water treatment (e.g., constructed wetlands, buffer strips) are anticipated to result in improvements to surface water quality more rapidly that mitigation measures to reduce nitrate pollution in shallow groundwater. As noted previously, shallow groundwater is a contributing source of nutrients to surface waters; shallow groundwater moves slowly; and shallow groundwater will require longer time frames to respond to the full effects of source control measures.

The 30-year timeline to meet more-stringent dry-season biostimulatory substances allocations are based on the estimate that legacy nutrient loads, which are unrelated to current practices and are originating from groundwater and baseflow, may locally continue to contribute elevated nutrients to project area surface waters for several decades.[72] Therefore, staff anticipates that it will take a significant amount of time for legacy pollutant loads in shallow groundwater, and the subsequent baseflow pollutant loads to stream reaches, to attenuate.

In addition to these TMDL benchmarks, the Agricultural Order should establish timeframes for individual dischargers to achieve water quality standards; achieving water quality standards will result in achieving TMDL allocations based on a tiered-approach. Highest priority dischargers should have the shortest timeframe, such as those dischargers who pose the greatest risk to water quality due to discharges of nutrients. Lower prioritized dischargers that are also contributing to the impairments could have a longer timeframe, with the ultimate goal of verifiable progress towards achieving final load allocations, and therefore the TMDL, no later than thirty years from the effective date of the TMDL. Regarding urban storm water sources, wasteload allocations (WLAs) will be incorporated into NPDES MS4 storm water permits, and compliance with achieving wasteload allocations and timeline benchmarks will be implemented consistent with the requirements proposed in Section 7.4 .

[72] For example, the U.S. Geological Survey (USGS) reports that in spite of many years of efforts to reduce nitrate levels in the Mississippi River Basin, concentrations have not consistently declined during the past two decades. USGS concludes that elevated nitrate in groundwater are a substantial source contributing to nitrate concentrations in river water. Because nitrate moves slowly through groundwater systems to rivers, the full effect of management strategies designed to reduce loading to surface waters and groundwaters may not be seen in these rivers for decades. (see *“No Consistent Declines in Nitrate Levels in Large Rivers of the Mississippi River Basin”* USGS News Release dated 08/09/2011).

Table 7-5. Proposed Timelines to Achieve Interim and Final TMDL Allocations[A]

MILESTONES FOR WASTE LOAD ALLOCATIONS (WLAs)			
Water body	**First Interim WLA**[73]	**Second Interim WLA**	**Final WLA**
All waterbodies given wasteload allocations (WLAs) in Table 6-7	Achieve **MUN standard-based** and **Unionized Ammonia objective-based** allocations: Allocation-3 Allocation-4 **12 years after effective date of TMDL**	Achieve **Wet Season** (Nov. 1 to Apr. 30) **Biostimulatory target-based** TMDL allocations: Allocation-1 Allocation-2 **20 years after effective date of TMDL**	Achieve **Dry Season** (May 1 to Oct. 31) **Biostimulatory target-based** TMDL allocations: Allocation-1 Allocation-2 **30 years after effective date of TMDL**
MILESTONES FOR LOAD ALLOCATIONS (LAs)			
Water body	**First Interim LA**	**Second Interim LA**	**Final LA**
All waterbodies given load allocations (LAs) in Table 6-7	Achieve **MUN standard-based** and **Unionized Ammonia objective-based** allocations: Allocation-3 Allocation-4 **12 years after effective date of TMDL**	Achieve **Wet Season** (Nov. 1 to Apr. 30) **Biostimulatory target-based** TMDL allocations: Allocation-1 Allocation-2 Allocation-5 Allocation-6 **20 years after effective date of TMDL**	Achieve **Dry Season** (May 1 to Oct. 31) **Biostimulatory target-based** TMDL allocations: Allocation-1 Allocation-2 Allocation-5 Allocation-6 **30 years after effective date of TMDL**

[A] Refer back to Section 6.5 for a complete tabulation and description of the wasteload allocations and load allocations for the identified pollutant/water body combinations.

7.9.2 Evaluation of Progress

Water Board staff anticipate reviewing data and evaluating implementation efforts every three years. Water Board staff will utilize information submitted pursuant to the Agricultural Order to evaluate efforts on croplands. When and as appropriate, Water Board staff will rely on information generated by the County Farm Bureaus, University of California Cooperative Extension, and/or Natural Resources Conservation Service as part of existing and future projects (i.e. Clean Water Act Section 319(h) grants) to determine that existing rangeland efforts continue to protect water quality. Staff will also review annual

[73] It is important to recognize that the MUN standard for nitrate does not apply to all waterbodies in the project area (refer back to Table 2-1). Refer to Table 6-7 for a tabulation of the waste load allocations and load allocations for identified waterbody/pollutant combinations. . Note however, that unionized ammonia is a general Basin Plan objective, and all waterbodies would be required to meet this objective at the 12-year, first interim TMDL target benchmark.

reports submitted under the Phase II NPDES MS4 General Permit and the monitoring and reporting program to evaluate if MS4 entities are continuing to meet waste load allocations.

Recognizing there are uncertainties including, but not limited to, extreme inter-annual variability in pollutant loading to surface waters based on climatic conditions, flows, water management practices, uncertainties about the nexus between receiving water pollutant concentrations and leachate concentrations (refer back to footnote 120), etc., measures of TMDL implementation progress will not necessarily be limited to receiving water column concentration-based metrics and/or time-weighted average concentrations of water column pollutants.

Other metrics that can provide insight on interim progress to reduce nutrient pollution may be utilized, for example:

- assessments of mass-based load reductions;
- improvements in flow-weighted concentrations;
- estimates of the percent/scope/degree of implementation of management practices capable of ultimately achieving load allocations;
- improvements in receiving water nutrient-response indicators (i.e., dissolved oxygen, chlorophyll *a*, microcystins), etc.

In addition, while the waste load and load allocations are based on the MUN water quality standard of 10 mg/L, or biostimulatory numeric criteria, restoration of the AGR beneficial use (based on the 30 mg/L nitrate-N Basin Plan guideline value) during TMDL implementation can be used as an indication of interim progress.

Water Board staff may conclude in future reviews that ongoing implementation efforts may be insufficient to ultimately achieve the allocations and numeric target. If this occurs, Water Board staff will recommend revisions to the implementation plan. Water Board staff may conclude and articulate in the three-year review that to date, implementation efforts and results are likely to result in achieving the allocations and numeric target, in which case existing and anticipated implementation efforts should continue. If allocations and numeric targets are being met, Water Board staff will recommend the water body be removed from the 303(d) list.

7.10 Optional Special Studies and Reconsideration of the TMDLs

Additional monitoring and voluntary optional special studies would be useful to evaluate the uncertainties and assumptions made in the development of this TMDL. The results of special studies may be used to reevaluate waste load allocations and load allocations proposed in this TMDL. Implementing parties may submit work plans for optional special studies (if implementing parties choose to conduct special studies) for approval by the Executive Officer. Special studies completed and final reports shall be submitted for Executive Officer approval. Additionally, eutrophication is an active area of research; consequently ongoing scientific research on eutrophication and biostimulation may further inform the Water Board regarding wasteload or load allocations that are protective against biostimulatory impairments, implementation timelines, and/or downstream impacts.

Agricultural stakeholders have underscored the need to periodically re-evaluate the TMDL, including the proposed load allocations. Staff concurs in principle about the need to periodically re-evaluate the TMDL and water quality targets. At this time, based on the information and analyses presented in this TMDL Project Report staff maintains there is sufficient information to begin to implement the TMDL and make progress towards nutrient pollution reductions and attainment of water quality standards and the proposed allocations. It should be reiterated that immediate compliance with water quality objectives and attainment of water quality standards is not required nor expected. However, in recognition of the uncertainties regarding nutrient pollution and biostimulatory impairments, staff proposes that the Water Board reconsider the waste load and load allocations, if merited by optional special studies and new research, ten years after the effective date of the TMDL, which is upon approval by the Office of Administrative Law (OAL). A time schedule for optional studies and Water Board reconsideration of the TMDL is presented in Table 7-6.

Further, the Central Coast Water Board may also reconsider these TMDLs, the nutrient water quality criteria, or other TMDL elements on the basis of potential future promulgation of a statewide nutrient policy for inland surface waters in the State of California.

Table 7-6. Proposed time schedule for optional studies and Water Board reconsideration of WLAs and LAs.

Proposed Actions	Description	Time Schedule-Milestones
Optional studies work plans	Implementing parties shall submit work plans for optional special studies (if implementing parties choose to conduct special studies) for approval by Executive Officer	By five years after the effective date of the TMDL
Final optional studies	Optional studies completed and final report submitted for Executive Officer approval.	By eight years after the effective date of the TMDL
Reconsideration of TMDL	If merited by optional special studies or information from ongoing research into eutrophication issues, the Water Board will reconsider the Wasteload and Load allocations and/or implementation timelines adopted pursuant to this TMDL.	By ten years after the effective date of the TMDL

7.11 Potential Review of Water Quality Standards

Based on relevant future information, data, and research, the Central Coast Water Board has the discretion to conduct a water quality standards review which may potentially include one or more of the following: (1) The Water Board may designate critical low-flow conditions below which numerical water quality criteria do not apply, as consistent with federal regulations and policy; (2) The Water Board may authorize lowering of water quality to some degree if and where appropriate, if the Water Board finds water quality lowering to be necessary to accommodate important economic or social development. In authorizing water quality lowering the Water Board shall make any such authorizations consistent with the provisions and requirements of federal and state anti-degradation policies; (3) The Water Board may authorize revision of water quality standards, if appropriate and consistent with federal and state regulations, to remove a designated beneficial use, establishing subcategories of uses, establishing site specific water quality objectives, or other modification of the water quality standard. When a standards action is deemed appropriate, the Water Board shall follow all applicable requirements, including but not limited to those set forth in part 131 of Title 40 of the Code of Federal Regulations and Article 3 of Division 7, Chapter 4 of the California Water Code.

7.12 Assessing TMDL Achievement and Delisting Decisions

Achieving surface water nutrient reductions of the scale identified in this TMDL and in an agricultural watershed is necessarily subject to uncertainties. Agricultural stakeholders have noted some of these uncertainties, as reproduced below:

"It may not be possible to grow a leafy green vegetable or strawberry crop and comply with TMDL targets. These crops require soil solution concentrations in excess of the proposed targets and it will not be possible to completely eliminate system "leakage" in excess of numeric targets."

Kay Mercer, agricultural consultant
President, KMI

In a letter to Water Board staff dated Aug. 9, 2012

Staff maintains it is prudent to allow for flexibility, adaptation, and re-assessment as appropriate. It also should be noted that immediate compliance with water quality objectives are not contemplated or required by TMDLs. Staff are proposing interim wasteload and load allocations and benchmarks, and periodic re-consideration of the TMDL and appropriateness of the biostimulatory numeric water quality targets based on new research and information.

Also, various metrics of assessing interim progress towards TMDL achievement were presented in Section 7.7.

In terms of ultimately assessing TMDL achievement in waterbodies, evaluating exceedances of TMDL numeric targets identified herein and assessing future de-listing decisions to remove waterbodies from the CWA Section 303(d) list, staff will use the de-listing criteria and methodologies identified in Section 3 (California Delisting Factors) of the State Water Resources Control Board's *Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List* (i.e., "Listing Policy", SWRCB, 2004), or as consistent with any relevant revisions of the Listing Policy promulgated in the future.

7.12.1 Additional Considerations for Nutrient Water Quality Targets & Allocations

It is important to recognize the proposed nutrient water quality biostimulatory targets developed in this TMDL are predictions of the nutrient concentration levels necessary to be protective against biostimulation *based on current conditions*. However, recall that biostimulation is the result of a *combination of factors* (nutrients, flow and aeration, shading, canopy, etc.). Therefore, note that increased canopy shading, increased flow and aeration of stream water, and better water management can potentially achieve the same goal (better dissolved oxygen conditions, flushing of algae, etc.) regardless of whether the predicted biostimulatory nutrient targets and allocations herein are achieved. In other words, it is not necessary to be singularly focused on attempting to achieve the nutrient numeric water column concentration targets proposed in this TMDL, while disregarding other important factors that can limit the risk of biostimulation.

A goal of this TMDL is to address and mitigate biostimulatory impairments (as expressed by dissolved oxygen imbalances, excess algal biomass, and associated downstream impacts). In the future, if watershed conditions change (increased riparian canopy shading, better aeration of water column, better dissolved oxygen conditions in the water column), it will be prudent to potentially reconsider proposed nutrient numeric targets proposed herein. Less stringent nutrient numeric targets are generally merited in cases where increased canopy shading and/or water column aeration in a stream are attained. [74]

Additionally, attainment of receiving water TMDL numeric targets for nutrient-response indicators (i.e., dissolved oxygen water quality objectives, chlorophyll *a* targets and microcystin targets) may constitute a proxy demonstration of the attainment of the nitrate, nitrogen and orthophosphate-based seasonal biostimulatory wasteload and load allocations.

[74] Regardless of the appropriate levels of nutrients necessary to protect against biostimulation and downstream biostimulatory impacts, nitrate water quality objectives must still be met to protect other beneficial uses (e.g., MUN-drinking water standards, GWR-groundwater recharge)

7.13 Cost Estimate

7.13.1 Preface

The TMDLs contained herein address impairments due to exceedances of existing State water quality objectives. Although the State must consider a variety of factors in establishing the different elements of a TMDL, considering the economic impact of the required level of water quality is not among them. The SWRCB Office of Chief Counsel notes that the economic impact was already previously determined when the water quality standard was adopted[75] consistent with Water Code Section 13241 and pursuant to the basin planning process. The statutory directive under the federal Clean Water Act to adopt TMDLs to "implement the applicable water quality standards" is not qualified by the predicate "so long as it is economically desirable to do so." This conclusion does not change when a TMDL is established to implement a narrative water quality objective (SWRCB, Office of Chief Counsel, 2002). Therefore, not only would an in-depth economic analysis be redundant, it would be inconsistent with federal law (SWRCB, Office of Chief Counsel, 2002). Further, the SWRCB Office of Chief Counsel states that under the Porter-Cologne Water Quality Control Act §13141 (i.e., implementation of agricultural water quality control programs), the Regional Boards "are not required to do a formal cost-benefit analysis" under the statute. This statute focuses only on costs and financing sources (SWRCB, Office of Chief Counsel, 1997).

7.13.2 Cost Estimates for Irrigated Agriculture

In accordance with §13141 of the Porter-Cologne Water Quality Control Act, prior to implementation of any agricultural water quality control program the Water Boards are required to estimate the total cost of such a program. It should be noted that the statute does not require the Water Boards to do, for example, a cost-benefit analysis or an economic analysis (see preface above).

There is substantial uncertainty in calculating total costs associated with TMDL implementation measures. This is in part, due to the uncertainty surrounding the number of facilities and farms that will require TMDL implementation. Also, it is important to note that the Water Board cannot mandate or designate the specific types of on-site actions[76] necessary to reduce nutrient loading, or to meet allocations by the various responsible parties. Specific actions or management measures that are described or identified in the project report can only be suggestions or examples of actions that are known to be effective at reducing loading.

Further, it is should be recognized that implementation measures to reduce nutrient pollution are already required by compliance with an existing regulatory

[75] State Water Resources Control Board, Office of Chief Counsel, memo June 12, 2002: *"The Distinction Between a TMDL's Numeric Targets and Water Quality Standards"*

[76] Porter-Cologne Water Quality Control Act §13360.(a)

program [Agricultural Order No. R3-2012-0011, including any pending and future renewals of the Order]. Compliance with these implementation measures are required *with or without* the TMDL and are therefore not attributable to TMDL implementation As outlined in Section 7.3, this TMDL is relying on the Agricultural Order for TMDL implementation, and this TMDL is not proposing the adoption of new regulatory tools for irrigated cropland. In part, the TMDL can be considered an informational tool to focus and facilitate implementation, and assist the Water Board in making its plan to implement state water quality standards.

In addition, the proposed TMDL is not anticipated to incur additional, incremental costs to owners/operators of irrigated lands on the basis of surface receiving water quality monitoring. The Cooperative Monitoring Program (an entity that collects data on behalf of growers to comply with the Agricultural Order) at this time appears to be collecting data at a sufficient temporal and spatial scale to allow determination of progress towards achievement of the TMDL.

Also noteworthy, the cost estimates in TMDLs do not require economic cost-benefit analysis (see §13141 of the Porter-Cologne Water Quality Control Act; and SWRCB, Office of Chief Counsel, 1997) and these estimates thus constitute gross out-of-pocket expenses which do not contemplate potential net cost-savings associated with TMDL implementation measures (for example long-term savings associated with improved irrigation and nutrient efficiency). In addition, some of the implementation costs likely will not constitute direct out-of-pocket expenses to growers, as the state and federal government have made funding sources, incentive payments, and grants available to address nonpoint sources of pollution and to implement TMDLs (see Section 7.15). For example, in Fiscal Year 2011, just one grant funding source (i.e., the Proposition 84 Agricultural Water Quality Grant Program) made $1,250,000 available to assist growers with irrigation and nutrient management in the Santa Maria Watershed.

Load allocations for irrigated cropland are proposed to be implemented using an existing regulatory tool – the Agricultural Order. As such, the extent this TMDL would incur incremental costs – if any – above and beyond what is already required in the Agricultural Order is necessarily subject to significant uncertainty.

Indeed, the State Water Resources Control Board recently issued a draft Water Quality Order explicitly concluding that generally, TMDL implementation does not incur additional costs above and beyond what is already in the Agricultural Order:

> *"[A] discharger's implementation of the Agricultural Order will constitute compliance with certain applicable TMDLs.* ***In other words, the TMDL provision does not lead to any costs above and beyond what is already required by the Agricultural Order. In addition, the Agricultural Order is simply the implementation vehicle for TMDL compliance**** *– it does not require dischargers to do anything more than would be required of them under the applicable TMDLs"*
>
> * *emphasis added*
>
> *From: California State Water Resources Control Board, Draft Water Quality Order, Change Sheet #1 (Circulated 09/19/12) In the Matter of the Petitions Of Ocean Mist Farms And Rc Farms; Grower-Shipper Association Of Central California, Grower-Shipper Association Of Santa Barbara And San Luis Obispo Counties, And Western Growers For Review of Conditional Waiver of Waste Discharge Requirements Order No. R3-2012-0011 Discharges from Irrigated Lands*

However, because of the magnitude and scope of nutrient pollution in the lower Santa Maria River and Oso Flaco Lake watersheds, staff anticipates a higher degree and scope of nutrient pollution mitigation measures will need to occur, either voluntarily or due to TMDL implementation, relative to other areas of California's central coast region. Therefore, staff concludes it would be prudent to develop estimates associated with potential incremental costs pertaining to attainment of water quality standards for nutrients and TMDL implementation.

Cost estimates to comply with the existing Agricultural Order have previously been developed (Central Coast Regional Water Quality Control Board, 2011). It should be noted that these were scoping level assessments because it is difficult to estimate costs due to the absence of information regarding current extent of management practices implementation, and how the costs of the Agricultural Order would represent incremental increases above current costs. Water Board Agricultural Program staff therefore applied best professional judgment and conservative assumptions in constructing an estimate of total cost for management practice implementation for the Agricultural Order. The assumptions and information that went into developing the Agricultural Order cost estimates can be found in: *Central Coast Regional Water Quality Control Board. 2011. Technical Memorandum: Cost Considerations Concerning Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands; in: Appendix F – Staff Recommendations for Agricultural Order (March, 2011).* Table 7-7 presents the cost estimates to implement the Agricultural Order throughout the entire Central Coast Region.

Table 7-7. Cost estimates to implement Agricultural Order for Central Coast Region.

Table 7: Estimation of Cost to Implement Management Practices

Management Practice Category	Area Basis (Acres)	Acres/ Operation	Acres	Correction Factor	Acres Practice Applied to:	Cost/Acre [d]	Cost Year 1	% Year 1 Cost in Yrs 2-4	Cost Years 2-4	Cost 5 Years
Sediment / Erosion Control & Stormwater Management	Total irrigated farm acreage[a]	NA	539,284	5%	26,964	$992	$26,748,486	25%	$26,748,486	$53,496,973
Irrigation Management	Operations with tailwater[b]	NA	74,121	50%	37,061	$903	$33,465,632	10%	$13,386,253	$46,851,884
Nutrient & Salt Management	Total Vegetable Crop acreage[c]	NA	444,443	20%	88,889	$56	$4,977,762	25%	$4,977,762	$9,955,523
Pesticide Runoff / Toxicity Elimination	102 Operations on toxicity impaired streams	20	2,040	50%	1,020	$72	$73,440	50%	$146,880	$220,320
Aquatic Habitat Protection	10 Large Operations on temp. & turbidity impaired streams	1,000	10,000	50%	5,000	$1,184	$5,920,000	10%	$2,368,000	$8,288,000
						One Year	$71,185,320		Five Years	$118,812,700
						Per Operation	$23,728		Per Operation	$39,604

[a] State Farmland Mapping Program (FMMP) data consists of farmland classifications that include Prime Farmland, Farmland of Statewide Importance, Unique Farmland, and Farmland of Local Importance.

[c] Total Vegetable Crop acreage from County Crop Reports, Table 12. Staff assumed these crops have high potential to discharge nitrogen to groundwater.

[b] Amount of irrigated acreage that has tailwater and is enrolled and active. Source: Central Coast Regional Water Quality Control Board Agricultural Regulatory Program Database, December 2009. While the number of operations is dynamic, staff has not made a broad effort to verify the accuracy of reported irrigated acreage and tailwater acreage. Growers can continually update their irrigated acreage and tailwater acreage to reflect seasonal growing changes. The Water Board officially requested acreage updates in 2007 and 2008.

[d] Median of high end of cost range/acre, or, unit cost/acre, whichever is higher from Table 5.

Staff endeavored to estimate incremental costs associated with implementing this TMDL, by using the information in Table 7-7. Accordingly staff: (1) scaled down the acreage in Table 7-7 requiring implementation of management practices to the scale of the TMDL project area; and (2) staff scaled up some of the correction factors[77] found in Table 7-7 in recognition of the fact that the magnitude of nutrient pollution exceeds most other areas of the central coast region and will likely require greater efforts to address. The acreage and correction factors are shown in Table 7-8.

[77] Correction factors are an estimate of the ratio of irrigated acres that might be subject to actual management to reduce pollutant discharges.

Table 7-8. Farmland acreage and correction factors for Central Coast Region vs. TMDL project area.

	Amount of farmland[A] (acres)	Regional Correction Factor[B] Used for Agricultural Order	Correction Factor used for TMDL Project Area	Basis for Scaling Up Correction Factor in TMDL Project Area
Central Coast Region (Region 3)	738,429	50%	**50%**	Not scaled up: TMDL project area growers have already substanitally improved irrigation efficiency in recent years see Section 7.15
TMDL project area	52,854	20%	**60%**	Scaled up by factor of 3 Magnitude of nutrient pollution in surface waters and groundwater in the TMDL project area will require more concerted efforts to address than in many other central coast watersheds.
Farmland Acreage Ratio: TMDL Project Area compared to Region 3	7.2% Ratio: TMDL Project Area compared to Region 3	50%	**100%**	Scaled up by factor of 2 Magnitude of nutrient pollution in surface waters and groundwater in the TMDL project area will require more concerted efforts to address than in many other central coast watersheds.

[A] source: CA Dept. of Conservation, Div of Land Resource Protection, Farmland Mapping and Monitoring Program, 2008.
[B] correction factors are an estimate of the ratio of irrigated acres that might be subject to actual management to reduce pollutant discharges.

Table 7-9 presents the geographically scaled-down, estimated compliance costs associated with the Agricultural Order that may be incurred for farmland within the TMDL project area (based on the regional estimates from Table 7-7).

Table 7-10 illustrates estimated summed costs are that are associated with compliance with the Agricultural Order, plus incremental costs potentially attributable to TMDL implementation.

Table 7-9. Cost estimates based on standard compliance with Agricultural Order in TMDL Project Area.

Management Practice Category	Area Basis (Acres)[A]	Acres	Correction Factor	Acres Practice Applied to:	Cost per Acre	Cost - Year 1	% Year 1 Cost in Yrs 2-5	Cost Years 2-5	Ag Order Cost 5 Years
Irrigation Management	7.2% of corresponding acreage from Table 7-7	5,337	50%	2,669	$903	$2,410,107	10%	$964,043	$3,374150
Nutrient Management	7.2% of corresponding acreage from Table 7-7	32,000	20%	6,400	$56	$358,400	25%	$358,400	$716,800
Aquatic Habitat Protection	7.2% of corresponding acreage from Table 7-7	720	50%	360	$1,184	$426,240	10%	$170,496	$596,736
									$4,687,686

[A] The 7.2% fraction in this column is the ratio (%) of FMMP farm acres in the TMDL area compared to FMMP farm acres in all of Region 3

Table 7-10. Cost estimates associated w/ Agricultural Order compliance plus estimated incremental TMDL implementation costs in the TMDL Project Area.

Management Practice Category	Area Basis (Acres)[A]	Acres	Correction Factor	Acres Practice Applied to:	Cost per Acre	Cost - Year 1 of TMDL Implementation	% Year 1 Cost in Yrs 2-5	Cost Years 2-5	Ag Order plus TMDL Cost 5 Years
Irrigation Management	10% of corresponding acreage from Table 7-7	5,337	50%	2,669	$903	$2,410,107	10%	$964,043	$3,374,150
Nutrient Management	10% of corresponding acreage from Table 7-7	32,000	60%	19,200	$56	$1,075,200	25%	$1,075,200	$2,150,400
Aquatic Habitat Protection	10% of corresponding acreage from Table 7-7	720	100%	720	$1,184	$852,480	10%	$340,992	$1,193,472
									$6,718,022

[A] The 7.2% fraction in this column is the ratio (%) of FMMP farm acres in the TMDL area compared to FMMP farm acres in all of Region 3

Based on the information presented in Table 7-9 and Table 7-10, the incremental costs associated with TMDL implementation for five years are approximately 3 million dollars as shown in Table 7-11. As discussed previously, this estimate is subject to significant uncertainty, however staff endeavored to use available information to develop these estimates in an effort to inform the interested public and decisions makers.

Table 7-11. Incremental costs attributable to TMDL implementation.

A. Management Practice Category	B. Ag Order Standard Compliance Cost Estimate 5 Years	C. Ag Order plus TMDL Implementation Cost 5 Years	D. Incremental Cost Attributable to TMDL Implementation 5 Years *(Column B substracted from Column c)*
Irrigation Management	$3,374,150	$3,374,150	$0
Nutrient Management	$716,800	$2,150,400	$1,433,600
Aquatic Habitat Protection	$596,736	$1,193,472	$596,736
Total	$4,687,686	$6,718,022	
Total Incremental Cost Attributable to TMDL Implementation* (5 Years)			**$2,030,336**

* *Total from Column B subtracted from Total from Column C*

Based on information in the 2011 technical documentation for the Agricultural Order and information developed in this section, an estimated incremental cost attributable to TMDL implementation for irrigated agriculture over 5 years is approximately **$2 million.** This represents, on average, an estimated unit-area cost of **$38 per acre of farmland*** in the TMDL project area **over a period of five years of implementation**.

These represent incremental costs specifically associated with TMDL implementation; it should be reiterated that implementation measures to reduce nutrient pollution are already required by compliance with an existing regulatory program (Agricultural Order No. R3-2012-0011) regardless of whether or not there is a TMDL.

* *as represented by the* CA Dept. of Conservation, Div of Land Resource Protection, Farmland Mapping and Monitoring Program, 2008

7.13.3 Cost Estimates for MS4 Entities

Anticipating incremental costs attributable specifically to TMDL implementation with any accuracy is challenging for several reasons. Many of the actions, such as review and revision of policies and ordinances by a governmental agency, could incur no significant costs beyond the program budgets of those agencies. However, other actions, such as establishing nonpoint source implementation programs and establishing assessment workplans carry discrete costs.

Cost estimates are further complicated by the fact that some implementation actions are necessitated by other regulatory requirements or are actions anticipated regardless of whether or not the TMDL is adopted. Therefore assigning all of these costs to TMDL implementation would be inaccurate. It also is important to note that reported MS4 program costs are not all attributable to compliance with MS4 permits. Many program components, and their associated costs, existed before any MS4 permits were issued. For example, street sweeping and trash collection costs cannot be solely or even principally attributable to MS4 permit compliance, since these practices have long been implemented by municipalities. Therefore, true program cost resulting from MS4 permit requirements is some fraction of reported costs.

Guidance and information on preparing scoping-level cost estimations were provided to staff by Brandon Steets, P.E. of Geosyntec Consultants. Geosyntec Consultants is an engineering firm with substantial experience assisting MS4 entities in California with TMDL implementation. Estimated BMP capital and O&M costs are available in Technical Appendix C of the Strategic BMP Planning and Analysis Tool (SBPAT)[78]. SBPAT is a public domain, water quality analysis tool intended to facilitate the selection of BMP project opportunities and technologies in urban watersheds. These estimated unit BMP capital costs and annual maintenance costs are presented in Table 7-12 and Table 7-13, respectively. These tables are from technical appendix C of the SBPAT documentation.

Unit-area costs are based on cost per treated acre for a specific management practice. It would be highly speculative for staff to identify what percentage of the area of the MS4 footprint would require implementation, and indeed what percentage of this area will receive implementation with or without a TMDL pursuant to existing permits and other environmental projects. Implementation over 100% of the MS4 footprint is clearly impractical, and cost-prohibitive. Implementation will undoubtedly be focused are areas or land uses that are identified as water quality risks and require implementation. Therefore, it is presumed that implemenation, on a unit-area basis, will occur over catchement areas that are substantially smaller than the footprint of the MS4.

[78] Online linkage: http://www.sbpat.net/

Table 7-12. Estimated unit BMP capital costs by design volume, flow rate, and footprint area.

	Best Management Practice	Reference Catchment Size (acres)	Normalized Capital Cost $ / ac-ft	Normalized Capital Cost $ / cfs	Normalized Capital Cost $ / ft^2
Distributed	Cisterns	1	$122,000 - $203,000	NA	NA
	Bioretention	1	$361,000 - $602,000	NA	$3.80 - $6.30
	Vegetated Swales	10	NA	$12,600 - $21,000	$5.30 - $8.90
	Green Roofs	1	$3,490,000 - $5,800,000	NA	$20 - $35
	Permeable Pavement	1	NA	$153,000 - $255,000	$3.00 - $5.00
	Gross Solids Separators	10	NA	$50,000- $84,000	NA
	Catch Basin Inserts	10	NA	$5,400 - $9,000	NA
	Media Filters	10	NA	$47,000 - $78,000	NA
Regional	Infiltration Basins	100	$58,000 - $97,000	NA	$3.30 - $5.50
	Dry Detention Basins	100	$32,000 - $54,000	NA	$1.80 - $3.00
	SSF Wetlands	100	NA	$140,000 - $233,000	NA
	Constructed SF Wetlands	100	$36,000 -$48,000	NA	$1.80 - $3.00
	Treatment Plants	100	NA	$400,000 - $670,000	NA
	Hydrodynamic Devices	100	NA	$50,000- $84,000	NA
	Channel Naturalization	100	NA	NA	$1.80 - $3.00

Table 7-13. Estimated unit BMP annual maintenance costs by design volume, flow rate, and footprint area.

	Best Management Practice	Reference Catchment Size (acres)	Normalized Annual Maintenance Cost $ / ac-ft	Normalized Annual Maintenance Cost $ / cfs	Normalized Maintenance Cost $ / ft^2
Distributed	Cisterns	1	$1,400 - $2,300	NA	NA
	Bioretention	1	$7,300 - $12,200	NA	$0.08-$0.13
	Vegetated Swales	10	NA	$200 - $300	$0.85-$1.40
	Green Roofs	1	$6,500 - $10,900	NA	$0.04-$0.06
	Permeable Pavement	1	NA	$300 - $400	$0.01-$0.02
	Gross Solids Separators	10	NA	$20 -$40	NA
	Catch Basin Inserts	10	NA	$1,300 - $2,200	NA
	Media Filters	10	NA	$6,500 - $10,900	NA
Regional	Infiltration Basins	100	$1,200 - $1,900	NA	$0.07 - $0.11
	Dry Detention Basins	100	$300 - $500	NA	$0.02 - $0.03
	SSF Wetlands	100	NA	$1,600 - $2,700	NA
	Constructed SF Wetlands	100	$1,100 - $1,800	NA	$0.05 - $0.09
	Treatment Plants	100	NA	$500 - $800	NA
	Hydrodynamic Devices	100	NA	$20 -$40	NA
	Channel Naturalization	100	NA	NA	$0.02 - $0.03

Geosyntec consultants suggested that for urban nutrient pollution control, Water Board staff should primarily focus on unit-area costs associated with bioretention and wetland treatement strategies (refer again to Table 7-12 and Table 7-13). Some these management strategies could represent entirely new practices associated with TMDL implementation that might not occur under existing permit requirements or as associated with other non-regulatory watershed improvement projects. Therefore, some unit-area costs potentially associated with strategies to implement the TMDL can be estimated. This approach is consistent with legal guidance from the State Water Resources Control Board's Office of Chief Counsel, whom have stated that economic considerations in a TMDL should determine: 1) what methods of compliance are reasonably foreseeable to attain the allocations; and 2) what are the *costs of these methods* (SWRCB, Office of Chief Counsel, 1997).

Therefore, for implementation of this TMDL by MS4 entities, a range of unit costs to implement bioretention and vegetated and wetland treatments strategies are estimated to range as shown in Table 7-14.:

Table 7-14. Unit costs for MS4 TMDL implementation

Implementation Strategy Methods	Costs of Method
SSF wetlands (subsurface flow wetlands)	➢ Estimated Normalized Capital Costs ($/cfs): $140,000 - $233,000 ($/cfs) to treat 100 acres of catchment size. ➢ Estimated Annual Maintenance Cost ($/cfs): $1,600 - $2,700 ($/cfs) to treat 100 acres of catchment size.
Constructed SF wetlands (surface flow wetlands)	➢ Estimated Normalized Capital Costs ($/ft^2): $1.80 - $3.00 ($/ft^2) to treat 100 acres of catchment size. • Estimated Annual Maintenance Cost ($/ft^2): $0.05 to $0.09 ($/ft^2) to treat 100 acres of catchment size.
Channel Naturalization	➢ Estimated Normalized Capital Costs ($/ft^2): $1.80 - $3.00 ($/ft^2) to treat 100 acres of catchment size. ➢ Estimated Annual Maintenance Cost ($/ft^2): $0.02 to $0.03 ($/ft^2) to treat 100 acres of catchment size

7.14 Sources of Funding

The Central Coast Water Board recognizes that certain limited resource farmers (as defined by the U.S. Dept. of Agriculture) may have difficulty achieving compliance with this TMDL. The Central Coast Water Board will prioritize assistance for these farmers, including but not limited to technical assistance, grant opportunities, and necessary flexibility to achieve compliance (e.g., adjusted monitoring, reporting, or time schedules).

In accordance with §13141 of the Porter Cologne Water Quality Control Act, prior to implementation of any agricultural water quality control program the Water Board is required to identify potential sources of funding. Accordingly, in this section, Staff provides some examples of funding sources. Potential sources of financing to TMDL implementing parties include the following:

7.14.1 Federal Farm Bill

Title II of the 2008 Farm Bill (the Food, Conservation, and Energy Act of 2008, in effect through 2012) authorizes funding for conservation programs such as the Environmental Quality Incentives Program (EQIP) and the Conservation Stewardship Program. Both of these programs provide financial and technical assistance for activities that improve water quality on agricultural lands. For example, the NRCS provides financial and technical assistance to growers to improve water quality.

The assistance is through the Agricultural Water Enhancement Program, an element of the NRCS EQIP. The program is a voluntary conservation initiative in which NRCS develops partnership agreements with eligible growers. Farm bills typically are in place for four to five years. Subsequent farm bills may expand, reduce, eliminate, or replace EQIP. Farm bills or other future legislation may authorize spending for direct grants, loans, or cost sharing for irrigation practices that improve water quality.

7.14.2 State Water Resouces Control Board - 319(h) Grant Program

The Division of Financial Assistance administers water quality improvement programs for the State Water Board. The programs provide grant and loan funding to reduce nonpoint source pollution discharge to surface waters. The Division of Financial Assistance currently administers two programs that improve water quality—the Agricultural Drainage Management Loan Program and the Agricultural Drainage Loan Program. Both of these programs were implemented to address the management of agricultural drainage into surface water. The Agricultural Water Quality Grant Program provides funding to reduce or eliminate the discharge of nonpoint source pollution from agricultural lands into surface and groundwater. It is currently funded through bonds authorized by Proposition 84. The State Water Pollution Control State Revolving Fund Program also has funding authorized through Proposition 84. It provides loan funds to a wide variety of point_source and non point source water quality control activities. The State Water Board also administers Clean Water Act funds that can be used for agricultural water quality improvements.

More information is also available from the California State Water Resources Control Board site at http://www.swrcb.ca.gov/water_issues/programs/grants_loans/319h/index.shtml, or contact Melenee Emanuel, State Board Division of Water Quality, 319(h) Grants Program at (916) 341-5271.

7.14.3 Agricultural Water Quality Grant Program

The Agricultural Water Quality Grant Program provides funding for projects that reduce or eliminate non-point source pollution discharge to surface waters from agricultural lands. Funding from Propositions 40 and 50 were administered through two solicitations, most recently the 2005-2006 Consolidated Grants Process. Additional funds will be made available in the future through Proposition 84. More information on the Agricultural Water Quality Grant Program is available from the State Water Resources Control Board at:

http://www.waterboards.ca.gov/water_issues/programs/grants_loans/awqgp/index.shtml

7.14.4 Safe, Clean, and Reliable Drinking Water Supply Act of 2010

This act was passed by the Legislature as SBX 7_2, and if approved by voters in November of 2010, would provide grant and loan funding for a wide range of water-related activities, including agricultural water quality improvement, watershed protection, and groundwater quality protection. The actual amount and timing of funding availability will depend on its passage, on the issuance of bonds and the release of funds and on the kinds of programs and projects proposed and approved for funding.

7.14.5 Other Sources of Funding for Growers and Landowners

Both the Cachuma Resource Conservation District and the Coastal San Luis Resource Conservation District can provide access to and/or facilitate a land owner's application for federal cost-share assistance through various local, state and federal funding programs. For certain projects these RCDs may also be able to apply for other grant funds on behalf of a cooperating landowner, grower or rancher. More information may be obtained from their websites.

Cachuma RCD - http://www.rcdsantabarbara.org/

Coastal San Luis RCD - http://www.coastalrcd.org/

7.15 Existing Implementation Efforts

There are many proactive agricultural producers within the TMDL project area as evidenced by their participation in Resource Conservation District special projects[79] [80] as well as implementation of irrigation and nutrient management measures. For example, some growers have purchased laboratory equipment

[79] Cachuma Resource Conservation District. Santa Maria River Watershed Non-Point Source Pollution Management Plan. September 2000.
[80] Cachuma Resource Conservation District. Nitrate and Sediment Assessment, Oso Flaco Watershed, San Luis Obispo County, California. August 2004

to conduct soil and petiole testing that is helpful in evaluating soil and crop nutrient conditions; thereby optimizing the use of fertilizers.

In addition, many agricultural producers have implemented irrigation management practices and field grading practices to reduce runoff. For example, staff evaluated data submitted as part of the Agricultural Order and found that the TMDL Project Area contains 421 ranches totaling 46,467 acres of irrigated agriculture. This data also indicates that nearly over half of all operations (55%) and irrigated acreage (44%) utilize micro-irrigation practices during the growing season as shown in Table 7-15.

Table 7-15. Irrigation Management Measures in Project Area

Irrigation Type	Number of Ranches	Acreage	Crop Type
Micro-irrigation (year-round)	72	4,000	Orchards, vineyards, nursery, greenhouses (some row crops)
Non Sprinkler (growing season)	160	16,563	Row crops (broccoli, strawberry, cauliflower, head lettuce)
Sprinkler (growing season)	137	16,551	Row crops (broccoli, strawberry, cauliflower, head lettuce)
Sprinkler and surface irrigation (year-round)	52	8,897	Row crops (broccoli, head lettuce)
Surface Irrigation (year-round)	9	456	Row Crops (strawberry, broccoli)
Totals	421	46,467	

8 PUBLIC PARTICIPATION

Staff conducted stakeholder outreach efforts throughout the project process. Staff worked with city, county, state, and federal agencies during the data collection and data analysis phases. Results of coordinated efforts were publicized in newspapers and distributed via email.

Staff made several presentations and engaged with stakeholders during the development of the TMDL. Staff made contact with and/or persons from the following list attended the meetings:

- Cattle ranchers
- Cachuma Resource Conservation District
- Coastal San Luis Resource Conservation District
- Irrigated agriculture representatives
- City of Santa Maria
- Central Coast Salmon Enhancement

- City of Guadalupe
- Santa Barbara County
- San Luis Obispo County
- Laguna County Sanitation District
- Nipomo Community Services District
- Northern Chumash Tribal Council
- San Luis Obispo Coast Keeper
- San Luis Obispo Farm Bureau
- State Parks
- U.S. Fish and Wildlife Service
- UC Cooperative Extension

Staff conducted CEQA stakeholder scoping meetings on December 12, 2006, and February 26, 2007, and October 16, 2008. Staff addressed questions and comments from attendees.

Staff held other stakeholder meetings in January 25, 2011, June 14, 2012, and November 9, 2012 prior to the formal public comment period preceding the Central Coast Water Board public hearing to consider adoption of the TMDL. Staff responded orally to public comments and questions at the stakeholder meetings.

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A. APPENDIX A - WATERSHED DESCRIPTION

The Santa Maria Watershed (Santa Maria Hydrologic Unit 312.00 in the Basin Plan) is located in northwestern Santa Barbara County and southwestern San Luis Obispo County, California. Headwaters extend into portions of Ventura County to the east. The Oso Flaco Lake subwatershed is located in the northwest portion of the Santa Maria Watershed, though there are no surface water interactions with the Santa Maria River. The watersheds are about 50 miles north of Point Conception and about 150 miles south of Monterey Bay on the central California coast. The climate is mild with a rainfall average of 14 inches per year in the Project Area.

The area is a broad alluvial plain near the ocean, tapering gradually inland. Upland or mesa areas, foothills, and mountain complexes further define the alluvial plain boundary. The following information was taken from the Santa Maria Estuary Enhancement Plan (SMEEP, March, 2004):

> The Guadalupe-Nipomo Dunes complex, located approximately 40 miles north of Point Conception, is one of the most extensive coastal dune and dune wetland habitats in the nation. The Santa Maria River is one of the largest rivers on the central coast of California (between Point Lobos and Point Conception), and it begins at the confluence of the Cuyama and Sisquoc rivers. The Santa Maria River flows through the dunes complex and forms the estuary at its mouth. Portions of the upper Sisquoc River, from its origin in the Los Padres National Forest boundary, was designated as wild and scenic (Public Law 90-542, 16 U.S.C. 1271-1287, as amended) in 1992. Other major tributaries that contribute to the Santa Maria or Sisquoc River include La Brea Creek, Tepusquet Creek, and Foxen Creek that flow into the Sisquoc River, and Nipomo Creek, Suey Creek, and Solomon-Orcutt Creek that flow into the Santa Maria River. Huasna Creek and Alamo Creek also flow into the Cuyama River upstream from Twitchell Reservoir.
>
> Downstream of Highway 1 the Santa Maria River flows freely in the natural riverbed and the channel is bordered by extensive stands of riparian vegetation (dominated by willows) in some areas, and earthen agricultural levees adjacent to cultivated fields and urbanized portions of the City of Guadalupe on the southern high river terrace. Levees in the study reach were constructed for the purpose of protecting bottomland fields from flood flows and were constructed by individual landowners rather than by the U.S. Army Corps of Engineers (USACE) or the Santa Barbara Flood Control District (SBFCD).
>
> Upstream of Highway 1 the Santa Maria River is physically constrained by earthen and rock levees that were constructed by the USACE in the 1950s to protect the City of Santa Maria and adjacent agricultural lands from flooding. Flows from the Cuyama River are regulated by Twitchell Dam, which was also constructed by the Bureau of Reclamation in the 1950s as part of the comprehensive Santa Maria Flood Control Project. Twitchell Dam functions both as a water conservation and flood control facility. The USACE levees extend from Fugler Point (near the town of Garey) and terminate at the upstream side of the Highway 1 Bridge in the City of Guadalupe.

> The Santa Maria River exhibits substantial variability in its hydrology and biology. Upstream of Highway 1, the river is dry for most of the year, flowing intermittently in a braided pattern during and shortly after rainfall events, and during releases from Twitchell Dam[81]. Riparian vegetation in this reach is comprised primarily of willows, mulefat, with mock heather, coyote brush, other coastal scrub species on higher terraces, and weeds; vegetation is not contiguous and is absent in some reaches along the levees and in the scour zones. Downstream from Highway 1, shallow surface water is almost always present and riparian vegetation is more prevalent, in some places forming a wide, dense riparian corridor. Flows observed during the dry season above Highway 1 are largely a result of agricultural or urban runoff, and releases from Twitchell Dam that are conducted for the purpose of recharging the Santa Maria groundwater basin. Alternatively, flows observed downstream from Highway 1 during the dry season are due primarily to agricultural and urban runoff, as well as emergence of subsurface flow. A significant source of water into the estuary is Solomon-Orcutt Creek, which drains a primarily agricultural area as well as the community of Orcutt for a watershed area of approximately 50,000 acres.

The Santa Maria Valley groundwater basin extends south from the Nipomo Mesa to the Orcutt Uplands. The Santa Maria groundwater basin is divided into five sub-basins: the Santa Maria, Orcutt, Nipomo, and Upper and Lower Guadalupe sub-basins. The Upper Guadalupe sub-basin constitutes the upper unconfined portion of the sub-basin and the Lower-Guadalupe is a deeper confined aquifer separated from the upper sub-basin by clay layers. Coarse-grained alluvial channel deposits in the river grade to finer silt and clay flood deposits as distance from the river channel increases.

The groundwater system supplies most of the area's water supplies, and is closely related to the impairments. The land uses in the lower Santa Maria river and Oso Flaco Lake watersheds (the Project Area) are a blend of open space including rangeland, irrigated agriculture, rural residential, and urban areas.

The Oso Flaco Lake watershed drains about 20 square miles of primarily agricultural land (strawberries/vegetables) and is located in southwest San Luis Obispo County, just north of the Lower Santa Maria River watershed. Prior to the 1860's, the outlet of the Santa Maria River was in the proximity of Oso Flaco Lake. Early in the 20th century, some of the floodwater from the Santa Maria River was routed through the creek; however, this route was permanently blocked when the river levees were constructed in the early 1960s [82].

Oso Flaco Lake and Little Oso Flaco Lake are features within the Guadalupe/Nipomo Dune Lakes complex, unique in that they are freshwater bodies located in ocean sand dunes (see Appendix D, Figure 1). Outflow from Oso Flaco Lake enters the Pacific Ocean via a channel that may be occasionally obstructed by dune sand and require clearing [83]. Oso Flaco Lake receives flow from Little Oso Flaco Lake through a 1,000- foot channel. Little Oso Flaco Lake

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[81] The purpose of the releases from Twitchell Dam is to recharge the Santa Maria groundwater basin. During dry periods of the year, water is released at a rate to ensure percolation occurs upstream of the Bonita School Road crossing (Santa Maria Valley Water Conservation District).
[82] Cachuma Resource Conservation District. 2004. Nitrate and Sediment Assessment, Oso Flaco Lake.
[83] Cachuma Resource Conservation District. 2000. Santa Maria River Watershed Non-point Source Pollution Management Plan.

receives flow from Oso Flaco Creek and Little Oso Flaco Creek, which meets Oso Flaco Creek approximately one mile upstream of the lake (see Appendix D, Figure 2).

The watershed area and major waterbodies are shown in Figure A-1.

There are several municipalities within the Santa Maria Watershed. The largest city is the City of Santa Maria, which is located in the western portion of the watershed. The City is approximately 22 square miles and has an estimated population of approximately 91,110 (2000 Census). To the west of the City of Santa Maria, the City of Guadalupe is home to approximately 5,659 people (2000 Census). There are also several small unincorporated towns within this watershed, including Nipomo in San Luis Obispo county and Orcutt in Santa Barbara county.

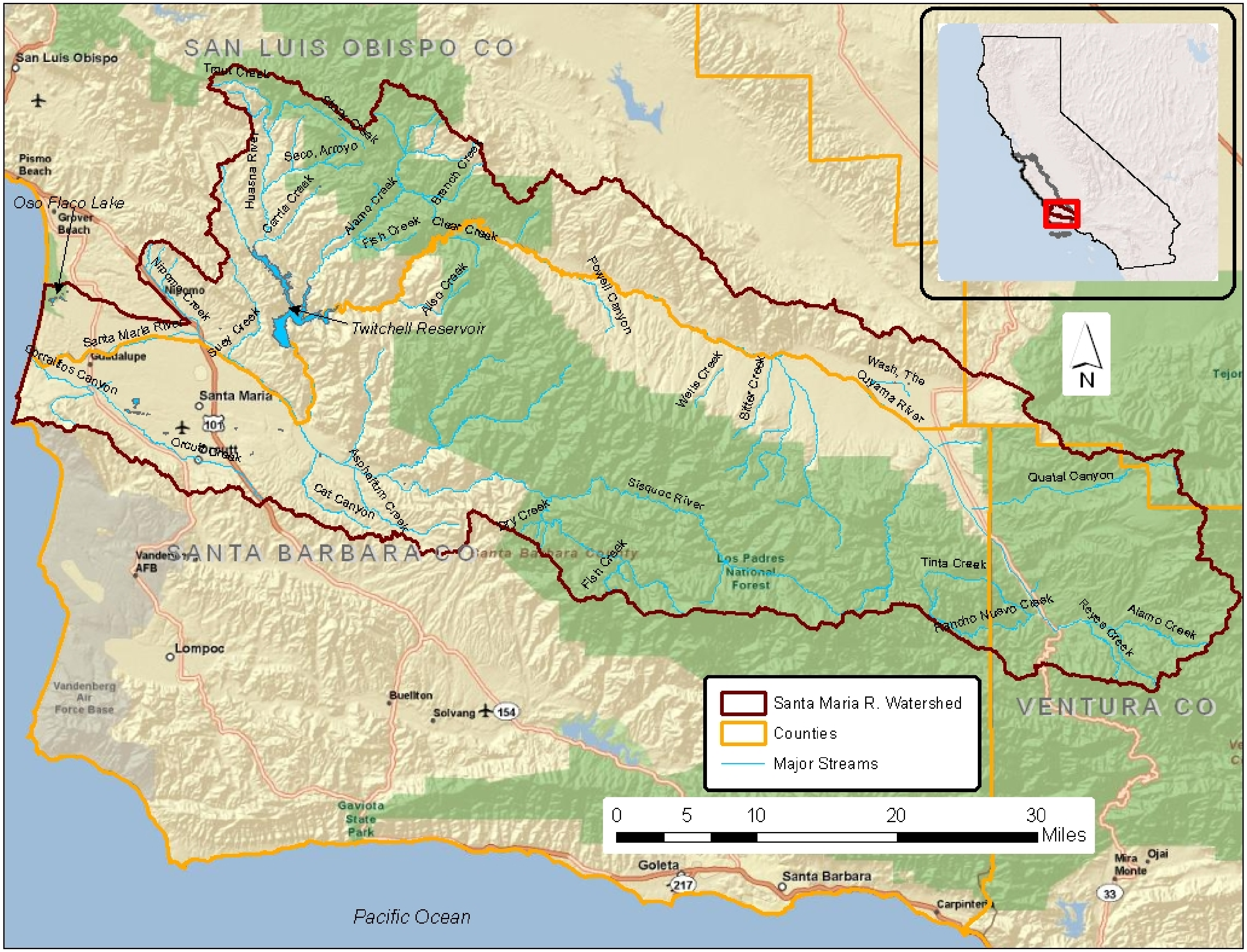

Figure A-1. Watershed Area and major waterbodies.

Project Area Subwatersheds

Staff has defined the Project Area as the Lower Santa Maria River watershed and the Oso Flaco Lake watershed, as described in the impairment assessment (see Section 3.4 of the Project Report). Staff used information contained in the Santa Maria Valley Watershed Map[84] and the USGS National Hydrography Dataset (NHD) to further delineate 18 subwatersheds within the Project Area. Figure A-2 shows these subwatersheds and Table A-1 tabulates the subwatershed names

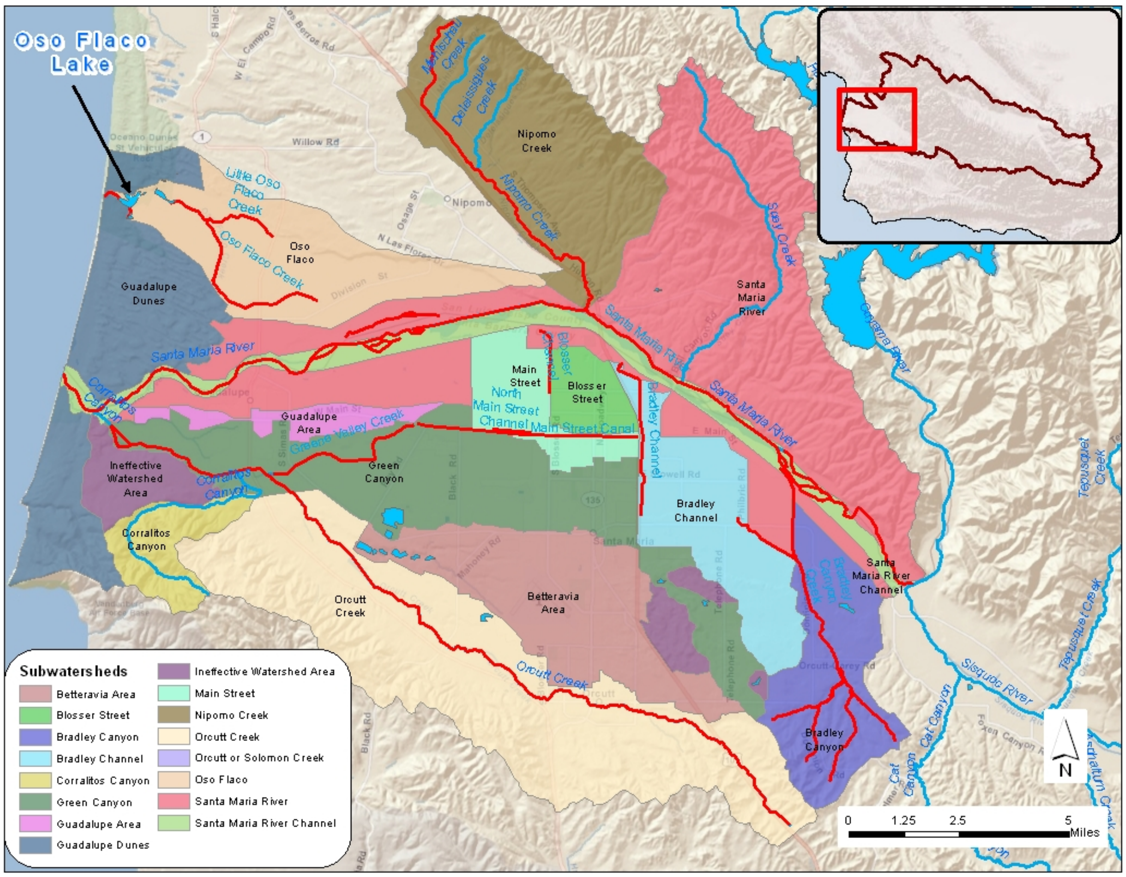

Figure A-2. Subwatersheds within the TMDL Project Area

[84] Santa Barbara County Flood Control and Water Conservation District. 1985. Santa Maria Valley Watershed Map, by Ernst Wiedmann.

Table A-1. Project Area Subwatersheds

Subwatershed Name	Notes
Betteravia Area	Eventually drains to Orcutt
Blosser Street	Blosser Channel
Bradley Canyon	Bradley Canyon Creek
Bradley Channel	Bradley Channel
Corralitos Canyon	Corralitos Canyon
Greene Canyon	Greene Valley Creek and Orcutt Creek
Guadalupe Area	Drains to the Lower Santa Maria River
Guadalupe Dunes	Drains to Pacific Ocean or Percolates
Ineffective Watershed Area	No drainage. Water either percolates or evaporates
Main Street	Main St. Canal
Nipomo Creek	Nipomo Creek
Orcutt Creek	Orcutt Creek
Oso Flaco	Oso Flaco Creek and Oso Flaco Lake
Santa Maria River	Drains to Santa Maria River
Santa Maria River Channel	Santa Maria River

Land Use and Land Cover

To represent land use and land cover staff used the National Land Cover Data (NLCD) provided by the Multi-Resolution Land Characteristics Consortium (MRLC, 1992). The MRLC membership includes the U.S. Geological Survey (USGS), U.S. Environmental Protection Agency (USEPA), National Oceanic and Atmospheric Administration (NOAA), U.S. Forest Service (USFS), National Atmospheric and Space Administration (NASA), and the Bureau of Land Management (BLM).

The NLCD was derived from images acquired by Landsat's Thematic Mapper (TM) sensor, as well as a number of ancillary data sources, and depicted in Figure A-3.

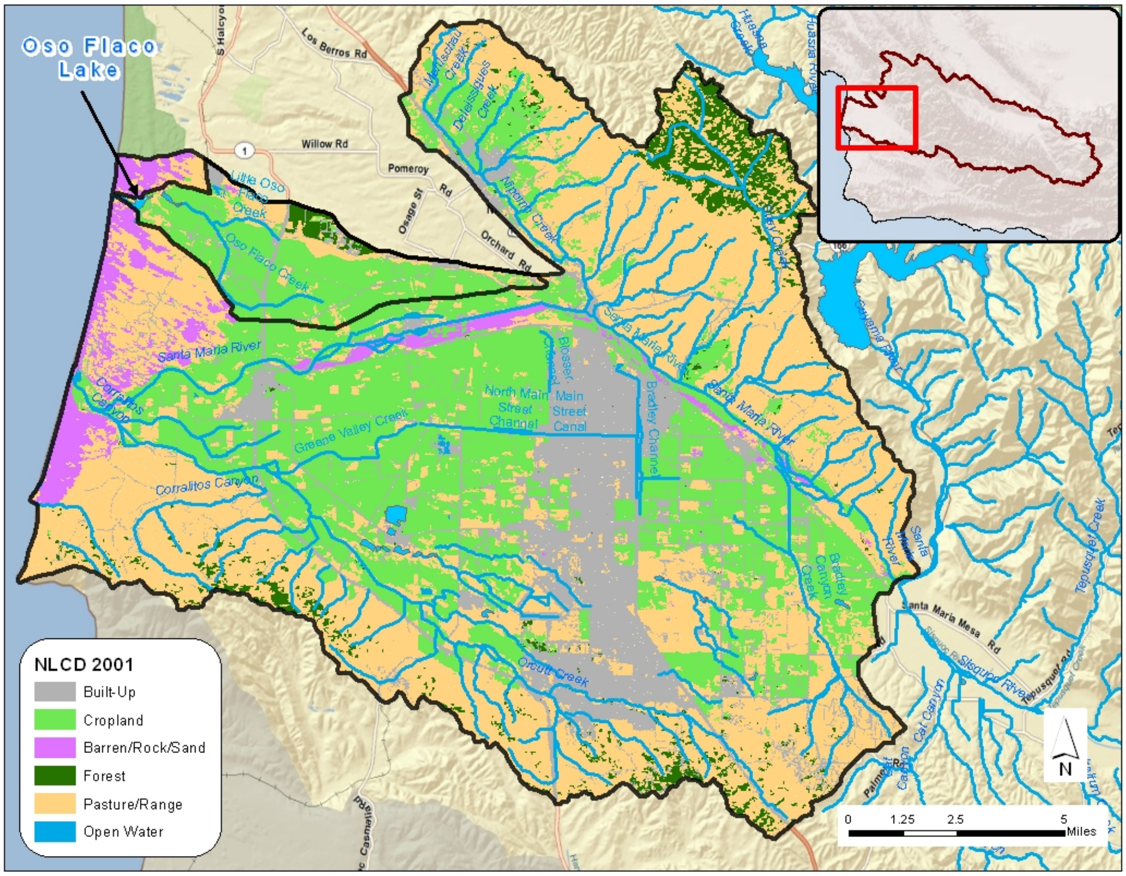

Figure A-3. NLCD Land Use and Land Cover

Staff used the NLCD data and subwatershed areas described above to derive land use/ land cover statistics for each subwatershed. Table A-2 and Table A-3 tabulate land use data for each subwatershed by area and percent, respectively.

Table A-2. Land Use/Land Cover by subwatershed (acres)

Watershed	Forest	Cropland	Pasture/Range	Barren Land (Rock/Sand/Clay)	Built up	Open Water
Betteravia Area	75	2,603	3,257	6	5,336	3
Blosser Street	0	9	13	0	1,974	3
Bradley Canyon	91	2,349	4,175	0	1,064	1
Bradley Channel	3	4,107	1,524	11	1,740	9
Corralitos Canyon	99	2	2,669	0	151	0
Greene Canyon	18	9,002	3,390	10	3,380	54
Guadalupe Area	0	1,304	266	0	276	0
Guadalupe Dunes	114	116	6,667	3,810	409	27
Main Street	0	2,227	134	1	1,224	0
Nipomo Creek	236	3,551	7,884	3	1,704	0
Orcutt Creek	1,662	3,746	14,772	1	3,347	26
Santa Maria River	3,175	8,999	17,945	38	2,795	5
Santa Maria River Channel	13	2,422	1,135	1,345	690	28
Oso Flaco	392	6,294	1,652	40	1,041	66
Ineffective Watershed Area*	7	12	2,278	114	99	0
Total	5,885	46,743	67,761	5,379	25,230	222

*an ineffective watershed area is an unnamed depression where water either percolates or evaporates.

Table A-3. Percent Land Use/Land Cover by subwatershed

Watershed	Forest	Cropland	Pasture/Range	Barren Land (Rock/Sand/Clay)	Built up	Open Water
Betteravia Area	1%	23%	29%	0%	47%	0%
Blosser Street	0%	0%	1%	0%	99%	0%
Bradley Canyon	1%	31%	54%	0%	14%	0%
Bradley Channel	0%	56%	21%	0%	24%	0%
Corralitos Canyon	3%	0%	91%	0%	5%	0%
Greene Canyon	0%	57%	21%	0%	21%	0%
Guadalupe Area	0%	71%	14%	0%	15%	0%
Guadalupe Dunes	1%	1%	60%	34%	4%	0%
Main Street	0%	62%	4%	0%	34%	0%
Nipomo Creek	2%	27%	59%	0%	13%	0%
Orcutt Creek	7%	16%	63%	0%	14%	0%
Santa Maria River	10%	27%	54%	0%	8%	0%
Santa Maria River Channel	0%	43%	20%	24%	12%	0%
Oso Flaco	4%	66%	17%	0%	11%	1%
Ineffective Watershed Area*	0%	0%	91%	5%	4%	0%

*an ineffective watershed area is an unnamed depression where water either percolates or evaporates.

Nutrient Ecoregions

Nutrient ecoregions are U.S. EPA designations for subregions of the United States that denote areas with ecosystems that are generally similar (e.g., physiography, climate, geology, soils, land use, hydrology). The Project Area is located in Ecoregion III subecoregion 6 – Southern and Central California Chaparral and Oak Woodlands with a portion of the greater Santa Maria River watershed outside the Project Areas located in subecoregion 8 – Southern California Mountains (see Figure A-4). The primary distinguishing characteristic of subecoregion 6 is its Mediterranean climate of hot dry summers and cool moist winters, and associated vegetative cover comprising mainly chaparral and oak woodlands; grasslands occur in some lower elevations and patches of pine are found at higher elevations. Most of the region consists of open low mountains or foothills, but there are areas of irregular plains in the south and near the border of the adjacent Central California Valley ecoregion.

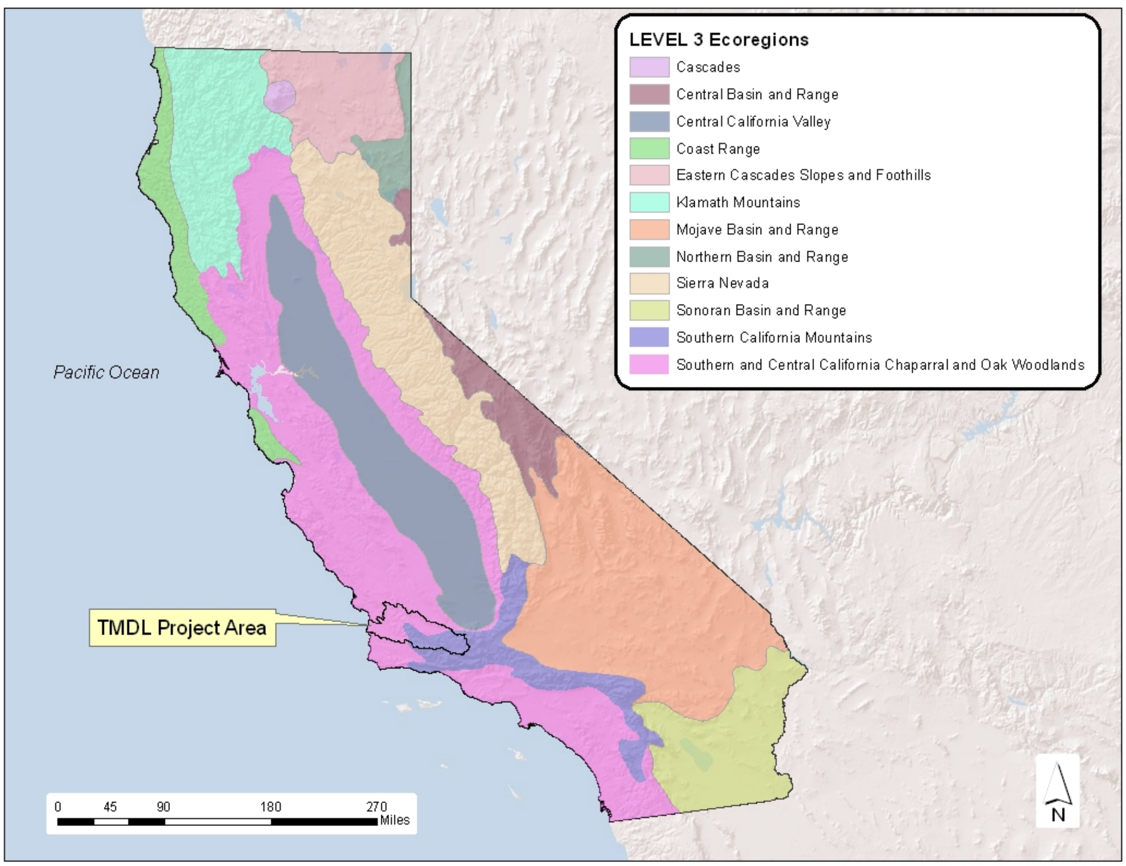

Figure A-4. California Level III nutrient ecoregions.

Ecoregional natural variation illustrates that a single, uniform regulatory numeric nutrient water quality target is not appropriate at the national or state-level scale. At the larger geographic scales natural ambient nutrient concentrations, and associated biostimulatory risks in surface waters are highly variable due to variations in vegetation, hydrology, climate, geology and other natural factors. As such, it is important to consider natural variability of nutrient concentrations locally at smaller geographic scales, e.g., the ecoregional, watershed, or subwatershed-scales. Therefore, note that some subsequent elements or sections of this Project Report will reference to nutrient water quality conditions in Ecoregion III subecoregion 6 (i.e., Calif. Oak and Chaparral subecoregion).

In 2000, the USEPA published ambient numeric criteria to support the development of State nutrient criteria in rivers and streams of Nutrient Ecoregion III. Narrative from the 2000 USEPA guidance is reproduced below (emphasis added):

> (The 2000 report) presents EPA's nutrient criteria for **Rivers and Streams in Nutrient Ecoregion III.** These criteria provide EPA's recommendations to States and authorized Tribes for use in establishing their water quality standards consistent with section 303(c) of CWA. Under section 303(c) of the CWA, States and authorized Tribes have the primary responsibility for adopting water quality standards as State or Tribal law or regulation. The standards must contain scientifically defensible water quality criteria that are protective of designated uses. **EPA's recommended section 304(a) criteria are not laws or regulations** – they are guidance that States and Tribes may use as a starting point for the criteria for their water quality standards.
>
> In developing these criteria recommendations, EPA followed a process which included, to the extent they were readily available, the following elements critical to criterion derivation:
>
> **Historical and recent nutrient data in Nutrient Ecoregion III:** Data sets from Legacy STORET, NASQAN, NAWQA and EPA Region10 were used to assess nutrient conditions from 1990 to 1998.
>
> **Reference sites/reference conditions in Nutrient Ecoregion III:** Reference conditions presented are based on 25th percentiles of all nutrient data including a comparison of reference condition for the aggregate ecoregion versus the subecoregions. States and Tribes are urged to determine their own reference sites for rivers and streams within the ecoregion at different geographic scales and to **compare** them to EPA's reference conditions.
>
> The intent of developing ecoregional nutrient criteria is to represent conditions of surface waters that are minimally impacted by human activities and thus protect against the adverse effects of nutrient over enrichment from cultural eutrophication. EPA's recommended process for developing such criteria includes physical classification of waterbodies, determination of current reference conditions, evaluation of historical data and other information (such as published literature), use of models to simulate physical and ecological processes or determine empirical relationships among causal and response variables (if necessary), expert judgment, and evaluation of downstream effects. To the extent allowed by the information available, EPA has used elements of this process to produce the information contained in this document. **The values for both causal (total nitrogen, total phosphorus) and biological and physical response (chlorophyll *a*, turbidity) variables <u>represent a set of starting points</u> for States and Tribes to use in establishing their own criteria in standards to protect uses.** The values presented in this document generally represent nutrient levels that protect against

the adverse effects of nutrient over enrichment and are based on information available to the Agency at the time of this publication. However, States and Tribes should critically evaluate this information in light of the specific designated uses that need to be protected.

-from: Ambient Water Quality Criteria Recommendations – River and Streams in Nutrient Ecoregion III, USEPA December 2000.

Note that USEPA defines a reference stream as follows:

> *"A reference stream is a least impacted waterbody within an ecoregion that can be monitored to establish a baseline to which other waters can be compared. Reference streams are not necessarily pristine or undisturbed by humans."*

EPA proposed that the 25th percentiles of all nutrient data could be assumed to represent unimpacted reference conditions for each aggregate ecoregion, and also provided a comparison of reference condition for the aggregate ecoregion versus the subecoregions. These 25th percentile values were characterized as criteria recommendations that could be used to protect waters against nutrient over-enrichment (USEPA, 2000a). However, EPA also noted that States and Tribes may "need to identify with greater precision the nutrient levels that protect aquatic life and recreational uses."

For reference, USEPA's 25th percentiles (representing unimpacted reference conditions) for the California Oak and Chaparral Subecoregion (i.e., nutrient subecoregion 6) are presented in Table A-4. USEPA Reference conditions for Level III subecoregion 6 streams..

Table A-4. USEPA Reference conditions for Level III subecoregion 6 streams.

Parameter	25th Percentiles based on all seasons data for the Decade
Total Nitrogen (TN) – mg/L	0.52
Total Phosphorus (TP) – mg/L	0.03
Chlorophyll *a* – µg/L	2.4
Turbidity - NTU	1.9

It should be re-emphasized that the above ecoregional criteria are not regulatory standards, and USEPA in fact considers them "starting points" developed on the basis of data available at the time. USEPA has recognized that States need to evaluate these values critically, and assess the need to develop nutrient targets appropriate to difference geographic scales and at higher spatial resolution.

At the national-scale, natural ambient nutrient concentrations in surface waters are highly variable due to variations in vegetation, hydrology, climate, geology and other natural factors. As such, it is important to consider natural variability of nutrient concentrations at the ecoregional or watershed-scales.

Precipitation

Average annual precipitation data was obtained from the California Department of Forestry and Fire Protection (FRAP, http://frap.cdf.ca.gov) as shown in Figure A-5. Average annual precipitation in the Lower Santa Maria River/Oso Flaco Lake watersheds (Project Area) ranges from 13 to 18 centimeters (5 to 7 inches).

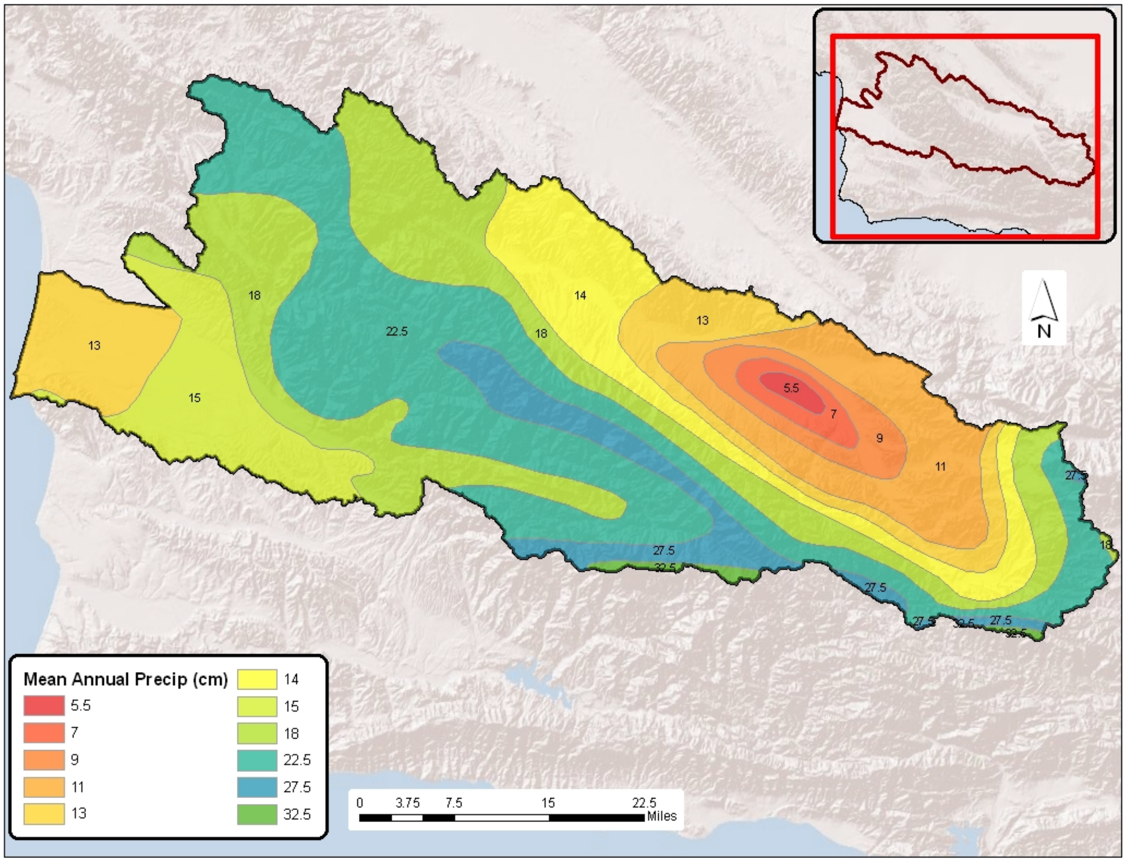

Figure A-5. Average annual precipitation (cm).

Vegetation and Canopy

Nutrient-related impacts and biostimulation may often occur areas where the river is wide, water is shallow, tree canopy is open, and light is readily available. As such, having estimates of variations in tree canopy cover are important to consider. Tree canopy and shading can vary from zero percent, particularly along coastal sloughs, water conveyance structures and disturbed landscapes, to significantly higher levels in natural forested areas. (see Figure A-6 and Figure A-7).

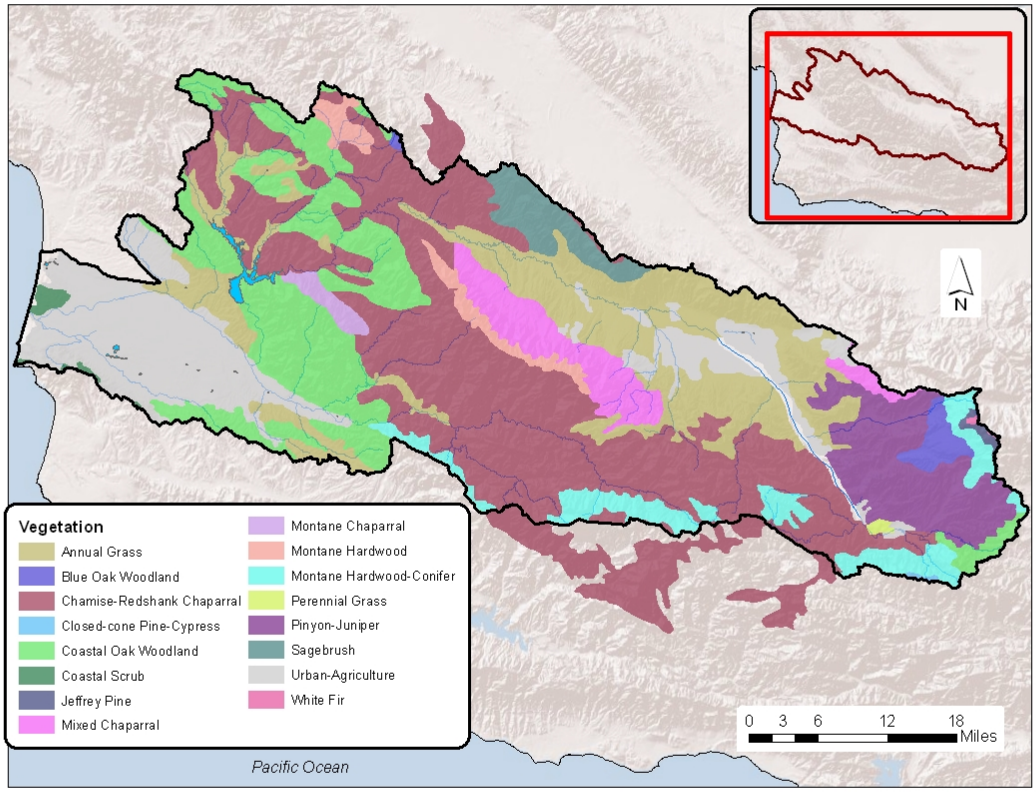

Figure A-6. Vegetation Communities.

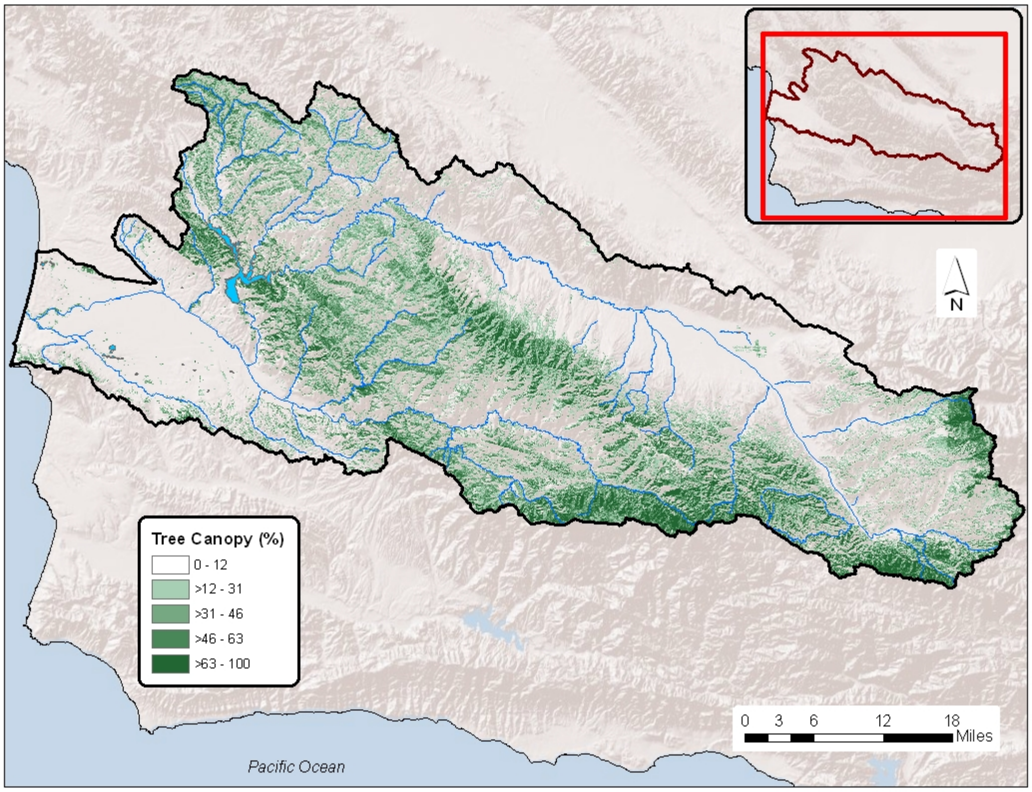

Figure A-7. Tree canopy (%).

Hydrology, Estimated Flows and Loads

The mainstem of Santa Maria River extends approximately 24-miles from the Santa Maria River estuary to the confluence of the Sisquoc and Cuyama rivers. The river channel is dry, on average, more than 90% of the time. A 46-year record (1941-1987) of the USGS gage at Guadalupe (USGS 11141000) reports continuous periods of zero flow in each year, occasional lasting up to three years in duration.

The Santa Maria River exhibits substantial hydrologic variability. Upstream of Highway 1, the river is dry for most of the year, flowing intermittently in a braided pattern during and shortly after rainfall events, and during releases from Twitchell Dam[85]. Flows observed during the dry season above Highway 1 are largely a result of agricultural or urban runoff, and releases from Twitchell Dam that are conducted for the purpose of recharging the Santa Maria groundwater basin. Alternatively, flows observed downstream from Highway 1 during the dry season are due primarily to agricultural and urban runoff, as well as emergence of subsurface flow.

Staff used the following flow data to estimate mean annual and mean dry season flows for streams within the project area:

- USGS gage station data.
- Continuous flow data as reported in *Final Follow-Up Water Quality Monitoring Report: Continuous Monitoring of Flows,* Cooperative Monitoring Program (CMP), dated August 14, 2009. Flow data from April to December 2008.
- Mean annual flow estimates from USGS's high resolution National Hydrography Dataset Plus (NHDplus) [86].
- Instantaneous flow data from the Central Coast Ambient Monitoring Program (CCAMP) and Cooperative Monitoring Program (CMP). Flow data period varies, but generally from 2005 to 2008.

Table A-5 is a summary of estimated annual and dry season flows for project area streams using the data sources cited above. Figure A-8 and Figure A-9 graphically depict estimated annual and dry season (May-Oct) flows, respectively. Table A-6 and Table A-7 summarize estimated flows, loads, and percent reductions on an annual and dry season basis. Figure A-10 and Figure A-11 depict estimated annual and dry season nitrate loads, respectively.

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[85] The purpose of the releases from Twitchell Dam is to recharge the Santa Maria groundwater basin. During dry periods of the year, water is released at a rate to ensure percolation occurs upstream of the Bonita School Road crossing (Santa Maria Valley Water Conservation District).
[86] The NHDPlus Version 1.0 is (2005) was created by the U.S. Environmental Protection Agency and the U.S. Geological Survey as an integrated suite of application-ready geospatial data sets that incorporate many of the best features of the National Hydrography Dataset (NHD) and the National Elevation Dataset (NED). The NHDPlus includes a stream network (based on the 1:100,000-scale NHD), improved networking, naming, and "value-added attributes" (VAA's).

Table A-5. Summary of Estimated Mean Flows (cfs) for Project Area streams.

		CCAMP/CMP Flow Data [A]				CMP Flow Study [B]	NHDPlus [C]	USGS [D]	
Water body	Site ID	Sample Count	Mean Flow (cfs)	Dry Season Count	Dry Season Mean Flow (cfs)	Mean Flow (cfs)	Mean Annual Flow (cfs)	Mean Annual Flow (cfs)	Dry Season Mean Flow (cfs)
Santa Maria River	312SMA	133	22.90	61	**9.95**		**61.98**		
	312SMI	31	71.01	13	0.17		53.25	**29.90**	**0.54**
Orcutt Creek	312ORC	82	12.76	39	**7.72**	**7.2**	7.21		
	312GVT	15	1.04	5	**1.36**		**4.08**		
	312ORB	29	1.31	11	0.33			**2.35**	**0.21**
Green Valley Creek	312GVS	95	1.78	44	**1.10**	**0.89**	1.58		
Main Street Canal	312MSD	82	**3.86**	37	**0.69**				
Blosser Channel	312BCD	14	**1.44**	4	**0.41**				
Bradley Channel	312BCU	14	**0.49**	5	**0.20**				
	312BCJ	75	**4.20**	38	**0.78**				
Nipomo Creek	312NIP	10	0.70	2	**0.0015**		**0.36**		
Bradley Canyon Creek	312BCC	38	0.97	20	**0.19**		**0.17**		
Little Oso Flaco Creek	312OFN	88	**1.68**	43	**0.87**				
Oso Flaco Creek	312OFC	88	4.09	44	**2.63**	**2.44**			

Note: Values indicated in **bold** are used to estimate mean annual and mean dry season (May-Oct) nitrate loads.

[A] Monitoring program instantaneous measurements.
[B] Continuous Monitoring of Flows, CMP 2009.
[C] NHDPlus mean annual flow using Unit Runoff Method.
[D] USGS gage data for Santa Maria River at Guadalupe (USGS 11141000, CCAMP 312SMI) and Orcutt Creek near Orcutt (USGS 11141050, CCAMP 312ORB).

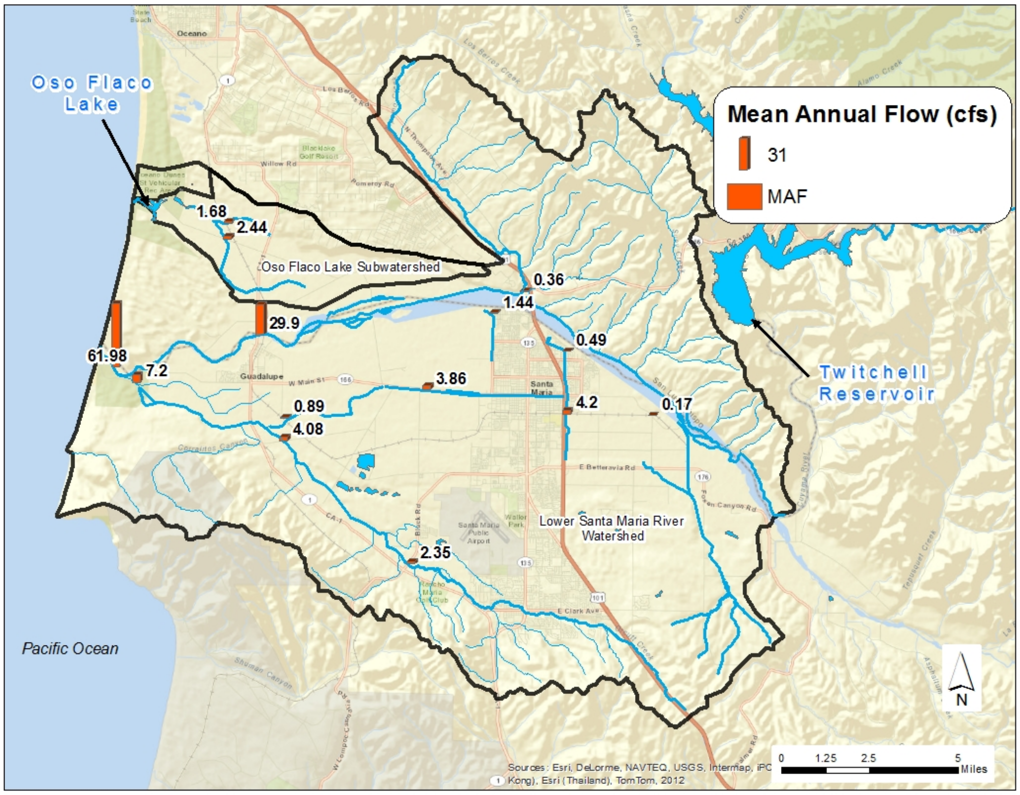


Figure A-8. Estimated mean annual flow (cfs).

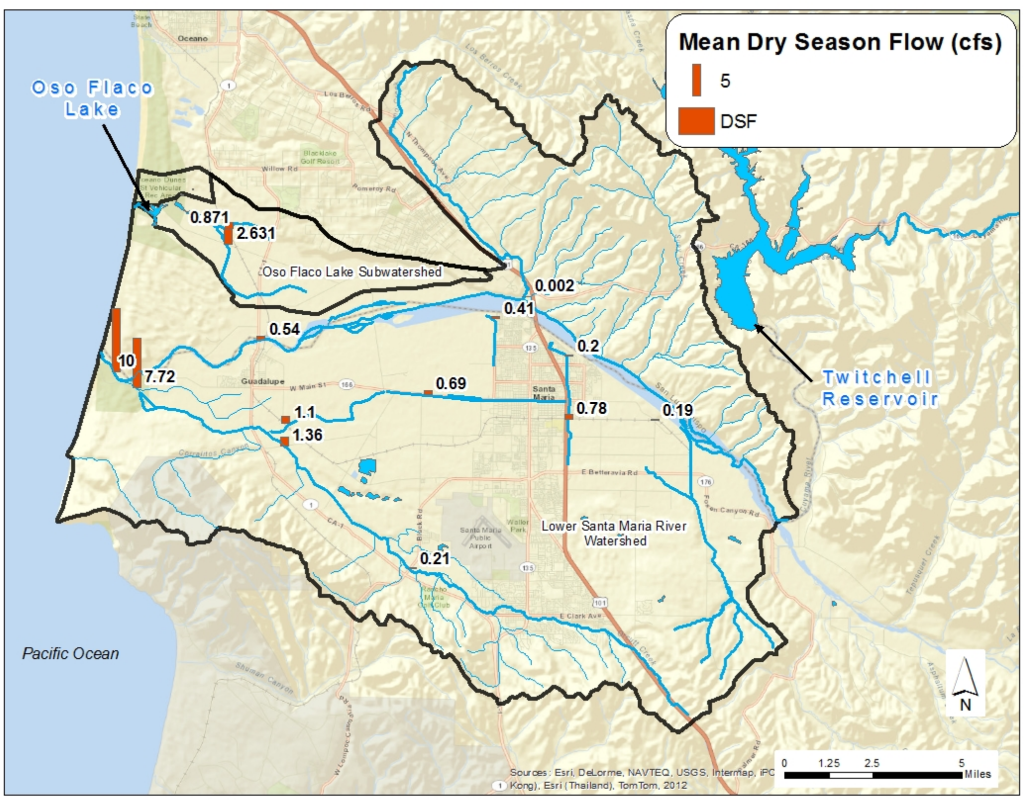


Figure A-9. Estimated mean dry season (May-Oct) flow (cfs).

Table A-6. Existing estimated mean annual nitrate loads and percent reductions.

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	NO3-N Numeric Target Used for Loading Capacity (mg/L)
Santa Maria River	312SMA	61.98	28.3	3,453,121	976,147	72%	Wet Season Biostim (8.0)
	312SMI*	29.90	30.8	1,813,117	588,674	68%	MUN (10)
Orcutt Creek	312ORC	7.20	35.5	503,228	113,403	77%	Wet Season Biostim (8.0)
	312GVT	4.08	36.4	292,726	64,335	78%	Wet Season Biostim (8.0)
	312ORB*	2.35	13.5	62,574	37,081	41%	Wet Season Biostim (8.0)
Green Valley Creek	312GVS	0.89	54.7	95,848	14,018	85%	Wet Season Biostim (8.0)
Main Street Canal	312MSD	3.86	21.6	164,303	76,066	54%	MUN (10)
Blosser Channel	312BCD	1.44	5.4	15,308	28,348	0%	MUN (10)
Bradley Channel	312BCU	0.49	11.9	11,460	9,630	16%	MUN (10)
	312BCJ	4.20	19.6	162,181	82,746	49%	MUN (10)
Nipomo Creek	312NIP	0.36	1.2	850	7,082	0%	MUN (10)
Bradley Canyon Creek	312BCC	0.17	11.0	3,602	2,620	27%	Wet Season Biostim (8.0)
Little Oso Flaco Creek	312OFN	1.68	41.0	135,853	18,887	86%	Year-Round (5.7)
Oso Flaco Creek	312OFC	2.44	38.6	185,430	27,382	85%	Year-Round (5.7)

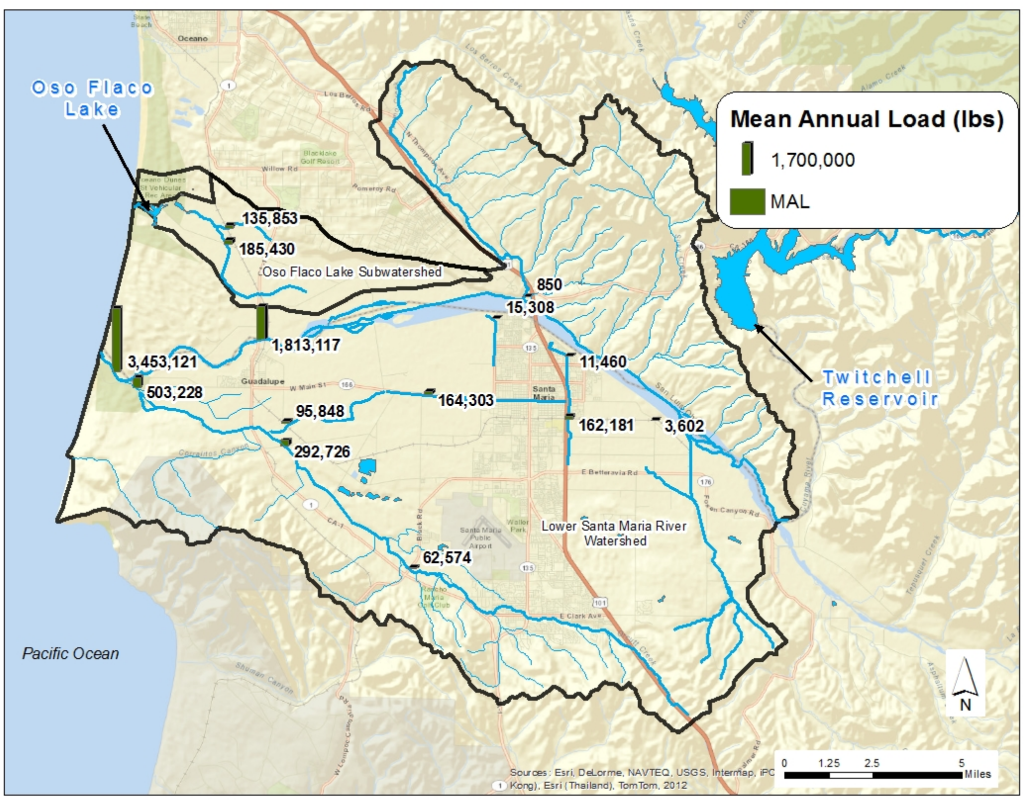


Figure A-10. Estimated mean annual nitrate loads (lbs.).

Table A-7. Existing estimated mean dry season (May – Oct) nitrate loads and percent reductions.

Water body	Site ID	Estimated Mean Dry Flow (cfs)	Mean Dry Season Conc. (mg/L)	Est. Existing Mean Dry Load (lbs.)	Mean Dry Loading Capacity (lbs.)	% Reduction Goal	NO3-N Numeric Target Used for Loading Capacity (mg/L)
Santa Maria River	312SMA	10.00	28.84	567,709	84,659	85%	Dry Season Biostim (4.3)
	312SMI*	0.54	34.42	36,589	10,632	71%	MUN (10)
Orcutt Creek	312ORC	7.72	32.8	497,833	65,357	87%	Dry Season Biostim (4.3)
	312GVT	1.36	41.00	109,781	11,514	90%	Dry Season Biostim (4.3)
	312ORB*	0.21	16.0	6,600	1,778	73%	Dry Season Biostim (4.3)
Green Valley Creek	312GVS	1.10	54.43	117,873	9,312	92%	Dry Season Biostim (4.3)
Main Street Canal	312MSD	0.69	18.82	25,560	13,585	47%	MUN (10)
Blosser Channel	312BCD	0.41	2.60	2,096	8,072	0%	MUN (10)
Bradley Channel	312BCU	0.20	15.93	6,273	3,938	37%	MUN (10)
	312BCJ	0.78	33.26	51,079	15,357	70%	MUN (10)
Nipomo Creek	312NIP	0.002	0.35	1	39	0%	MUN (10)
Bradley Canyon Creek	312BCC	0.19	6.66	2,491	1,609	0%	Dry Season Biostim (4.3)
Little Oso Flaco Creek	312OFN	0.87	36.39	62,378	9,772	84%	Year-Round (5.7)

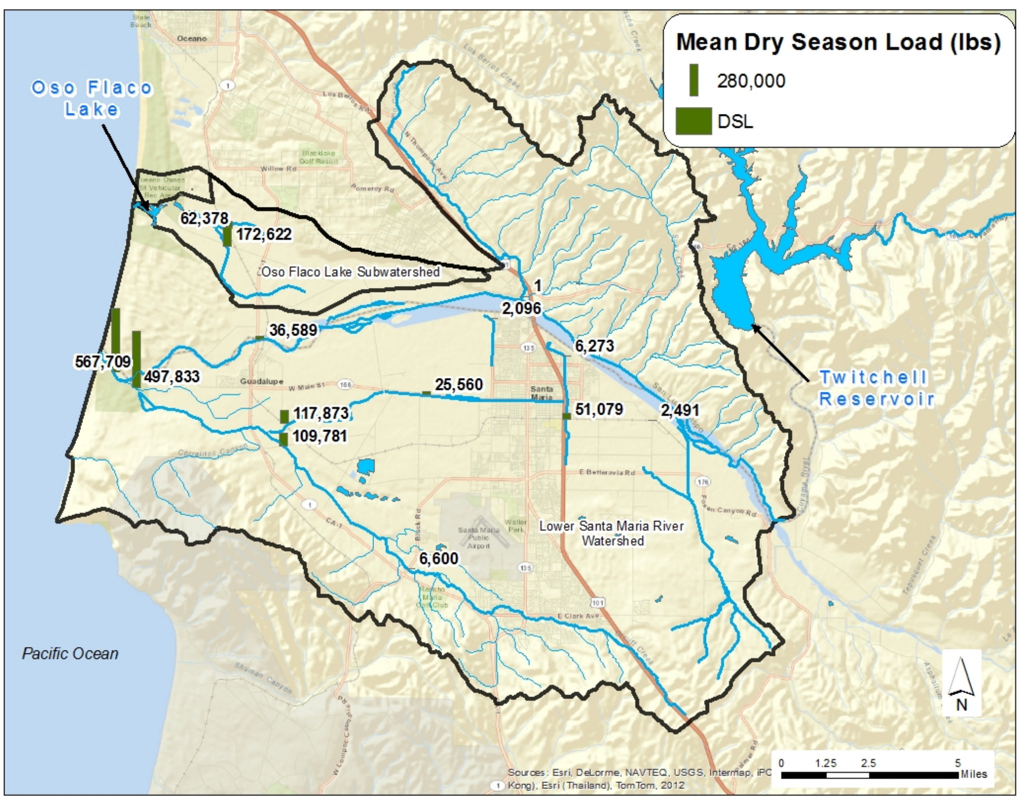


Figure A-11. Estimated mean dry season nitrate loads (lbs.).

Groundwater Quality

Groundwater (as baseflow) can be a source of nutrient loads to surface waters (USEPA, 1999). In addition, although TMDLs do not directly address groundwater quality problems, many surface waters are in fact designated for groundwater recharge beneficial use in the Basin Plan. Excessive nutrient concentrations in surface waters can potentially contribute to nitrate concentrations in groundwater.

The Santa Barbara County Water Agency (SBCWA 1994 and 2002) reported that the quality of ground water generally decreases (i.e., gets worse) from east to west through the Santa Maria Valley. Since surface water and groundwater in the valley are inextricably linked, degradation of surface water quality may ultimately lead to low quality groundwater in the primary recharge zone which is the Santa Maria River upstream from the Bonita School Road crossing.

Some nutrient loading models (e.g., STEPL, see Section 5.1) require data input for groundwater nutrient concentrations to allow baseflow load estimates to surface waters. Figure A-12 illustrates the estimated nitrate as nitrogen concentration in project area shallow groundwater (data source: USGS GWAVA model). Figure A-13 shows phosphorus concentrations observed in groundwater from shallow wells (40 ft. to 200 ft. below ground surface-total well depth) and from springs (data source: USGS NURE database). Based on the data presented, project area mean nitrate-N concentration in groundwater is 12.7 mg/L and the project area mean concentration of phosphorus in groundwater is 0.127 mg/L.

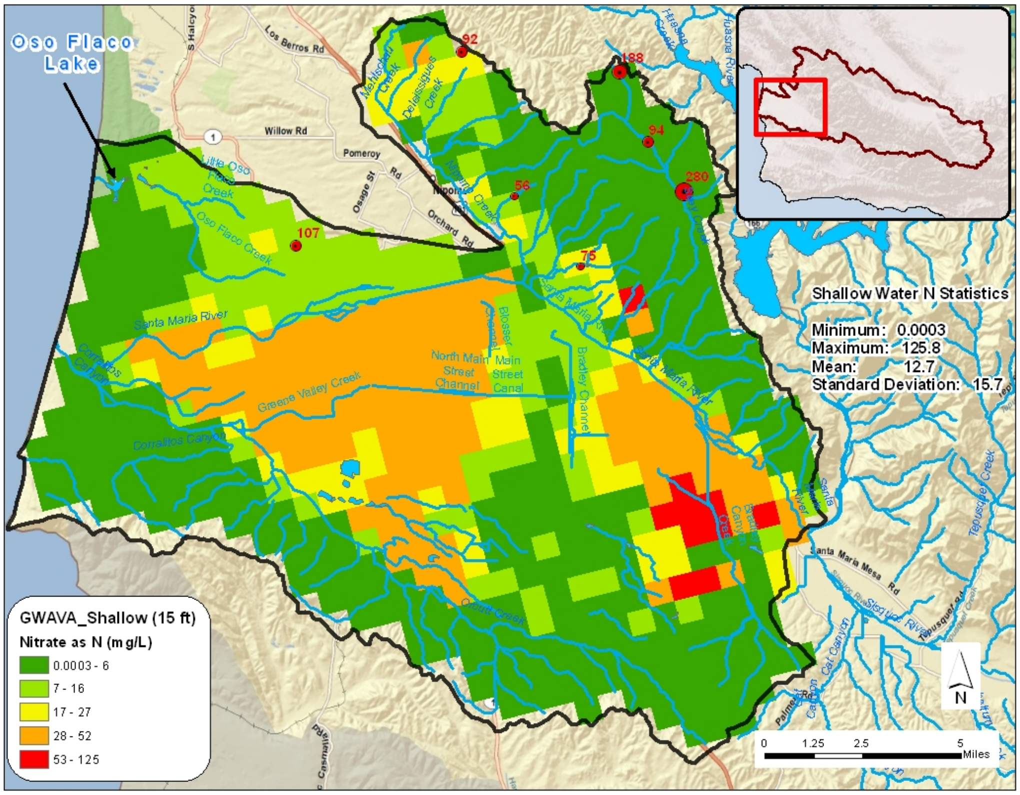


Figure A-12. GWAVA shallow groundwater nitrate concentrations

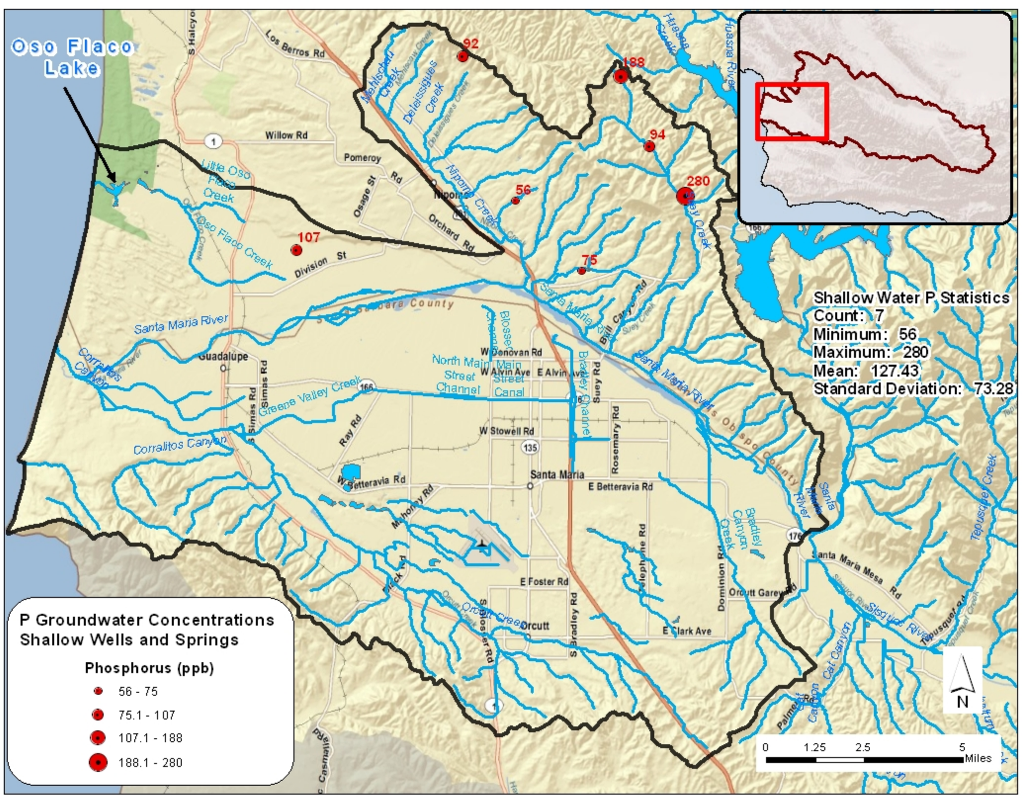


Figure A-13. USGS NURE phosphorus concentrations in shallow wells and springs

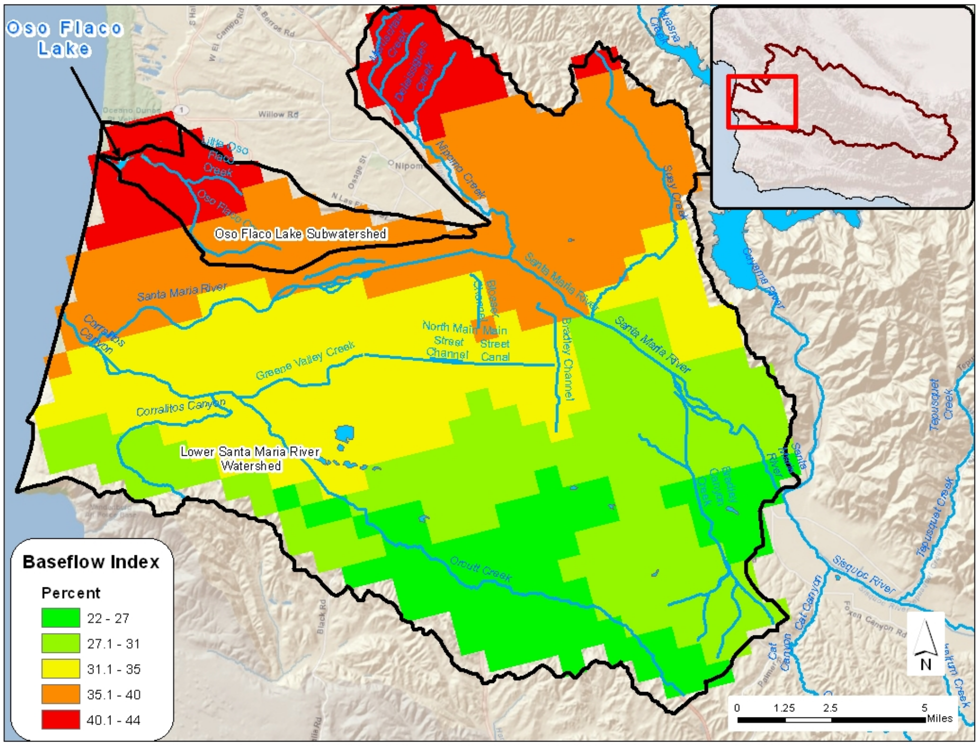


Figure A-14. Baseflow Index

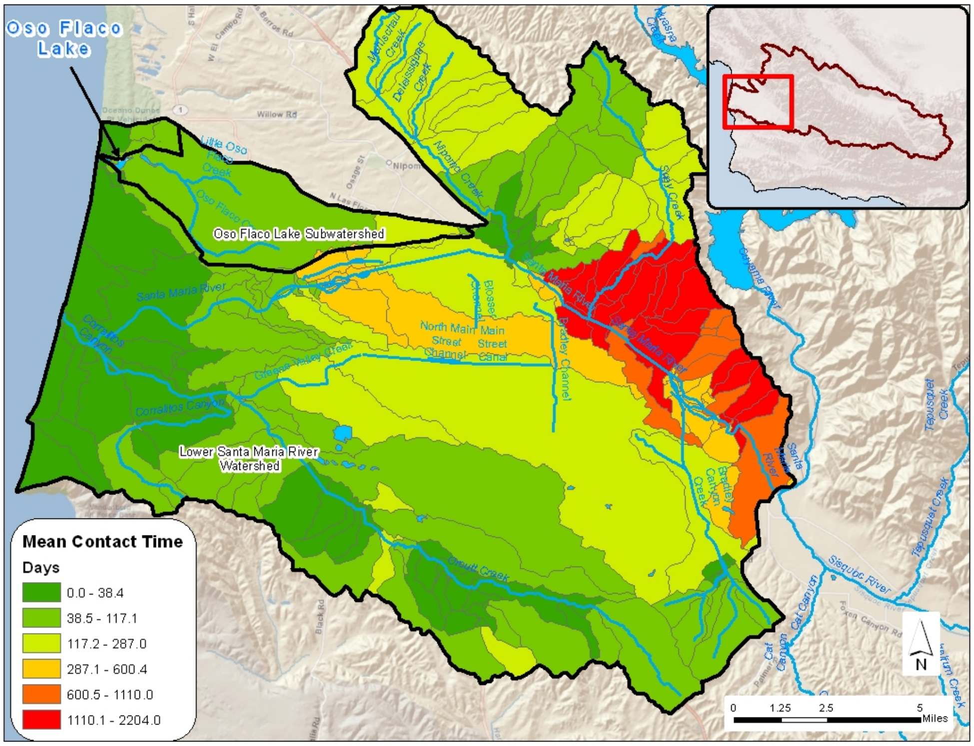


Figure A-15. Mean Contact Time

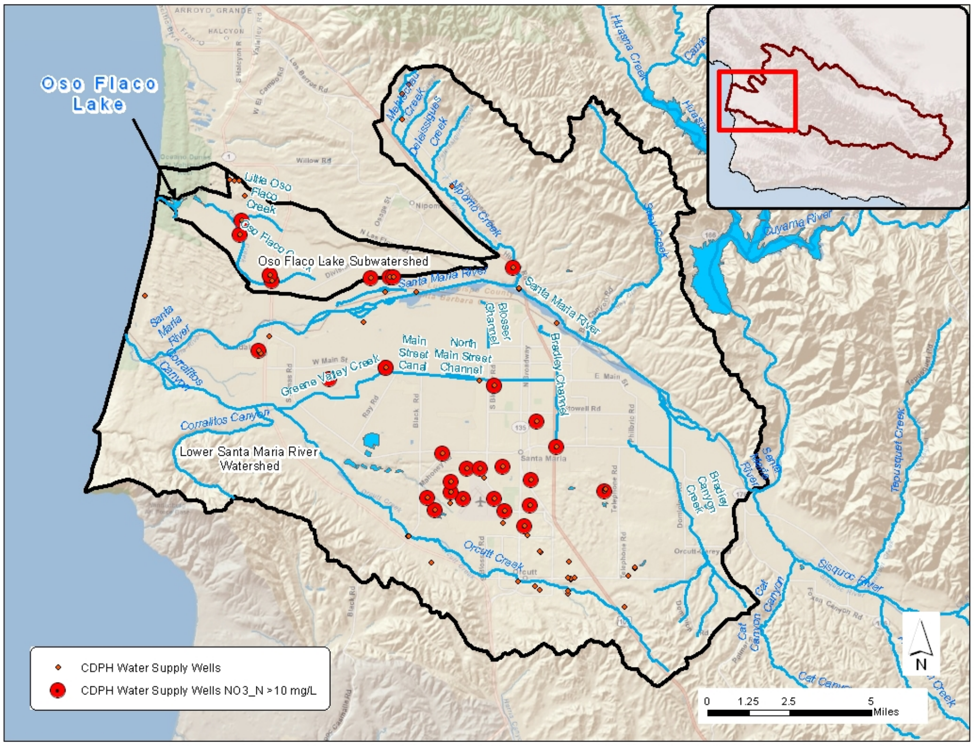


Figure A-16. CDPH Nitrate concentration in water supply wells

Soils

Soils have physical and hydrologic characteristics which may have a significant influence on the transport and fate of nutrients. Watershed researchers and TMDL projects often assess soil characteristics in conjunction with other physical watershed parameters to estimate the risk and magnitude of nutrient loading to waterbodies (Mitsova-Boneva and Wang, 2008; McMahon and Roessler, 2002; Kellog et al., 1996). The relationship between nutrient export (loads) and soil texture is illustrated in Figure A-17. Generally, fine-textured soils with lower capacity for infiltration of precipitation/water are more prone to runoff, and are consequently associated with a higher risk of nutrient loads to surface waters.

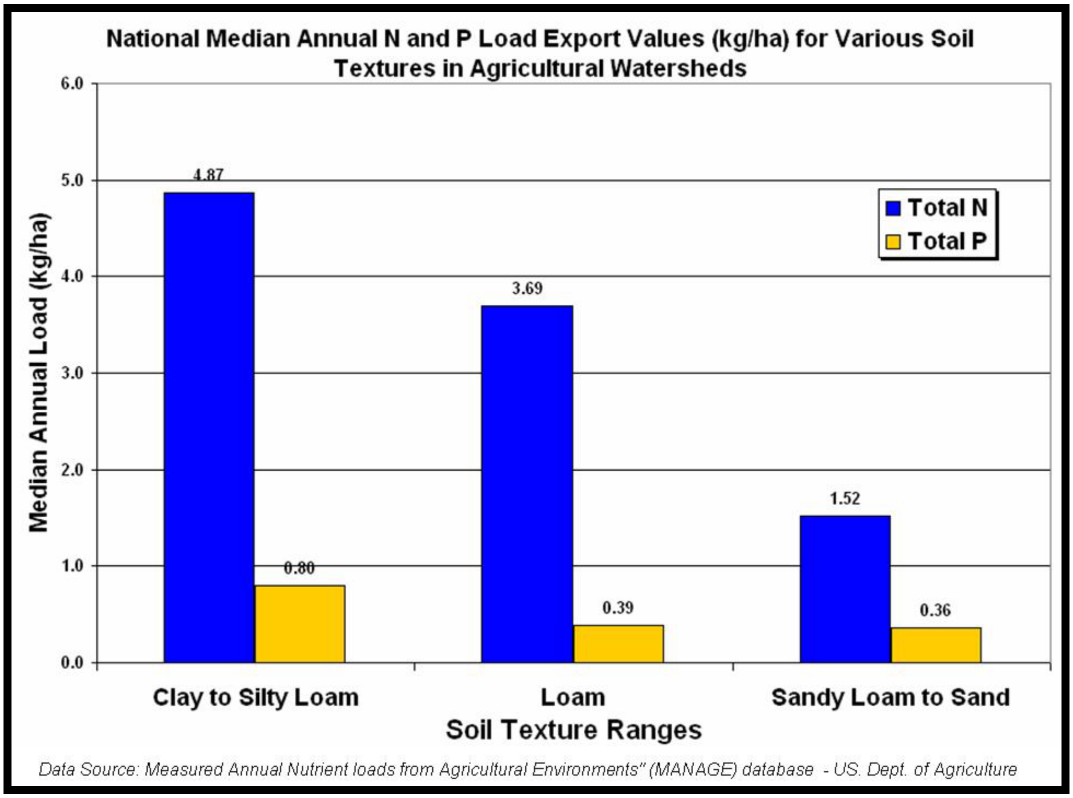
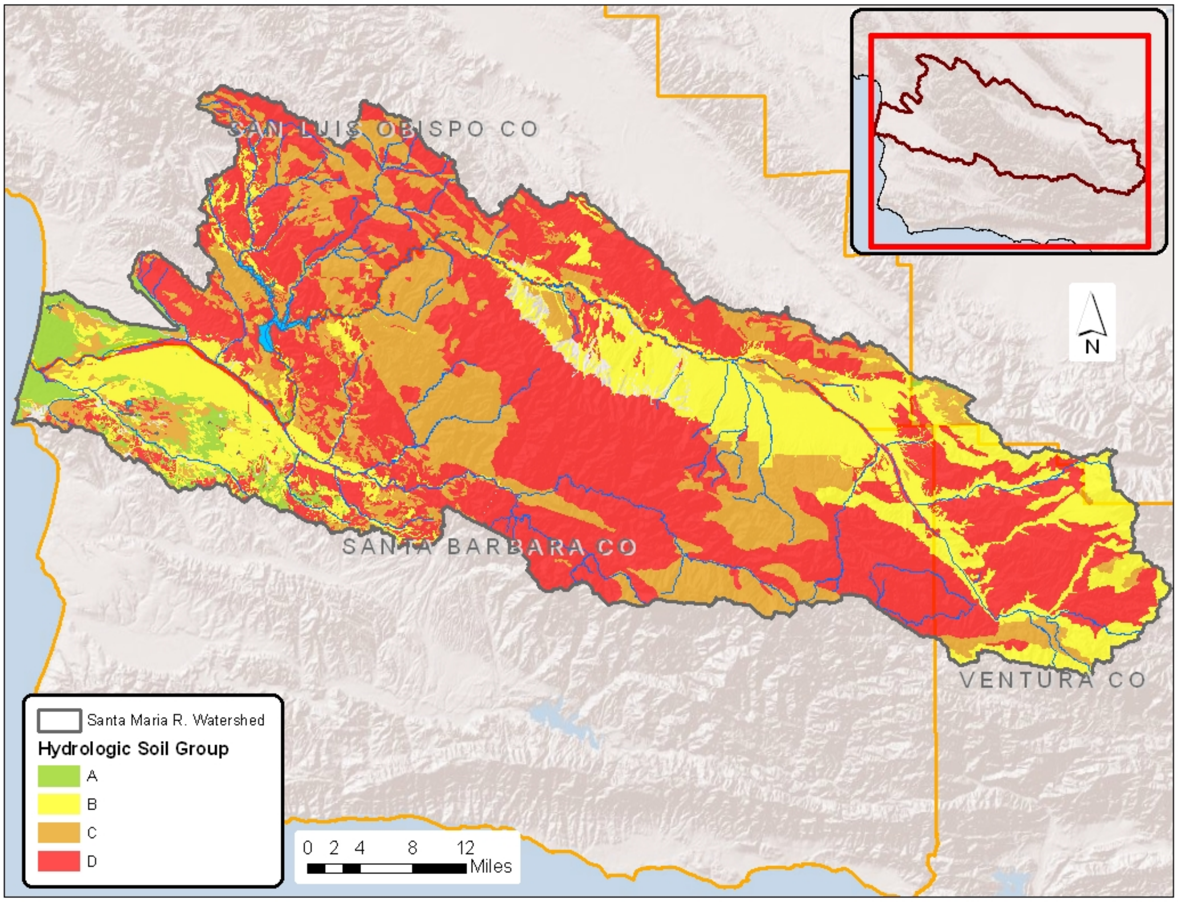


Figure A-17. Median annual Total N and Total P export for soil textures.

Soil surveys for San Luis Obispo and Santa Barbara counties was compiled by the U.S. Department of Agriculture National Resources Conservation Service (NRCS) and is available online under the title of Soil Survey Geographic (SSURGO) Database. SSURGO has been updated with extensive soil attribute data, including Hydrologic Soil Groups. Hydrologic Soil Groups are a soil attribute associated with a mapped soil unit, which indicates the soil's infiltration rate and potential for runoff. Figure A-18 illustrates the distribution of hydrologic soil groups in the Project Area along with a tabular description of the soil group's hydrologic properties.



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)

Figure A-18. Hydrologic soil groups.

Critical Habitat

The U. S. National Marine Fisheries Service (USNMFS) along with the U. S. Fish and Wildlife Service (USFWS) are the federal partners responsible for administering the Endangered Species Act (ESA). The USFWS takes the lead in recovering and conserving imperiled species by evaluating habitat and designating critical habitat for the conservation of endangered and threatened species. Figure A-19 depicts the extent of critical habitat established to protect the endangered steelhead within the Santa Maria River, Sisquoc River, and Sisquoc river tributaries. Figure A-20 depicts the location of critical habitat established to protect the endangered tidewater goby within the Santa Maria River Estuary. Note that critical habitat is also designated for the endangered

California tiger salamander and California red-legged frog throughout various locations within in the Santa Maria River watershed.

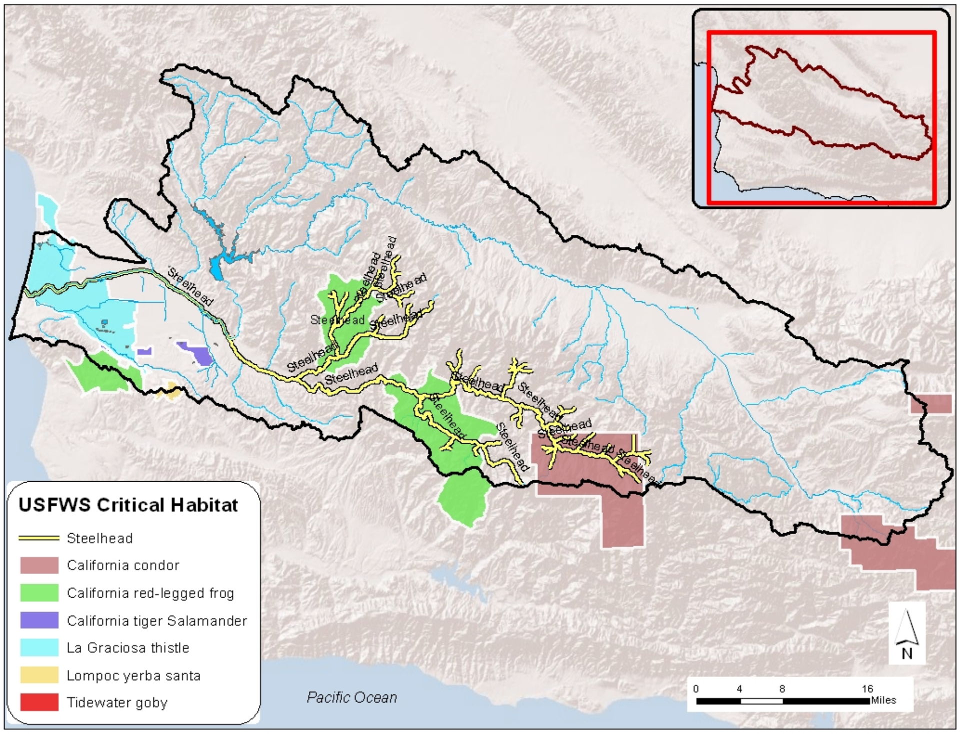


Figure A-19. USFWS critical habitat in the Santa Maria River watershed

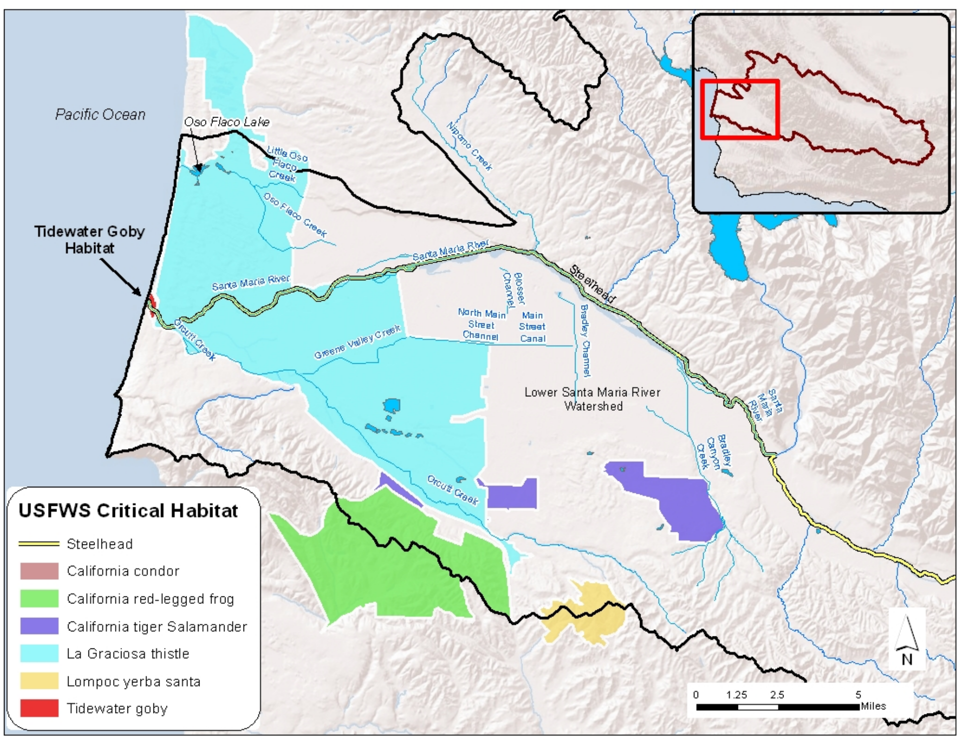


Figure A-20. USFWS critical habitat for the Lower Santa Maria R. watershed

Oso Flaco Lake and Little Oso Flaco Lake are classified by the U.S. Fish and Wildlife Service (USFWS) as palustrine emergent wetlands, a valuable habitat for wildlife. As such, the Oso Flaco Lakes are a resource for many recreational and educational activities such as bird watching, fishing and school trips. Oso Flaco also supports habitat for one of the last remaining populations of Marsh Sandwort (endangered), as well as other state and federally listed species that include the California Least Tern, California Red-Legged Frog, Western Snowy Plover, Gambel's Watercress, and La Graciosa Thistle. Additionally, the USFWS has proposed critical habitat designation for the Tidewater Goby within the Oso Flaco Lake unit, although this designation has not been finalized.

Flow and Load Duration Curves (Santa Maria River above Estuary)

Flow duration curves are graphical representations of the flow regime of a stream at a given site. Flow duration curves serve as the foundation for developing load duration curves and they are a type of cumulative distribution function. The flow duration curve represents the fraction of flow observations that exceed a given flow at the site of interest. The observed flow values are first ranked from highest to lowest, then, for each observation, the percentage of observations exceeding that flow is calculated. The lowest measured flow occurs at an exceedance frequency of 100 percent, indicating that flow has equaled or exceeded this value 100 percent of the time, while the highest measured flow is found at an exceedance frequency of 0 percent. The median flow occurs at a flow exceedance frequency of 50 percent. Flow duration curves can be subjectively divided into several hydrologic flow regime classes. These hydrologic classes facilitate the analytical uses of load duration curves, in terms of water quality response to flow and to pollutant loading conditions. Figure A-21 shows a flow duration curve for the Santa Maria River above Estuary (site 312SMA).

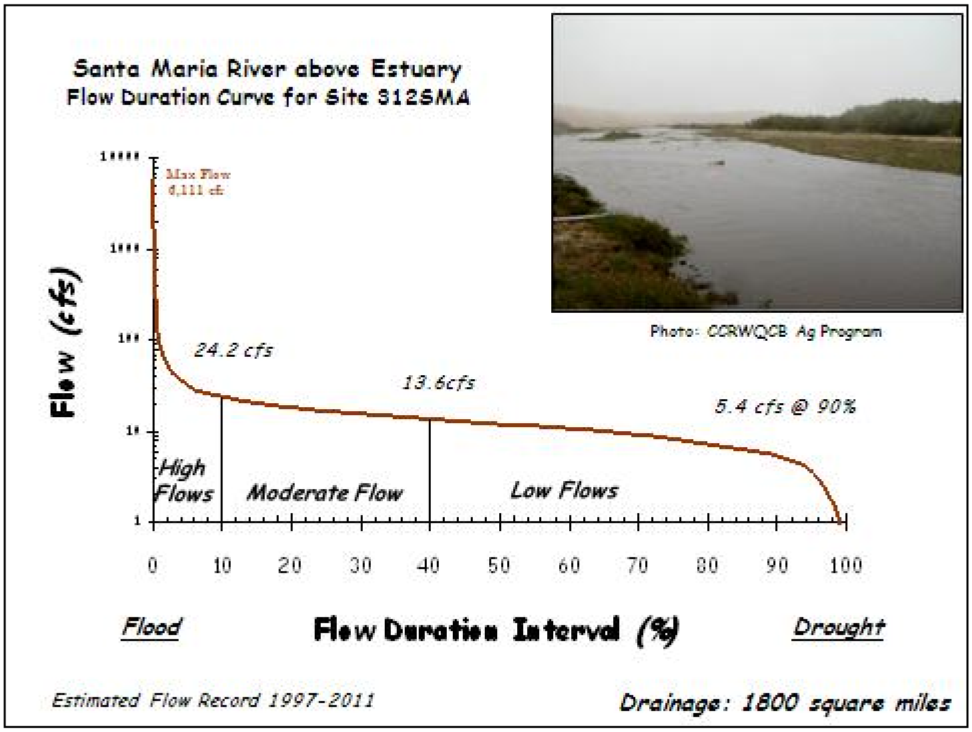


Figure A-21. Flow duration curve for Santa Maria River above Estuary (312SMA).

Load duration curves are based on flow duration curves. Load duration curves display the allowable loading capacity (based on the relevant water quality criterion, in this example the MUN water quality objective of 10 mg/L nitrate nitrogen) across the continuum of flow percentiles and also display historical pollutant load observations at the monitoring site. In lieu of flow, the y-axis is expressed in terms of nitrate nitrogen load in pounds per day (lbs/day). For this Project Report, the curve represents the instantaneous sample water quality criterion for nitrate expressed in terms of a load curve by multiplying each flow from the ranked flow record by the applicable water quality criterion and a conversion factor and plotting the resulting points. Figure A-22 shows a nitrate flow duration curve the Santa Maria River above Estuary.

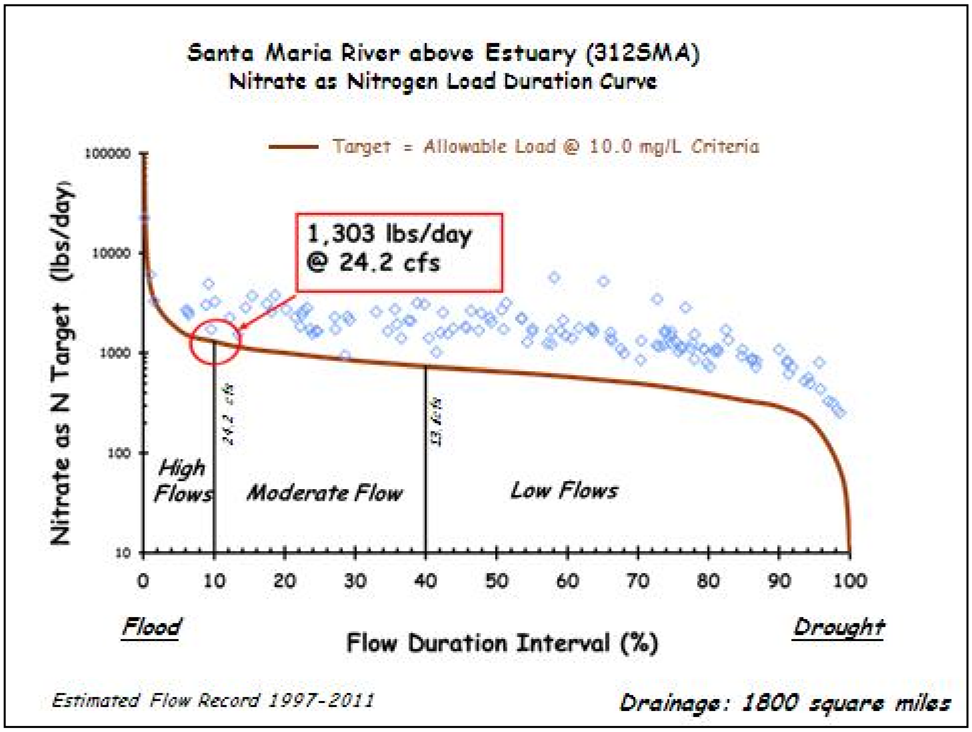


Figure A-22. Nitrate Load duration curve for Santa Maria River above Estuary (312SMA).

Each pollutant data point from observed data is converted to a daily load by multiplying the concentration by the corresponding average daily flow on the day the sample was taken. The load is then plotted on the load duration curve graph. Points plotting above the curve represent exceedances of the water quality objective (i.e., the allowable load, or total maximum daily load). Those plotting below the curve represent compliance with water quality objective and therefore represent compliance with the maximum daily loads.

As shown in Figure A-22, daily load values exceed the allowable nitrate load under all flow conditions (high, moderate, and low). Staff used the 90th percentile nitrate loads and the allowable load for the three reference flow conditions to estimate the percent reductions necessary to achieve the load allocations as shown in Table A-8.

Table A-8. Estimated nitrate nitrogen load reductions for Santa Maria River above Estuary (312SMA).

Reference flow (exceedance % in flow regime)	Existing Load for Nitrate: 90th percentile of Nitrate loads within flow range	Allowable load for the Reference flow percentile	% Load Reduction Nitrate
0.05	9,310.7	1,707.6	81.7
0.25	3,130.5	912.4	70.9
0.6	2,323.5	585.4	74.8

B. Appendix B: Data Analysis

Table B-1. Summary of waterbodies, monitoring sites (CCAMP and CMP), and site descriptions in the Santa Maria River and Oso Flaco Lake Watersheds.

Water body	Site ID	Site Description
Santa Maria River	312SMA	Santa Maria River @ Rancho Guadalupe Dunes Preserve
	312SMI	Santa Maria River @ Highway 1
	312SBC	Santa Maria River @ Bull Canyon Road
Orcutt Creek	312ORC	Orcutt Solomon Creek u/s Santa Maria River @ Sand Plant
	312ORN	Orcutt Creek North Fork Tributary (near sand plant)
	312ORI	Orcutt Solomon Creek @ Highway 1
	312GVT	Orcutt Creek @ Brown Road
	312ORB	Orcutt Solomon Creek @ Black Road
	312ORS	Orcutt Creek @ Solomon Rd
Greene Valley Creek	312GVS	Greene Valley Creek @ Simas Road
Main Street Canal	312MAB	Main Street Ditch @ Bonita School Road
	312MSD	Main Street Canal u/s Ray Road @ Highway 166
	312MSS	Main Street Canal @ South Daylight location nr Hanson Way
Betteravia Lakes Region	312MHD	Mahoney Dip between Betteravia and Black Road
Blosser Channel	312BCD	Blosser Channel d/s of groundwater recharge ponds
Bradley Channel	312BCU	Bradley Channel u/s of ponds @ Magellan Drive
	312BCJ	Bradley Channel @ Jones Street
Nipomo Creek	312NIP	Nipomo Creek @ Highway 166
	312NIT	Nipomo Creek @ Teft Street
Bradley Canyon Creek	312BCC	Bradley Canyon Creek @ culvert u/s Santa Maria R.
	312BCF	Bradley Canyon diversion channel @ Foxen Canyon Road
Cuyama River (below res.)	312CUT	Cuyama River below Twitchell @ White Rock Lane
Huasna River	312HUA	Huasna River @ School Road Bridge
Alamo Creek	312ALA	Alamo Creek at Alamo Creek Road
Cuyama River (above res.)	312CUY	Cuyama River d/s Buckhorn Road
	312CCC	Cuyama River d/s Cottonwood Canyon
	312CUL	Cuyama River above Lockwood turnoff
	312CAV	Cuyama River @ Highway 33
Salisbury Creek	312SAL	Salisbury Creek @ Branch Canyon Wash
Sisquoc River	312SIS	Sisquoc River @ Santa Maria Way
	312SIV	Sisquoc River u/s Tepusquet Road
La Brea Creek	312BRE	La Brea Creek u/s Sisquoc River
Oso Flaco Lake	312OFL	Oso Flaco Lake @ culvert
Little Oso Flaco Creek	312OFN	Little Oso Flaco Creek @ train trestle
Oso Flaco Creek	312OFC	Oso Flaco Creek @ Oso Flaco Lake Road
	312USC	Oso Flaco Creek @ Oso Flaco Lk. Rd. upstream of creek confluence
	312OSR	Oso Flaco Creek @ Hwy 1 and south RR trestle
	312OLR	Oso Flaco Creek @ Hwy 1 & Oso Flaco Lk Rd (North ditch)
	312BSR	Oso Flaco Creek @ Bonita School & Division (south ditch)

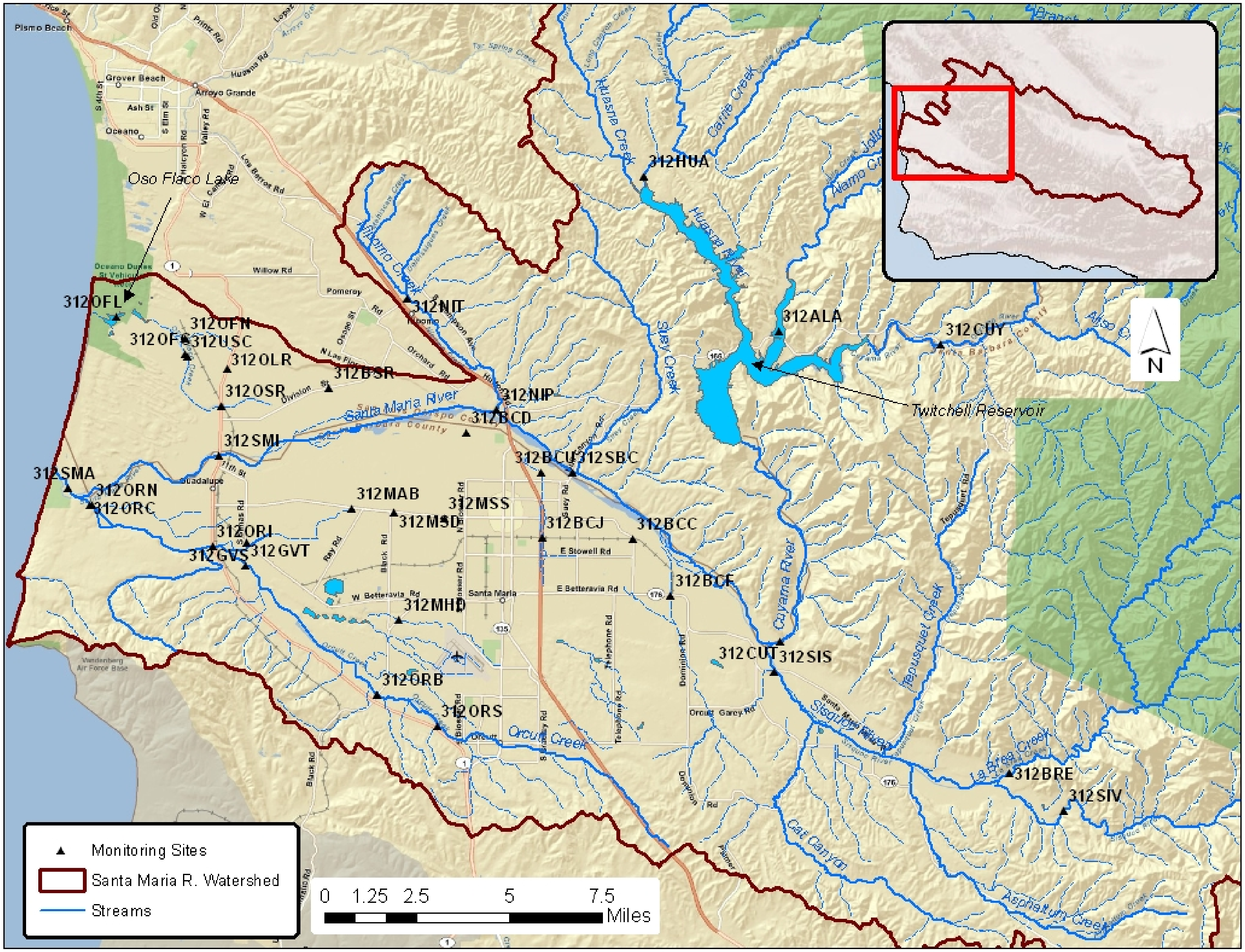


Figure B-1. Monitoring sites in the Lower Santa Maria River watershed.

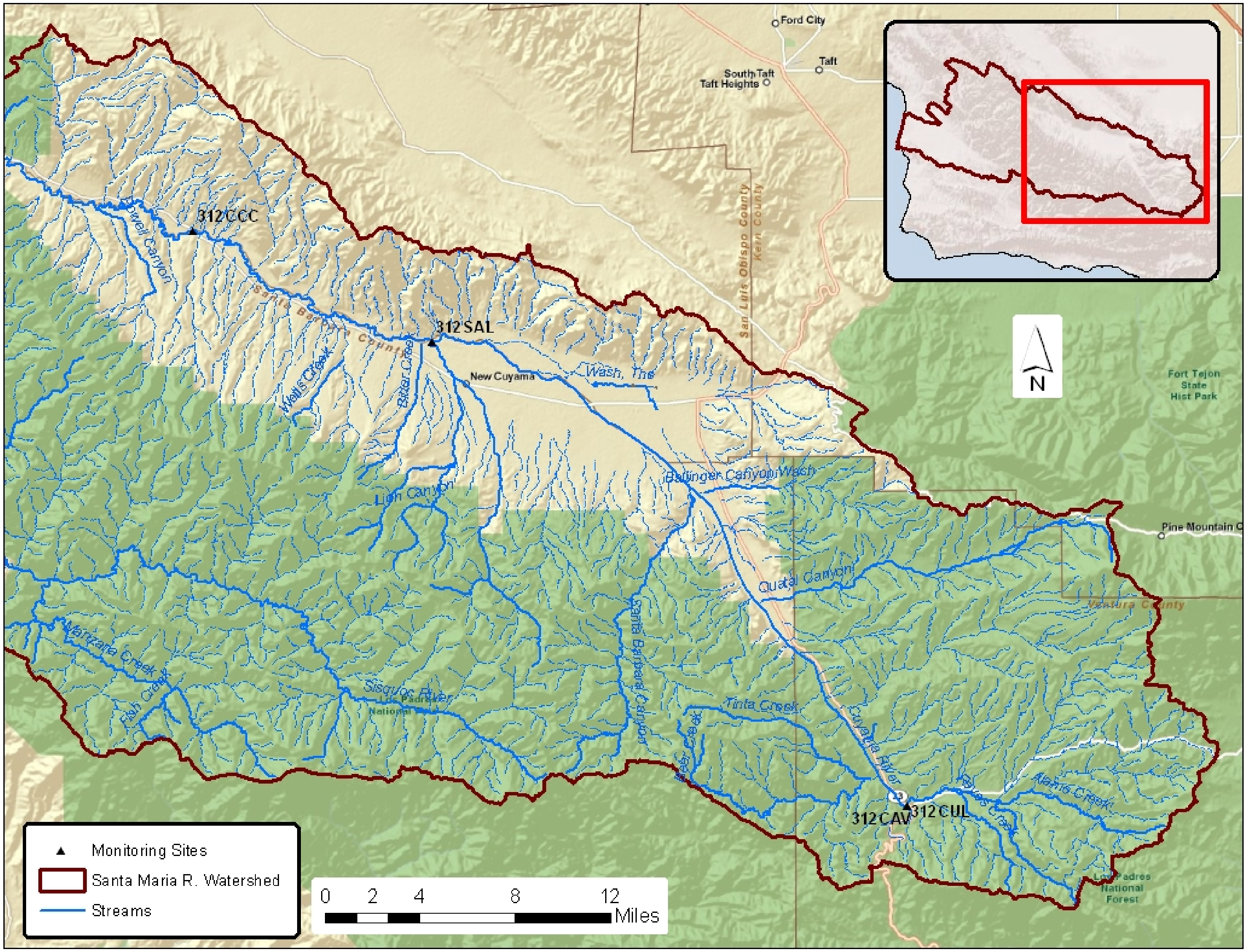
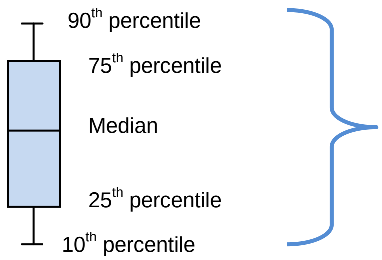


Figure B-2. Monitoring sites in the Upper Santa Maria River watershed.

Table B-2. CCAMP Summary of Un-ionized Ammonia (NH_3) as Nitrogen (mg/L).

Water body	Site ID	Sample Count	Median	Mean	Count > 0.025	Percent > 0.025
Santa Maria River	312SMA	159	0.0036	0.0082	12	7.5
	312SMI	33	0.0021	0.0101	1	3.0
	312SBC	3	0.0009	0.0029	0	0.0
Orcutt Creek	312ORC	81	0.0040	0.0100	11	13.6
	312ORN	12	0.0076	0.0149	2	16.7
	312ORI	80	0.0071	0.0472	23	28.8
	312GVT	12	0.0152	0.0172	4	33.3
	312ORB	34	0.0025	0.0298	5	14.7
	312ORS	7	0.0015	0.0015	0	0.0
Greene Valley Creek	312GVS	68	0.0024	0.0723	14	20.6
Main Street Canal	312MAB	9	0.0429	0.1083	7	77.8
	312MSD	68	0.0794	0.2935	46	67.6
	312MSS	23	0.2282	0.4239	17	73.9
Betteravia Lakes Region	312MHD	2	0.0008	0.0008	0	0.0
Blosser Channel	312BCD	21	0.0201	0.0416	9	42.9
Bradley Channel	312BCU	25	0.0078	0.0287	5	20.0
	312BCJ	53	0.0372	0.3922	35	66.0
Nipomo Creek	312NIP	20	0.0012	0.0037	1	5.0
	312NIT	14	0.0011	0.0023	0	0.0
Bradley Canyon Creek	312BCC	28	0.0167	0.1151	12	42.9
	312BCF	10	0.0046	0.1448	3	30.0
Cuyama River (below res.)	312CUT	10	0.0022	0.0039	0	0.0
Huasna River	312HUA	12	0.0004	0.0012	0	0.0
Alamo Creek	312ALA	26	0.0005	0.0026	0	0.0
Cuyama River (above res.)	312CUY	13	0.0045	0.0061	0	0.0
	312CCC	18	0.0024	0.0027	0	0.0
	312CUL	3	0.0022	0.0028	0	0.0
	312CAV	21	0.0008	0.0020	0	0.0
Sisquoc River	312SIS	5	0.0075	0.0066	0	0.0
	312SIV	22	0.0009	0.0033	0	0.0
La Brea Creek	312BRE	16	0.0008	0.0035	0	0.0
Oso Flaco Lake	312OFL	24	0.0012	0.0028	0	0.0
Little Oso Flaco Creek	312OFN	70	0.0021	0.0034	1	1.4
Oso Flaco Creek	312OFC	77	0.0069	0.0730	21	27.3
	312USC	12	0.0387	0.3017	6	50.0
	312OSR	11	0.0110	0.0374	4	36.4
	312OLR	10	0.1142	0.3695	9	90.0
	312BSR	18	0.0110	0.0246	5	27.8

Water quality objective for unionized ammonia is 0.025 mg/L as nitrogen.



Explanation of box and whisker plots.

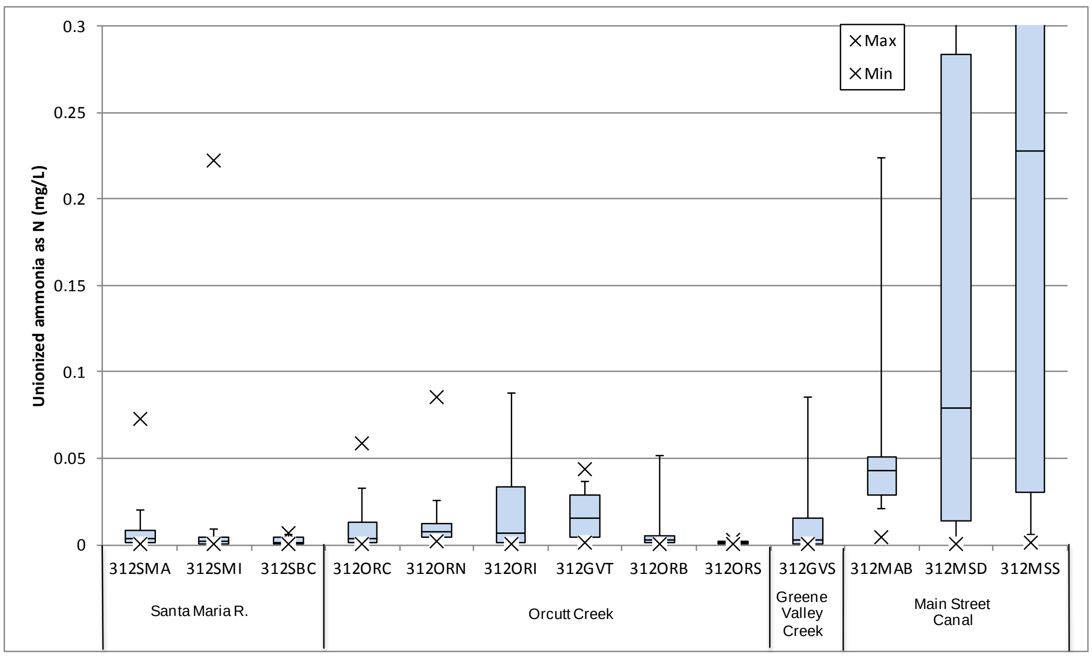


Figure B-3. Unionized ammonia as N for sites in Lower Santa Maria River watershed.

Note: Not shown are 312ORI maximum (0.85 mg/L), 312ORB maximum (0.70 mg/L), 312GVS maximum (2.37 mg/L), 312MAB maximum ((0.62 mg/L), 312MSD maximum (4.53 mg/L) and 90th percentile (0.71 mg/L), 312ORB maximum (0.70 mg/L),and 312MSS maximum (2.00 mg/L), 90thpercentile (1.04 mg/L),and 75th percentile (0.6 mg/L).

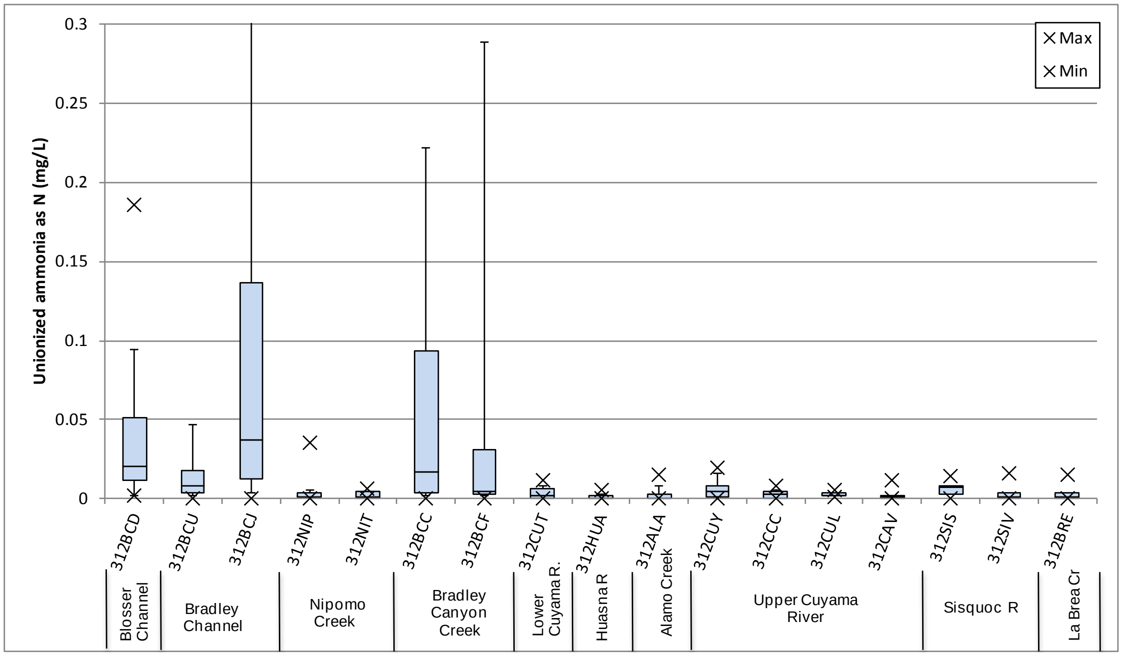


Figure B-4. Unionized ammonia as N for sites in Middle and Upper Santa Maria River watershed.

Note: Not shown are 312BCU maximum (0.36 mg/L), 312BCJ maximum (8.27 mg/L) and 90th percentile (0.85 mg/L), 312BCC maximum (1.28 mg/L), and 312BCF maximum (1.20 mg/L).

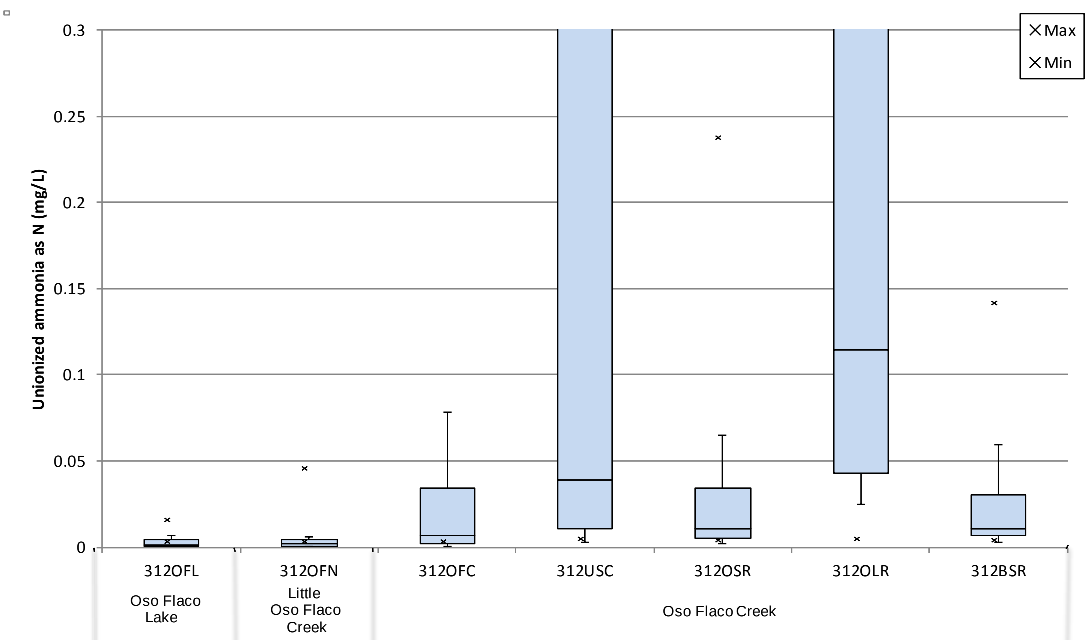


Figure B-5. Unionized ammonia as N for sites in Oso Flaco Lake watershed.

Note: Not shown are 312OFC maximum (2.12 mg/L), 312USC maximum (2.23 mg/L), 90th percentile (0.49 mg/L), and 312OLR maximum (1.43 mg/L), 90th percentile (0.49 mg/L), and 75th percentile (0.46 mg/L).

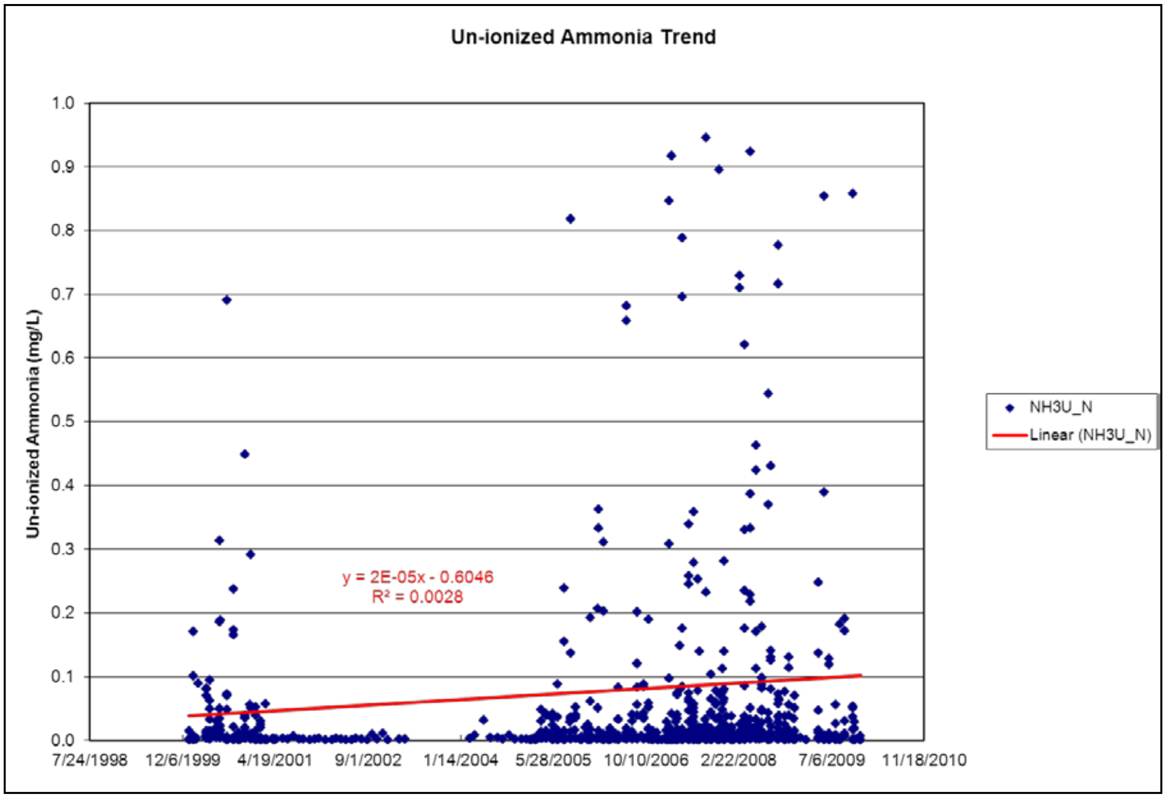


Figure B-6. Un-ionized ammonia as nitrogen (mg/L) concentrations over time.
Note: Compilation of all CCAMP/CMP monitoring sites in Santa Maria/Oso Flaco Lake watersheds. Data for 19 values over 1.0 mg/L (max of 8.27 mg/L) are not represented on graph for clarity.

Table B-3. CCAMP Summary of Nitrate as Nitrogen (mg/L)

	Site ID	Sample Count	Median	Mean	Count > 10	Percent > 10	Count > 30	Percent > 30
Santa Maria River	312SMA	129	26.3	28.3	128	99.2	38	29.5
	312SMI	24	26.0	30.8	23	95.8	10	41.7
	312SBC	5	0.2	0.3	0	0.0	0	0.0
Orcutt Creek	312ORC	48	31.0	35.5	48	100.0	29	60.4
	312ORN	3	38.2	36.0	3	100.0	2	66.7
	312ORI	46	52.4	52.4	44	95.7	38	82.6
	312GVT	12	36.0	36.4	12	100.0	7	58.3
	312ORB	29	11.1	13.5	15	51.7	1	3.4
	312ORS	2	0.7	0.7	0	0.0	0	0.0
Greene Valley Creek	312GVS	29	54.5	54.7	29	100.0	26	89.7
Main Street Canal	312MSD	36	15.5	21.6	27	75.0	7	19.4
	312MSS	14	7.7	14.1	5	35.7	2	14.3
Blosser Channel	312BCD	21	2.9	5.4	3	14.3	0	0.0
Bradley Channel	312BCU	26	9.4	11.9	11	42.3	2	7.7
	312BCJ	17	15.0	19.6	11	64.7	2	11.8
Nipomo Creek	312NIP	22	1.2	1.2	0	0.0	0	0.0
	312NIT	15	5.2	4.6	0	0.0	0	0.0
Bradley Canyon Creek	312BCC	9	9.1	11.0	4	44.4	0	0.0
	312BCF	11	10.0	14.2	6	54.5	1	9.1
Cuyama River (below res.)	312CUT	12	0.1	0.1	0	0.0	0	0.0
Huasna River	312HUA	12	0.1	0.2	0	0.0	0	0.0
Alamo Creek	312ALA	28	0.2	0.2	0	0.0	0	0.0
Cuyama River (above res.)	312CUY	15	0.1	0.2	0	0.0	0	0.0
	312CCC	19	0.1	0.1	0	0.0	0	0.0
	312CUL	3	0.1	0.1	0	0.0	0	0.0
	312CAV	24	0.1	0.1	0	0.0	0	0.0
Salisbury Creek	312SAL	1	0.1	0.1	0	0.0	0	0.0
Sisquoc River	312SIS	6	0.1	0.2	0	0.0	0	0.0
	312SIV	25	0.0	0.1	0	0.0	0	0.0
La Brea Creek	312BRE	20	0.1	0.1	0	0.0	0	0.0
Oso Flaco Lake	312OFL	28	30.0	30.6	28	100.0	17	60.7
Little Oso Flaco Creek	312OFN	37	39.0	41.0	36	97.3	33	89.2
Oso Flaco Creek	312OFC	41	34.5	38.6	41	100.0	28	68.3
	312USC	3	35.0	37.1	3	100.0	2	66.7
	312OSR	2	34.4	34.4	2	100.0	2	100.0
	312OLR	2	52.2	52.2	2	100.0	2	100.0
	312BSR	9	80.0	80.8	9	100.0	9	100.0

MUN Water quality objective for nitrate is 10 mg/L as nitrogen.
AGR Irrigation water guideline to protect against severe problems for sensitive crops is 30 mg/L as nitrogen (Basin Plan Table 3-3).

The Water Quality Control Plan, Central Coast Basin Objective for municipal and domestic supply uses of inland surface waters (Section II.A.2) states the following: 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. The maximum contaminant level listed in Table 3-2 (inorganic and fluoride concentrations not to be exceeded in domestic or municipal supply) for nitrate is 10.0 mg/L (NO3 as N).

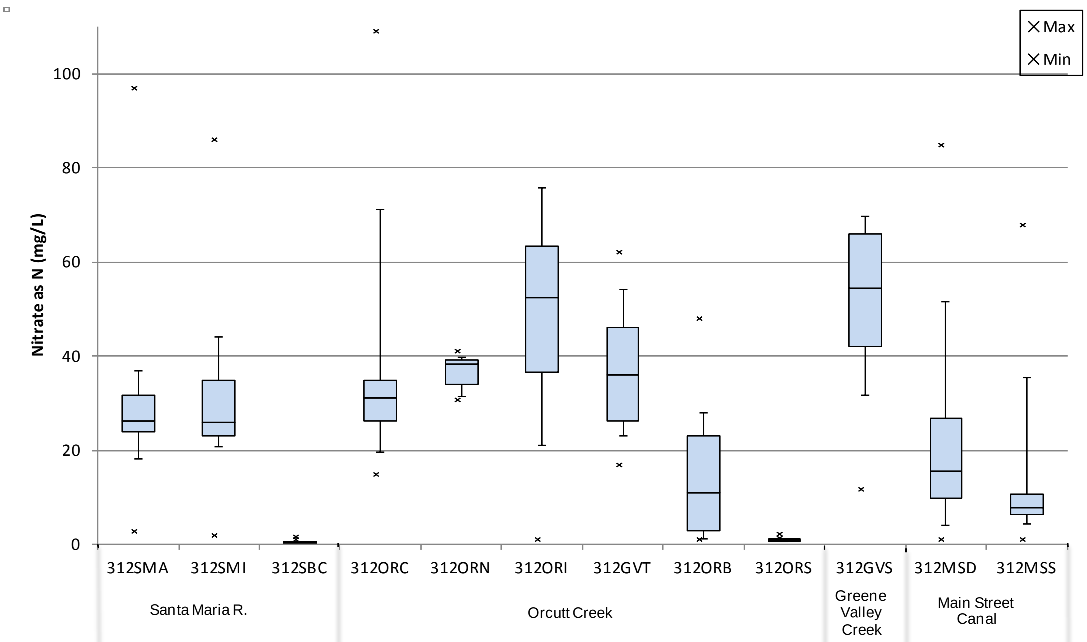


Figure B-7. Nitrate as N for sites in Lower Santa Maria River watershed.
Note: Not shown are 312ORI maximum (159 mg/L) and 312GVS maximum (150 mg/L).

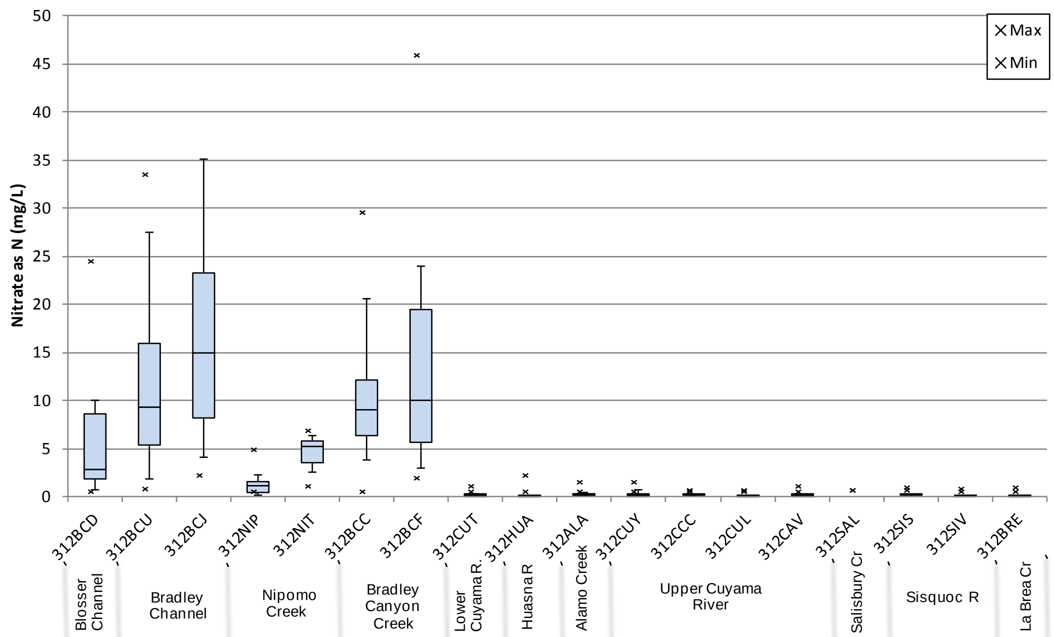


Figure B-8. Nitrate as N for sites in Middle and Upper Santa Maria River watershed.
Note: Not shown is 312BCJ maximum (78 mg/L).

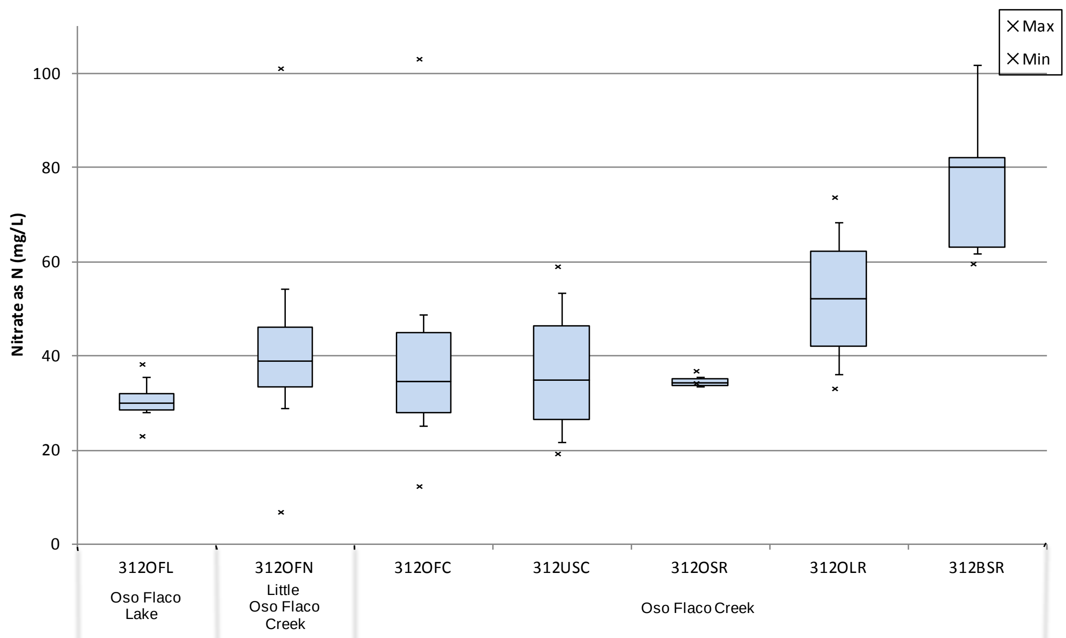


Figure B-9. Nitrate as N for sites in Oso Flaco Lake watershed.
Note: Not show is 312BSR maximum (125 mg/L).

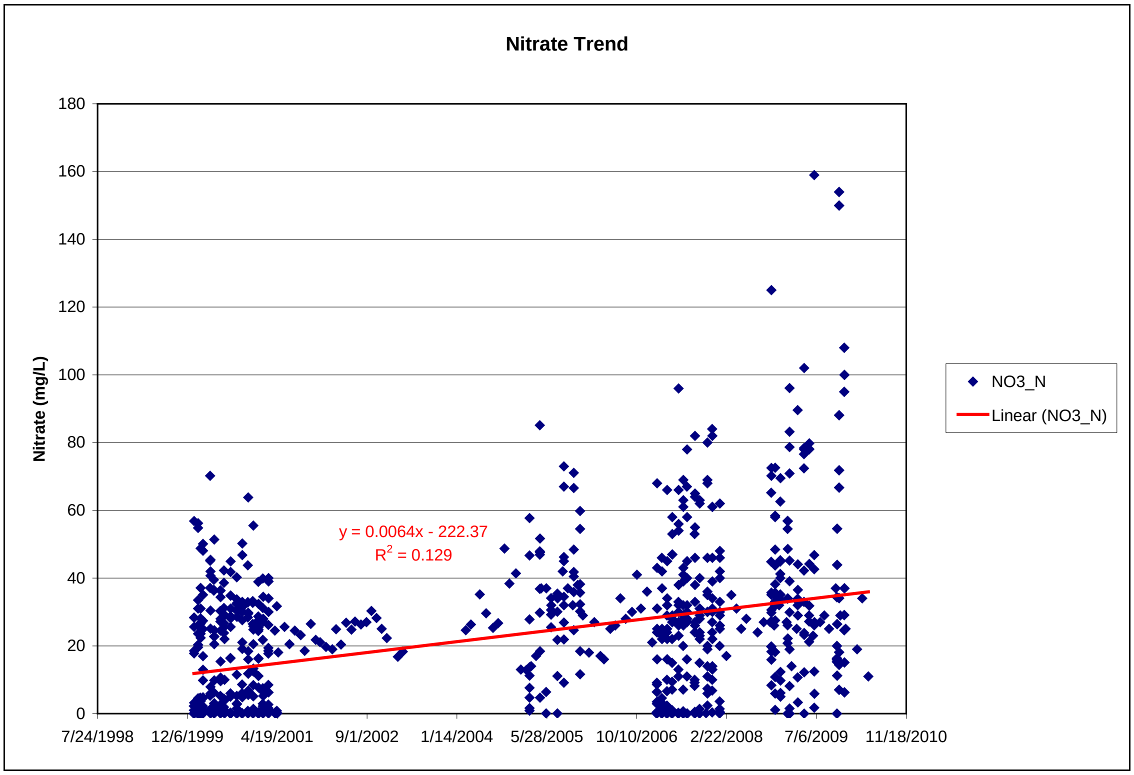


Figure B-10. Nitrate as nitrogen concentrations (mg/L) over time.
Note: Compilation of all CCAMP/CMP monitoring sites in Santa Maria/Oso Flaco Lake watersheds.

Table B-4. CCAMP Summary of Total Nitrogen as Nitrogen (mg/L).

Water body	Site ID	Sample Count	Median	Mean
Santa Maria River	312SMA	85	29.00	29.63
	312SMI	12	27.00	30.65
	312SBC	3	0.50	0.43
Orcutt Creek	312ORC	23	31.20	30.81
	312ORI	22	53.10	51.65
	312GVT	12	40.00	40.75
	312ORB	21	15.40	19.80
	312ORS	1	2.50	2.50
Greene Valley Creek	312GVS	12	65.00	59.00
	312MSD	20	19.80	39.30
	312MSS	11	17.00	35.84
Blosser Channel	312BCD	18	5.95	8.31
Bradley Channel	312BCU	20	12.50	16.24
Nipomo Creek	312NIP	16	1.80	1.89
	312NIT	12	5.85	5.42
	312BCF	9	19.90	22.01
Cuyama River (below res.)	312CUT	11	0.50	0.82
Huasna River	312HUA	12	0.39	0.44
Alamo Creek	312ALA	22	0.27	0.31
Cuyama River (above res.)	312CUY	9	0.10	0.78
	312CCC	15	0.62	0.62
	312CAV	17	0.45	0.52
Sisquoc River	312SIS	5	0.10	0.26
	312SIV	18	0.10	0.19
La Brea Creek	312BRE	13	0.12	0.30
Oso Flaco Lake	312OFL	22	31.00	31.09
Little Oso Flaco Creek	312OFN	19	36.50	36.87
Oso Flaco Creek	312OFC	18	38.70	43.57
	312BSR	6	80.00	53.33

Note: 25th percentile of all watershed data is 1.075 mg/L

Table B-5. CCAMP Proportion of Nitrate (as N) in Total Nitrogen (mg/L).

Water body	Site ID	Sample Count	Geomean	Median	Mean
Santa Maria River	312SMA	83	92.21	93.33	92.65
	312SMI	12	97.79	100.00	97.85
	312SBC	1	100.00	100.00	100.00
Orcutt Creek	312ORC	23	93.15	93.94	93.27
	312ORI	22	94.65	96.05	94.75
	312GVT	12	88.60	90.85	88.95
	312ORB	20	72.00	87.78	76.17
	312ORS	1	16.40	16.40	16.40
Green Valley Creek	312GVS	12	95.69	98.17	95.83
Main street Canal	312MSD	20	62.12	68.78	65.28
	312MSS	10	55.47	58.33	60.48
Blosser Channel	312BCD	18	52.67	67.98	64.68
Bradley Channel	312BCU	20	78.07	86.40	81.71
Nipomo Creek	312NIP	14	50.47	56.35	53.54
	312NIT	12	72.39	84.96	79.38
Bradley Canyon Creek	312BCF	9	78.50	82.76	79.93
Huasna River	312HUA	1	73.33	73.33	73.33
Alamo Creek	312ALA	11	61.09	82.98	70.03
Cuyama River (above res.)	312CUY	2	35.21	41.00	41.00
	312CAV	2	49.48	52.22	52.22
Sisquoc River	312SIS	1	46.59	46.59	46.59
	312SIV	1	44.87	44.87	44.87
La Brea Creek	312BRE	1	50.00	50.00	50.00
Oso Flaco Lake	312OFL	22	97.11	96.87	97.15
Little Oso Flaco Creek	312OFN	19	99.15	100.00	99.17
Oso Flaco Creek	312OFC	18	89.43	94.42	90.35
	312BSR	6	96.88	98.35	96.91

Statistics based on percent of nitrate (as N) in total nitrogen for paired samples.

Table B-6. CCAMP Summary of Dissolved Oxygen (mg/L)

Water body	Site ID	Count	Median	Mean	Count < 7	Percent < 7	Count < 5	Percent < 5	Count > 13	Percent > 13
Santa Maria River	312SMA	167	9.4	9.9	2	1.2	0	0.0	1	0.6
	312SMI	39	9.0	9.8	4	10.3	0	0.0	6	15.4
	312SBC	6	10.6	10.4	0	0.0	0	0.0	0	0.0
Orcutt Creek	312ORC	86	8.7	8.8	5	5.8	0	0.0	1	1.2
	312ORN	12	8.6	8.6	1	8.3	0	0.0	0	0.0
	312ORI	85	10.6	11.2	0	0.0	0	0.0	18	21.2
	312GVT	12	9.0	9.1	0	0.0	0	0.0	0	0.0
	312ORB	38	9.0	9.3	4	10.5	1	2.6	2	5.3
	312ORS	7	7.8	7.6	3	42.9	1	14.3	0	0.0
Greene Valley Creek	312GVS	68	9.0	8.5	20	29.4	4	5.9	0	0.0
Main Street Canal	312MAB	9	10.6	10.2	0	0.0	0	0.0	0	0.0
	312MSD	72	8.8	9.0	14	19.4	5	6.9	0	0.0
	312MSS	23	8.3	8.2	3	13.0	0	0.0	0	0.0
Betteravia Lakes Region	312MHD	2	9.7	9.7	0	0.0	0	0.0	0	0.0
Blosser Channel	312BCD	24	10.8	11.0	2	8.3	1	4.2	8	33.3
Bradley Channel	312BCU	28	10.1	9.6	5	17.9	4	14.3	3	10.7
	312BCJ	54	10.7	11.5	2	3.7	1	1.9	14	25.9
Nipomo Creek	312NIP	25	8.7	9.2	1	4.0	0	0.0	1	4.0
	312NIT	17	9.5	9.5	4	23.5	0	0.0	2	11.8
Bradley Canyon Creek	312BCC	30	7.5	8.3	10	33.3	3	10.0	2	6.7
	312BCF	13	8.5	7.7	4	30.8	4	30.8	0	0.0
Cuyama River (below res.)	312CUT	12	10.8	10.8	0	0.0	0	0.0	1	8.3
Huasna River	312HUA	12	9.3	9.1	2	16.7	0	0.0	0	0.0
Alamo Creek	312ALA	30	9.3	9.2	4	13.3	0	0.0	0	0.0
Cuyama River (above res.)	312CUY	18	9.9	9.8	0	0.0	0	0.0	0	0.0
	312CCC	20	10.7	10.7	0	0.0	0	0.0	2	10.0

Water body	Site ID	Count	Median	Mean	Count < 7	Percent < 7	Count < 5	Percent < 5	Count > 13	Percent > 13
	312CUL	3	8.7	9.1	0	0.0	0	0.0	0	0.0
	312CAV	26	8.9	9.3	0	0.0	0	0.0	0	0.0
Salisbury Creek	312SAL	1	8.3	8.3	0	0.0	0	0.0	0	0.0
Sisquoc River	312SIS	6	11.4	11.2	0	0.0	0	0.0	0	0.0
	312SIV	27	9.9	9.4	3	11.1	1	3.7	1	3.7
La Brea Creek	312BRE	21	11.0	10.1	3	14.3	1	4.8	0	0.0
Oso Flaco Lake	312OFL	29	9.2	9.8	5	17.2	0	0.0	4	13.8
Little Oso Flaco Creek	312OFN	81	9.1	9.3	11	13.6	3	3.7	4	4.9
Oso Flaco Creek	312OFC	80	9.1	9.0	5	6.3	1	1.3	1	1.3
	312USC	12	9.2	9.3	0	0.0	0	0.0	0	0.0
	312OSR	11	9.9	9.9	0	0.0	0	0.0	0	0.0
	312OLR	10	8.9	9.2	0	0.0	0	0.0	0	0.0
	312BSR	18	9.6	9.9	0	0.0	0	0.0	1	5.6

Based on the following beneficial uses:
COLD or SPAWN (OF Lake) not less than 7.0 mg/L
WARM not less than 5.0 mg/L
CCAMP COLD/WARM screening value for oxygen super-saturation not greater than 13 mg/L.

Water Quality Control Plan, Central Coast Basin, Cold Water Habitat Objective, Chapter III, Section II.A.2 General Objectives for all Inland Surface Waters, Enclosed Bays and Estuaries states the following: The dissolved oxygen concentration shall not be reduced below 7.0 mg/l at any time.

Water Quality Control Plan, Central Coast Basin, General Objective, Chapter III, Section II.A.2 General Objectives for all Inland Surface Waters, Enclosed Bays and Estuaries states the following: For waters not mentioned by a specific beneficial use, dissolved oxygen concentration shall not be reduced below 5.0 mg/l at any time.

Table B-7. Santa Maria River Estuary (312SME) Dissolved Oxygen (mg/L) Estuary Monitoring by UC Davis, Granite Canyon Marine Laboratory

Station Code	Sample Date	Agency Code	DO Result (mg/L)
312SME_L	1/5/2008	UCD-GC	5.55
312SME_L	2/22/2008	UCD-GC	8.18
312SME_L	4/28/2008	UCD-GC	11.92
312SME_L	4/28/2008	UCD-GC	11.78
312SME_L	5/28/2008	UCD-GC	9.99
312SME_L	8/11/2008	UCD-GC	10.69
312SME_L	9/11/2008	UCD-GC	11.71
312SME_L	10/9/2008	UCD-GC	10.11
312SME_L	9/8/2009	UCD-GC	9.75
312SME_L	9/23/2009	UCD-GC	7.78
312SME_L	9/23/2009	UCD-GC	7.68
312SME_L	10/15/2009	UCD-GC	6.48
312SME_L	10/21/2009	UCD-GC	8.89
312SME_L	10/29/2009	UCD-GC	6.83
312SME_U	1/5/2008	UCD-GC	3.42
312SME_U	2/22/2008	UCD-GC	5.35
312SME_U	5/28/2008	UCD-GC	9.64
312SME_U	8/11/2008	UCD-GC	9.32
312SME_U	9/11/2008	UCD-GC	10.64
312SME_U	10/9/2008	UCD-GC	8.62
312SME_U	10/9/2008	UCD-GC	8.48
312SME_U	9/8/2009	UCD-GC	9.13
312SME_U	9/23/2009	UCD-GC	20.80
312SME_U	10/15/2009	UCD-GC	6.82
312SME_U	10/21/2009	UCD-GC	6.6
312SME_U	10/29/2009	UCD-GC	7.15

Summary of UCD-GC Dissolved Oxygen Concentrations at 312SME (mg/L)

Site	Count	Median (mg/L)	Mean (mg/L)	Count < 7	Percent < 7
312SME_L	14	9.3	9.1	3.0	21.4
312SME_U	12	8.6	8.8	4.0	33.3
All	26	8.8	9.0	7.0	26.9

Note: The Spawning beneficial use is designated for the Santa Maria River Estuary, therefore the water quality objective for dissolved oxygen concentration is 7 mg/L.

Table B-8. CCAMP Summary of Dissolved Oxygen (% saturation)

Water body	Site ID	Count	Median	Mean	Max	Min
Santa Maria River	312SMA	172	96.35	95.91	144.6	7.8
	312SMI	38	95.55	101.77	181.6	65
	312SBC	6	100.8	101.08	105	97.7
Orcutt Creek	312ORC	92	88.9	91.93	156.4	59.9
	312ORN	12	90.3	90.44	109	73.8
	312ORI	91	96.4	119.81	227.1	7.8
	312GVT	12	96.5	96.92	124.8	74.8
	312ORB	38	89.95	92.76	186.8	50.8
	312ORS	7	82.4	74.09	94.9	36.3
Green Valley Creek	312GVS	74	91.6	90.26	130.6	16.4
Main Street Canal	312MAB	9	111	113.17	137.8	93
	312MSD	78	93	95.09	198.7	8.8
	312MSS	22	85.25	85.08	100.7	66.6
Betteravia Lakes Region	312MHD	2	93.9	93.90	105.6	82.2
Blosser Channel	312BCD	24	106.3	117.95	200.2	16.6
Bradley Channel	312BCU	28	94.6	98.66	191.7	8.8
	312BCJ	59	111.2	130.31	254.1	71.7
Nipomo Creek	312NIP	25	88.8	92.70	144.1	63.4
	312NIT	17	90.5	98.61	162.8	54.9
Bradley Canyon Creek	312BCC	31	85	89.38	180	30.9
	312BCF	13	75.6	75.95	116.8	36.2
Cuyama River (below res.)	312CUT	12	105.5	109.36	172.3	86.6
Huasna River	312HUA	12	109.2	102.49	138.3	60.6
Alamo Creek	312ALA	30	98.25	100.10	145	65.6
Cuyama River (above res.)	312CUY	18	104.85	104.49	132.5	89.7
	312CCC	20	107.6	112.51	178.2	82
	312CUL	6	86.9	85.73	91.5	78.8
	312CAV	52	94.9	95.15	124.4	75.5
Salisbury Creek	312SAL	1	83.5	83.50	83.5	83.5
Sisquoc River	312SIS	6	108.05	110.03	131.6	93.3
	312SIV	27	97.6	96.59	173.8	38.3
La Brea Creek	312BRE	21	106.6	103.43	158.2	36.8
Oso Flaco Lake	312OFL	29	93.1	99.18	200	50
Little Oso Flaco Creek	312OFN	87	94.8	95.41	163	33.6
Oso Flaco Creek	312OFC	88	92.35	91.97	132.8	39.1
	312USC	12	96.3	98.28	109.7	93.1
	312OSR	11	104.4	108.35	141.6	94.2
	312OLR	10	100.9	100.91	110.2	93.8
	312BSR	18	100.5	107.70	148.4	88.4

Note: For waters not mentioned by a specific beneficial use, median values should not fall below 85% saturation.

Table B-9. CCAMP Summary of pH concentrations (-log[H+])

Water body	Site ID	Count	Median	Mean	Count < 6.5	Percent < 6.5	Count > 8.3	Percent > 8.3	Count < 7	Percent < 7	Count > 8.5	Percent > 8.5
Santa Maria River	312SMA	166	7.83	7.82	0	0	3	1.8	0	0.0	0	0.0
	312SMI	37	7.90	7.85	0	0	1	2.7	0	0.0	0	0.0
	312SBC	4	8.26	8.22	0	0	2	50.0	0	0.0	0	0.0
Orcutt Creek	312ORC	85	7.75	7.71	0	0	0	0.0	1	1.2	0	0.0
	312ORN	12	7.81	7.76	0	0	0	0.0	0	0.0	0	0.0
	312ORI	84	7.78	7.82	0	0	7	8.3	0	0.0	1	1.2
	312GVT	12	7.75	7.64	0	0	0	0.0	0	0.0	0	0.0
	312ORB	37	7.77	7.84	0	0	2	5.4	0	0.0	2	5.4
	312ORS	7	7.53	7.50	0	0	0	0.0	0	0.0	0	0.0
Greene Valley Creek	312GVS	68	7.76	7.71	0	0	0	0.0	0	0.0	0	0.0
Main Street Canal [1,2]	312MAB	9	8.51	8.47	0	0	8	88.9	0	0.0	5	55.6
	312MSD	71	7.96	7.92	0	0	8	11.3	0	0.0	2	2.8
	312MSS	23	8.07	8.00	0	0	5	21.7	1	4.3	2	8.7
Betteravia Lakes Region	312MHD	2	7.44	7.44	0	0	0	0.0	1	50.0	0	0.0
Blosser Channel [1,]	312BCD	24	8.78	8.76	0	0	17	70.8	0	0.0	15	62.5
Bradley Channel [1]	312BCU	28	8.16	8.21	0	0	11	39.3	0	0.0	6	21.4
	312BCJ	53	8.56	8.68	0	0	39	73.6	0	0.0	28	52.8
Nipomo Creek	312NIP	23	7.99	7.93	0	0	1	4.3	0	0.0	0	0.0
	312NIT	17	7.88	7.83	0	0	0	0.0	0	0.0	0	0.0
Bradley Canyon Creek [1]	312BCC	29	7.98	8.06	0	0	9	34.6	0	0.0	3	11.5
	312BCF	13	7.93	7.94	0	0	3	23.1	0	0.0	0	0.0
Cuyama River (below res.)	312CUT	11	8.14	8.05	0	0	2	18.2	0	0.0	0	0.0
Huasna River	312HUA	12	7.55	7.63	0	0	0	0.0	0	0.0	0	0.0
Alamo Creek	312ALA	28	7.70	7.80	0	0	2	7.1	0	0.0	0	0.0
Cuyama River (above res.) [1, 3]	312CUY	16	8.17	**8.17**	0	0	4	25.0	0	0.0	0	0.0
	312CCC	19	7.94	7.98	0	0	3	15.8	0	0.0	0	0.0

Water body	Site ID	Count	Median	Mean	Count < 6.5	Percent < 6.5	Count > 8.3	Percent > 8.3	Count < 7	Percent < 7	Count > 8.5	Percent > 8.5
	312CUL	3	8.25	8.26	0	0	1	33.3	0	0.0	0	0.0
	312CAV	23	7.99	7.99	0	0	3	13.0	0	0.0	0	0.0
Sisquoc River	312SIS	6	8.47	8.46	0	0	5	83.3	0	0.0	2	33.3
	312SIV	26	8.02	8.04	0	0	7	26.9	0	0.0	2	7.7
La Brea Creek	312BRE	20	7.99	8.01	0	0	4	20.0	0	0.0	1	5.0
Oso Flaco Lake	312OFL	27	7.86	7.86	0	0	1	3.7	0	0.0	0	0.0
Little Oso Flaco Creek	312OFN	80	7.70	7.73	0	0	1	1.3	0	0.0	0	0.0
Oso Flaco Creek	312OFC	81	7.66	7.68	0	0	2	2.5	0	0.0	0	0.0
	312USC	12	8.15	8.20	0	0	3	25.0	0	0.0	0	0.0
	312OSR	11	8.20	8.30	0	0	5	45.5	0	0.0	2	18.2
	312OLR	10	8.26	8.27	0	0	4	40.0	0	0.0	2	20.0
	312BSR	18	8.18	8.21	0	0	5	27.8	0	0.0	3	16.7

[1] Indicates waterbodies on the 2008-2010 303(d) List of Impaired waterbodies for this constituent.
[2] Exceeds WQO's for MUN, AG, REC1&2: not less than 6.5 and not greater than 8.3.
[3] Exceeds University of California Agricultural Extension Service guidelines provided in Table 3-3 (Central Coast Water Board Basin Plan, Chapter III, Section II.A.2 Objectives for all Inland and Surface Waters, Enclosed Bays and Estuaries). In Table 3-3 of the Basin Plan (page III-8), water quality guidelines state that severe problems may occur when pH is greater than 8.4 or less than 6.5 in irrigation supply water.

Water quality objectives based on the following beneficial uses:
MUN, AG, REC1&2: not less than 6.5 and not greater than 8.3
COLD, WARM, MAR, and no designated BU: not less than 7 and not greater than 8.5

Main St. Canal - The Water Quality Control Plan, Central Coast Basin objective for non-contact water recreation uses (Section II.A.2. Objectives for All Inland Surface Waters, Enclosed Bays, and Estuaries, II.A.2.a) states the following: pH value shall neither be depressed below 6.5 nor raised above 8.3.

Sisquoc River - After review of the available data and information, RWQCB staff concludes that the water body-pollutant combination should not be placed on the section 303(d) list because there are no known unnatural sources in the upper Sisquoc River. Staff believes the elevated pH is natural and a result of the geology of the watershed.

Table B-10. CCAMP Summary of water column chlorophyll *a* concentrations (µg/L)

Water body	Site ID	Count	Median	Mean	Count > 8	% > 8	Count > 15	% > 15	Count > 40	% > 40
Santa Maria River	312SMA	165	3.3	8.3	56	33.9	31	18.8	3	1.8
	312SMI	36	2.0	9.7	3	8.3	2	5.6	2	5.6
	312SBC	4	1.5	2.0	0	0.0	0	0.0	0	0.0
Orcutt Creek	312ORC	85	2.8	6.7	23	27.1	12	14.1	1	1.2
	312ORN	12	2.9	3.6	1	8.3	0	0.0	0	0.0
	312ORI	84	3.3	7.4	23	27.4	14	16.7	1	1.2
	312GVT	12	13.8	15.2	8	66.7	6	50.0	1	8.3
	312ORB	39	4.3	12.6	15	38.5	6	15.4	3	7.7
	312ORS	7	4.0	3.6	0	0.0	0	0.0	0	0.0
Greene Valley Creek	312GVS	67	2.0	3.6	9	13.4	2	3.0	0	0.0
Main Street Canal	312MAB	9	3.6	4.3	2	22.2	0	0.0	0	0.0
	312MSD	70	3.0	6.4	16	22.9	8	11.4	0	0.0
	312MSS	23	1.9	7.4	6	26.1	5	21.7	0	0.0
Betteravia Lakes Region	312MHD	2	4.7	4.7	0	0.0	0	0.0	0	0.0
Blosser Channel	312BCD	21	6.0	10.1	6	28.6	4	19.0	1	4.8
Bradley Channel	312BCU	26	5.7	9.2	8	30.8	6	23.1	1	3.8
	312BCJ	53	3.2	4.8	8	15.1	2	3.8	0	0.0
Nipomo Creek	312NIP	22	4.6	5.6	6	27.3	1	4.5	0	0.0
	312NIT	14	2.5	5.8	3	21.4	2	14.3	0	0.0
Bradley Canyon Creek	312BCC	28	2.7	3.3	2	7.1	0	0.0	0	0.0
	312BCF	11	5.0	7.1	5	45.5	2	18.2	0	0.0
Cuyama River (below res.)	312CUT	11	2.0	2.9	1	9.1	0	0.0	0	0.0
Huasna River	312HUA	11	5.0	7.8	4	36.4	1	9.1	0	0.0
Alamo Creek	312ALA	26	1.0	2.4	2	7.7	1	3.8	0	0.0
Cuyama River (above res.)	312CUY	14	2.0	3.5	1	7.1	1	7.1	0	0.0
	312CCC	17	2.2	5.9	2	11.8	2	11.8	1	5.9
	312CUL	3	2.0	1.9	0	0.0	0	0.0	0	0.0
	312CAV	22	2.1	4.6	2	9.1	2	9.1	1	4.5
Salisbury Creek	312SAL	1	20.0	20.0	1	100.0	1	100.0	0	0.0
Sisquoc River	312SIS	5	1.0	2.6	1	20.0	0	0.0	0	0.0
	312SIV	25	1.0	2.5	2	8.0	1	4.0	0	0.0
La Brea Creek	312BRE	20	2.0	2.3	1	5.0	0	0.0	0	0.0
Oso Flaco Lake	312OFL	28	13.1	29.8	18	64.3	12	42.9	6	21.4
Little Oso Flaco Creek	312OFN	73	1.4	2.4	3	4.1	1	1.4	0	0.0
Oso Flaco Creek	312OFC	80	2.8	6.3	14	17.5	8	10.0	1	1.3
	312USC	12	5.2	6.0	1	8.3	1	8.3	0	0.0
	312OSR	11	1.5	1.9	0	0.0	0	0.0	0	0.0
	312OLR	10	4.0	4.1	1	10.0	0	0.0	0	0.0
	312BSR	17	5.0	8.5	5	29.4	2	11.8	0	0.0

Chlorophyll *a* exceedances based on the following criteria;:USEPA guidance of 8 µg/L, North Carolina and State of Oregon criteria of 15 µg/L, and Central Coast Water Board 305b “stand alone” listing criteria of 40 µg/L.

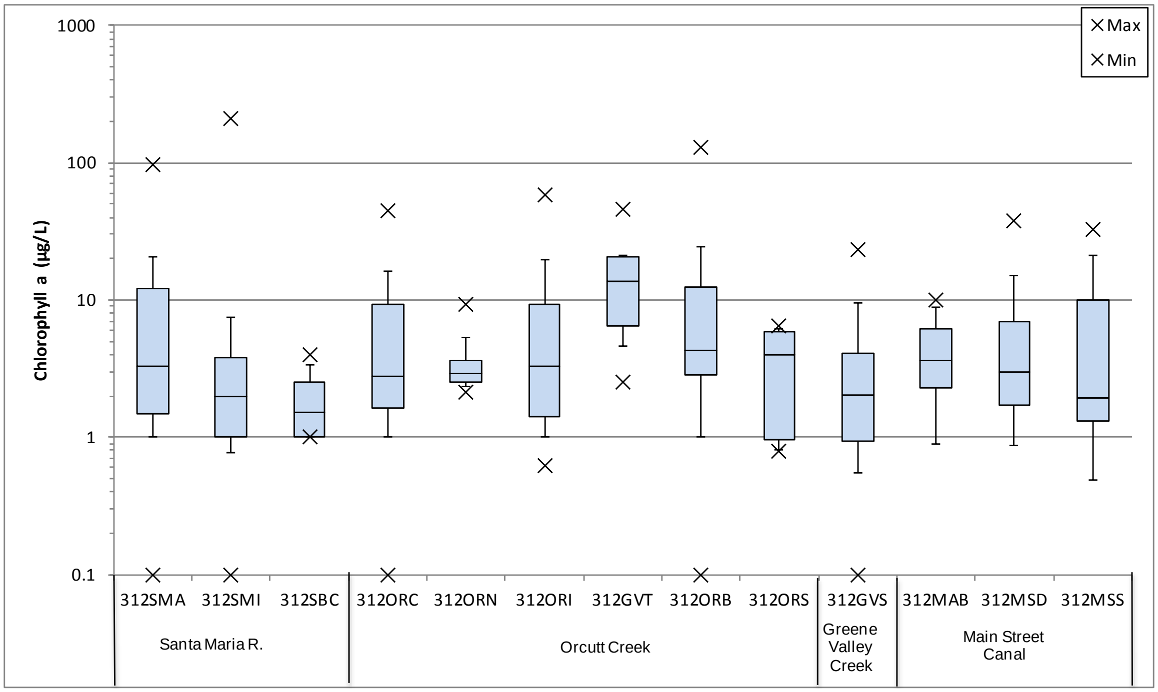


Figure B-11. Chlorophyll *a* for sites in Lower Santa Maria River watershed.

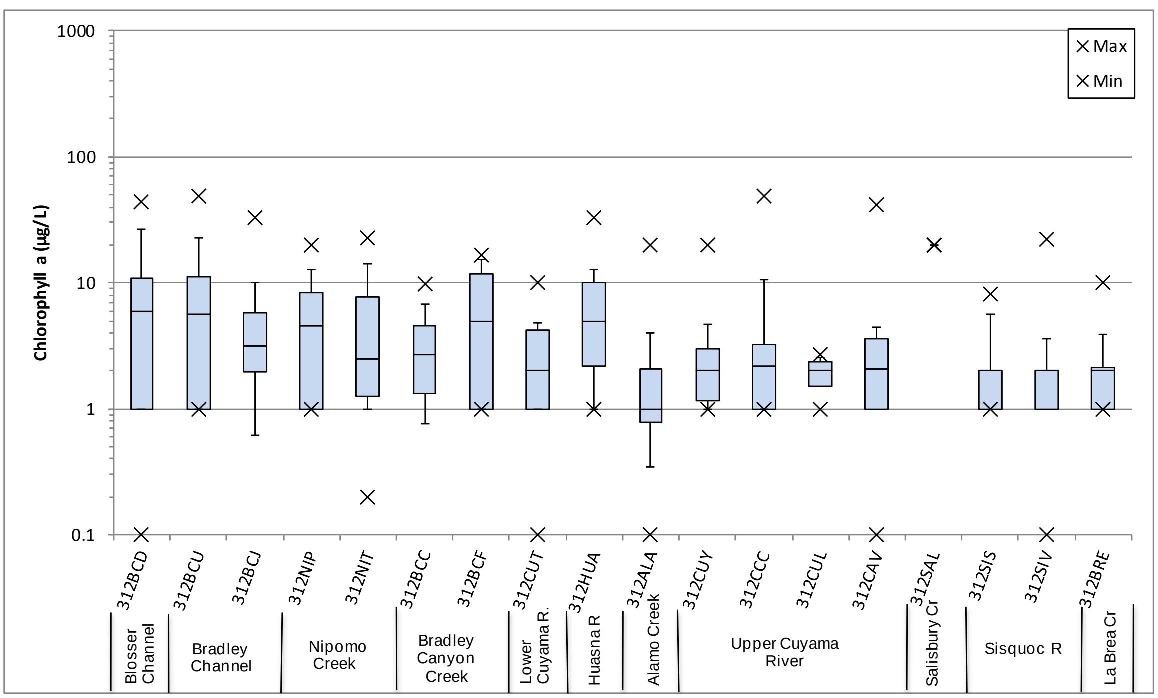


Figure B-12. Chlorophyll *a* for sites in Middle and Upper Santa Maria River watershed.

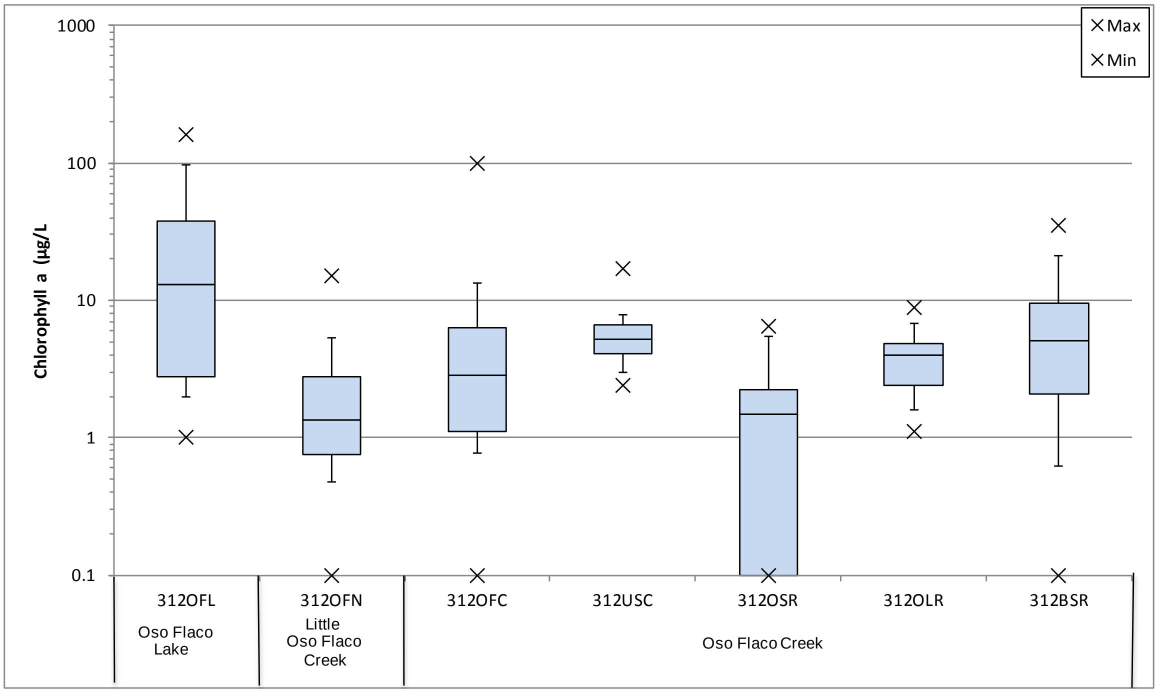


Figure B-13. Chlorophyll *a* for sites in Oso Flaco Lake watershed.

Table B-11. CCAMP Summary of Filamentous Algae Coverage (% Surface coverage)

Water body	Site ID	Count	Average	Count > 50%	Percent > 50%
Santa Maria River	312SMA	86	1.95	1	1.16
	312SMI	17	1.88	0	0.00
Orcutt Creek	312ORC	33	4.09	0	0.00
	312ORI	34	11.94	3	8.82
	312GVT	12	0.08	0	0.00
	312ORB	22	5.14	0	0.00
Greene Valley Creek	312GVS	24	16.88	4	16.67
	312MSD	32	11.16	3	9.38
	312MSS	11	0.00	0	0.00
Blosser Channel	312BCD	19	10.79	1	5.26
Bradley Channel	312BCU	21	23.38	5	23.81
	312BCJ	12	3.92	0	0.00
Nipomo Creek	312NIP	17	1.65	0	0.00
	312NIT	12	21.75	3	25.00
Bradley Canyon Creek	312BCC	11	1.18	0	0.00
	312BCF	8	0.00	0	0.00
Cuyama River (below res.)	312CUT	7	0.71	0	0.00
Huasna River	312HUA	11	16.36	1	9.09
Alamo Creek	312ALA	25	5.76	0	0.00
Cuyama River (above res.)	312CUY	13	2.46	0	0.00
	312CCC	15	8.53	1	6.67
	312CUL	3	0.67	0	0.00
	312CAV	21	5.14	0	0.00
Sisquoc River	312SIS	3	1.67	0	0.00
	312SIV	18	13.11	3	16.67
La Brea Creek	312BRE	15	22.00	4	26.67
Oso Flaco Lake	312OFL	5	0.00	0	0.00
Little Oso Flaco Creek	312OFN	32	30.63	9	28.13
Oso Flaco Creek	312OFC	28	10.61	3	10.71
	312BSR	6	0.00	0	0.00

Exceedances based on CCAMP criteria of 50% surface coverage.

Table B-12. CCAMP Summary of turbidity data (NTU).

Water body	Site ID	Count	Median	Mean	Count > 25	Percent > 25
Santa Maria River [1]	312SMA	164	119.9	240.2	157	95.7
	312SMI	30	20.4	407.5	14	46.7
	312SBC	2	32.4	32.4	1	50.0
Orcutt Creek [1]	312ORC	81	200.2	378.9	79	97.5
	312ORN	12	468.7	442.9	12	100.0
	312ORI	79	35.0	179.5	45	57.0
	312GVT	13	29.0	79.9	7	53.8
	312ORB	33	14.2	209.3	9	27.3
	312ORS	8	169.8	845.5	4	50.0
Greene Valley Creek[1]	312GVS	75	9.6	148.4	27	36.0
Main Street Canal [1]	312MAB	9	37.1	213.7	5	55.6
	312MSD	65	56.8	156.9	47	72.3
	312MSS	23	15.2	71.3	9	39.1
Betteravia Lakes Region	312MHD	2	146.7	146.7	1	50.0
Blosser Channel	312BCD	18	5.6	142.0	6	33.3
Bradley Channel	312BCU	19	16.8	136.4	8	42.1
	312BCJ	53	62.0	328.2	48	90.6
Nipomo Creek	312NIP	14	17.9	17.0	2	14.3
	312NIT	12	4.7	6.9	1	8.3
Bradley Canyon Creek [1]	312BCC	28	89.6	522.5	19	67.9
	312BCF	8	98.6	237.7	8	100.0
Cuyama River (below res.)	312CUT	7	12.5	456.1	3	42.9
Huasna River	312HUA	11	0.2	4.0	1	9.1
Alamo Creek	312ALA	21	0.3	2.5	0	0.0
Cuyama River (above res.)	312CUY	9	1.1	113.4	1	11.1
	312CCC	11	3.9	168.0	4	36.4
	312CAV	18	9.9	227.2	6	33.3
Sisquoc River	312SIS	3	16.3	18.0	1	33.3
	312SIV	19	0.3	3.0	1	5.3
La Brea Creek	312BRE	16	0.8	1.5	0	0.0
Oso Flaco Lake	312OFL	23	7.4	11.7	2	8.7
Little Oso Flaco Creek	312OFN	75	25.6	107.0	39	52.0
Oso Flaco Creek	312OFC	76	186.5	365.4	73	96.1
	312USC	12	322.0	819.8	12	100.0
	312OSR	11	107.3	421.5	9	81.8
	312OLR	10	654.0	829.1	10	100.0
	312BSR	18	137.5	375.9	16	88.9

[1] Indicates waterbodies on the 2008-2010 303(d) List of Impaired waterbodies for this constituent.

Exceedance based on 25 NTU threshold that inhibits steelhead and cojo salmon from feeding which results in reduced size and weight. Siegler 1984 for COLD BU.

Waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses. Water Quality Control Plan, Central Coast Basin, Chapter III, Section II.A.2 Objectives for all Inland Surface Waters, Enclosed Bays and Estuaries.

Sigler et al. (1984) states that turbidities of 25 NTU's or greater caused reduction in juvenile salmonid growth due to interference with their ability to find food.

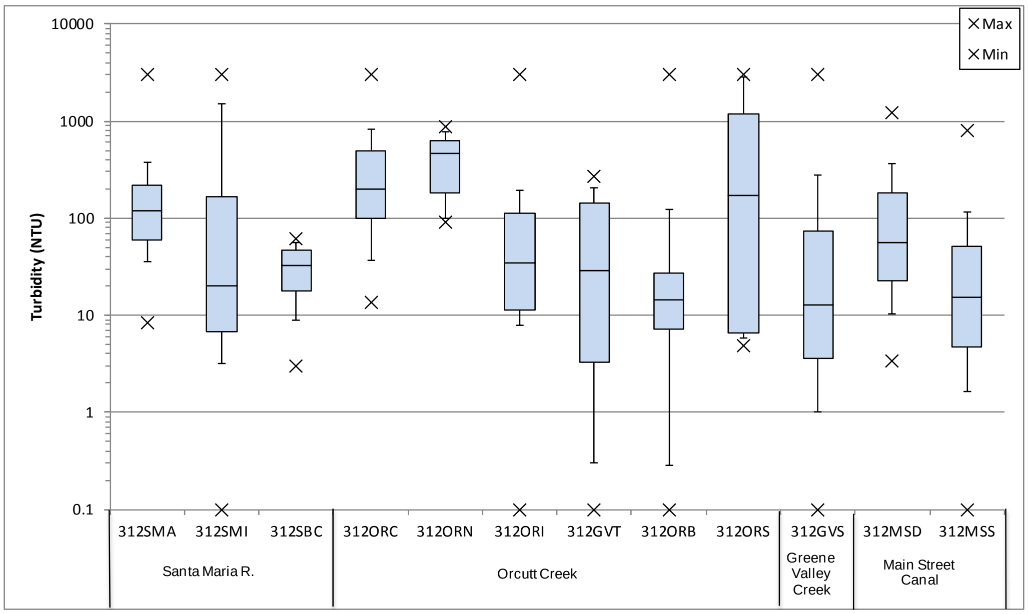


Figure B-14. Turbidity for sites in Lower Santa Maria River watershed.

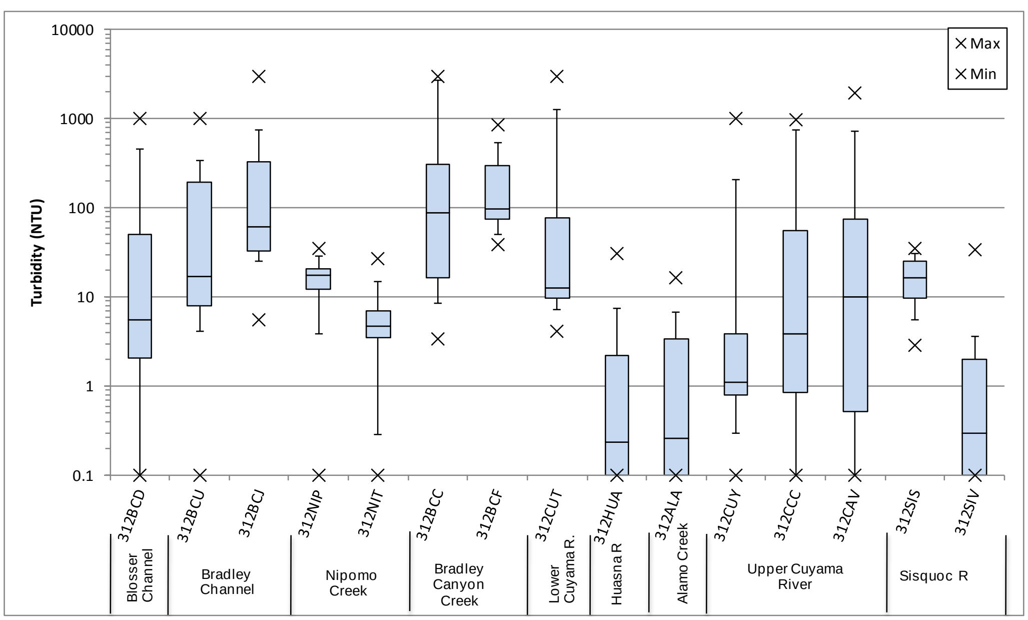


Figure B-15. Turbidity for sites in Middle and Upper Santa Maria River watershed.

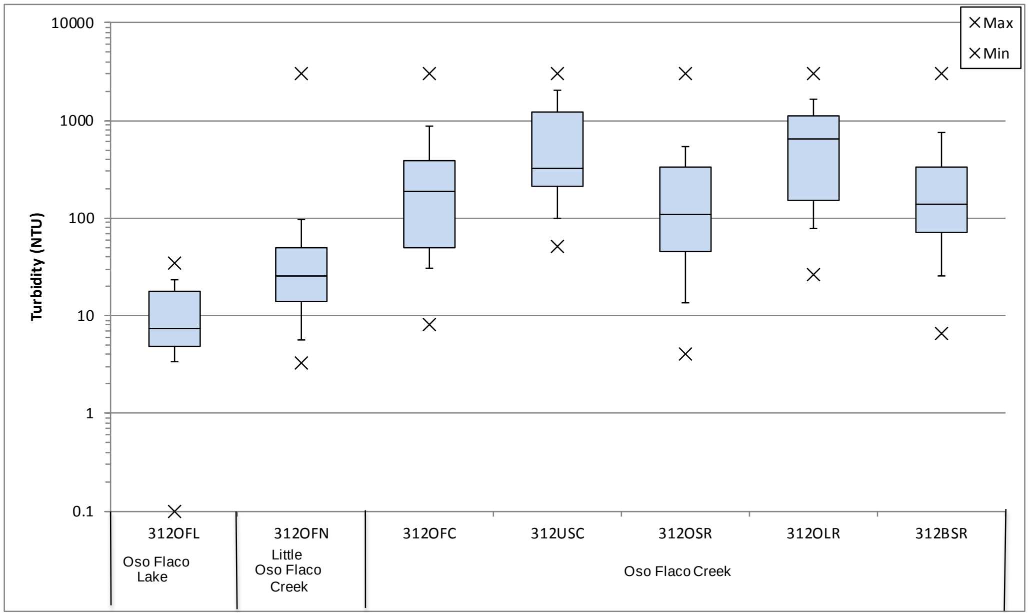


Figure B-16. Turbidity for sites in Oso Flaco Lake watershed.

Table B-13. CCAMP Summary of orthophosphate as phosphorus - OP as P (mg/L).

Water body	Site ID	Count	Median	Mean	Geomean
Santa Maria River	312SMA	171	0.28	0.295	0.243
	312SMI	39	0.18	0.284	0.144
	312SBC	5	0.03	0.152	0.059
Orcutt Creek	312ORC	90	0.30	0.344	0.272
	312ORN	12	0.32	0.317	0.287
	312ORI	88	0.29	0.361	0.280
	312GVT	12	0.26	0.306	0.244
	312ORB	38	0.65	0.648	0.564
	312ORS	7	0.34	0.440	0.373
Greene Valley Creek	312GVS	72	0.16	0.195	0.136
Main Street Canal	312MAB	9	0.25	0.429	0.338
	312MSD	74	1.41	5.950	1.905
	312MSS	23	0.58	1.577	0.700
Betteravia Lakes Region	312MHD	2	0.25	0.249	0.234
Blosser Channel	312BCD	21	0.22	0.243	0.194
Bradley Channel	312BCU	26	0.46	0.526	0.453
	312BCJ	57	0.40	0.592	0.380
Nipomo Creek	312NIP	22	0.13	0.184	0.145
	312NIT	14	0.33	0.318	0.297
Bradley Canyon Creek	312BCC	29	0.60	1.474	0.608
	312BCF	11	0.43	0.483	0.418
Cuyama River (below res.)	312CUT	12	0.01	0.014	0.012
Huasna River	312HUA	12	0.13	0.166	0.133
Alamo Creek	312ALA	28	0.06	0.052	0.044
Cuyama River (above res.)	312CUY	15	0.01	0.081	0.016
	312CCC	19	0.01	0.092	0.014
	312CUL	3	0.01	0.020	0.016
	312CAV	24	0.01	0.026	0.012
Salisbury Creek	312SAL	1	2.19	1.180	0.613
Sisquoc River	312SIS	6	0.02	0.028	0.013
	312SIV	25	0.02	0.020	0.015
La Brea Creek	312BRE	20	0.11	0.096	0.086
Oso Flaco Lake	312OFL	28	0.18	0.198	0.150
Little Oso Flaco Creek	312OFN	79	0.10	0.139	0.088
Oso Flaco Creek	312OFC	83	0.18	0.257	0.165
	312USC	12	0.23	0.272	0.215
	312OSR	11	0.17	0.185	0.121
	312OLR	10	0.19	0.236	0.179
	312BSR	18	0.13	0.161	0.120

Note: 25^{th} percentile of all watershed data is 0.108 mg/L.

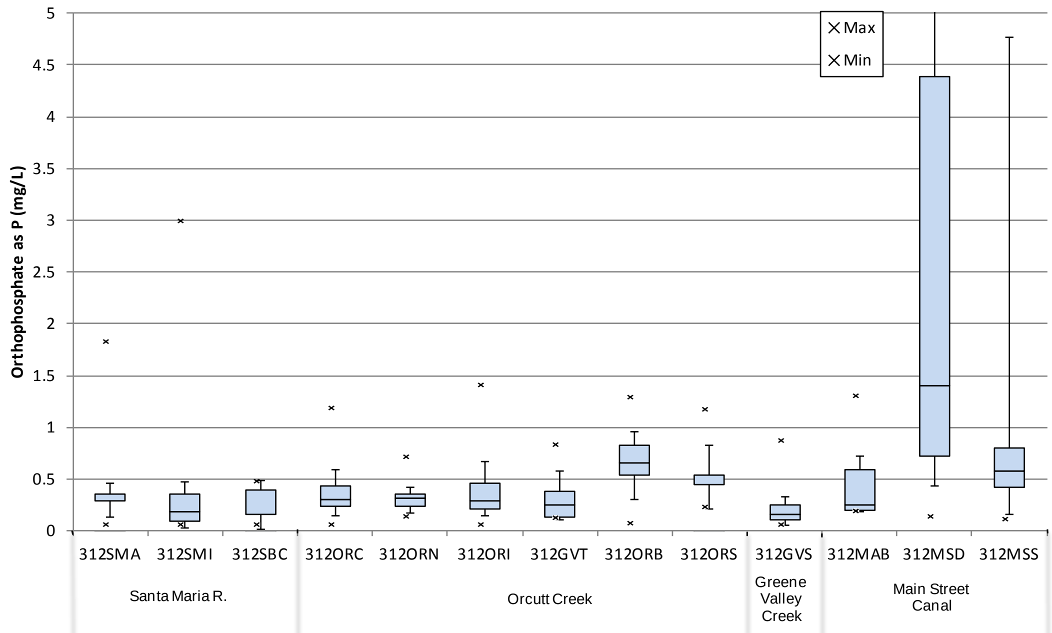


Figure B-17. Orthophosphate as P for sites in Lower Santa Maria River watershed

Note: Not shown is 312MSD maximum (93.7 mg/L) and 90th percentile (12.5 mg/L), also 312MSS maximum of (10.4 mg/L).

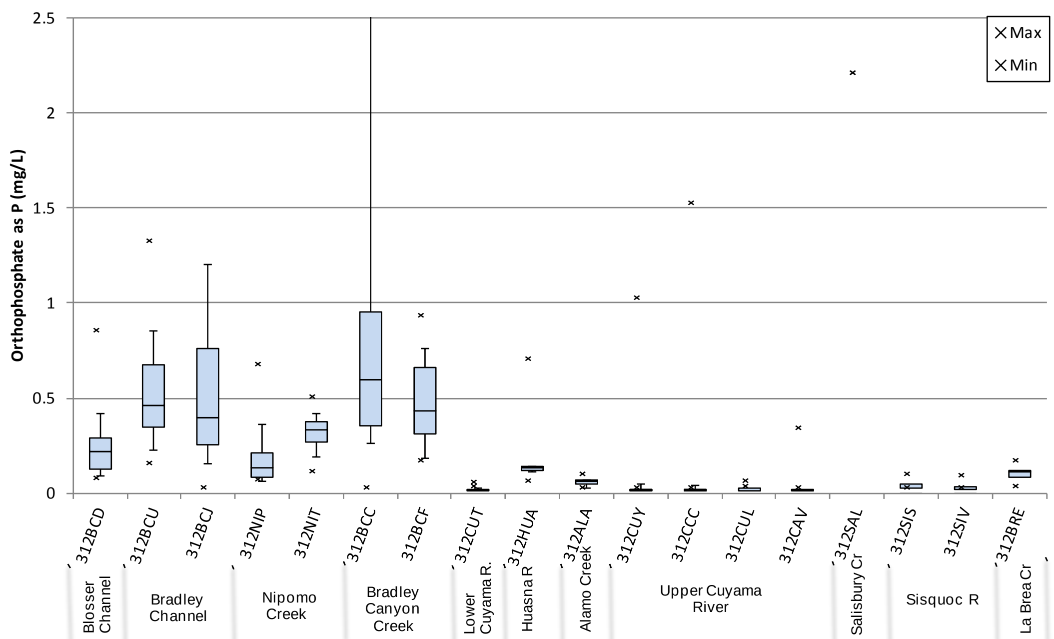


Figure B-18. Orthophosphate as P for sites in Middle and Upper Santa Maria River watershed

Note: Not shown are 312BCJ maximum (4.17 mg/L), 312BCC maximum (12.1 mg/L) and 90th percentile (4.15 mg/L). Only one sample was obtained for Salisbury Creek (312SAL).

Table B-14. CCAMP Proportion of orthophosphate in total phosphorus (mg/L).

Water body	Site	Sample Count	Geomean	Median	Mean
Santa Maria River	312SMA	15	53.27	71.43	65.46
	312SMI	9	69.70	85.07	83.42
	312SBC	2	34.47	51.60	51.60
Orcutt Creek	312ORC	9	47.83	80.33	65.97
	312ORI	8	38.19	61.68	53.86
	312ORB	7	38.80	86.67	61.64
Main Street Canal	312MSD	7	68.92	84.40	73.32
Blosser Channel	312BCD	6	52.12	72.67	60.68
Bradley Channel	312BCU	7	59.05	66.18	66.03
Nipomo Creek	312NIP	7	54.87	66.67	60.02
	312NIT	5	58.49	82.61	67.07
	312BCF	4	76.64	82.86	79.53
Cuyama River (below res.)	312CUT	3	21.51	20.00	21.75
Huasna River	312HUA	1	28.60	28.60	28.60
Alamo Creek	312ALA	7	52.61	75.00	63.47
Cuyama River (above res.)	312CUY	1	52.63	52.63	52.63
	312CCC	2	70.71	70.83	70.83
	312CAV	4	19.27	28.09	26.33
Sisquoc River	312SIS	1	18.86	18.86	18.86
	312SIV	2	41.40	44.29	44.29
La Brea Creek	312BRE	6	57.45	70.71	66.07
Oso Flaco Lake	312OFL	7	38.07	38.64	50.54
Little Oso Flaco Creek	312OFN	6	60.37	75.60	67.19
Oso Flaco Creek	312OFC	7	62.39	75.26	67.53

Statistics based on percent of orthophosphate (as P) in total phosphorus for paired samples.

Table B-15. CCAMP Water column TN:TP ratios (geomean of individual monitoring site samples).

Water body	Site	Count	Geomean	Median	Mean
Santa Maria River	312SMA	11	59.55	26.30	26.05
	312SMI	9	59.16	62.00	68.06
	312SBC	1	1.67	1.67	1.67
Orcutt Creek	312ORC	9	45.72	49.84	50.44
	312ORI	8	63.12	56.91	79.31
	312ORB	7	8.85	10.00	11.58
	312MSD	7	4.97	5.97	7.24
Blosser Channel	312BCD	6	9.37	7.67	16.49
Bradley Channel	312BCU	7	11.49	14.05	16.43
Nipomo Creek	312NIP	6	8.90	9.76	9.73
	312NIT	5	14.63	15.53	15.05
	312BCF	4	22.37	22.76	36.84
Cuyama River (below res.)	312CUT	1	14.29	14.29	14.29
Huasna River	312HUA	1	4.00	4.00	4.00
Alamo Creek	312ALA	3	7.81	7.14	8.49
Cuyama River (above res.)	312CUY	1	1.32	1.32	1.32
	312CAV	2	1.73	1.76	1.76
La Brea Creek	312BRE	1	3.57	3.57	3.57
Oso Flaco Lake	312OFL	7	83.52	83.53	85.49
Little Oso Flaco Creek	312OFN	8	163.99	166.73	172.57
Oso Flaco Creek	312OFC	7	77.56	88.78	86.76

Statistics based on TN:TP ratios of paired samples

Table B-16. CCAMP Summary of Temperature (ºC).

Water body	Site ID	Count	Median	Mean	Count > 21	Percent > 21
Santa Maria River	312SMA	170	16.5	16.1	19	11.2
	312SMI	41	15.6	16.7	7	17.1
	312SBC	5	12.7	14.3	0	0.0
Orcutt Creek[1]	312ORC	91	16.9	17.3	18	19.8
	312ORN	12	17.2	17.2	3	25.0
	312ORI	90	17.8	18.0	25	27.8
	312GVT	12	18.0	17.8	2	16.7
	312ORB	37	15.3	15.5	4	10.8
	312ORS	7	14.4	14.3	0	0.0
Greene Valley Creek[1]	312GVS	74	17.4	17.7	14	18.9
Main Street Canal	312MAB	9	21.3	19.7	5	55.6
	312MSD	78	17.9	17.8	19	24.4
	312MSS	23	16.7	16.8	3	13.0
Betteravia Lakes Region	312MHD	2	13.3	13.3	0	0.0
Blosser Channel	312BCD	24	17.5	18.2	6	25.0
Bradley Channel	312BCU	28	16.1	16.4	5	17.9
	312BCJ	59	20.1	20.0	28	47.5
Nipomo Creek	312NIP	25	16.2	15.8	4	16.0
	312NIT	17	15.7	16.4	4	23.5
Bradley Canyon Creek	312BCC	34	17.3	18.4	12	35.3
	312BCF	12	15.1	15.5	2	16.7
Cuyama River (below res.)	312CUT	11	14.1	15.9	2	18.2
Huasna River	312HUA	12	18.9	19.3	4	33.3
Alamo Creek	312ALA	30	18.1	18.5	5	16.7
Cuyama River (above res.)	312CUY	18	17.5	18.3	5	27.8
	312CCC	20	15.0	16.5	4	20.0
	312CUL	3	14.5	12.9	0	0.0
	312CAV	26	13.7	15.6	7	26.9
Salisbury Creek	312SAL	1	15.5	15.5	0	0.0
Sisquoc River	312SIS	5	16.1	15.1	0	0.0
	312SIV	26	16.9	16.8	3	11.5
La Brea Creek	312BRE	20	15.5	16.2	4	20.0
Oso Flaco Lake	312OFL	28	16.4	15.9	2	7.1
Little Oso Flaco Creek	312OFN	85	16.6	16.4	7	8.2
Oso Flaco Creek	312OFC	86	15.7	16.2	8	9.3
	312USC	12	18.6	17.8	4	33.3
	312OSR	12	19.5	18.5	3	25.0
	312OLR	10	19.6	19.5	5	50.0
	312BSR	18	20.5	19.1	7	38.9

[1] Indicates waterbodies on the 2008-2010 303(d) List of Impaired waterbodies for this constituent.

This Evaluation Guideline is relevant for Greene Valley Creek as it is a tributary to Orcutt Creek and ultimately Santa Maria River. A recent publication (Steelhead/Rainbow Trout (Oncorhynchus mykiss) Resources South of the Golden Gate, California (Becker, G.S and I.J Reining, October 2008) identifies Santa Maria River as having "Definite run or population" and as being a viable migration corridor to the upper watershed of the Sisquoc River, where steelhead are still observed regularly. Therefore, discharge of warm water from Greene Valley Creek is specifically prohibited by the General Objectives in the Central Coast Water Quality Control Plan which states that natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Board that such alteration in temperature does not adversely affect beneficial uses.

Natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Board that such alteration in temperature does not adversely affect beneficial uses (General Objective in Water Quality Control Plan, Central Coast Basin, Chapter III, Section II.A.2 Objectives for all Inland Surface Waters, Enclosed Bays and Estuaries).

Inland Fishes of California (Moyle 1976) states that for rainbow trout the optimum range for growth and completion of most life stages is 13-21 degrees C (page 129).

Biostimulatory Conditions in Santa Maria River and Oso Flaco Lake Watersheds

The purpose of this section is to discuss nutrients and related biostimulatory indicators as they relate to aquatic life beneficial uses. The Basin Plan contains the following narrative water quality objective:

> *"Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses."*

California does not currently have numeric standards to protect aquatic life beneficial uses, either for direct toxicity or for indirect effects as a biostimulatory substance. As such, CCAMP staff developed a technical report titled, "*Interpreting Narrative Objectives for Biostimulatory Substances for California Central Coast Waters*" (CCAMP, 2010) which outlines an approach for interpreting the narrative biostimulatory substances objective. In this approach, CCAMP staff employed Basin Plan Objectives, U.S. Environmental Protection Agency (U.S. EPA) standards, guideline values from the literature, CCAMP monitoring data, and modeled estimates of potential algal growth and resultant oxygen deficits. The resulting numeric endpoints can be used for regional water quality assessments and to support assessment decisions for the California Integrated Report for addressing Clean Water Act Sections 303(d) and 305(b). The CCAMP report describes how numeric endpoints were derived in the following:

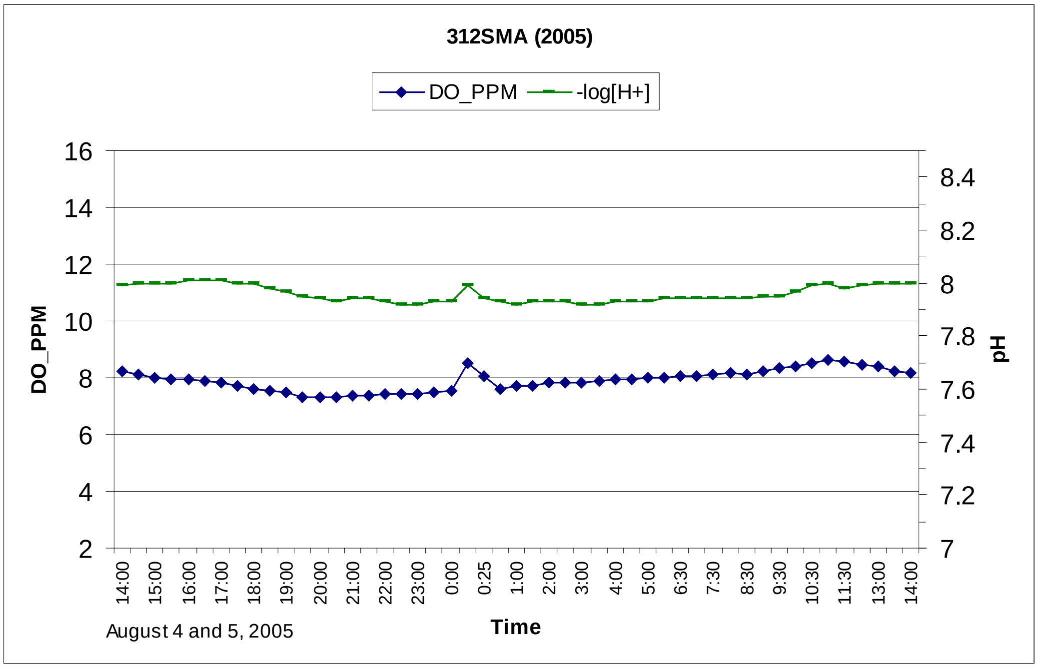
> "We identified a pool of long-term monitoring locations, or "sites", from the extensive CCAMP dataset that have always met either warm or cold water oxygen objectives based on both monthly grab samples and 24-hour continuous monitoring. From this dataset, we identified an upper range for dissolved oxygen concentration of 13 milligrams per liter (mg/L), over which site oxygen concentrations rarely or never fell. We established 13 mg/L as an upper limit for oxygen, to address the U.S. EPA 'Gold Book' (U.S. EPA, 1986) water quality standard for excessive gas saturation. We identified a reference subset of the initial set of sites that showed no other signs of eutrophication, such as oxygen levels over 13 mg/L, water column chlorophyll a exceeding 15 micrograms per liter (µg/L) or observed floating algal cover exceeding 50%."

It is important to note that excessive algal growth in waterbodies is characterized by wide swings in dissolved oxygen concentrations, typically dropping below concentrations set to protect for aquatic life at night, and often rising above fully saturated levels during daytime (U.S. EPA, 2000b). Low oxygen conditions can result in fish kills and harm to other aquatic life. Some species, such as trout, are particularly sensitive to low oxygen conditions, which is why more rigorous standards are necessary to support cold water fish habitat.

CCAMP collected diel (24-hour) data to determine if oxygen levels drop during the highest risk time of day, which is pre-dawn. This is important because monitoring staff conducts routine monthly grab sampling between 9 a.m. and 4 p.m., when oxygen levels are typically highest. Therefore, results of CCAMP monthly grab samples, as presented in Section 3.2.1.3 *Low Dissolved Oxygen Exceedances*, generally represent higher daytime oxygen values, as opposed to the lower (high risk) oxygen values that occur before dawn.

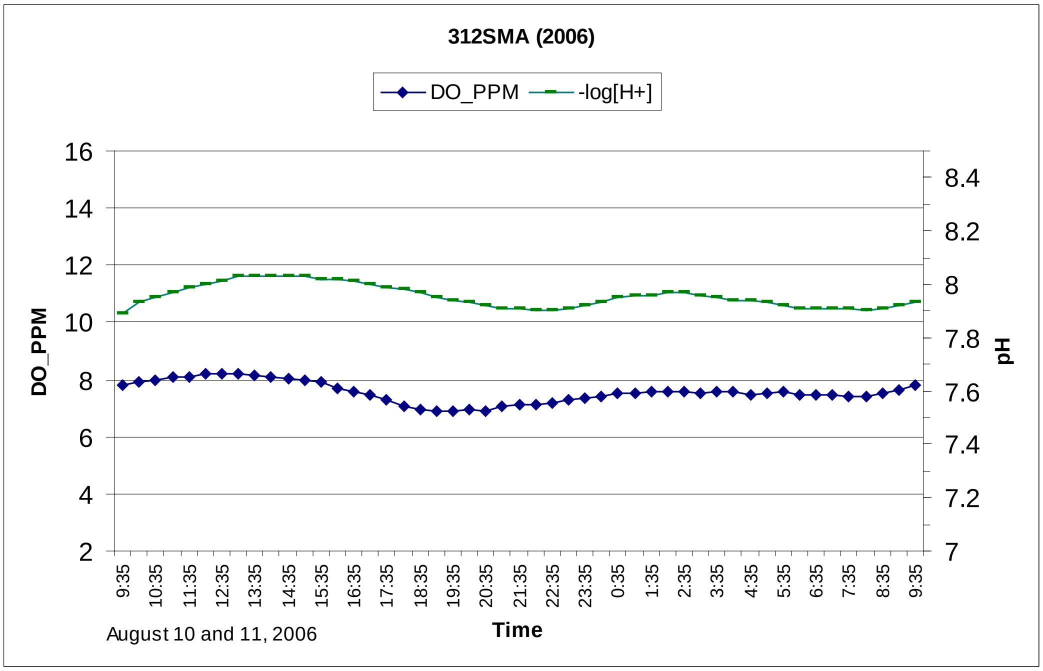
As previously stated, diel dissolved oxygen data is useful to determine if oxygen levels drop during the highest risk time of day, which is pre-dawn. TMDL staff assessed CCAMP diel dissolved oxygen data (8 sites) in the Santa Maria River and Oso Flaco Lake watersheds. The diel dissolve oxygen data was also paired with chlorophyll a concentrations, floating algal cover observations, and photographs obtained near the dates of the diel monitoring. Note that staff asserts biostimulatory conditions exist when dissolved oxygen concentrations dip below the levels necessary to protect the beneficial use (WARM/COLD) or when dissolved oxygen concentrations spike above the CCAMP screening criteria of 13 mg/L, indicating oxygen super-saturation. Chlorophyll *a* concentrations above the CCAMP screening level of 15 µg/L is not used as a primary indicator of biostimulatory conditions, but instead as an additional line of evidence. Also note that percent algal cover and photographic evidence did not result in staff's conclusion of biostimulation.

Santa Maria River above Estuary (SMA) - DO WQO > 7 ppm (SPWN)



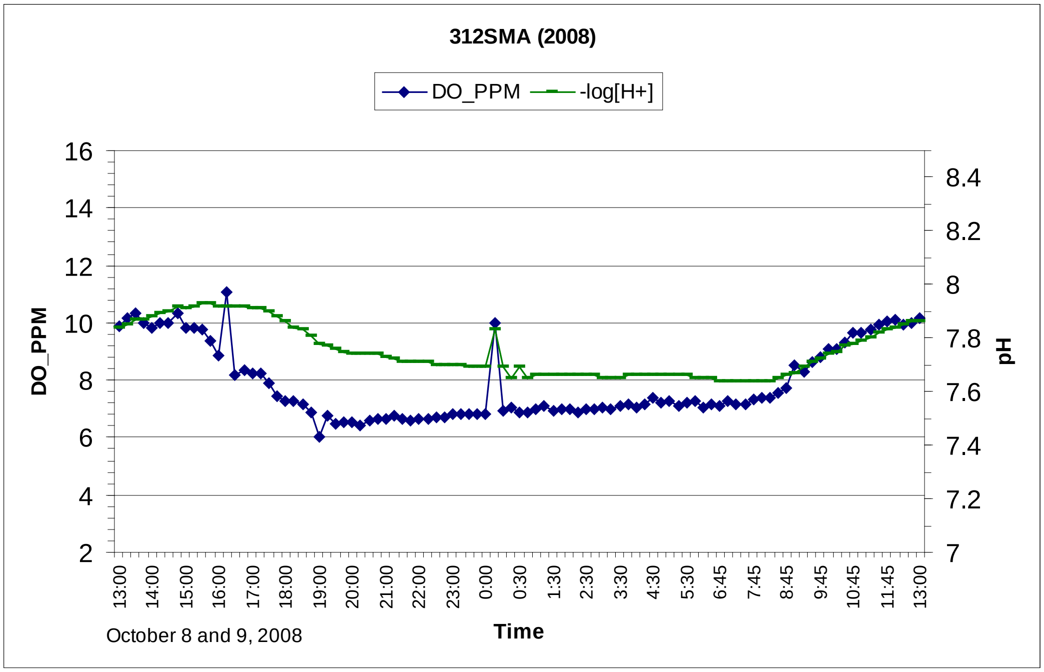
Aug. 24, 2005
Chlor_a = 20 ug/L
Alga_Fila = 0%
Biostimulatory Conditions? No, based on DO, chlor a, and algae.

Santa Maria River above Estuary (SMA) - DO WQO > 7 ppm (SPWN)



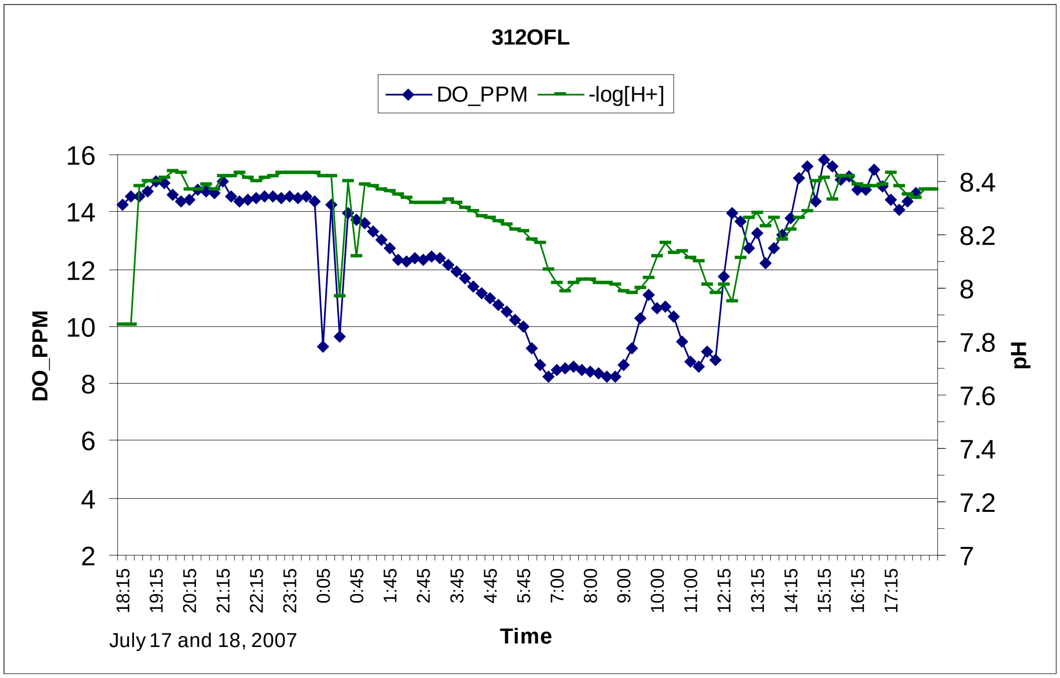
Aug. 10, 2006
Chlor_a = 12.20 ug/L
Alga_Fila = 1%
Biostimulatory Conditions? No, based on DO, chlor a, and algae.

Santa Maria River above Estuary (SMA) - DO WQO > 7 ppm (SPWN)



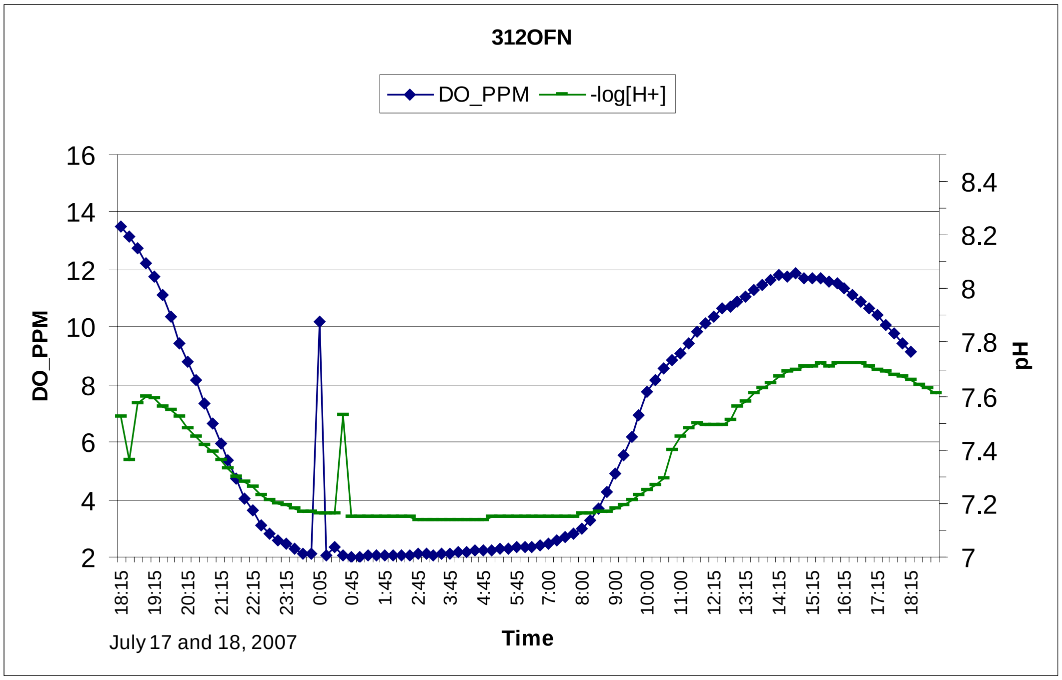
Oct. 22, 2008
Chlor_a = 28.2 ug/L
Alga_Fila = 0 %
Biostimulatory Conditions? No, based on DO, chlor a, and algae.

Oso Flaco Lake (OFL) – DO WQO > 7 ppm (SPWN)



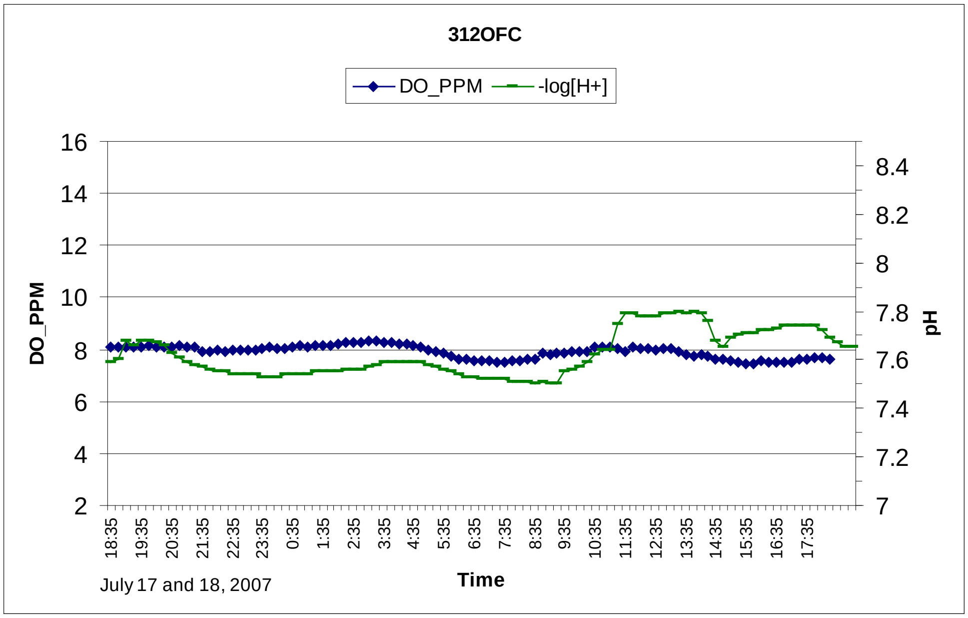
July 18, 2007
Chlor_a = 50 ug/L
Alga_Fila = N/A. 0% in Feb, Mar, Apr, May, and Dec 2007
Biostimulatory Conditions? Yes, based on DO swing (CCAMP > 13) and high Chlor a.

Little Oso Flaco Creek (OFN) - DO WQO > 5ppm (WARM)



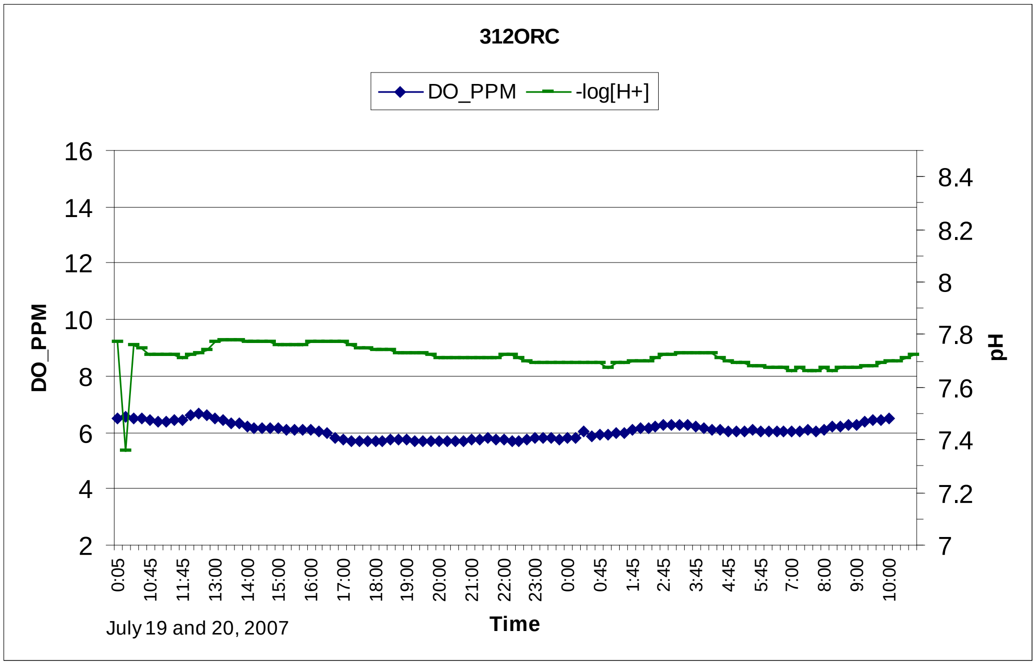
July 18, 2007
Chlor_a = 0 ug/L
Alga_Fila = 0.
Biostimulatory Conditions? Yes, based on low DO and high swing (CCAMP > 13).

Oso Flaco Creek (OFC) - DO WQO > 5ppm (WARM)



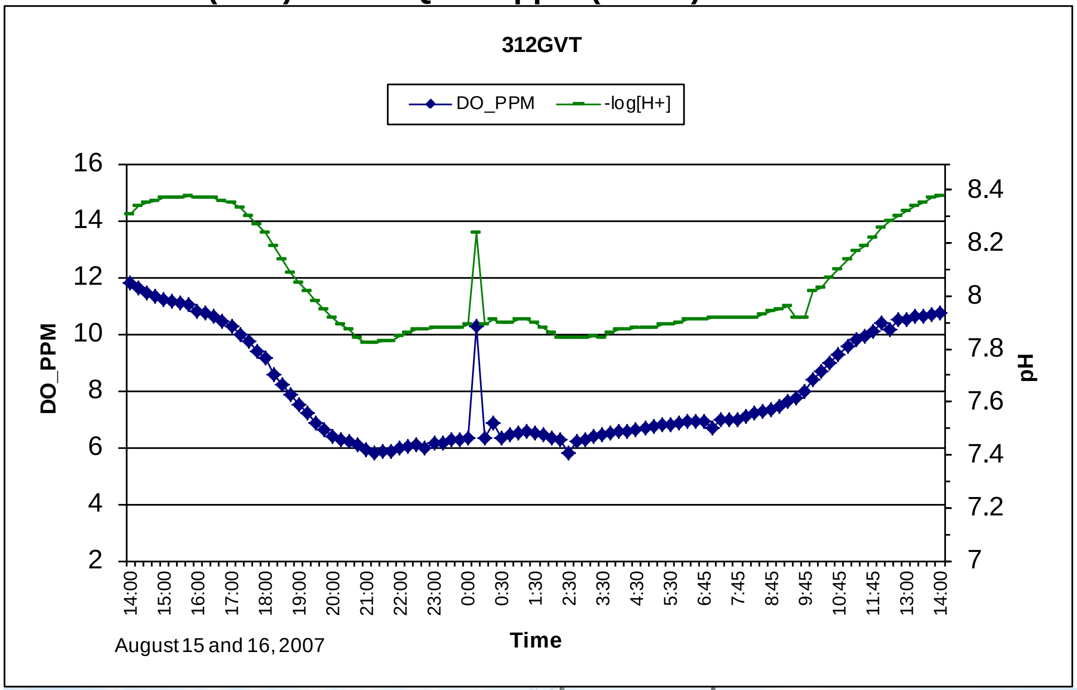
July 18, 2007
Chlor_a = 18.2 ug/L
Alga_Fila = 0%
Biostimulatory Conditions? No, based on DO, chlor a, and algae.

Orcutt Creek (ORC) - DO WQO > 7ppm (COLD)



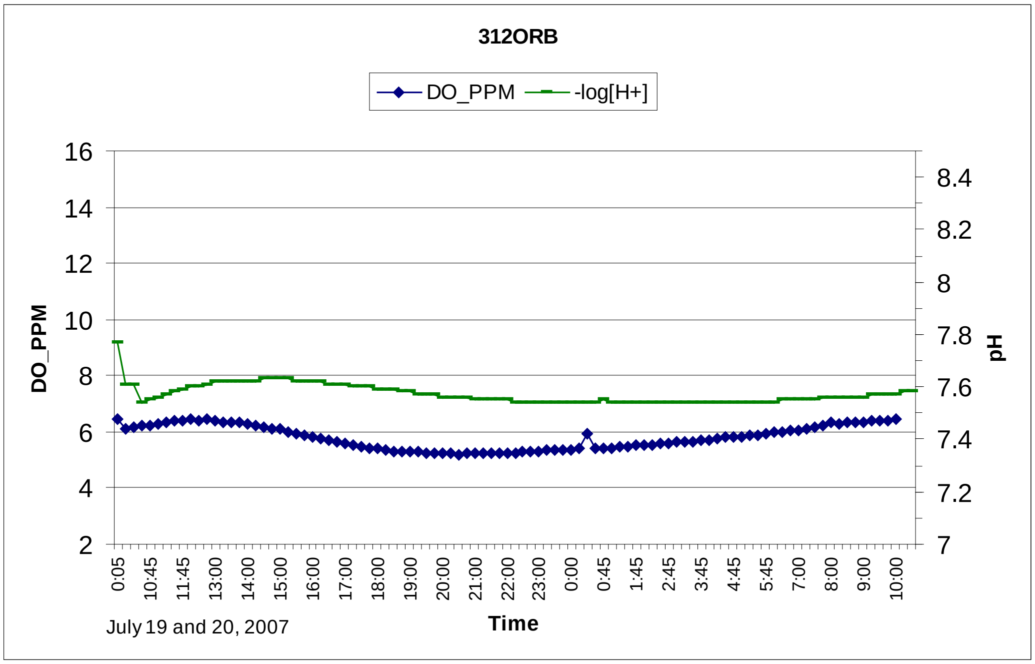
July 18, 2007
Chlor_a = 12.5 ug/L
Alga_Fila = 0%
Biostimulatory Conditions? Yes, based on low DO.

Orcutt Creek (GVT) - DO WQO > 7ppm (COLD)



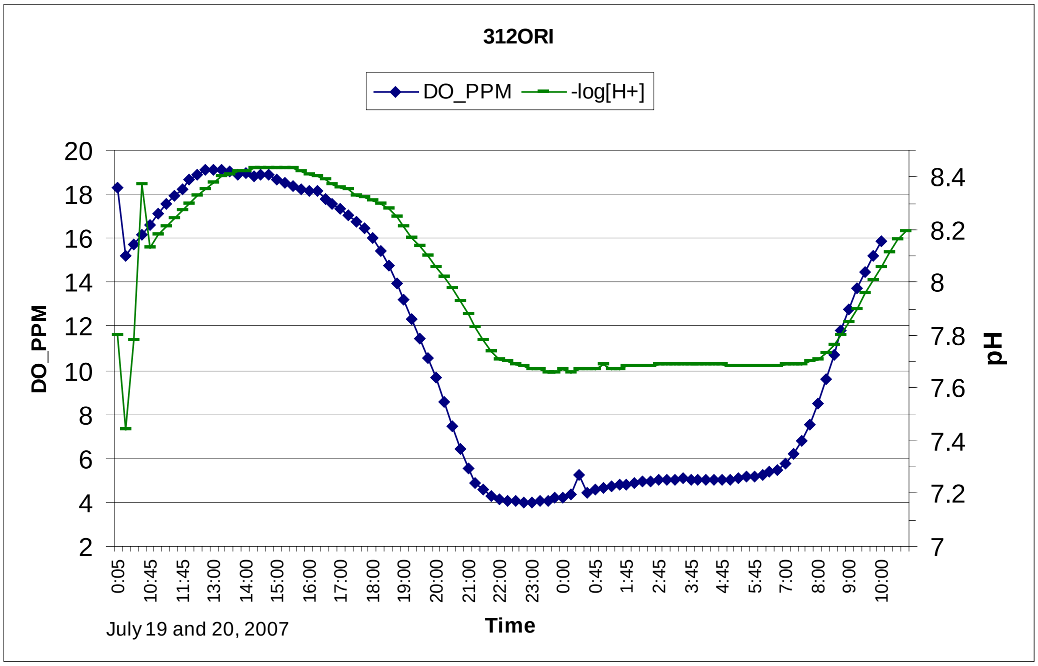
July 18, 2007
Chlor_a = 2.5 ug/L
Alga_Fila = 0%
Biostimulatory Conditions? Yes, based on low DO.

Orcutt Creek (ORB) - DO WQO > 7ppm (COLD)



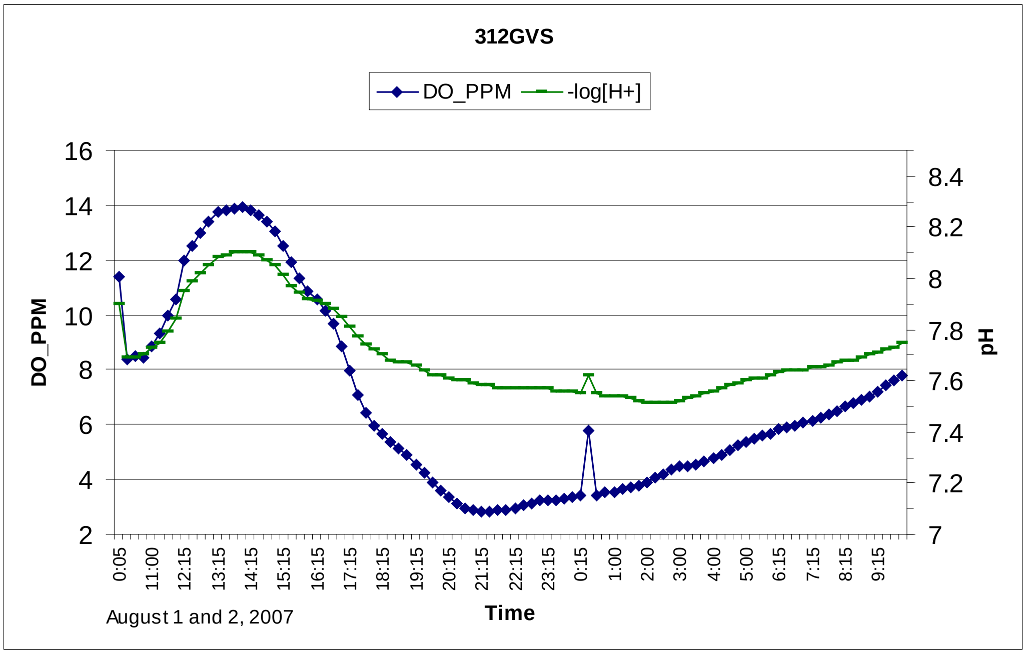
July 18, 2007
Chlor_a = 12.8 ug/L
Alga_Fila = 0%
Biostimulatory Conditions? Yes, based on low DO.

Orcutt Creek (ORI) - DO WQO >7ppm (COLD)



July 18, 2007
Chlor_a = 15.8 ug/L
Alga_Fila = 0%
Biostimulatory Conditions? Yes, based on low DO, swing (CCAMP >13), Chlor a.

Greene Valley Creek (GVS) - DO WQO >7ppm (COLD)



July 26, 2007
Chlor_a = 2.25 ug/L
Alga_Fila = 2 %
Biostimulatory Conditions? Yes, based on low DO and swing (CCAMP >13).

Appendix C - Stream Nutrient Numeric Target Development

Contents

C.1 Introduction

This appendix describes the development of nutrient numeric targets for stream reaches within the Santa Maria River and Oso Flaco Lake watersheds. Pending nutrient numeric targets and TMDL development for Oso Flaco Lake is contained in Appendix D (separate attachment). Note that the Nutrient TMDL for Oso Flaco Lake will be developed as a separate, lake specific TMDL project and is not part of the current nutrient TMDL for inland streams within the lower Santa Maria River and Oso Flaco Lake watersheds.

The Central Coast Basin Plan has narrative criteria regarding biostimulatory substances, which states: “Waters shall not contain biostimulatory substances in concentrations that promote aquatic growth to the extent that such growths cause nuisance or adversely affect beneficial uses.” They do not however specify what levels of algal growth constitute a nuisance.

Water Board staff are required to develop technically defensible numeric water quality targets that are protective of the Basin Plan’s narrative objective for biostimulatory substances. Targets should be based on established methodologies or peer-reviewed numeric criteria. It is important to recognize that definitive and unequivocal scientific certainty is not necessary in a TMDL process with regard to development of nutrient water quality targets protective against biostimulation. Numeric targets should be scientifically defensible, but are not required to be definitive. Eutrophication is an ongoing and active area of research. If the water quality objectives and numeric targets for biostimulatory substances are changed in the future, then any TMDLs and allocations that are potentially adopted for biostimulatory substances pursuant to this project may sunset and be superseded by revised water quality objectives.

Recent biostimulation research of inland surface waters within an agricultural watershed in the California central coast region indicates that existing nutrient numeric water quality objectives found in the Basin Plan (i.e., the 10 mg/L nitrate-nitrogen MUN objective) is unlikely to reduce benthic algal growth below even the highest water quality benchmarks[1]. Therefore, the 10 mg/L nitrate-nitrogen objective is insufficiently protective against biostimulatory impairments. Consequently, staff concludes that it is necessary to set nutrient numeric targets more stringent than the existing numeric objectives found for nitrate in the Basin Plan (i.e., the 10 mg/L MUN objective).

In USEPA (2000) nutrient criteria guidance for streams, three general approaches for criteria setting are recommended:

(1) Statistical analysis of data: identification of reference reaches for each stream class based on best professional judgment or percentile selections of data plotted as frequency distributions;
(2) Use of predictive relationships (e.g., trophic state classifications, models, biocriteria); and
(3) Application and/or modification of established nutrient/algal thresholds (e.g., nutrient concentration thresholds or algal limits from published literature).

USEPA (2000) states that a weight of evidence approach combining any or all of the three approaches above will produce criteria of greater scientific validity.

Table 1. USEPA-recommended approaches for developing nutrient criteria for streams.

USEPA-Recommended Approaches	Approach Assessed in this TMDL project?	Methodology	Notes
Use of Predictive Relationships (modeling; biocriteria)	☑	California NNE Approach	Staff used NNE benthic biomass model tool to screen and corroborate targets based on USEPA-recognized statistical approaches
Statistical Analysis of Data	☑	USEPA-recommended statistical analysis: 25th percentile of nutrient data for stream population	Staff used USEPA recognized statistical approach in development of nutrient numeric criteria.
Use of established concentration thresholds from published literature	☑	USEPA published nutrient criteria for Ecoregion III, Subecoregion 6	Staff evaluated USEPA ecoregional criteria. Staff finds subecoregion III-6 criteria are inappropriate, and over-protective for the TMDL project area. The ecoregional-scale approach lumps together streams of with significantly different characteristics: headwater streams, alluvial valley streams, coastal confluence streams, etc. USEPA itself recognizes ecoregional criteria may not sufficiently address local variation.

[1] University of California, Santa Cruz. 2010. Final Report: Long-term, high resolution nutrient and sediment monitoring and characterizing in-stream primary production. Proposition 40 Agricultural Water Quality Grant Program. Dr. Marc Los Huertos, Ph.D., project director.

Staff followed USEPA guidance for the development of draft targets with the goal being to account for physical and hydrologic variation within the TMDL project area (see *Nutrient Criteria Technical Guidance Manual, River and Streams* - USEPA July 2000). Development of nutrient criteria should account for the natural variation that exists at both regional and basin levels. Different waterbody processes and responses dictate that nutrient criteria be specific to waterbody type. No single criterion will be sufficient for each waterbody type. USEPA recommends classifying and group streams by type or comparable characteristics (e.g., fluvial morphology, hydraulics, physical, biological or water quality attributes). Classification will allow criteria to be identified on a broader scale rather than a site-specific scale. The aforementioned stream classification recommendation by USEPA is supported by recent research published for California's central coast region, as illustrated below:

> "*Sections of the Pajaro River watershed have been listed by the State of California as impaired for nutrient and sediment violations under the Clean Water Act ……* ***The best evidence linking elevated nutrient concentrations to algae growth was shown when the stream physiography, geomorphology, and water chemistry were incorporated into the survey and analysis."****
>
> ***emphasis added***
>
> *From: University of California, Santa Cruz. Final Report: Long-Term, High Resolution Nutrient and Sediment Monitoring and Characterizing In-stream Primary Production. Proposition 40 Agricultural Water Quality Grant Program.*

Staff used USEPA's 25th percentile approach for developing nutrient targets for streams. 25th percentile values are characterized by USEPA as criteria recommendations that could be used to protect waters against nutrient over-enrichment (USEPA, 2000)[2]. This is because the 25th percentile of the entire population has been shown by USEPA to represent a surrogate for an actual reference population.

An additional line of evidence for establishing nutrient water quality targets in the TMDL project area was provided by an application of the California Nutrient Numeric Endpoint (CA NNE) approach (Tetra Tech 2006). Use of the USEPA 25th percentile approach in conjunction with the CA NNE spreadsheet provide an additional line of evidence, and also may help corroborate the reasonableness numeric targets derived using the USEPA 25th percentile approach.

It is important to recognize that the CA NNE spreadsheet tool is highly sensitive to user inputs for tree canopy shading and turbidity. Shading and turbidity have significant effects on light availability, and consequently photosynthesis and potential biostimulation. The light extinction coefficient is an important input parameter to the CA NNE spreadsheet tool. This coefficient is calculated in the spreadsheet as a function of turbidity. Higher levels of turbidity can preclude good sunlight penetration and limit the production of algal biomass:

> *"...when nutrients are as high as they are in this system, talking about limiting nutrients probably isn't that relevant. In those cases,* ***light is probably what actually limits production*** *either* ***because of turbidity*** *which keeps overall biomass low or surface blooms which reduce light levels at depth."**
> **emphasis added*
> *— Dr. Jane Caffrey (University of West Florida), personal communication to Water Board staff, Sept. 12, 2011 regarding Lower Salinas River Nutrient TMDL.*

[2] U.S. Environmental Protection Agency. 2000. Nutrient Criteria Technical Guidance Manual, River and Streams. EPA-822-B-00-002.

Nutrient target results provided by the CA NNE spreadsheet tool can vary substantially, based on even small changes in turbidity input. As such, it important to have plausible canopy and turbidity conditions that are reasonably representative of reach-scale conditions. The default value in the NNE spreadsheet tool is 0.6 NTU. The USEPA (2000) ecoregional criteria (Ecoregion III-6) for turbidity in reference conditions is 1.9 NTU. Both of these values (0.6 NTU and 1.9 NTU) represent ambient conditions in relatively undisturbed reference streams. It should be noted that relatively undisturbed ambient turbidity conditions in some agricultural alluvial valley floor waterbodies may be closer to 20 or 30 NTU. For illustrative purposes, Figure 1 below illustrates the appearance of water with various ranges of turbidity.

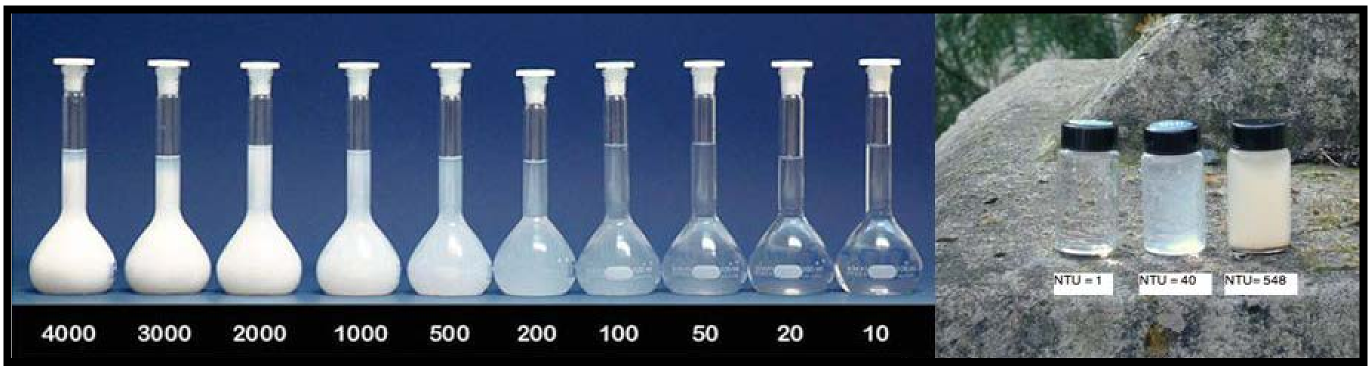


Figure 1

Further, a cursory evaluation of water column turbidity, soil conditions, and regional geology illustrate the variability in ambient conditions at the reach-scale or watershed-scale. Figure 2 shows both the Oso Flaco Lake watershed and the Lower Santa Maria River watershed, along with turbidity conditions, and soil texture (% clay). The Oso Flaco Lake watershed contains a greater percentage of clay-rich soils and substrates per unit area and displays substantially higher ambient turbidity conditions relative to stream reaches in the Lower Santa Maria River watershed. A difference in five or ten NTU turbidity input into the NNE spreadsheet tool will provide significantly different results. Unlike sand, silt, or gravel, which are typically transported as bedload, clay is likely to be transported in suspension in the water column even at very low stream velocities, thereby contributing to ambient turbidity.

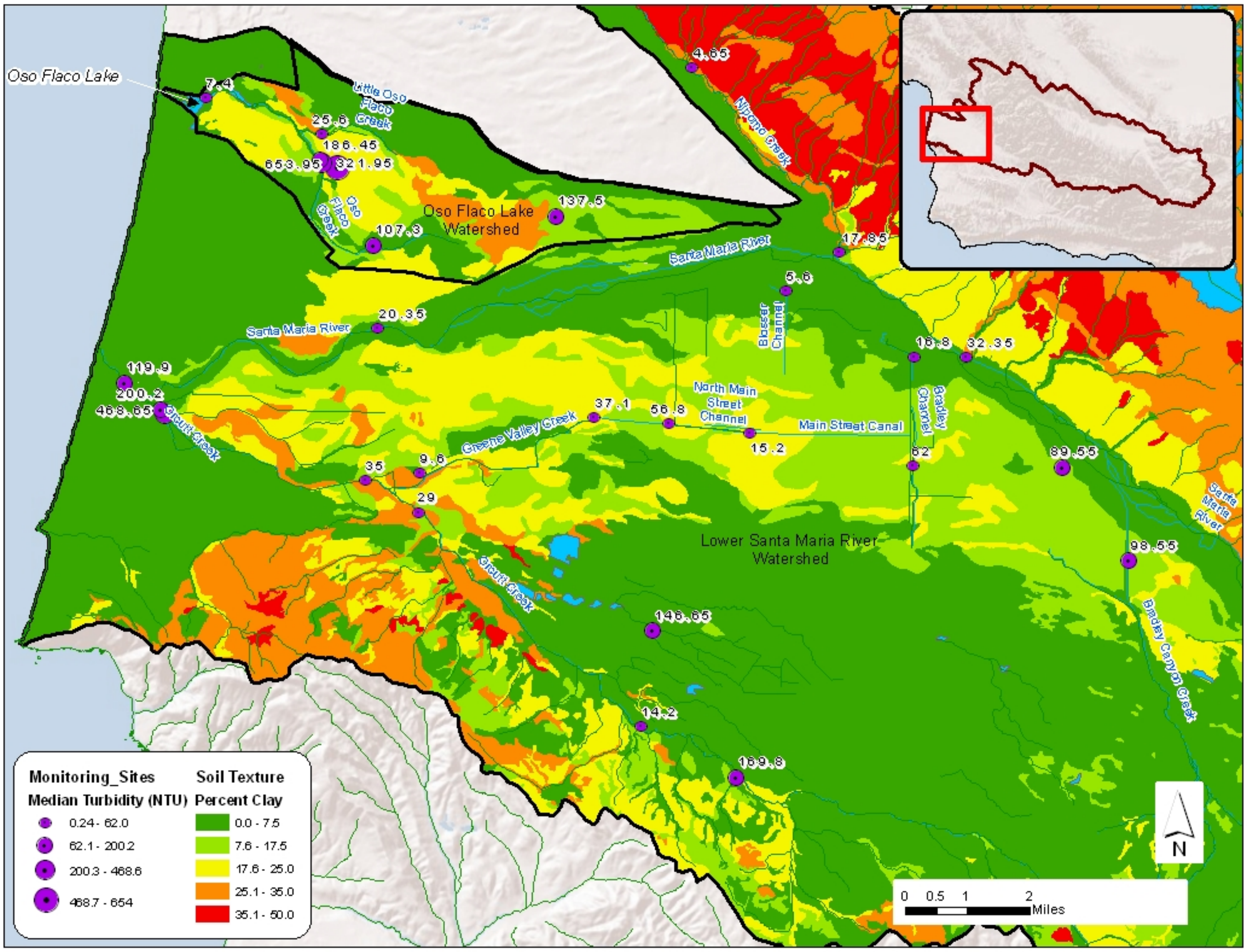
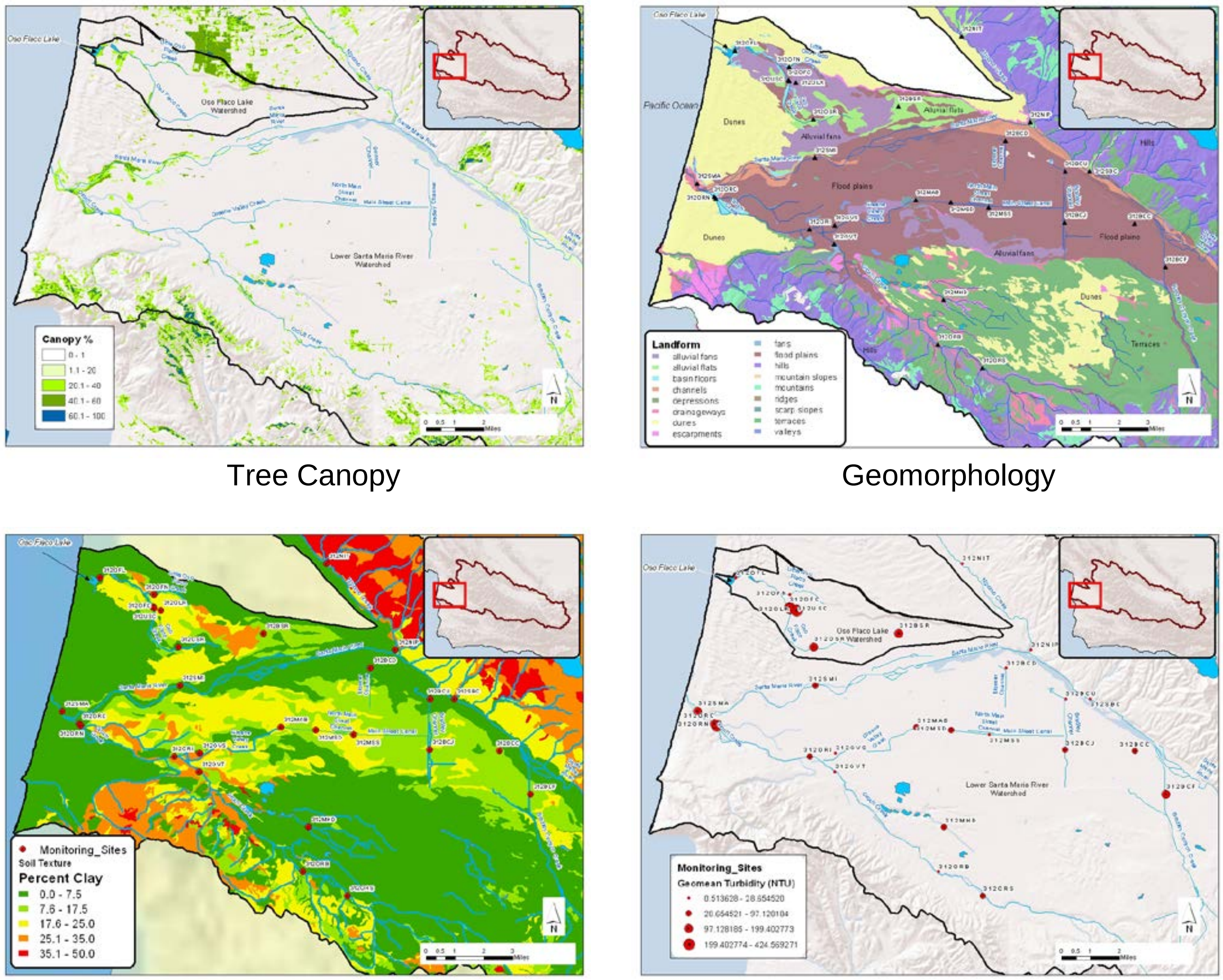


Figure 2. Lower Santa Maria River/Oso Flaco Lake, Water Column Turbidity (Median NTU) and Soil Texture (% Clay)

Staff used field observations and digital datasets for tree canopy cover (source: National Land Cover Dataset, 2001) as presented in the Project Report, to estimate plausible canopy shading for stream categories. Additionally, as noted previously, stream geomorphology and stream physiography is important to consider with respect to establishing linkages between nutrient concentrations and algal growth (UC Santa Cruz, 2010)[3]. Consequently, staff used geomorphic classifications and soil properties data from the NRCS-SSURGO database to assist in classifying and grouping streams with comparable characteristics. Figure 3 conceptually illustrates some of the stream-reach and water column properties staff evaluated in grouping and classifying stream reaches with comparable characteristics, consistent with USEPA guidance.

[3] University of California, Santa Cruz. 2010. Final Report: Long-term, high resolution nutrient and sediment monitoring and characterizing in-stream primary production. Proposition 40 Agricultural Water Quality Grant Program. Dr. Marc Los Huertos, Ph.D., project director.



Tree Canopy | Geomorphology

Soils | Turbidity

Figure 3. Conceptual illustration of stream and water column characteristics used by staff in grouping stream reaches for nutrient target development.

C.2 California Nutrient Numeric Endpoints Approach

As noted previously, an additional line of evidence for establishing nutrient water quality targets in the TMDL project area was provided by an application of the California Nutrient Numeric Endpoint (CA NNE) approach (Tetra Tech 2006). The CA NNE approach utilizes nutrient response indicators to develop potential nutrient water quality criteria. The CA NNE approach also includes a set of relatively simple spreadsheet scoping tools for application in stream/river systems (spreadsheet variant of QUAL2E model) and reservoirs (spreadsheet variant of BATHTUB model) to assist in evaluating the translation between response indicators (e.g. algal biomass) and nutrient concentrations. Accordingly, staff used the CA NNE benthic biomass spreadsheet tool that is based on the QUAL2E model to develop potential water quality targets for response indicators (e.g., benthic chlorophyll a density and corresponding estimated algal biomass density). These targets determine how much algae can be present without impairing designated beneficial uses. Numeric models (e.g., QUAL2K or BATHTUB) are then used to convert the initial water quality targets for the response variables into numeric targets for nutrients.

The CA NNE Approach defines three risk categories for indicators (measures of algal growth and oxygen deficit): 1) Presumably unimpaired; 2) Potentially impaired; 3) Likely impaired. Additional detail on the three risk categories is provided by TetraTech, 2007, as reproduced below:

> The California NNE approach recognizes that there is no clear scientific consensus on precise levels of nutrient concentrations or response variables that result in impairment of a designated use. To address this problem, waterbodies are classified in three categories, termed Beneficial Use Risk Categories (BURCs). BURC I waterbodies are not expected to exhibit impairment due to nutrients, while BURC III waterbodies have a high probability of impairment due to nutrients. BURC II waterbodies are in an intermediate range, where additional information and analysis may be needed to determine if a use is supported, threatened, or impaired. Tetra Tech (2006) lists consensus targets for response indicators defining the boundaries between BURC I/II and BURC II/III.

The table below synthesizes the consensus BURC boundaries for various secondary indicators developed by TetraTech for the CA NNE approach. The BURC II/III boundary provides an initial scoping point to establish minimum requirements for a TMDL.

Table 2.
Nutrient Numeric Endpoints for Secondary Indicators – Risk Classification Category Boundaries: I & II and II & III

Beneficial Use Risk-Category I. Presumptive unimpaired (use is supported).
Beneficial Use Risk Category II. Potentially impaired (may require an impairment assessment)
Beneficial Use Risk Category III. Presumptive impaired (use is not supported or highly threatened)

RESPONSE VARIABLE	RISK – CATEGORY BOUNDARY	BENEFICIAL USE						
		COLD	WARM	REC-1	REC-2	MUN[1]	SPWN	MIGR
Benthic Algal Biomass in streams (mg chl-a/m[2])	I / II	100	150	C	C	100	100	B
Maximum	II / III	150	200	C	C	150	150	B
Planktonic Algal Biomass in Lakes and Reservoirs (as µg/L Chl-a)[2] – summer mean	I / II	5	10	10	10	5	A	B
	II / III	10	25	20	25	10	A	B
Clarity (Secchi depth, meters.)[3] – lakes summer mean	I / II	A	A	2	2	A	A	B
	II / III	A	A	1	1	A	A	B
Dissolved Oxygen (mg/l) Streams – the mean of the 7 daily minimums	I / II	9.5	6.0	A	A	A	8.0	C
	II / III	5.0	4.0	A	A	A	5.0	C
pH maximum – photosynthesis driven	I / II	9.0	9.0	A	A	A	C	C
	II / III	9.5	9.5	A	A	A	C	C
DOC (mg/l)	I / II	A	A	A	A	2	A	A
	II / III	A	A	A	A	5	A	A

A = No direct linkage
B = More research needed to quantify linkage
C = Addressed by Aquatic Life Criteria

[1] For application to zones within water bodies that include drinking water intakes.
[2] Reservoirs may be composed of zones or sections that will be assessed as individual water bodies
[3] Assumes that lake clarity is a function of algal concentrations, does not apply in waters of high non-algal turbidity

Staff developed nitrogen and phosphorus NNE nutrient targets in this appendix using existing NNE predictor run spreadsheet templates developed by the Water Board's Central Coast Ambient Monitoring Program staff (available at http://www.ccamp.us/nne/nne_runs/).

C.3 Nutrient Target Selection

In developing nutrient targets, it is important to recognize that

1. ambient nutrient concentrations in and of themselves, are not sufficient to predict the risk of biostimulation because algal productivity depends on several additional factors such as stream morphology, hydraulics, light availability, etc.; and,
2. An important tenet of the CA NNE approach (Tetra Tech 2006) is that targets should not be set lower than the value expected under natural conditions.

Staff developed targets by using a combination of recognized methods to bracket and calibrate nutrient targets appropriate to local conditions, and that are credibly neither over-protective nor under-protective. The USEPA nutrient criteria technical guidance manual for rivers prescribes a combination of several approaches when developing water quality criteria for nutrients, including

1) the application of reference conditions;
2) predictive stressor-response relationships; and

3) values from existing literature.

Both USEPA and researchers (UC Santa Cruz, 2010-refer back to footnote 1) have recognized that combining these approaches help in the development of scientifically valid numeric objectives for nutrients. Staff used a range of recognized nutrient target development methodologies; the USEPA recognized statistical-approaches, and the CA NNE approach. Additionally, staff identified a plausible range of ambient reach-scale stream conditions to account for local variation. This is consistent with USEPA guidance to classify streams by type or comparable characteristics, thereby allowing nutrient criteria to be applied such that they account for spatial variations in stream characteristics.

The aforementioned approaches have different strengths. The CA NNE is a predictive modeling approach that helps establish concentrations at which nutrients can have detrimental effects on the biological health of a stream. The USEPA 25th percentile approach is a statistical approach, which can provide a plausible approximation of nutrient concentrations one might expect during a relatively undisturbed state and given local conditions. As stated earlier, an important tenet of the CA NNE approach (Tetra Tech 2006)[4] is that targets should not be set lower than the value expected under background or relatively undisturbed conditions. Therefore, the 25th percentile USEPA approach can help satisfy the caveat where targets should not be set lower than expected under local background, or relatively undisturbed conditions.

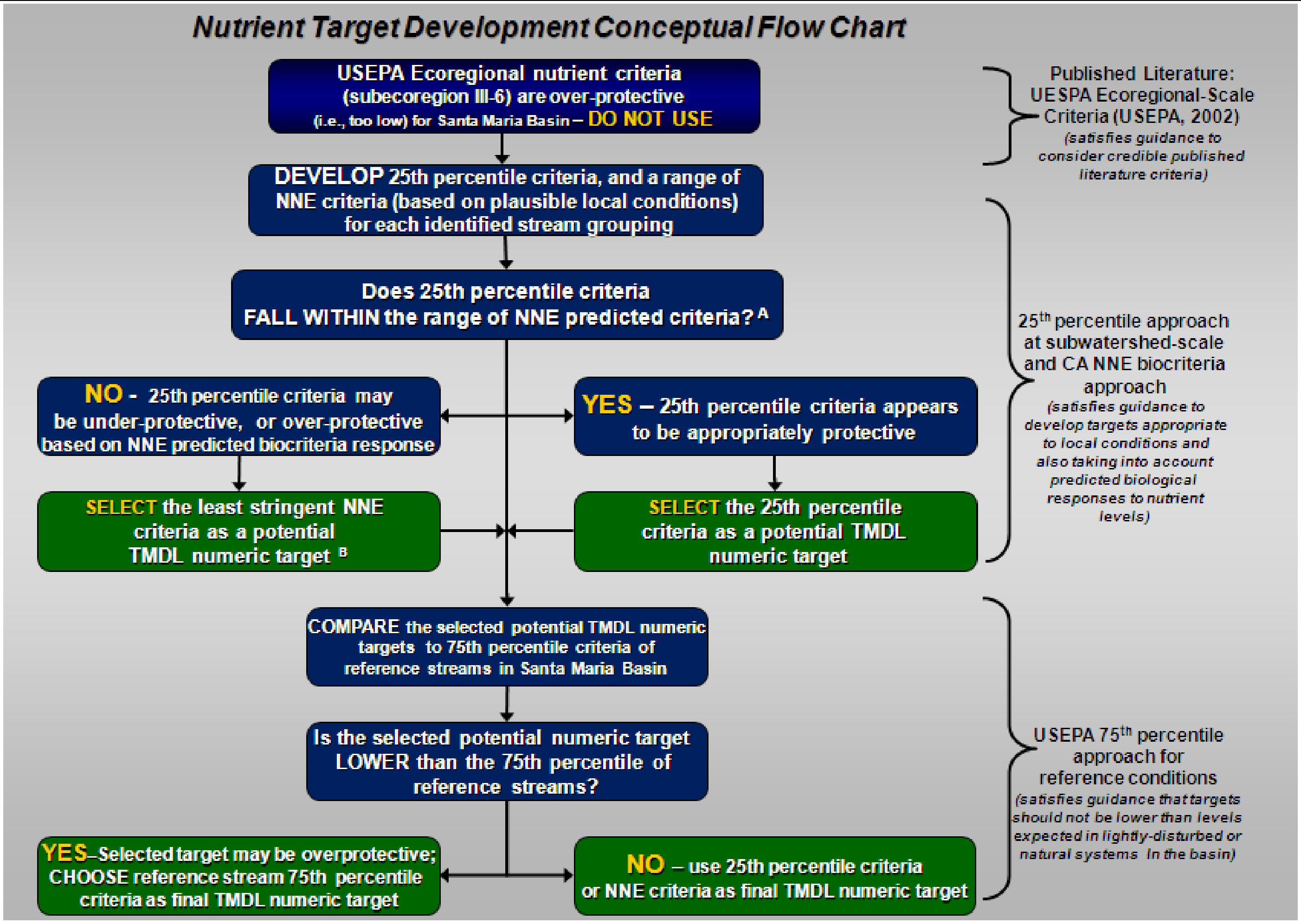
Further, staff received guidance from a researcher with expertise in central coast biostimulation problems that nutrient targets should not be more stringent than nutrient concentrations found in natural systems in the Santa Maria River basin. Therefore, staff applied the USEPA reference stream methodology (75th percentile approach) which ensures that biostimulation nutrient targets are no more stringent than nutrient concentrations found in natural or lightly-disturbed headwater and tributary reaches in the Santa Maria River basin.

In summary, staff was able to evaluate a range of plausible nutrient targets for identified stream reaches using the strengths of various approaches. After establishing plausible ranges of potential nutrient targets using the aforementioned methodologies, the development and selection of final nutrient TMDL targets were determined using the following hierarchical approach, as illustrated below:

Summary of published technical guidance used by staff in nutrient target development:

- ✓ Using a combination of recognized approaches (i.e., literature values, statistical approaches, predictive modeling approaches) result in criteria of greater scientific validity (source: USEPA, 2000. Nutrient Criteria Manual).
- ✓ Classify and group streams needing nutrient targets, based on similar characteristics (source: USEPA, 2000. Nutrient Criteria Manual).
- ✓ Targets should not be lower than expected concentrations found in background/natural conditions (source: CA NNE guidance – TetraTech, 2006).

[4] TetraTech. 2006. Technical approach to develop nutrient numeric endpoints for California. Prepared for USEPA Region IX (Contract No. 68-C-02-108 to 111)



Notes:

[A] Orthophosphate targets developed with percentile-based approaches were not calibrated to CA NNE results. CA NNE only provides results for total phosphorus which is typically not a good measure of orthophosphate. In contrast, nitrate typically comprises over 95% of water column total Nitrogen (TN) in project area streams; therefore, nitrate is a plausible surrogate for total nitrogen and can be compared to CA NNE TN target predictions.

[B] The marginally less stringent CA NNE numeric target is selected because central coast researchers have suggested that while it is reasonable to set lower nutrient numeric targets on stream reaches with limited anthropogenic sources, it may be prudent in areas with significant human disturbances to have less stringent targets until more information is available (source: Prop. 40 Nutrient Study–Pajaro River Watershed, 2011.)

Figure 4.

Note that orthophosphate numeric targets were based on USEPA 25th percentile methods. The CA NNE spreadsheet tool only calculates total phosphorus targets. In general, total phosphorus is not an adequate measurement of water column orthophosphate because orthophosphate is only a fraction to total water column phosphorus. The CA NNE calculations of total phosphorus generally appear to estimate targets that are lower than values expected under natural conditions in the Santa Maria River Basin. In addition, when NNE predicted targets for total phosphorus are plotted on a graph of orthophosphate data from throughout the Santa Maria River basin (n = 1,228), the CA NNE predicted targets for phosphorus appear to be unreasonably low (see figure below). As such, staff followed guidance to develop targets that are not below (i.e., more stringent) concentrations that may be expected under natural conditions; therefore, staff used the 25th percentiles for orthophosphate as TMDL numeric targets.

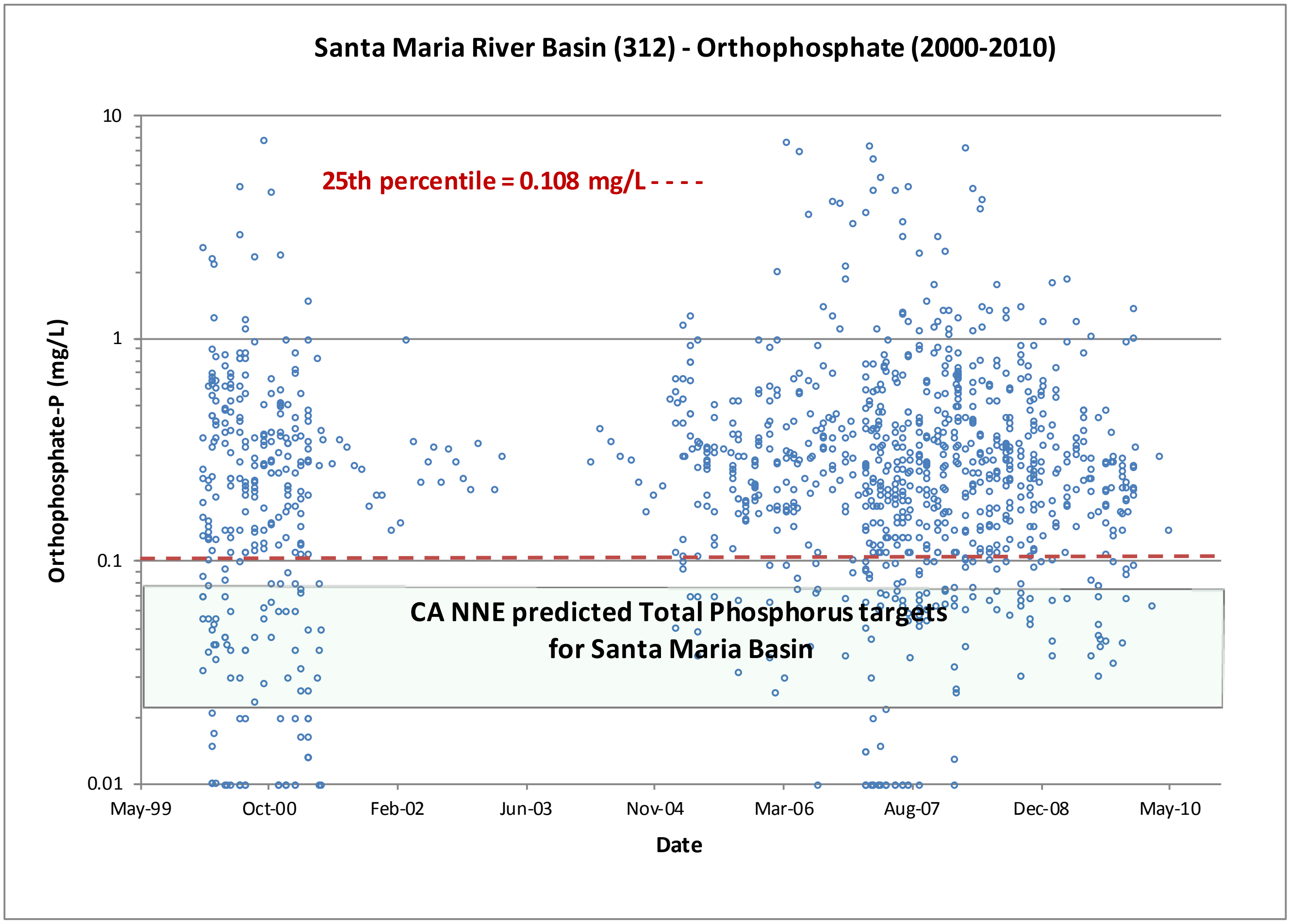


Figure 5

The following sections of this appendix present information pertaining to development of nutrient targets for streams within the project area.

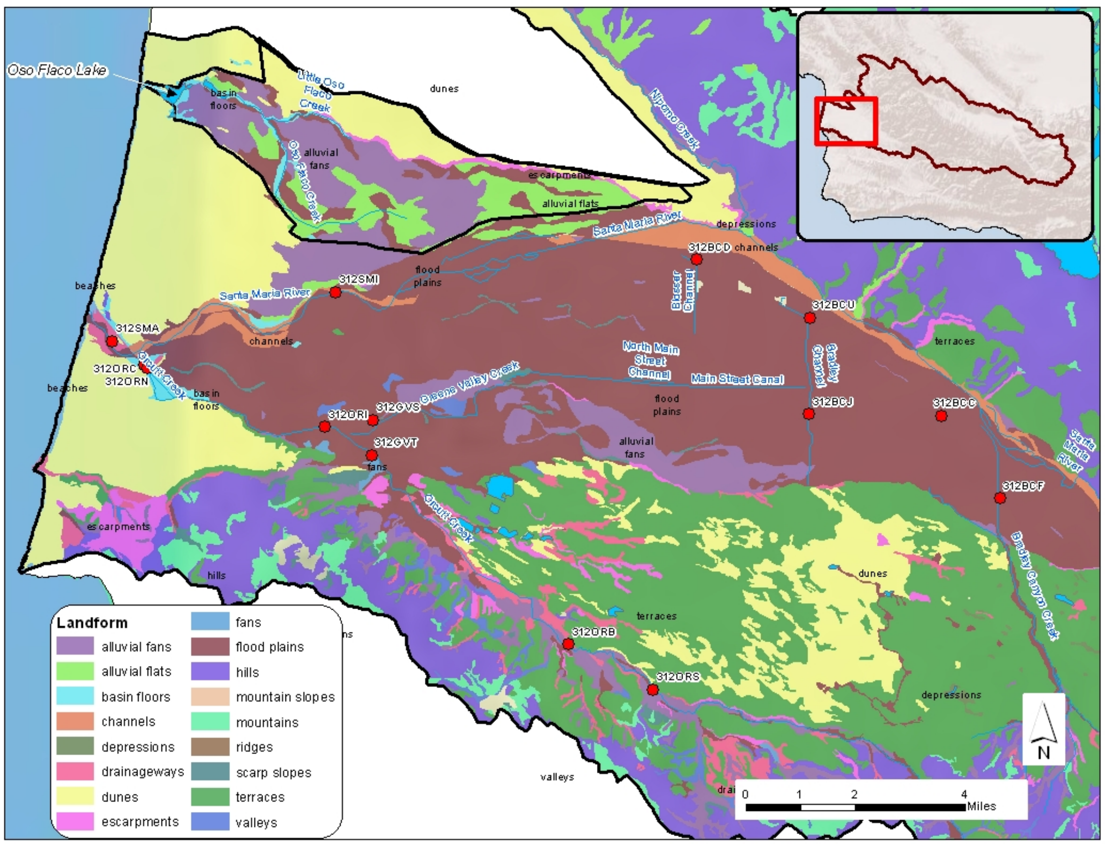
C.4 Lower Santa Maria River – Flood plain, Channel, Drainageway Stream Reaches

C.4.1 Lower Santa Maria River 25th Percentile Targets

Stream Conditions

- Geomorphic description: Flood plains, channels, drainageways. Low gradient slopes <1 degree (source: NRCS-SSURGO)
- Waterbodies: Santa Maria River/Estuary, Orcutt Cr., Greene Valley Cr., Blosser/Bradley Channels, Bradley Canyon Cr.
- Estimated average riparian tree canopy: <10% (source: NLCD, 2001 canopy raster, field observation)
- Substrate-soils: Dominantly sand, sandy loam, loamy sand <10% clay (source: NRCS-SSURGO)
- Turbidity conditions: 17 NTU (25th percentile-year round); 36 NTU (geomean-dry season, May-Oct.); 46 NTU (median-dry season, May-Oct)

Monitoring sites used for Santa Maria River 25th percentiles water quality data



Flood Plain, Channel, and Drainageway *Santa Maria River/ Estuary, Orcutt Cr., Greene Valley Cr, Blosser/Bradley Channel, Bradley Cyn. Cr.*	
Statistical Summary of Nitrate-N	
Time Period	Jan. 2000 – April 2010
Mean	29.66165955
Standard Error	1.095304649
Median	26.5
Mode	27
Standard Deviation	22.04258086
Range	158.9842697
Minimum	0.01573033
Maximum	159
Count	405
25th Percentile	16.8
Statistical Summary of Orthophosphate-P	
Time Period	Jan. 2000 – April 2010
Mean	0.407154903
Standard Error	0.025149289
Median	0.29106
Mode	0.0075
Standard Deviation	0.652428983
Range	12.0925
Minimum	0.0075
Maximum	12.1
Count	673
25th Percentile	0.1921

Figure 6

C.4.2 Lower Santa Maria River Nutrient Numeric Endpoint Analysis (Calif. NNE Approach)

Santa Maria River and Orcutt Creek are specifically designated for cold freshwater aquatic habitat (COLD) and Santa Maria River Estuary is designated for warm freshwater aquatic habitat (WARM) in Table II-1 of the Basin Plan. Therefore NNE analysis was limited to the BURC II /III category for COLD and WARM beneficial uses.

NNE Parameters:

- Beneficial Use Risk-Classification: (BURC): II / III
- Beneficial Use: **COLD**
- Response Variable: Benthic Algal biomass in streams
- Numeric Target: 150 mg chl-a/m^2
- Method: Revised QUAL2k, benthic chl a

Stream Condition Input:

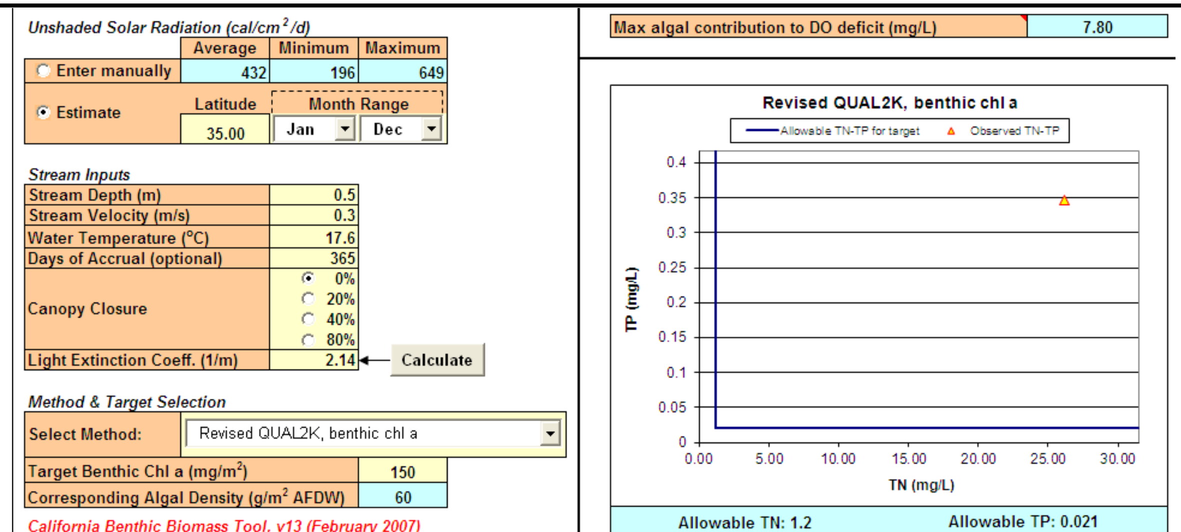
Higher Sunlight Availability Scenario

(based on plausible ranges of local conditions)

- 0% Tree Canopy Closure

- Ambient (low) Turbidity (17 NTU):

17 NTU turbidity = 25th percentile of Santa Maria River monitoring sites used in 25th percentile analysis



NNE Parameters:

- Beneficial Use Risk-Classification: (BURC): II / III
- Beneficial Use: **COLD**
- Response Variable: Benthic Algal biomass in streams
- Numeric Target: 150 mg chl-a/m^2
- Method: Revised QUAL2k, benthic chl a

Stream Condition Input:

Lower Sunlight Availability Scenario

(based on plausible ranges of local conditions)

- 0% Tree Canopy Closure

- "Typical" Dry Season Turbidity (36 NTU):

36 NTU turbidity = turbidity geomean of May-Oct sample of Santa Maria River monitoring sites used in 25th percentile analysis

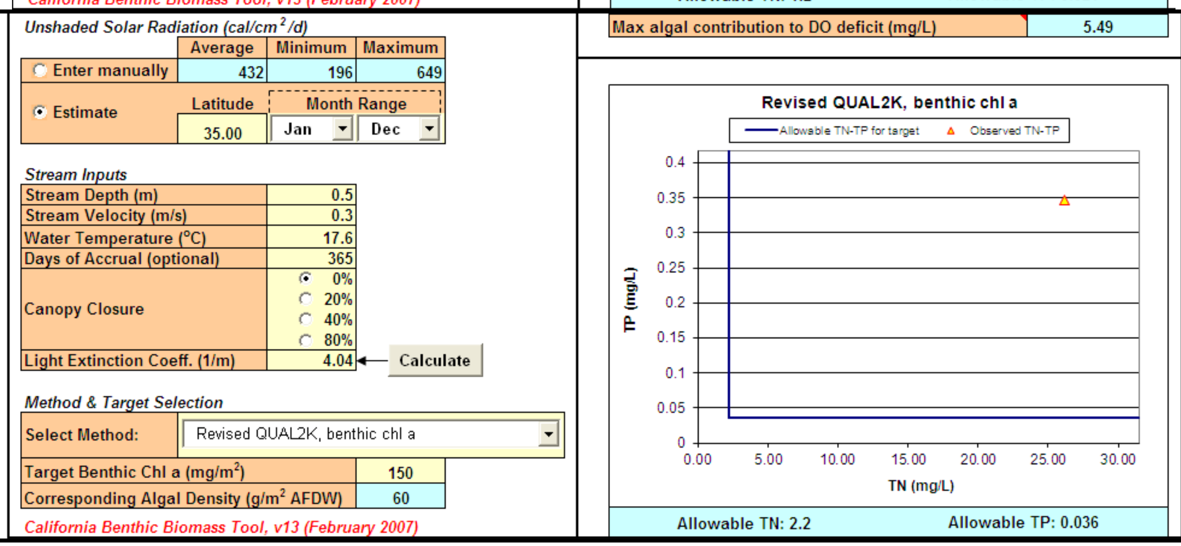


Figure 7.

NNE Parameters:

- Beneficial Use Risk-Classification: (BURC): II / III
- Beneficial Use: **WARM**
- Response Variable: Benthic Algal biomass in streams
- Numeric Target: 200 mg chl-a/m^2
- Method: Revised QUAL2k, benthic chl a

Stream Condition Input:

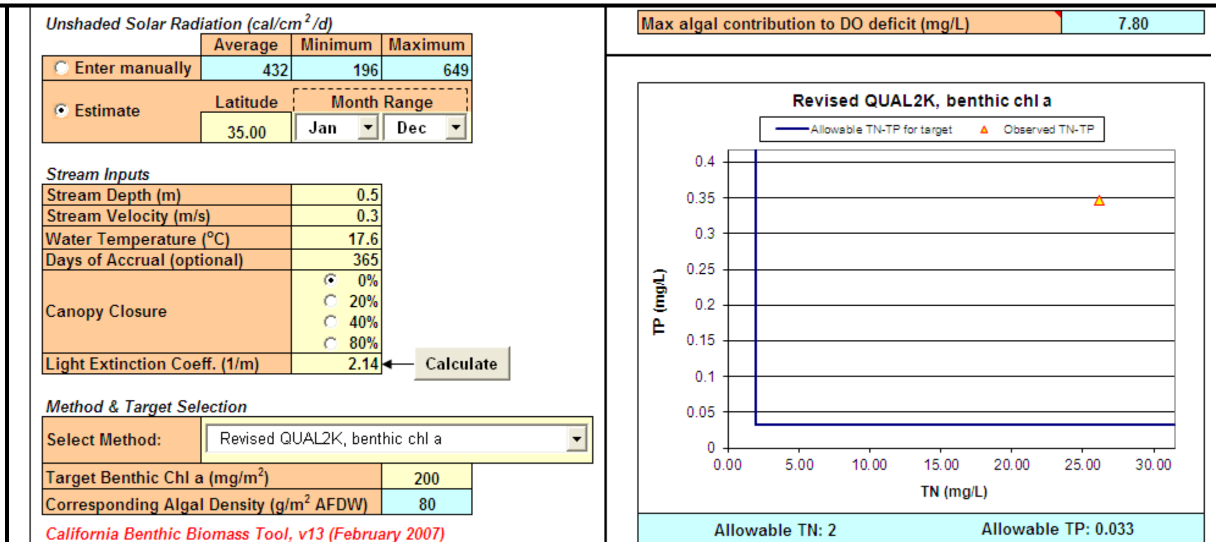
Higher Sunlight Availability Scenario

(based on plausible ranges of local conditions)

- 0% Tree Canopy Closure

- Ambient (low) Turbidity (17 NTU)

17 NTU turbidity = = 25^{th} percentile of Santa Maria River monitoring sites used in 25^{th} percentile analysis



NNE Parameters:

- Beneficial Use Risk-Classification: (BURC): II / III
- Beneficial Use: **WARM**
- Response Variable: Benthic Algal biomass in streams
- Numeric Target: 200 mg chl-a/m^2
- Method: Revised QUAL2k, benthic chl a

Stream Condition Input:

Lower Sunlight Availability Scenario

(based on plausible ranges of local conditions)

- 0% Tree Canopy Closure

- "Typical" Dry Season Turbidity (36 NTU)

36 NTU turbidity = turbidity geomean of May-Oct sample of Santa Maria River monitoring sites used in 25^{th} percentile analysis

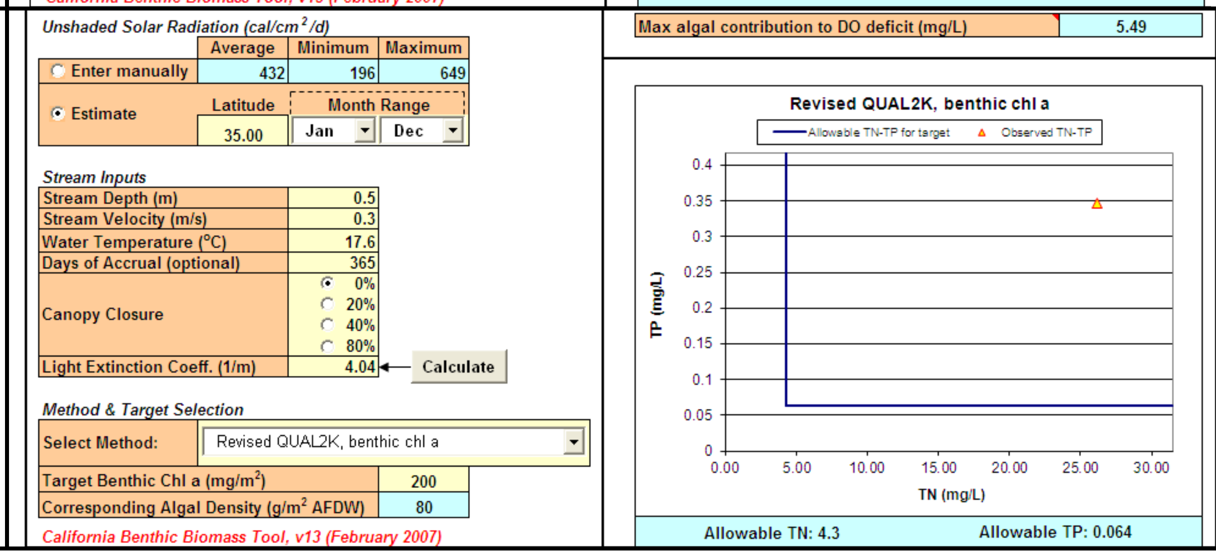


Figure 8.

C.4.3 Comparison of USEPA 25th Percentile Approach and Calif. NNE Approach (Lower Santa Maria River)

The USEPA 25th percentile targets presented in Section C.4.1- C.4.2 above are shown relative to the NNE Higher Sunlight Availability and NNE Lower Sunlight Availability scenarios, as shown in the figure below (next page). The 25th percentile targets are greater than the CA NNE predicted nutrient targets that are based on plausible ranges of observed local conditions. It is important to note that the 25th percentiles are calculated on nitrate-N and orthophosphate-P. These constituents are not directly comparable to the total N and total P results that the CA NNE spreadsheet tool provides, nevertheless nitrate is typically over 95% of total water column nitrogen in project area inland streams. Orthophosphate is estimated to generally (but not always) be the largest fraction of water column phosphorus in project area inland streams. For purposes of comparing the 25th percentile methodology and the CA NNE approach, nitrate and orthophosphate are plausible surrogates for total N and P in project area streams. The USEPA 25th percentile targets are shown relative to the NNE Higher Sunlight Availability and NNE Lower Sunlight Availability scenarios for WARM and COLD. As shown in the figure below, the 25th percentile value for nitrate-N (16.8 mg/L) exceeds the water quality objective for drinking water (10 mg/L) and therefore under protective. Consistent with the nutrient target development approach outlined in Section C.3, a more stringent CA NNE criteria of 4.3 mg/L nitrate-N is identified here as a potential numeric target for these streams. The 25th percentile value for orthophosphate-P (0.19 mg/L) in the Lower Santa Maria River is also greater than predicted CA NNE results. As mentioned in Section C3, the CA NNE total phosphate predictions appear to be much lower (overly protective) than what can be expected under ambient conditions in the Santa Maria Basin. Therefore, the 25th percentile value of 0.19 mg/L orthophosphate-P is selected as a potential numeric target for these streams. It should be noted that this orthophosphate-P numeric target is marginally greater than the value of 0.12 mg/L as recommended in a study conducted by San Jose State University and Merritt Smith Consulting.[i5]

[5] The Establishment of Nutrient Objectives, Sources, Impacts, and Best Management Practices for the Pajaro River and Llagas Creek. San Jose State University, Department of Civil Engineering and Applied Mathematics and Merritt Smith Consulting. February 28, 1994.

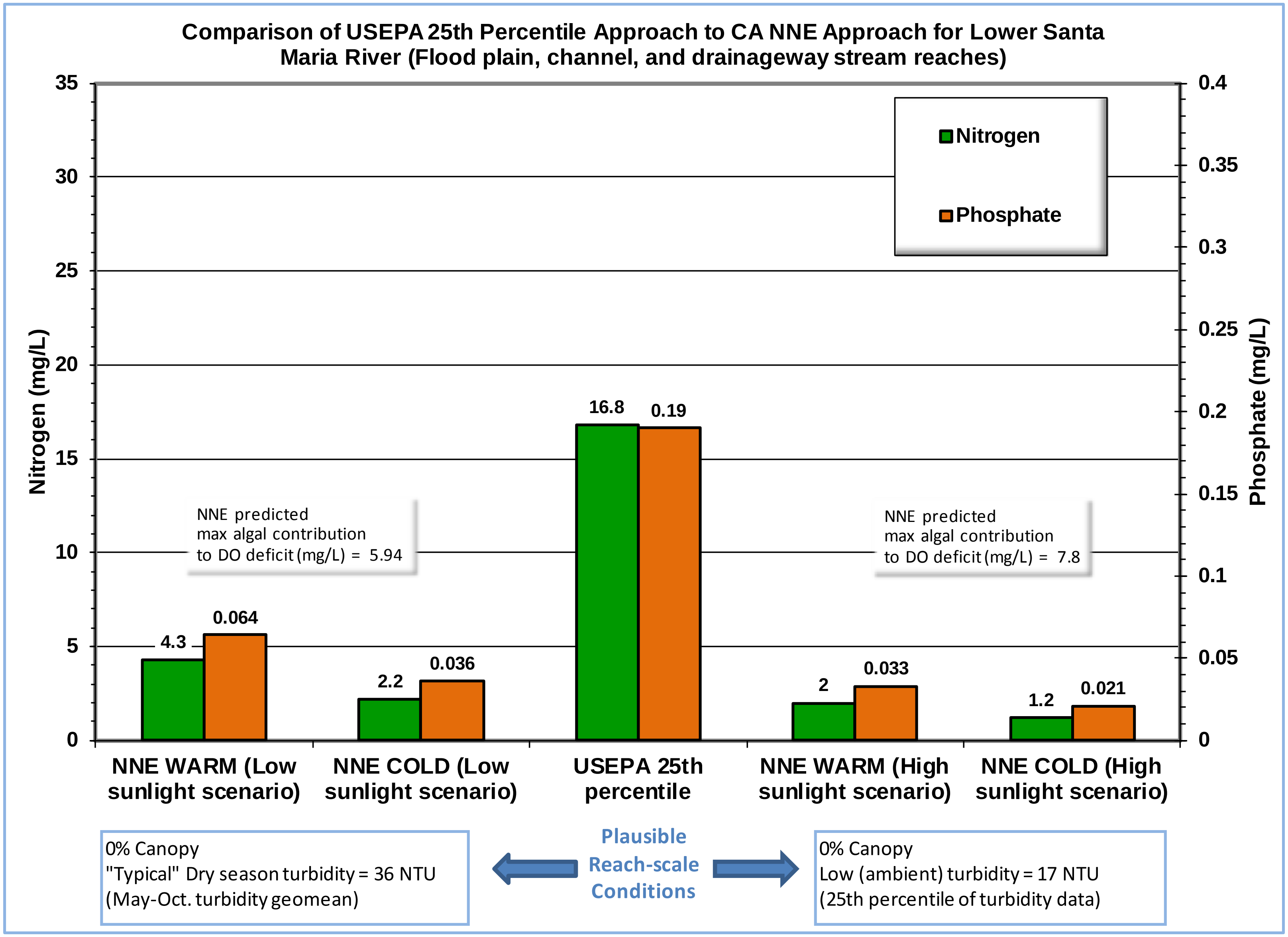

Comparison of USEPA 25th Percentile Approach to CA NNE Approach for Lower Santa Maria River (Flood plain, channel, and drainageway stream reaches)
Nitrogen (mg/L)
Phosphate (mg/L)
35
30
25
20
15
10
5
0
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Nitrogen
Phosphate
NNE predicted max algal contribution to DO deficit (mg/L) = 5.94
NNE predicted max algal contribution to DO deficit (mg/L) = 7.8
4.3
0.064
2.2
0.036
16.8
0.19
2
0.033
1.2
0.021
NNE WARM (Low sunlight scenario)
NNE COLD (Low sunlight scenario)
USEPA 25th percentile
NNE WARM (High sunlight scenario)
NNE COLD (High sunlight scenario)
0% Canopy
"Typical" Dry season turbidity = 36 NTU
(May-Oct. turbidity geomean)
Plausible Reach-scale Conditions
0% Canopy
Low (ambient) turbidity = 17 NTU
(25th percentile of turbidity data)

Figure 9.

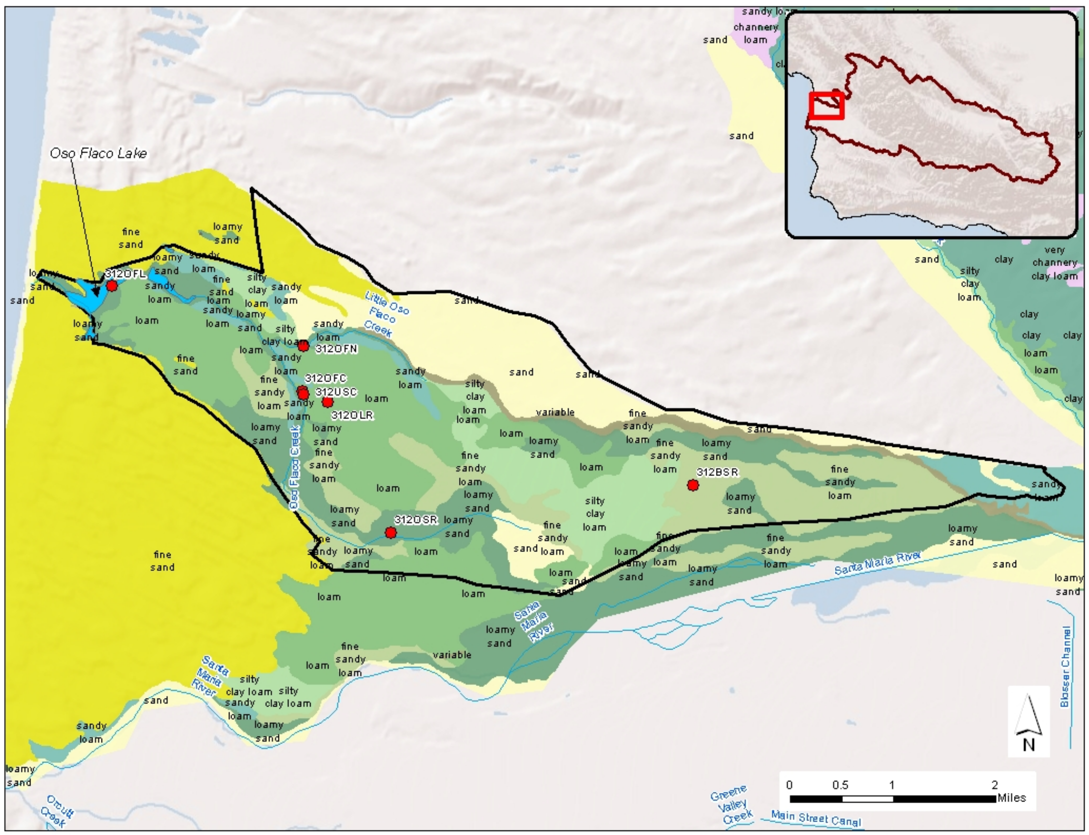
C.5 Oso Flaco Lake Tributary Streams– Alluvial Fan, Alluvial Flat Stream Reaches

C.5.1 Oso Flaco Lake Alluvial Fan/Flat Streams 25th Percentile Targets

Stream Conditions

- Geomorphic description: Alluvial fan, alluvial flats. Low gradient, slopes less than 1 degree (source: NRCS-SSURGO)
- Waterbodies: Oso Flaco Creek, Little Oso Flaco Creek, Oso Flaco Lake
- Estimated riparian tree canopy: <10% (source: NLCD, 2001 canopy raster, field observation)
- Substrate-soils: Dominantly loam, loamy sand, and sand (source: NRCS-SSURGO)
- Turbidity conditions: 20.6 NTU (25^{th} percentile-year round); 48 NTU (geomean-dry season, May-Oct.); 49 NTU (median-dry season, May-Oct)

Monitoring sites used for Alluvial fan, alluvial flat 25^{th} percentiles water quality data



Alluvial Fans, Alluvial Flats
Oso Flaco Creek, Little Oso Flaco Creek, Oso Flaco Lake

Statistical Summary of Nitrate-N

Time Period	Jan 2000 - Dec 2009
Mean	40.89
Standard Error	1.73
Median	34.8
Mode	30
Standard Deviation	18.9
Range	119.11
Minimum	5.89
Maximum	125
No. of Samples	119
25th Percentile	30

Statistical Summary of Orthophosphate-P

Time Period	Jan 2000 - Dec 2009
Mean	0.20
Standard Error	0.012
Median	0.16
Mode	0.0075
Standard Deviation	0.19
Range	1.1003
Minimum	0.0075
Maximum	1.1078
No. of Samples	241
25th Percentile	0.08

Figure 10.

C.5.2 Oso Flaco Lake Alluvial Fan/Flat Streams Nutrient Numeric Endpoint Analysis (Calif. NNE Approach)

NNE Parameters:

- Beneficial Use Risk-Classification: (BURC): II / III
- Beneficial Use: **COLD**
- Response Variable: Benthic Algal biomass in streams
- Numeric Target: 150 mg chl-a/m^2
- Method: Revised QUAL2k, benthic chl a

Stream Condition Input:

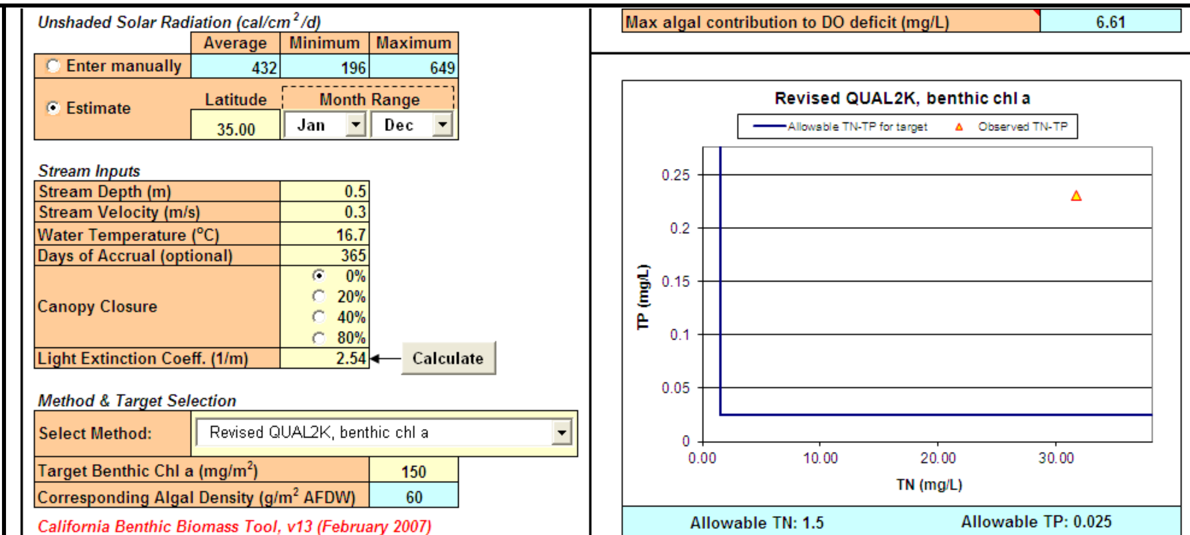
Higher Sunlight Availability Scenario

(based on plausible ranges of local conditions)

- 0% Tree Canopy Closure

- Ambient (low) Turbidity (21 NTU):

21 NTU turbidity = 25th percentile of Oso Flaco Lake watershed monitoring sites used in 25th percentile analysis



NNE Parameters:

- Beneficial Use Risk-Classification: (BURC): II / III
- Beneficial Use: **COLD**
- Response Variable: Benthic Algal biomass in streams
- Numeric Target: 150 mg chl-a/m^2
- Method: Revised QUAL2k, benthic chl a

Stream Condition Input:

Lower Sunlight Availability Scenario

(based on plausible ranges of local conditions)

- 0% Tree Canopy Closure

- "Typical" Dry Season Turbidity (48 NTU):

48 NTU turbidity = turbidity geomean of May-Oct sample of Oso Flaco Lake watershed monitoring sites used in 25th percentile analysis

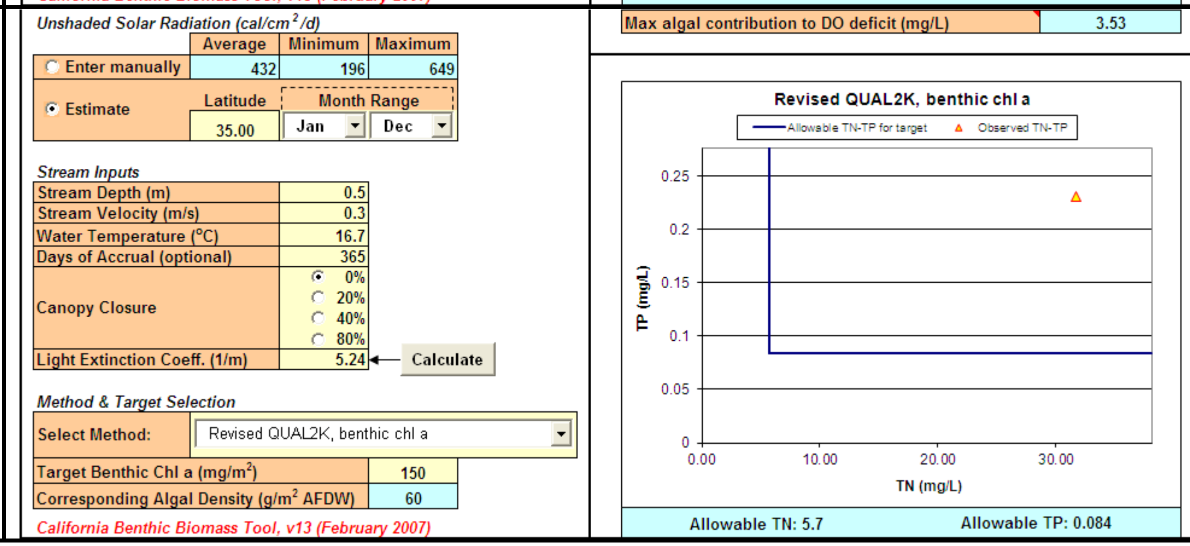


Figure 11.

NNE Parameters:

- Beneficial Use Risk-Classification: (BURC): II / III
- Beneficial Use: **WARM**
- Response Variable: Benthic Algal biomass in streams
- Numeric Target: 200 mg chl-a/m^2
- Method: Revised QUAL2k, benthic chl a

Stream Condition Input:

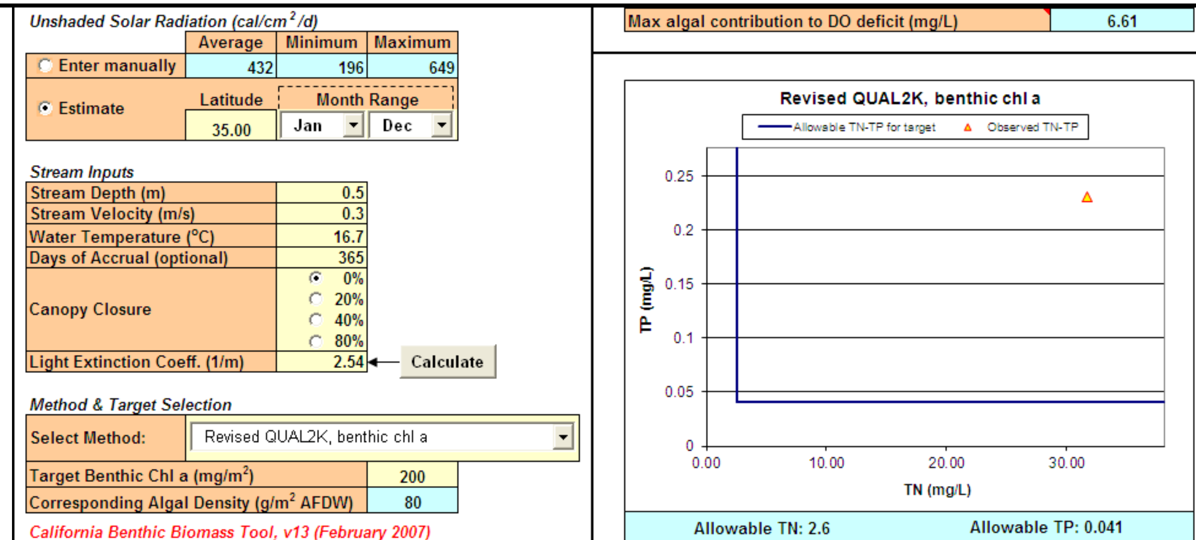
Higher Sunlight Availability Scenario

(based on plausible ranges of local conditions)

- 0% Tree Canopy Closure

- Ambient (low) Turbidity (21 NTU)

21 NTU turbidity = 25th percentile of lower Oso Flaco Lake alluvial fan/flats monitoring sites used in 25th percentile analysis above



NNE Parameters:

- Beneficial Use Risk-Classification: (BURC): II / III
- Beneficial Use: **WARM**
- Response Variable: Benthic Algal biomass in streams
- Numeric Target: 200 mg chl-a/m^2
- Method: Revised QUAL2k, benthic chl a

Stream Condition Input:

Lower Sunlight Availability Scenario

(based on plausible ranges of local conditions)

- 0% Tree Canopy Closure

- “Typical” Dry Season Turbidity (48 NTU)

48 NTU turbidity = turbidity geomean of May-Oct. samples of Oso Flaco Lake alluvial fan/flats monitoring sites used in 25th percentile analysis above

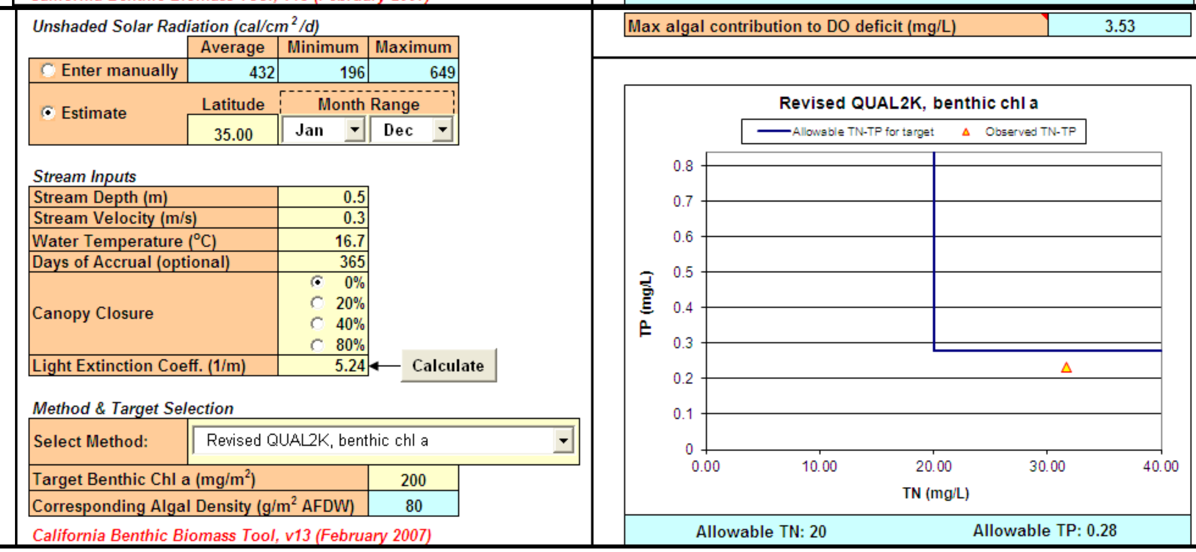


Figure 12.

C.5.3 Comparison of USEPA 25th Percentile Approach and Calif. NNE Approach (Alluvial Basin Floor Streams and Sloughs)

The USEPA 25th percentile targets presented in Section C.5.1 and C.5.2 above are shown (next page) relative to the NNE Higher Sunlight Availability and NNE Lower Sunlight Availability scenarios for WARM and COLD. As stated previously, these constituents are not directly comparable to the total N and total P results that the CA NNE spreadsheet tool provides, nevertheless nitrate is typically over 95% of total water column nitrogen in project area inland streams. Orthophosphate is estimated to generally (but not always) be the largest fraction of water column phosphorus in project area inland streams. For purposes of comparing the 25th percentile methodology and the CA NNE approach, nitrate and orthophosphate are plausible surrogates for total N and P in project area streams. The 25th percentile value for nitrate-N (30 mg/L) is three times higher than the water quality objective for drinking water (10 mg/L) and therefore under protective. In addition, the CA NNE predicted value for total nitrogen (20 mg/L) is two times higher than the drinking water quality objective, indicating that both of these potential numeric targets are under protective. Therefore, consistent with the nutrient target development approach outlined in Section C.3, a more stringent CA NNE criterion of 5.7 mg/L nitrate-N is identified as a potential numeric target for these streams. The 25th percentile value for orthophosphate-P (0.08 mg/L) in the Oso Flaco Lake watershed is proximal to the total phosphate prediction of CA NNE Low Sunlight scenario (0.084 mg/L). Therefore, the 25th percentile value of 0.08 mg/L orthophosphate-P is selected as a potential numeric target for these streams.

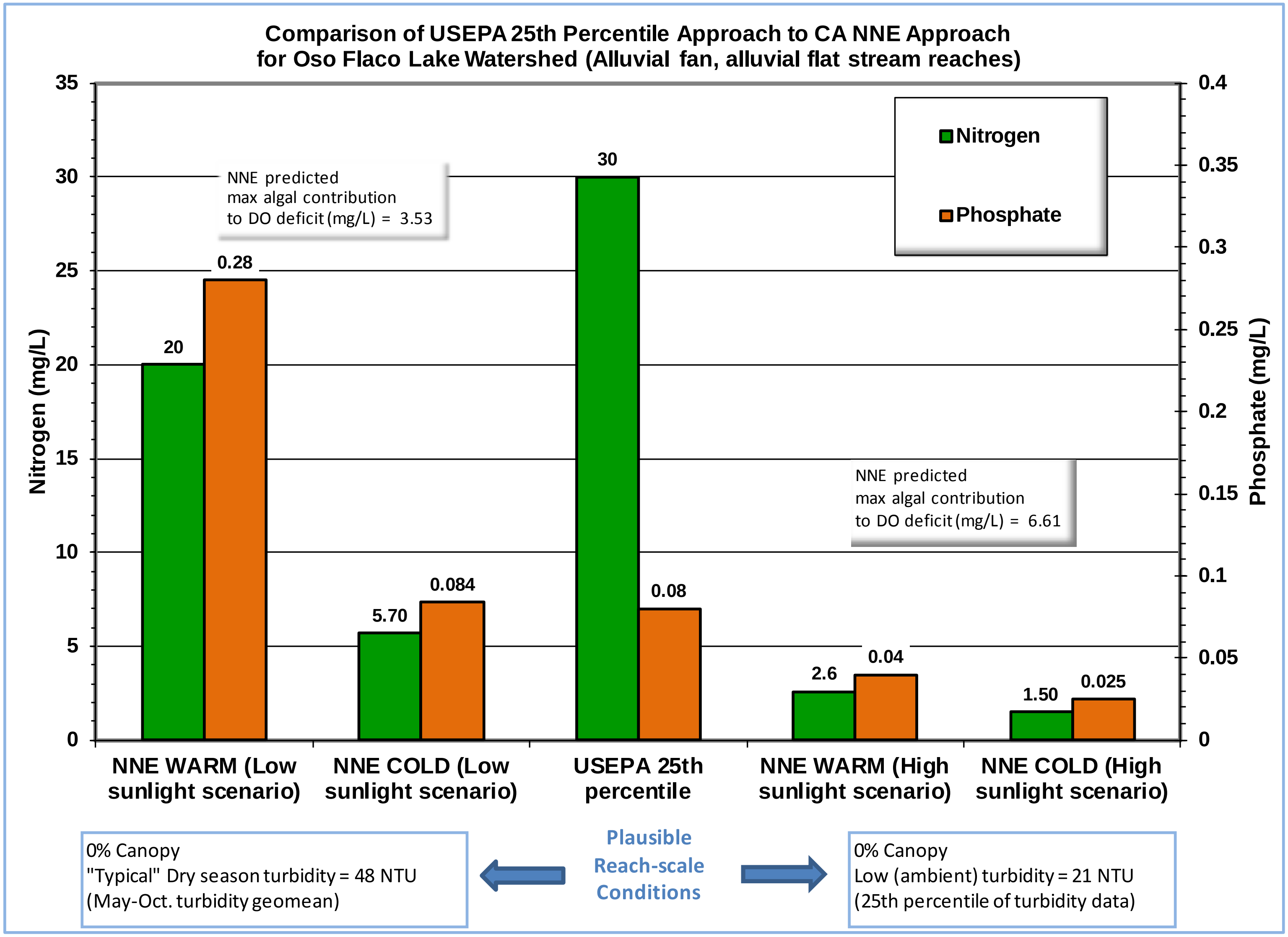

Comparison of USEPA 25th Percentile Approach to CA NNE Approach
for Oso Flaco Lake Watershed (Alluvial fan, alluvial flat stream reaches)
Nitrogen (mg/L)
Phosphate (mg/L)
Nitrogen
Phosphate
NNE predicted max algal contribution to DO deficit (mg/L) = 3.53
NNE predicted max algal contribution to DO deficit (mg/L) = 6.61
20
0.28
5.70
0.084
30
0.08
2.6
0.04
1.50
0.025
NNE WARM (Low sunlight scenario)
NNE COLD (Low sunlight scenario)
USEPA 25th percentile
NNE WARM (High sunlight scenario)
NNE COLD (High sunlight scenario)
0% Canopy
"Typical" Dry season turbidity = 48 NTU
(May-Oct. turbidity geomean)
Plausible Reach-scale Conditions
0% Canopy
Low (ambient) turbidity = 21 NTU
(25th percentile of turbidity data)

Figure 13.

C.6 Nutrient Concentrations in Headwater Reaches and Lightly-Disturbed Tributaries of the Santa Maria River Watershed

An important tenet of the California NNE approach (Tetra Tech, 2006 - refer back to footnote 4) is that targets should not be set lower than the concentrations expected under background or relatively undisturbed conditions. Further, Central Coast Biostimulation researchers suggest that regulatory nutrient targets should not be more stringent (i.e., lower) than nutrient concentrations found in natural systems in the Santa Maria River watershed (Dr. Marc Los Huertos[6], California State University, Monterey Bay, personal communication Oct. 14, 2011).

Therefore, staff applied the USEPA reference stream methodology, to ensure that biostimulation nutrient targets are no more stringent than expected nutrient concentrations found in natural or lightly-disturbed headwater and tributary reaches in the Santa Maria River watershed. USEPA's Technical Guidance Manual for Developing Nutrient Criteria for Rivers and Streams (USEPA, 2000 - refer back to footnote 2) describes an approach to establish a nutrient reference condition. The approach is to establish the upper 75th percentile of a reference population of streams. The 75th percentile was chosen by USEPA since it is likely associated with minimally impacted conditions, and will be protective of designated uses. USEPA defines a reference stream "as a least impacted waterbody within an ecoregion that can be monitored to establish a baseline to which other waters can be compared. Reference streams are not necessarily pristine or undisturbed by humans."

The following figures illustrate the range and statistics of nitrate (as N) and orthophosphate (as P) concentrations in headwater reaches and lightly disturbed tributaries of the Santa Maria River watershed. Note that the 75th percentiles for this population of stream data are 0.10 mg/L nitrate-N, and 0.06 mg/L orthophosphate-P. For comparative purposes, note that USEPA's reference condition for total phosphorus in subecoregion III-6 (Calif. Chaparral and Oak Woodlands) is 0.03 mg/L for total phosphorus[7]. Also noteworthy is that the 90^{th} percentile of nitrate-N in Santa Maria River watershed reference streams is 0.27 mg/L. This suggests that nitrate-N in reference stream conditions typically never exceeds about 1 mg/L except in outlier or anomalous conditions.

[6] Dr. Marc Los Huertos in an Assistant Professor of Science and Environmental Policy at California State University, Monterey Bay. Dr. Los Huertos has substantial research experience with agricultural water quality, aquatic ecology, and biostimulation in the California central coast region.

[7] USEPA. 2000. Ambient Water Quality Criteria Recommendations. Information Supporting the Development of State and Tribal Nutrient Criteria for River and Streams in Nutrient Ecoregion III – Xeric West. EPA-822-B-00-016.

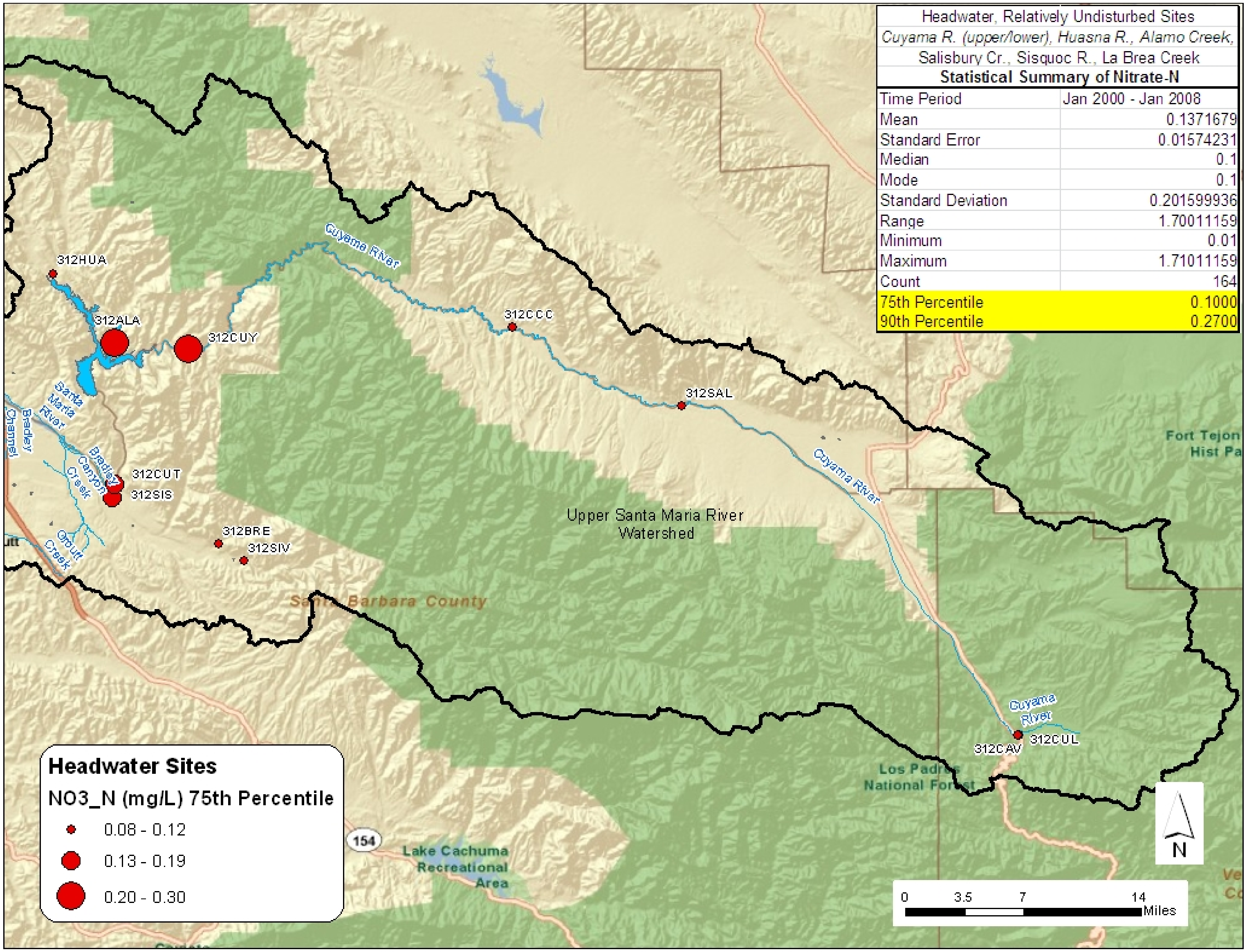

Headwater, Relatively Undisturbed Sites
Cuyama R. (upper/lower), Huasna R., Alamo Creek,
Salisbury Cr., Sisquoc R., La Brea Creek
Statistical Summary of Nitrate-N
Time Period Jan 2000 - Jan 2008
Mean 0.1371679
Standard Error 0.01574231
Median 0.1
Mode 0.1
Standard Deviation 0.201599936
Range 1.70011159
Minimum 0.01
Maximum 1.71011159
Count 164
75th Percentile 0.1000
90th Percentile 0.2700
312HUA
312ALA
312CUY
312CCC
312SAL
312CUT
312SIS
312BRE
312SIV
312CAV
312CUL
Cuyama River
Santa Maria River
Bradley Channel
Bradley Canyon Creek
Orcutt Creek
Upper Santa Maria River Watershed
Santa Barbara County
Fort Tejon Hist Pa
Los Padres National Forest
Lake Cachuma Recreational Area
154
Headwater Sites
NO3_N (mg/L) 75th Percentile
0.08 - 0.12
0.13 - 0.19
0.20 - 0.30
N
0 3.5 7 14 Miles

Figure 14.

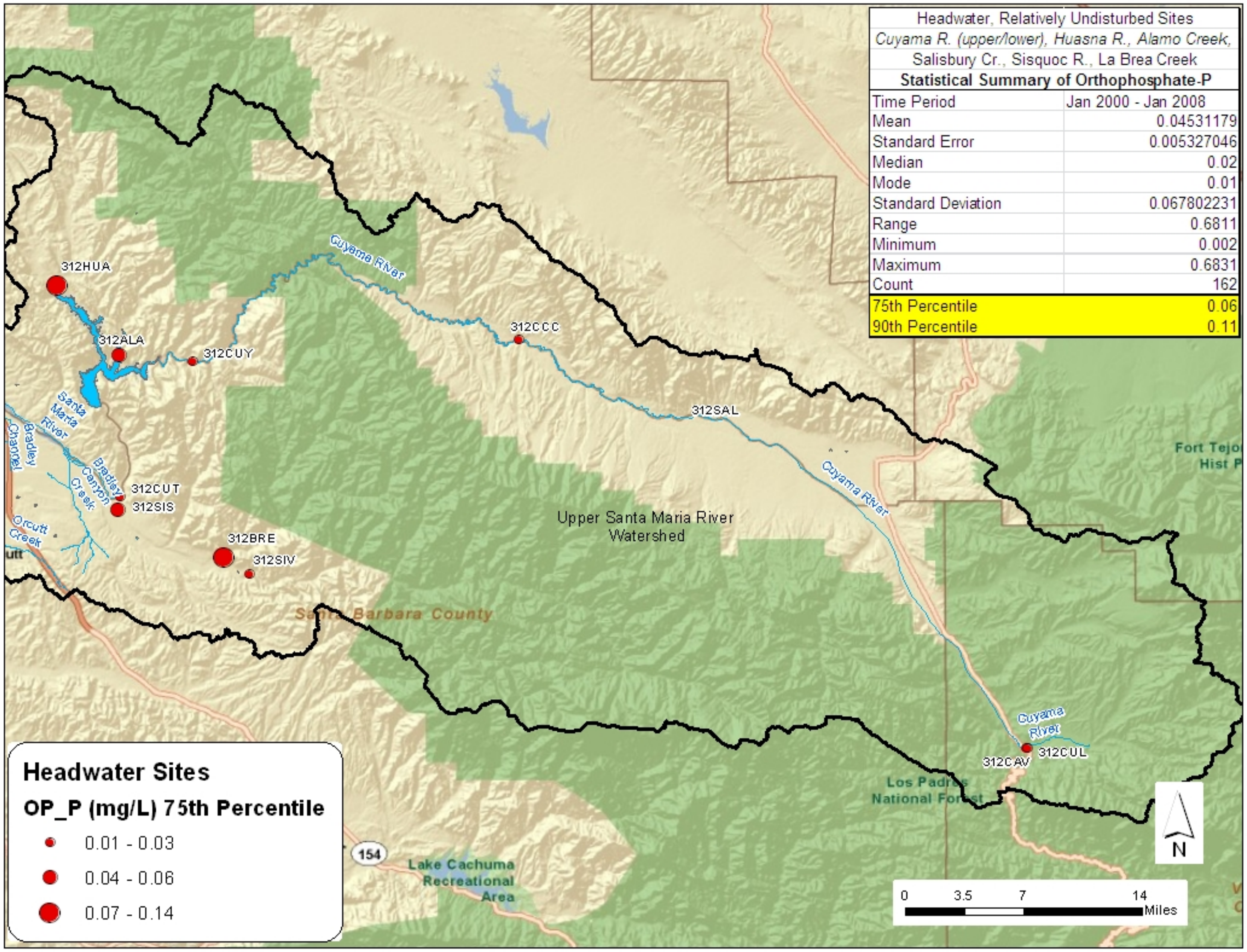

Headwater, Relatively Undisturbed Sites
Cuyama R. (upper/lower), Huasna R., Alamo Creek, Salisbury Cr., Sisquoc R., La Brea Creek
Statistical Summary of Orthophosphate-P
Time Period Jan 2000 - Jan 2008
Mean 0.04531179
Standard Error 0.005327046
Median 0.02
Mode 0.01
Standard Deviation 0.067802231
Range 0.6811
Minimum 0.002
Maximum 0.6831
Count 162
75th Percentile 0.06
90th Percentile 0.11
Headwater Sites
OP_P (mg/L) 75th Percentile
0.01 - 0.03
0.04 - 0.06
0.07 - 0.14
312HUA
312ALA
312CUY
312CCC
312SAL
312CUT
312SIS
312BRE
312SIV
312CAV
312CUL
Cuyama River
Upper Santa Maria River Watershed
Santa Barbara County
Los Padres National Forest
Lake Cachuma Recreational Area
154
N
0 3.5 7 14 Miles

Figure 15.

C.6.1 Comparison of Preliminary Numeric Criteria with 75th Percentile Numeric Criteria of Headwater Reaches

The preliminary and potential TMDL numeric criterion developed previously in this appendix with the 25th percentile approach and the CA NNE approach are show below relative to the 75th percentile criterion for headwater and lightly-disturbed reaches in the Santa Maria River basin. Generally, the previously developed potential criterion are not less than the 75th percentile reference stream criterion, and therefore conform to technical guidance that nutrient targets should not be lower than nutrient concentrations found in natural systems.

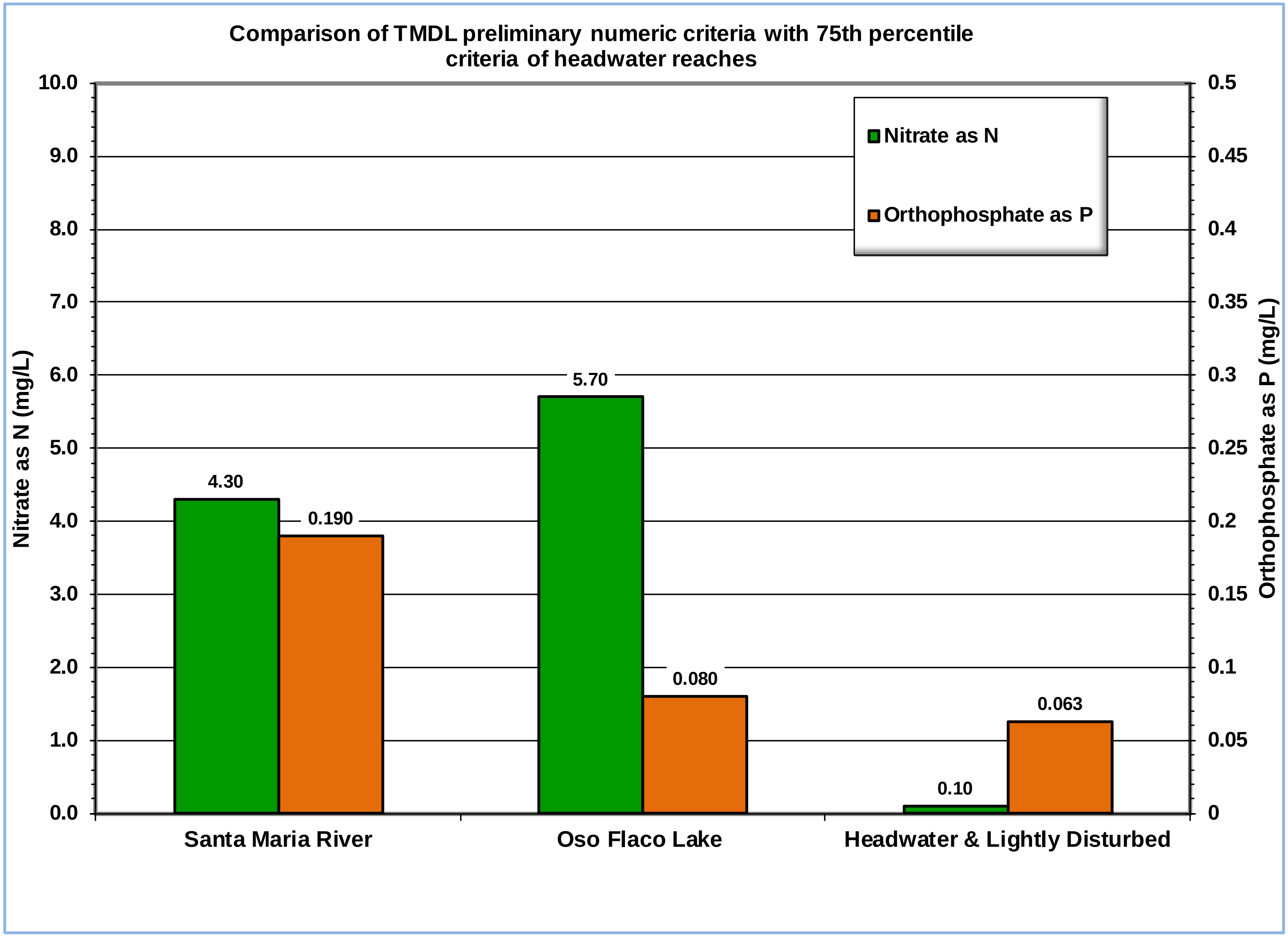

Comparison of TMDL preliminary numeric criteria with 75th percentile criteria of headwater reaches
Nitrate as N
Orthophosphate as P
Nitrate as N (mg/L)
Orthophosphate as P (mg/L)
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
4.30
0.190
5.70
0.080
0.10
0.063
Santa Maria River
Oso Flaco Lake
Headwater & Lightly Disturbed

Figure 16.

C.7 Seasonal Biostimulatory Numeric Targets

C.7.1 Basis for Dry-Season and Wet-Season Numeric Targets

Photo documentation, field observations, and input provided by researchers[8] with expertise in eutrophication issues in the central coast region indicate clear evidence of algae problems and biostimulation in the summer months, and that eutrophication is primarily a summer-time water quality problem in coastal confluence waterbodies and streams of within the project area (for example, see following figure).

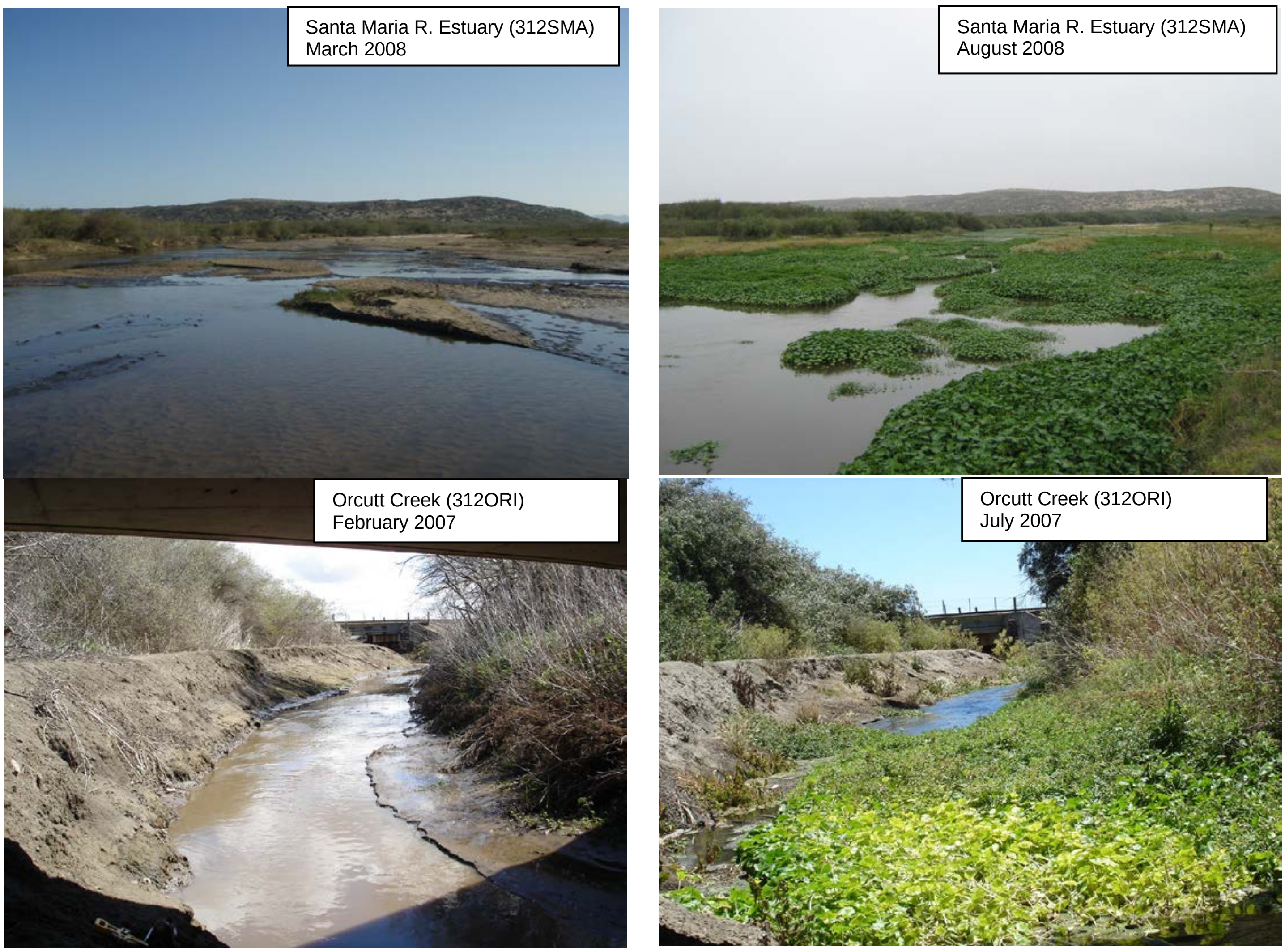


Figure 17.

Although there is some evidence of episodic excessive chlorophyll levels winter months, based on available water quality data, staff concludes that it would be unwarranted at

[8] Staff communications: Ken Johnson, Ph,D. (Senior Scientist, Monterey Bay Aquarium Research Institute); Brent Hughes (estuarine ecologist, Elkhorn Slough National Estuarine Research Reserve); Mary Hamilton (Environmental Scientist, Central Coast Ambient Monitoring Program)

this time to apply year-round nutrient numeric targets to implement the Basin Plan's biostimulatory objective for streams of the Lower Santa Maria River watershed (Lower Santa Maria River from Highway 1 to Santa Maria River Estuary, Orcutt Creek, Greene Valley Creek, Bradley Canyon Creek, Blosser Channel, Bradley Channel). Staff made this conclusion because winter nutrient loads are often associated with higher velocity stream flows which are likely to scour filamentous algae and transport it out of the Lower Santa Maria River watershed. These higher flows transport nutrient compounds and associated algal biomass through the watershed and ultimately into the ocean via the Santa Maria River Estuary. In short, evidence of algal impairment within streams of the Lower Santa Maria River watershed is less conclusive for winter time than for summer conditions. **Note that staff has concluded that similar conditions <u>do not</u> exist for Oso Flaco Lake and Oso Flaco Lake tributaries; therefore staff is recommending year-round numeric targets as described Appendix D, *Oso Flaco Lake Nutrient Numeric Target and TMDL Development*.** The nutrient numeric criteria developed in the preceding sections of this appendix are proposed to apply to streams of the Lower Santa Maria River watershed during the dry season (May 1 to October 31) when excessive algal growth and biostimulation problems appear to be unequivocal.

While there is some evidence of episodic excessive chlorophyll concentrations in the winter months, there is also substantial scientific uncertainty about the extent to which winter-time nitrogen phosphorus and nitrogen loads from valley floor and headwater reaches of the project area ultimately contribute to summer-time biostimulation problems in downstream receiving waterbodies. Loading during the winter months may have little effect on summer algal densities[9]. Alternatively, substantial internal loading of phosphorus and nitrogen in downstream and coastal confluence waterbodies may result over time from loads released from particulate matter, such as sediment or organic matter. The extent to which this sediment and organic matter-associated internal loading is consequential to summertime biostimulation problems in the project area or in downstream receiving waterbodies is currently uncertain. It is important to note that, in particular, phosphorus loads from headwater or upstream reaches may ultimately be released from stored sediments and may be a consequence of decades of natural loads that have nothing to do with current activities (personal communication, Dr. Marc Los Huertos, Oct. 17, 2011).

Therefore, to account for these uncertainties staff conclude that it is necessary to set seasonal (wet-season) nutrient numeric targets for the Lower Santa Maria River and tributaries, but at this time these targets should be less stringent than dry-season nutrient targets in acknowledgement of these uncertainties. Previous California nutrient TMDLs have similarly incorporated seasonal targets for nutrients for the same reasons.

At this time, staff proposes a TMDL nitrate target for the wet-season (Nov. 1 to April 30) that is less stringent than the dry-season targets developed previously in this appendix, but more stringent that the Basin Plan numeric objective for nitrate (i.e., the 10 mg/L MUN objective). Staff proposes incorporating a 20% explicit margin of safety to the

[9] State of Connecticut Dept. of Environmental Protection. 2005. A Total Maximum Daily Load Analysis for Linsley Pond in North Branford and Branford, Connecticut

Basin Plan nitrate MUN numeric objective for the wet-season numeric target to help account for uncertainty concerning biostimulatory problems in the wet season. As such, the proposed wet-season biostimulatory target for nitrate is 8 mg/L. The basis for identifying the 8 mg/L wet-season nitrate-N target is as follows:

1) Photo documentation, field observations, water quality data, and input provided by researchers (refer back to footnote 8) with expertise in eutrophication issues in the central coast region indicate clear evidence of algae problems and biostimulation in the summer months, and that eutrophication is primarily manifested as a summer-time water quality problem in project area waterbodies. In the winter higher flows, cooler temperatures, lower light availability, and scouring evidently limit algal production. There are substantial uncertainties regarding the extent to which winter-time algal biomass problems manifest themselves, and about the extent to which winter time loads of nitrogen ultimately contribute to biostimulation problems in the summer.
2) The USEPA similarly established a nutrient TMDL for inland stream in southern California which contained a winter time nitrogen target of 8 mg/L, based on the application of a 20% margin of safety to the Basin Plan's numeric objective of nitrate and to account for uncertainty regarding winter time algae problems[10].
3) Recent research on biostimulation on inland surface waters from an agricultural watershed in the California central coast region indicates that existing nutrient numeric water quality objectives found in the Basin Plan (i.e., the 10 mg/L nitrate-nitrogen MUN objective) is unlikely to reduce benthic algal growth below even the highest water quality benchmarks[11]. Therefore, the 10 mg/L nitrate-nitrogen objective is insufficiently protective against biostimulatory impairments. Consequently, staff concludes that it is necessary to set nutrient wet-season numeric targets more stringent than the existing numeric objectives found for nitrate in the Basin Plan (i.e., the 10 mg/L MUN objective).

Similarly, staff proposes to establish a wet season orthophosphate target that is less stringent than the dry-season orthophosphate targets developed previously in this appendix. Staff is proposing a wet season target to help account for uncertainty regarding biostimulatory problems associated with wet season loads of orthophosphate. Unfortunately, there are currently no established numeric water quality objectives for phosphates in the Basin Plan on which to base a less stringent wet-season target. However, phosphate targets for streams have been adopted in some other states. The State of Nevada adopted a total phosphate target of 0.3 mg/L for Class B streams, and for most reaches of Class A streams. As such, the proposed wet-season biostimulatory target for orthophosphate is 0.3 mg/L.

[10] USEPA. Total Maximum Daily Loads for Nutrients, Malibu Creek Watershed.

[11] University of California, Santa Cruz. 2010. Final Report: Long-term, high resolution nutrient and sediment monitoring and characterizing in-stream primary production. Proposition 40 Agricultural Water Quality Grant Program. Dr. Marc Los Huertos, Ph.D., project director.

The basis for this proposal is as follows:

1) Photo documentation, field observations, water quality data, and input provided by researchers (refer back to footnote 8) with expertise in eutrophication issues in the central coast region indicate clear evidence of algae problems and biostimulation in the summer months, and that eutrophication is primarily manifested as a summer-time water quality problem in the Lower Santa Maria River waterbodies. In the winter higher flows, cooler temperatures, lower light availability, and scouring evidently limit algal production. There are substantial uncertainties regarding the extent to which winter time algal biomass problems manifest themselves, and about the extent to which winter time loads of phosphorus ultimately contribute to biostimulation problems in the summer.
2) The State of Nevada adopted a total phosphate numeric criteria of 0.3 mg/L for Class B streams, and for most reaches of Class A streams[12]
3) USEPA nutrient target development guidance recognizes the use of established concentration thresholds from published literature (refer back to footnote 2).
4) A wet season value of 0.3 mg/L approximates the high end of orthophosphate concentrations found in reference conditions in the Santa Maria River basin (i.e., lightly-disturbed and natural stream systems). As shown in Section C.6, the 90th percentile, and the maximum concentrations of reference conditions in the Santa Maria River basin range from 0.11 mg/L to 0.68 mg/L orthophosphate, respectively. Therefore, the proposed wet-season of 0.3 mg/L satisfies the conditions that a wet season target at this time should be less stringent than a dry season target, and the proposed target itself falls well within the range of high-end concentrations (i.e., 0.11 to 0.68 mg/L) that can plausibly be expected under relatively undisturbed or reference conditions (see Figure 15 on page 24). In other words, 0.3 mg/L is consistent with high-end orthophosphate concentrations found in natural and lightly-disturbed stream systems in the Santa Maria River basin, and consequently does not plausibly appear to be under-protective for use as a less-stringent wet season target.

However, it should be noted that research into eutrophication in inland surface streams and estuaries are an active and ongoing area of research. Should future research and studies indicate systematic biostimulatory impairments in the winter months, or contributions to summertime biostimulation ultimately resulting from winter time loading, the Water Board may consider extending the more stringent dry season numeric targets to the wet season.

[12] USEPA, 1988. Phosphorus – Water Quality Standards Criteria Summaries: A Compilation of State/Federal Criteria. (Sept. 1988)

C.8 Final TMDL Numeric Targets for Biostimulatory Substances in Stream Reaches

Waterbody Type	Geomorphology & Stream Characteristics	Project Area Stream Reaches	Allowable Nitrate-N (mg/L)	Allowable Orthophosphate-P (mg/L)	Methodology for Developing Numeric Target	Notes Pertaining to Development of Targets
Alluvial Valley River – flood plain	Alluvial valley river. Alluvial flood plain, channels, drainageways. Moderate ambient turbidity; sandy substrate; <10 average canopy cover;	Lower Santa Maria River from Highway 1 to Santa Maria River Estuary, Orcutt Creek, Greene Valley Creek, Bradley Canyon Creek, Blosser Channel, Bradley Channel	**4.3** **Dry Season Samples (May 1-Oct31)** **8.0** **Wet Season Samples (Nov. 1-Apr. 30)**	**0.19** **Dry Season Samples (May 1-Oct. 31)** **0.3** **Wet Season Samples (Nov. 1-Apr. 30)**	Statistical Analysis (USEPA percentile-based approaches) Supported by Calif. NNE approach (NNE benthic biomass model tool) Wet-season targets based on Central Coast Basin Plan nitrate objectives and State of Nevada phosphate criteria for streams	Moderately high ambient turbidity (17 NTU-25th percentile), sandy substrate, poor sunlight penetration, low to moderate canopy cover indicates risk of biostimulation at relatively low concentrations of nutrients.
Oso Flaco Lake Tributaries	Alluvial fan, alluvial flats; Relatively high ambient turbidity; Loamy sand substrates; almost no canopy cover	Oso Flaco Creek, Little Oso Flaco Creek.	**5.7** **Dry Season Samples (May 1-Oct31)**	**0.08** **Dry Season Samples (May 1-Oct. 31)**	Statistical Analysis (USEPA percentile-based approaches) Supported by Calif. NNE approach (NNE benthic biomass model tool)	Loam, sandy loams, and sand. Relatively high ambient turbidity (20 NTU – 25th percentile) which precludes good sunlight penetration of water column; risk of biostimulation occurs at relatively higher nutrient concentrations.
Oso Flaco Lake	**In Development (see Appendix D)**					

Appendix D – Pending Nutrient Numeric Target and TMDL Development for Oso Flaco Lake

Contents

1 Introduction

This appendix describes nutrient numeric target and TMDL development for Oso Flaco Lake. A Nutrient TMDL for Oso Flaco Lake will be developed as a separate, lake-specific TMDL project. Please note that staff has developed draft nutrient TMDLs and associated numeric targets for two lake tributaries, Oso Flaco Creek and Little Oso Flaco Creek. It is anticipated that TMDLs for these Oso Flaco Lake tributary streams will be revised following completion of the Oso Flaco Lake Nutrient TMDL described herein.

2 Oso Flaco Lake Nutrient Numeric Target and TMDL Development

This appendix describes nutrient TMDL development for Oso Flaco Lake. Oso Flaco Lake is included on the 2010 303(d) list of impaired waters due to excessive nitrate levels. In addition, staff has concluded that Oso Flaco Lake does not support the spawning beneficial use due to low dissolved oxygen concentrations and that biostimulatory conditions exist within the lake (see Section 3 of Project Report). As a result of these impairments, staff is developing a nutrient TMDL to protect the designated beneficial uses of Oso Flaco Lake as tabulated below.

Table 1.

Designated Beneficial Uses for Oso Flaco Lake
Ground Water Recharge (GWR)
Water Contact Recreation (REC-1)
Non-Contact Water Recreation (REC-2)
Wildlife Habitat (WILD)
Warm Fresh Water Habitat (WARM)
Spawning, Reproduction, and/or Early Development (SPWN)
Preservation of Biological Habitats of Special Significance (BIOL)
Rare, Threatened, or Endangered Species (RARE)
Commercial and Sport Fishing (COMM)
Navigation (NAV)

3 Physical Setting

The Oso Flaco Lake watershed drains about 20 square miles of primarily agricultural land (strawberries/vegetables) and is located in south San Luis Obispo County, just north of the Lower Santa Maria River watershed. Prior to the 1860's, the outlet of the Santa Maria River was in the proximity of Oso Flaco Lake. Early in the 20th century, some of the floodwater from the Santa Maria River was routed through the creek; however, this route was permanently blocked when the river levees were constructed in the early 1960s [1].

Oso Flaco Lake and Little Oso Flaco Lake are features within the Guadalupe/Nipomo Dune Lakes complex, unique in that they are freshwater bodies located in ocean sand dunes (see Figure 1). Outflow from Oso Flaco Lake enters the Pacific Ocean via a channel that may be occasionally obstructed by dune sand and require clearing [2]. Oso Flaco Lake receives flow from Little Oso Flaco Lake through a 1,000- foot channel. Little Oso Flaco Lake receives flow from Oso Flaco Creek and Little Oso Flaco Creek, which meets Oso Flaco Creek approximately one mile upstream of the lake (see Figure 2).

[1] Cachuma Resource Conservation District. 2004. Nitrate and Sediment Assessment, Oso Flaco Lake.
[2] Cachuma Resource Conservation District. 2000. Santa Maria River Watershed Non-point Source Pollution Management Plan.

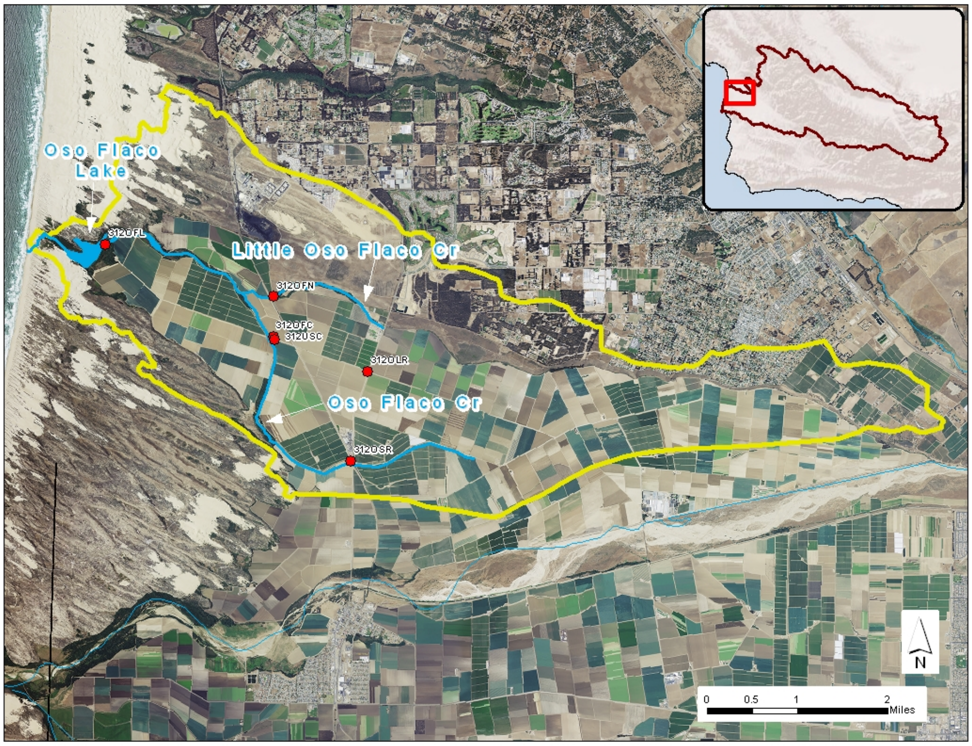


Figure 1. Oso Flaco Lake watershed.

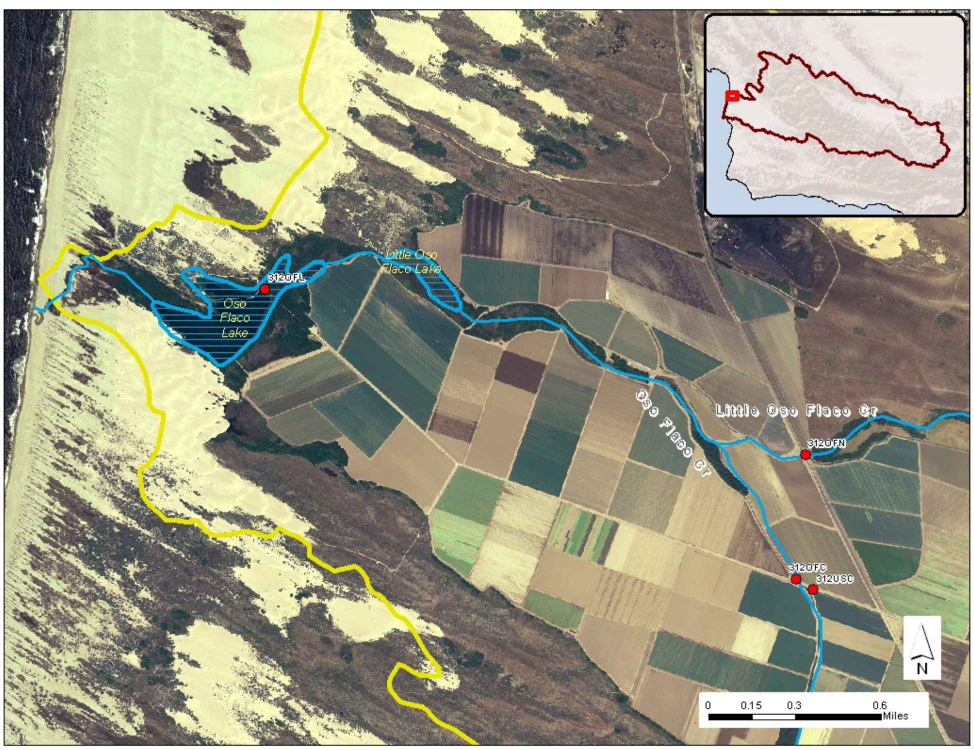


Figure 2. Oso Flaco Lake tributaries.

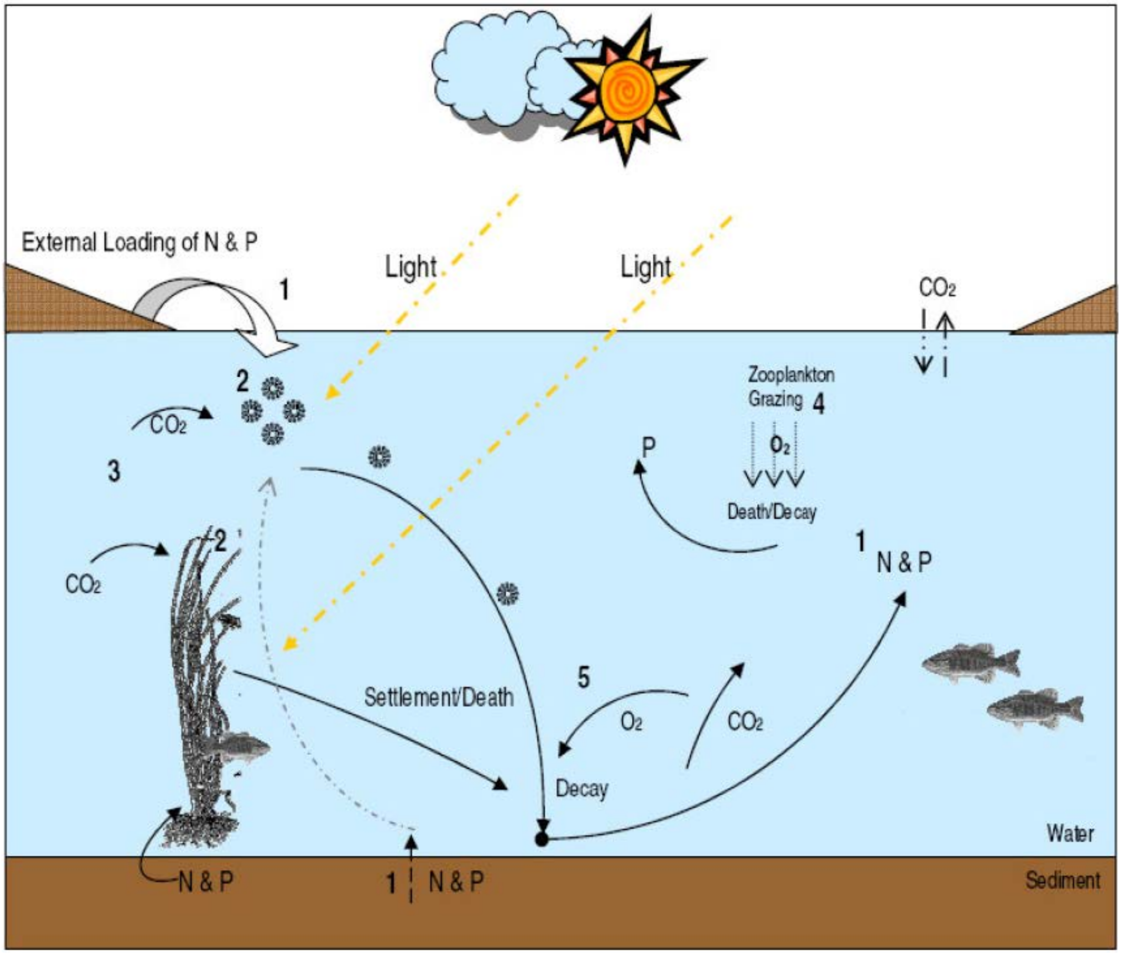
Oso Flaco Lake has a surface area of 40-acres (16 hectares) with depths ranging up to 6.8 feet (2 meters) and an average depth of approximately 4.7 feet (1.4 meters) The estimated lake volume is 173 acre-feet (231,185 cubic meters) [3]. Bathymetry data for Little Oso Flaco Lake is not available; however, the surface area is approximately 16 acres (6.5 hectares); based on aerial photo interpretation.

Oso Flaco Lake and Little Oso Flaco Lake are classified by the U.S. Fish and Wildlife Service (USFWS) as palustrine emergent wetlands, a valuable habitat for wildlife. As such, the Oso Flaco Lakes are a resource for many recreational and educational activities such as bird watching, fishing and school trips. Oso Flaco also supports habitat for one of the last remaining populations of Marsh Sandwort (endangered), as well as other state and federally listed species that include the California Least Tern, California Red-Legged Frog, Western Snowy Plover, Gambel's Watercress, and La Graciosa Thistle. Additionally, the USFWS has proposed critical habitat designation for the Tidewater Goby within the Oso Flaco Lake unit, although this designation has not been finalized.

4 Conceptual Model of Lake Nutrient Processes

There are many biological responses to nutrients (nitrogen and phosphorus) in lakes and Figure 3 presents a conceptual model of these basic relationships. To describe these processes in general, biologically available nutrients and light will stimulate phytoplankton and or macrophyte growth and as these plants grow they provide food and habitat for other organisms such as zooplankton and fish. When the aquatic plants die they will release nutrients (ammonia and phosphorus) back into the water through decomposition. The decomposition of plant material consumes oxygen from the water column; in addition the recycled nutrients are available to stimulate additional plant growth. Physical properties such as light, temperature, residence time, and wind mixing also play integral roles throughout the pathways presented in the Figure 3.

[3] 2011 Bathymetry Survey, Oso Flaco Lake. Reese Water & Land Survey for Coastal San Luis Resource Conservation District.



1. Nutrients (N and P) enter the lake through external loading from the surrounding watershed and internal recycling processes
2. Nutrients and light stimulate the growth of phytoplankton and macrophytes (aquatic plants)
3. Aquatic plants consume carbon dioxide and the increase the pH of the lake
4. Zooplankton (aquatic invertebrates) graze the phytoplankton population
5. Aquatic plants break down and or die and consume oxygen as part of decomposition and recycle ammonia, phosphorus, and carbon dioxide into the water and the sediments

Source: Machado Lake Eutrophic, Algae, Ammonia, and Odors (Nutrient TMDL), Draft Project Report, Regional Water Quality Control Board, Los Angeles Region. 2008. Adapted from U.S. EPA 1999.

Figure 3. Conceptual model of lake nutrient processes.

The typical biological processes shown in Figure 3 can become over-stimulated by the addition of excess nutrients to the lake and result in degraded water quality conditions and beneficial use impairment. The following flow chart (Figure 4) outlines the responses within the lake to excessive nutrient loading and how the beneficial uses will be impacted.

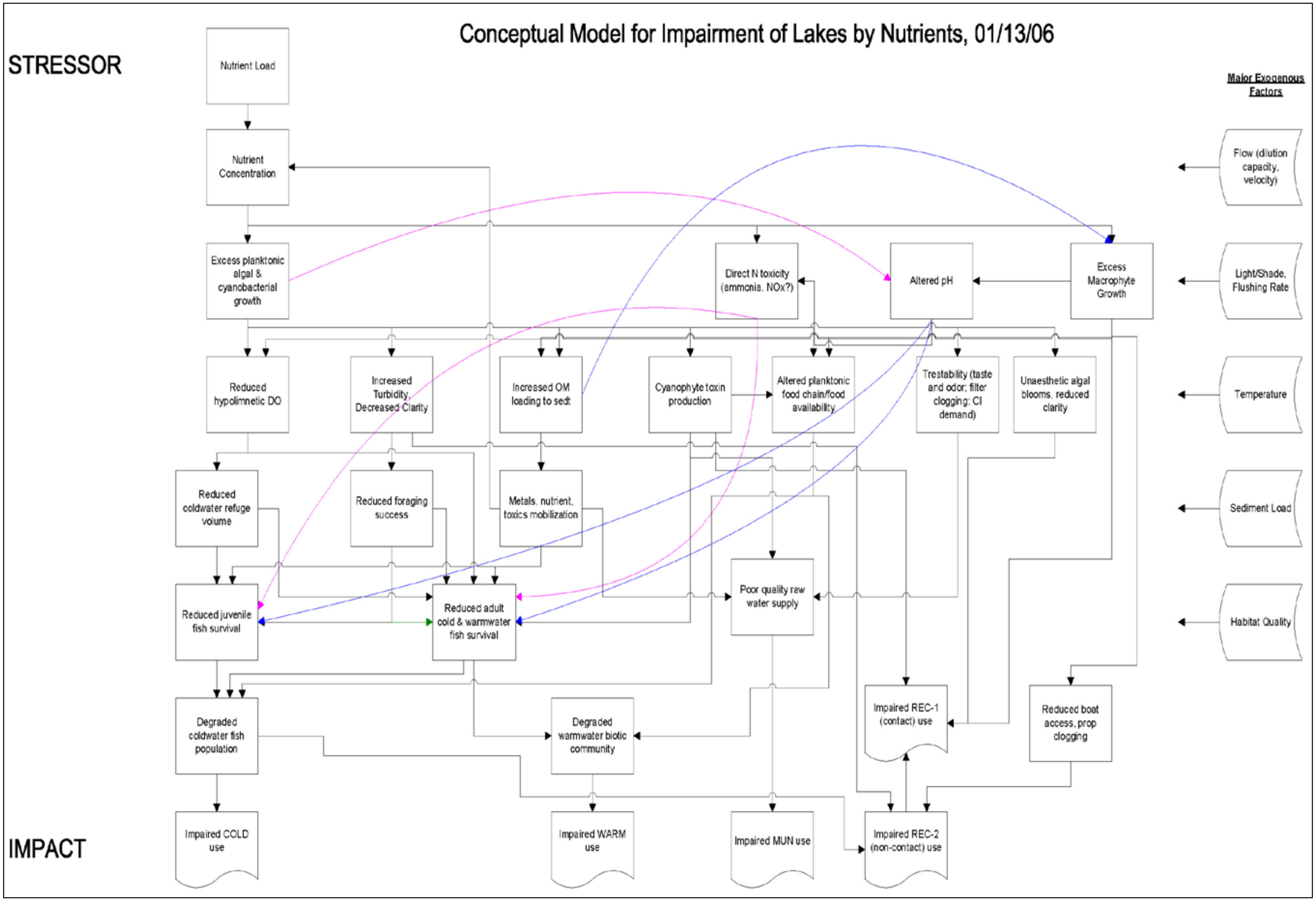


Figure 4. Conceptual Model for Impairment of Lakes by Nutrients. (see footnote 4, page 7)

Excessive nutrient loading leads to excessive phytoplankton and macrophyte growth, which are often considered the primary problems associated with increased nutrient concentrations in lakes. Excessive plant biomass often cause; increased turbidity, increased algal blooms, reduced dissolved oxygen concentrations, changes in the food chain, changes in the ecological balance of plant and animal communities, changes in the DO balance and pH, and unaesthetic conditions that lead to impairment of beneficial uses. A conceptual model of beneficial use impairment due to excessive nutrients is shown in Figure 4[4].

Typically, excessive plant growth can quickly lead to an altered planktonic community; in many cases the dominant phytoplankton species may become blue green algae and algal blooms may occur, especially in the summer months. Likewise, macrophyte growth may increase and become expansive throughout the lake (Figure 4). Particularly in shallow lakes, such as Oso Flaco Lake, the combination of available nutrients and greater light intensity throughout the water column provides the light that is needed for rapid plant growth. In addition, light can penetrate to the lake bottom promoting macrophyte growth. In comparison, in deep lakes a greater portion of the water column is not able to support photosynthesis as a majority of the water column is below the light penetration depth. Thus, the impacts of nutrient loading, and the resulting biological response of algal blooms and dominant macrophytes, are often very apparent in shallow lakes.

Plant growth can lead to increased pH in the lake due to rapid consumption of carbon dioxide. The elevated pH creates a harmful environment for organisms and can increase the concentration of ammonia potentially leading to direct toxicity of fish and other organisms. As these large phytoplankton populations and macrophytes die or break apart the decomposition process will consume oxygen and dramatically reduce the oxygen levels found in the lake. Low dissolved oxygen levels can become very stressful for fish and other organisms and may in fact lead to fish kills (Figure 4). Moreover, as the plant material is decomposed the nutrients are released and will recycle through the system. Shallow lakes tend to have increased biological productivity because it is likely that the photosynthetic zone and decomposition zone of the water column overlap, creating the situation in which as materials are decomposed and the nutrients released they are also immediately available for photosynthesis and plant growth continuing to drive ongoing impairments.

5 Lake Classification System

Lakes can be classified in many different ways; a common classification system is the trophic state. The trophic state of a lake is understood to be the biological response to nutrient additions. The relationship of chlorophyll levels and phosphorus concentrations in lakes has been studied in datasets worldwide and this relationship is used to define the trophic state of a lake (Wetzel, 2001)[5]. Lakes with low phosphorus and chlorophyll concentrations are considered oligotrophic, a good example would be Lake Tahoe. Lakes with high phosphorus and chlorophyll concentrations would be considered eutrophic.

Carlson (1977)[6] developed a simple production based trophic state index (TSI) to classify and describe lakes. The TSI uses algal biomass as the basis for trophic state classification. The TSI is a convenient way to quantify the relationship between nutrients and algal biomass based on three independent variables: Secchi depth (transparency), chlorophyll *a* and total phosphorus. Carlson's index utilizes the log transformation of Secchi depth measurements; each 10 unit division represents a halving or doubling of the Secchi depth. Because chlorophyll *a* (Chl) and total phosphorus (TP) are usually closely correlated to Secchi disk (SD) measurements, these parameters can also be assigned trophic state index values. The Carlson indices are relatively easy to calculate, the simplified equations are listed below.

[4] Technical Approach to Develop Nutrient Numeric Endpoints for California, July 2006. By Tetra Tech for USEPA.
[5] Wetzel, R. 2001. *Limnology*. Academic Press.
[6] Carlson, R.E. 1977. A trophic state index for lakes. *Limnology and Oceanography* 22:361-369

(1) TSI (Chl) = 30.6 + 9.81 ln(Chl)
(2) TSI (TP) = 4.15 + 14.42 ln(TP)
(3) TSI (SD) = 60 -14.41 ln(SD)

In addition to the three original indices Kratzer and Brezonik (1981)[7] developed a TSI index for total nitrogen. This index was designed to be used in nitrogen limiting conditions under which nitrogen would be a better predictor of algal biomass than phosphorus. The index is calculated using the following formula.

(4) TSI (TN) = 54.45 +14.43 ln(TN)

The Carlson trophic state indices are commonly used to define a lake's trophic state. The Trophic State Index generally relates lake characteristics and is used to interpret the TSI as shown in Table 2.

Employing a lake classification system such as the TSI is a meaningful and practical way to explore the relationships between variables and understand the nature of the lake. For example, identifying what factors may be driving algal biomass growth and influencing water quality in the lake can lead to effective management measures.

[7] Kratzer, C.R., and P.L. Brezonik. 1981. A Carlson-type trophic state index for nitrogen in Florida lakes. Water Resources Bulletin 17:713-715.

Table 2. Potential characteristics of lake conditions related to increases of TSI.

Trophic State	TSI	Chlorophyll a (µg/L)	SD (m)	TP (µg/L)	Characteristics	Fisheries and Recreation
Oligotrophic	< 30	<0.95	> 8	<6	Clear water, oxygen throughout the year in the hypolimnion	Salmonid fisheries dominate
Oligotrophic	30 – 40	0.95 - 2.6	8 – 4	6 –12	Hypolimnion of shallower lakes may become anoxic	
Mesotrophic	40 – 50	2.6 – 7.3	4 – 2	12 – 24	Water moderately clear; increasing probability of hypolimnetic anoxia during summer	Hypolimnetic anoxia results in loss of salmonids
Eutrophic	50 – 60	7.3 – 20	2 – 1	24 – 48	Anoxic hypolimnia, macrophyte problems possible	Warm-water fisheries only, bass may dominate
Eutrophic	60 – 70	20 – 56	0.5 – 1	48 – 96	Blue-green algae dominate, algal scums and macrophyte problems	Nuisance macrophytes, algal scums, and low transparency may discourage swimming and boating
Hyper- Eutrophic	70 – 80	56 – 155	0.25 – 0.5	96 – 192	Light limited productivity Dense algae and macrophytes	
Hyper-Eutrophic	>80	>155	<0.25	192 – 384	Algal scums, few macrophytes	Rough fish dominate

Adopted from Carlson, R., and J. Simpson. 1996. *A coordinator's guide to volunteer lake monitoring methods*. North American Lake Management Society and the Educational Foundation of America.

Fisheries may be expected to vary with latitude and altitude

Table 3 shows Central Coast Ambient Monitoring Program (CCAMP) data for the Oso Flaco Lake sampling location (312OFL) and corresponding evaluation of TSI conditions. It is important to note that CCAMP sampling site 312OFL does not adequately represent lake (lentic) conditions because this site is located downstream of turbulent flows associated with two 3-foot diameter drainage culverts (see Figure 5). Oso Flaco Lake is bisected by a manmade causeway and the culverts maintain hydraulic continuity between the two portions of the lake (see Figure 6). Also note that Secchi depth is not included in the CCAMP suite of testing parameters.

Table 3. CCAMP data (site 312OFL) and evaluation of TSI for Oso Flaco Lake.

Water Quality Parameter	**312OFL Mean Values (µg/L)**	**Sample Count**
Nitrate	30,600	28
Total N	31,090	22
Orthophosphate as P	198	28
Total P	376	7
Chlor_a	29.8	28
Formulae (Carlson 1997)		**Calculated TSI Values**
TSI (Chl) = 30.6 + 9.81 ln (Chl)		**64**
TSI (TP) = 4.15 + 14.42 ln (TP)		**90**
TSI (SD) = 60 – 14.41 ln (SD)		N/A
Nitrogen Limited Conditions (Kratzer and Brezonik, 1981; Carlson, 1992)		
TSI (TN) = 54.45 + 14.43 ln (TN)		**204**

CCAMP chlorophyll a and total phosphorus data suggests that the trophic state is eutrophic to hyper-eutrophic. As discussed in Section 3.2.3 of the Project Report, Oso Flaco Lake is phosphorus limited; therefore it may be inappropriate to perform an assessment of trophic state using total nitrogen measurements.

Figure 5. CCAMP sampling site 312OFL.

Figure 6.

6 Oso Flaco Lake Sampling

On February 9, 2012, Water Board staff performed one sampling event at Oso Flaco Lake with the intention of obtaining samples that are more representative of lake conditions. Instead of using the existing CCAMP monitoring site 312OFL, staff obtained samples from the pedestrian bridge that provides public beach access. The site (312OFL_Br) is located approximately 200 feet southwest of monitoring site 312OFL (see Figure 6). Depth to bottom of the lake was measured at 3.37 feet and the samples were obtained at 1115 under calm conditions using a Hydrolab DS5 water quality sonde. Results are shown in Table 4.

Table 4.

Sampling depth from bottom (ft)	pH	Conductivity (uS/cm)	Turbidity (NTU)	DO (mg/L)	DO (% sat)	H2O Temp (ºC)	Salinity (ppt)	Chlor a (ug/L)
~ 0.5	8.31	1873	52.4	22.18	217.9	14.28	1	121.91
~ 1.5	8.28	1869	35.7	21.89	214.1	14.32	1	119.43
~ 3	8.26	1877	28.3	22.35	218.4	14.27	1	111.92

In addition to the sonde measurements, staff conducted transparency tests using a transparency tube and collected water samples for laboratory analysis. The average depth of three transparency measurements was 0.1 meters.

Water samples were submitted for laboratory analysis of nitrogenous compounds, orthophosphorus, total phosphate, and chlorophyll *a*. Results of these laboratory analyses is shown in Table 5.

Table 5.

Nitrate as N (mg/L)	Total Nitrogen (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Ammonia as N (mg/L)	Nitrite as N (mg/L)	Orthophosphorus as P (mg/L)	Total Phosphate as P (mg/L)	Chlor a (µg/L)	Secchi Depth (m)
14	16	2.2	0.12	0.059	0.012	0.19	240	0.1

Based on this sampling event staff has concluded that there is no vertical stratification throughout the water column at site 312OFL_Br. In addition, oxygen concentrations indicate supersaturated conditions and chlorophyll *a* concentrations are extremely elevated. Using the Carlson TSI equation for transparency (Secchi depth or SD), the trophic state of the lake can be classified as hyper-eutrophic (TSI (SD) = 93), however more data is necessary define the trophic state.

California Department of Parks and Recreation funded a sediment and turbidity study of Oso Flaco Lake and Oso Flaco Creek. The study began in April 2010 and will conclude in July 2012. Hourly flow and turbidity measurements were collected from a site located between Oso Flaco Lake and Little Oso Flaco Lake, within a stream channel connecting the two waterbodies. Nitrate and orthophosphate grab samples were also collected, though at an infrequent interval. Data from this study is significant in that flow and loading estimates may be estimated for Oso Flaco Lake. Using this flow and nutrient data staff used the FLUX computer program[8] to estimate annual flow into Oso Flaco Lake and annual nitrate and orthophosphate loads for a one year period beginning October 2010. Additional flow and loading information is contained in Section 10.

7 Oso Flaco Lake Biostimulatory Conditions

Staff is proposing total nitrogen and total phosphorus TMDLs for Oso Flaco Lake because the lake is impaired by nitrate and low dissolved oxygen concentrations (see Section 3 of the Project Report). In addition, the following biostimulatory conditions associated with these nutrient substances have been observed:

- chlorophyll *a*, total phosphate, and lake water clarity indicate hypertrophic conditions based on the Carlson trophic status indicators (TSI) (see Section 5 above);
- wide swings in diel (24-hr) dissolved oxygen concentrations (see Figure 7);
- dissolved oxygen percent saturation levels indicate super saturated conditions (greater than 100% saturation)(see Figure 8); and,
- photo-documentation of algal blooms (see Figure 9).

[8] Walker, William, W., "Empirical Methods for Predicting Eutrophication in Impoundments - Report 2: Model Testing", prepared for Office, Chief of Engineers, U.S. Army, Washington, D.C., Technical Report E-81-9, U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi, September 1982.

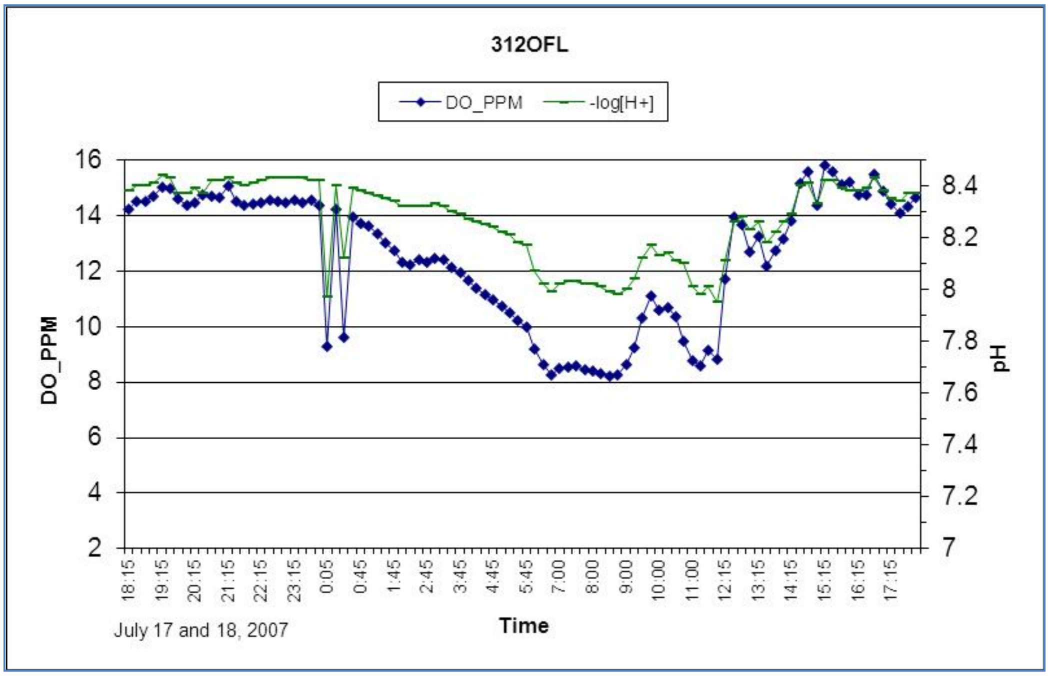


Figure 7. Diel dissolved oxygen and pH concentrations.

The DO concentration in a waterbody reflects the balance between reaeration and internal oxygen consumption, primarily through bacterial respiration. Excess growth of algae can affect DO concentrations in a variety of ways. As a direct effect, photosynthetic production by algae releases oxygen, while respiration consumes oxygen. This leads to a diurnal cycle in which the presence of algae increases oxygen concentrations during the day (if sufficient light is present) and decreases oxygen concentrations at night as shown in Figure 7. In addition, as an indirect effect, algae that die contribute to the pool of non-living organic matter subject to bacterial decomposition. This can result in dramatic DO depression during periods of algal bloom die-off.

Algae can also alter the pH of water through the uptake or release of CO_2. The following reactions demonstrate how photosynthetic organisms convert CO_2 and water to sugar and oxygen during photosynthesis and how during respiration the reaction is reversed. During daylight hours, photosynthesis and respiration occur simultaneously though photosynthesis occurs at a much faster rate. In the absence of sunlight, only respiration occurs.

$$\text{Photosynthesis: } 6CO_2 + 6H_2O + Sunlight \Rightarrow C_6H_{12}O_6 + 6O_2$$

$$\text{Respiration: } C_6H_{12}O_6 + 6O_2 \Rightarrow 6CO_2 + 6H_2O$$

During photosynthesis, CO_2 is consumed and pH increases. During respiration, CO_2 is released and dissolves in water to form carbonic acid (H_2CO_3), which lowers pH by adding hydrogen ions to the water.

$$H_2O + CO_2 \Leftrightarrow H_2CO_3 \Leftrightarrow H^+ + HCO_3^-$$

$$HCO_3^- \Leftrightarrow H^+ + CO_3^{2-}$$

During acidic conditions, carbonate (CO_3^{2-}) and bicarbonate (HCO_3^-) remove hydrogen ions from the water to form bicarbonate and carbonic acid, respectively. During basic conditions, calcium (Ca^{2+}) binds to hydroxyl ions (OH^-) to form calcium hydroxide. Removal of excessive hydrogen or hydroxyl ions prevents the system from experiencing large swings in pH.

As shown in Figure 7, dissolved oxygen and pH concentrations generally trend together, following daytime photosynthetic activity and nighttime respiratory activity of the in-lake algal biomass. Although oxygen and pH water quality objectives are not exceeded throughout this period, the lake system demonstrates wide diurnal variances that are indicative of biostimulatory conditions. Note that this data was obtained from CCAMP monitoring station 312OFL, where more turbulent water may aid in mixing and present greater potential for reaeration within the water column. It would be expected that data from a less disturbed site within the lake would demonstrate exacerbated oxygen and pH conditions.

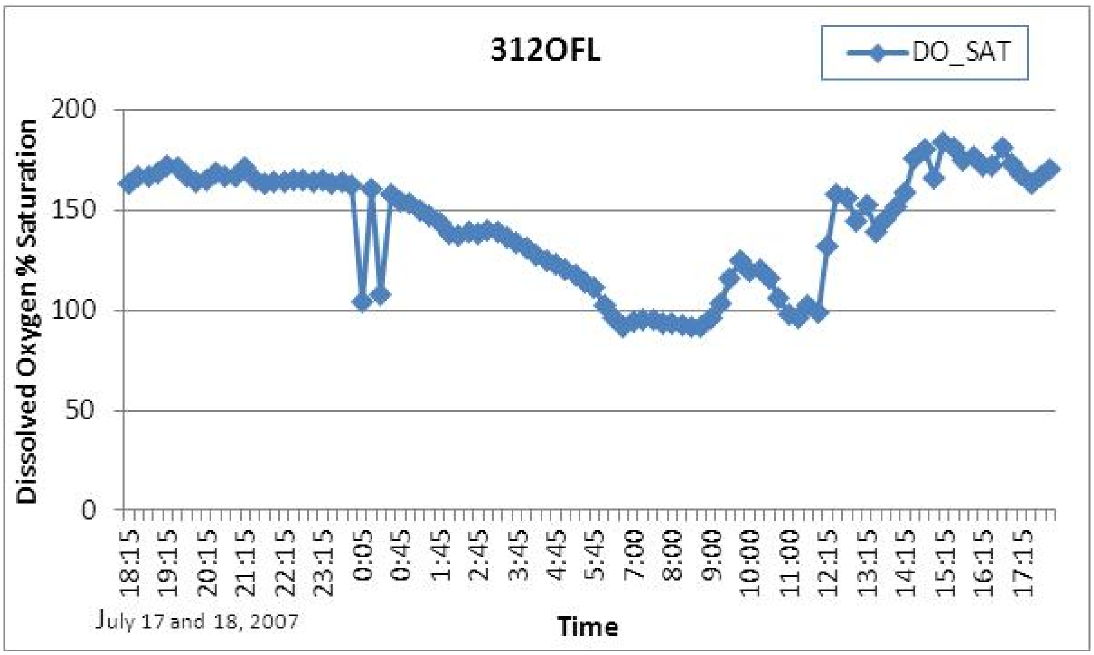


Figure 8. Diel dissolved oxygen saturation.

Supersaturated oxygen conditions can be indicative of excessive algal photosynthetic activity and can be exacerbated by rapid increases in water temperature. Total gas supersaturation can cause direct harm to fish when total dissolved gas saturation increases enough to cause "gas bubble trauma". This is a sometimes fatal condition which occurs when gas bubbles, primarily nitrogen and/or oxygen, are released into the bloodstream and accumulate in the skin, eyes, and gills of fish (Weitkamp, 2008)[9]. It is usually considered a problem for fish in discharge waters from dams, but can also be associated with eutrophication (Canadian Council of Ministers of the Environment, 1999[10]; Fidler and Miller, 1994[11]).

[9] Weitkamp, D.E. Total Dissolved Gas Supersaturation Biological Effects: Review of Literature, 1980-2007. Parametrix 411 108th Ave. NE, Suite 1800 Bellevue, Washington 98004-5571 June 2008.

[10] Canadian Council of Ministers of the Environment. 1999. Canadian water quality guidelines for the protection of aquatic life: Dissolved gas supersaturation. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

[11] Fidler, L.E. and S.B. Miller. British Columbia Water Quality Guidelines for Dissolved Gas Supersaturation. 1994. Environment Canada. Aspen Applied Sciences Ltd. Valemount, BC V0E 2Z0

Edsall and Smith (2008)[12] showed gas bubble trauma could be induced with oxygen supersaturation alone. U.S. EPA (1986)[13] has recommended an upper limit of 110% total dissolved gas saturation to protect fish from gas bubble trauma.

Diel dissolved oxygen saturation (Figure 8 above) follows a pattern that is similar to diel dissolved oxygen (Figure 7), in that diel oxygen saturation fluctuates in conjunction with daytime photosynthetic activity and nighttime respiratory activity of the in-lake algal biomass.

Figure 9. Oso Flaco Lake (Sept. 2007).

Figure 9 is a view south of Oso Flaco Lake with the pedestrian bridge visible in the center left of the photo and algal scum in the foreground.

Staff has concluded that biostimulatory impairment stem from excess nitrogen and phosphorus in the lake, causing excess algae growth which then impairs aquatic life and recreational use.

[12] Edsall, D. A. and C.E. Smith. Oxygen-induced gas bubble disease in rainbow trout, *Oncorhynchus mykiss* (Walbaum). 2008. US Fish and Wildlife Service, Fish Technology Center, Bozeman, Montana, USA. *Aquatic Research*, 22(2): 135 – 140.
[13] U.S. EPA, 1986. Quality Criteria for Water (The Gold Book). May 1, 1986. EPA440/5-86-001

8 Numeric Target Development

As mentioned in Section 6, only one sampling event has been conducted to assess in-lake water quality conditions that are representative of the lentic system. Because CCAMP monitoring results for site 312OFL (at lake culvert) do not adequately represent lake conditions due to excessive turbulence, mixing, and reaeration, staff has concluded that the development of numeric targets is not possible at this time. For example, the development of nutrient (nitrogen and phosphorus) numeric targets necessitates an understanding of lake responses to nutrient loading scenarios (e.g., algal productivity due to nutrient loading), while also taking into account hydraulic residence time, light availability, seasonality (growing season), and other key variables. Staff has proposed additional lake monitoring (see Section 7.9 of the Project Report) to fulfill this data need and staff will propose final nutrient numeric targets once this information is available. The remainder of this section provides background information pertaining to nutrient numeric targets and describes how staff will likely proceed in developing them for Oso Flaco Lake.

Oso Flaco Lake is 303(d) listed for nitrate and, as discussed in Section 3 of the Project Report, staff has concluded that, although not listed, Oso Flaco Lake is also impaired due to low dissolved oxygen concentrations and biostimulatory substances. Exceedance of the narrative Biostimulatory Substances (phosphorus and nitrogen) water quality objective results in eutrophic conditions. The characteristics of eutrophic conditions include excessive algal and macrophyte growth and low dissolved oxygen concentrations. The chemical pollutants that most stimulate excessive aquatic vegetative growth and stimulate eutrophication are nitrogen and phosphorus, thus numeric targets will be set for these constituents in this TMDL. Indicators and targets for parameters other than phosphorus and nitrogen may also be proposed in order to track the symptoms of eutrophication and improvements in water quality. These targets include dissolved oxygen and chlorophyll *a*. Chlorophyll *a* will gauge the biological response of Oso Flaco Lake to nutrient loads and is closely tied to the public perception of lake water quality. Dissolved oxygen will also serve as a measure of the lakes response to nutrient loads and assess the quality of aquatic habitat.

Regional Board staff interpreted the narrative biostimulatory substances water quality objective in the Basin Plan and concluded that the existing numeric nitrogen objective is not supportive of the narrative biostimulatory substance water quality objective. The nitrogen objective (10 mg/L) in the Basin Plan is based on criteria acceptable for drinking water and not appropriate to address eutrophic conditions in the lake. A review of available data and scientific literature demonstrates that the numeric objective of 10 mg/L for nitrogen is not sufficiently protective for controlling excessive algal/macrophyte growth and the symptoms of eutrophication in the lake. Therefore, the numeric target for total nitrogen will be more stringent than the existing numeric nitrogen objective in the Basin Plan to ensure attainment of the narrative biostimulatory substances water quality objective. Staff will develop the Oso Flaco Lake Nutrient TMDL and associated numeric targets to ensure protection of all the beneficial uses and attainment of nutrient related water quality objectives specified in the Basin Plan.

Other Regional Boards in California have adopted nutrient TMDLs for lakes in which they relied upon narrative water quality objectives, and in interpreting these narrative objectives, set TMDL numeric targets that were more stringent than existing numeric nutrient water quality objectives in the their Basin Plans. These Regions relied upon the narrative Biostimulatory Substances objective. Table 6 below lists the Regions, TMDLs, and numeric targets.

Table 6. Nutrient Numeric Targets Established in other California TMDLs

Region	TMDL	Final Numeric Targets		
		Total P (mg/L)	Total N (mg/L)	Chlorophyll a (µg/L)
5	Clear Lake Nutrient TMDL	87,100 kg (annual load)	No Target	73 (instantaneous maximum)
6	Indian Creek Reservoir Phosphorus TMDL	0.02	No Target	14
8	Lake Elsinore and Canyon Lake Nutrient TMDL	0.05	0.5	25
8	Nutrient TMDL for Big Bear Lake	0.02	1.0	5

8.1 Chlorophyll a Numeric Targets

Chlorophyll *a,* the dominant pigment in algal cells, is fairly easy to measure and is a valuable surrogate for algal biomass (Carlson, 1980[14]; Watson, et al., 1992[15]). Chlorophyll *a* is desirable as an indicator because algae are either the direct (e.g., nuisance algal blooms) or indirect (e.g., high/low dissolved oxygen and pH and high turbidity) cause of most problems related to excessive nutrient enrichment. Both seasonal mean and instantaneous maximum concentrations can be used to determine impairments, and these measurements may be easily incorporated in the existing CCAMP monitoring program.

A summer mean chlorophyll *a* concentration of 25 µg/L represents a general consensus for the boundary between eutrophic and degraded hypereutrophic conditions (Welch and Jacoby, 2004)[16], and average concentrations should be maintained below this level to protect WARM uses. Impairment of recreational uses can occur at somewhat lower levels. Carlson (1977, see footnote 6) shows that an average chlorophyll *a* concentration of around 20 µg/L corresponds to a Secchi disc depth of 3 m. The work of Walker (1987)[17] suggests that a mean chlorophyll *a* concentration of 25 µg/L is associated with severe algal blooms (concentration greater than 30 µg/L) occurring about one quarter of the time, while a mean concentration of 20 µg/L should reduce the frequency of severe blooms to about 15-20 percent of the time. Lake aesthetics and recreation potential are generally found to be impaired above about 20 or 25 µg/L chlorophyll *a* (Bachmann and Jones, 1974[18]; Heiskary and Walker, 1988[19]). Based on these and other lines of evidence, Tetra Tech (2006, see footnote 4) recommended to the State Water Quality Control Board that summer average chlorophyll *a* concentrations be not greater than 25 µg/L to support WARM uses and not greater than 20 µg/L to support REC-1 uses. Staff used this information to conclude

[14] Carlson, R.E. 1980. More complications in the chlorophyll-Secchi disk relationship. *Limnology and Oceanography* 25:378-382.
[15] Watson, V.J., P. Berlind, and L. Bahls. 1990. Control of algal standing crop by P and N in the Clark Fork River. In *Proceedings of the 1990 Clark Fork River Symposium*, University of Montana, MT.
[16] Welch, E.B., and J.M. Jacoby. 2004. *Pollutant Effects In Freshwater*. Third edition. London and New York. Spoon Press.
[17] Walker, W.W. 1987. Empirical Methods for Predicting Eutrophication in Impoundments. Report 4–Phase III: Applications Manual. Technical Report E-81-9. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.
[18] Bachmann, R. W. and J. R. Jones. 1974. Phosphorus inputs and algal blooms in lakes. *Iowa State J. Res*. 49(2)part1: 155-60.
[19] Heiskary S. and W. Walker. 1988. Developing phosphorus criteria for Minnesota lakes. *Lake and Reservoir Management* 4(1): 1-9.

that a summer average chlorophyll *a* concentration of 20 µg/L is an appropriate numeric target for Oso Flaco Lake. This value is expected to reduce the frequency of algal blooms, protect aquatic life beneficial uses and typical recreational activities such as, boating, swimming, viewing pleasure, and fishing.

Using the 20 µg/L chlorophyll a numeric target as the desired condition for Oso Flaco Lake, staff will then develop total nitrogen and total phosphorus numeric targets to attain the desired chlorophyll a numeric target, evaluate the nutrient loading capacity of the lake, and subsequently propose total maximum daily loads and allocations.

8.2 Total Nitrogen and Total Phosphorus Numeric Targets

U.S. EPA guidance[20] for establishing lake nitrogen and phosphorus numeric targets is nearly identical to their method for establishing stream numeric targets, whereby 25th percentile values for an eco-regional lake population is used (see Appendix C, pg. 2). Based on this approach the aggregate nutrient ecoregion III reference conditions (using the 25th percentile) are 0.017 mg/L total phosphorus and 0.4 mg/L total nitrogen. The reference conditions for subecoregion 6 (southern and central California chaparral and oak woodlands) are 0.172 mg/l for total phosphorus and 0.51 for total nitrogen; however U.S. EPA noted that the total phosphorus parameter was inordinately high, necessitating further investigation.

The EPA Nutrient Criteria Technical Guidance Manual Lakes and Reservoirs (2000) [21] recommends setting a numeric target for total phosphorus that is not greater than 0.1 mg/L. This guidance may be used to set numeric phosphorus and nitrogen numeric targets for Oso Flaco Lake. To maintain a balance of nutrients for biomass growth and prevent limitation by one nutrient or another, a ratio of total nitrogen to total phosphorus of 10 may be used to derive the total nitrogen numeric target of 1.0 mg/L as a monthly average concentration (Thomann, Mueller, 1987) [22]. A ratio of 10 typically limits the growth of nuisance species, such as cyanobacteria (blue green algae) (Welch and Jacoby, 2004)[23].

Staff concluded that it would not be appropriate to select nutrient numeric targets for Oso Flaco Lake that are based solely on established literature values. Also, because water quality data for lakes within the Central Coast region is not available, a reference state approach would not be appropriate. Instead, staff is proposing to develop nutrient numeric targets that are based on proven strong relationships between total phosphorus, total nitrogen, and chlorophyll *a* using the California Nutrients Numeric Endpoints (CA NNE) BATHTUB spreadsheet tool. The CA NNE BATHTUB tool, developed by Tetra Tech with support from U.S. EPA Region IX and the State Water Resources Control Board, is a user-friendly representation of the Army Corps of Engineers BATHTUB model (Walker, 1987[24]., 1996[25]).

9 Development of Oso Flaco Lake Nutrient Numeric Targets and TMDL

Staff proposes using the CA NNE BATHTUB Tool mentioned above to establish total nitrogen and total phosphorus targets for Oso Flaco Lake by calculating combinations of N and P loading that results in

[20] U.S. EPA. 2001. Ambient Water Quality Criteria Recommendations, Lakes and Reservoirs in Nutrient Ecoregion III. EPA 822-B-01-008

[21] U.S. EPA. 2000. Nutrient Criteria Technical Guidance Manual Lakes and Reservoirs. EPA 822-B00-001.

[22] Thomann, Robert V., and John A. Mueller, 1987. Principles of Surface Water Quality Modeling and Control, Harper and Row, New York, 1987.

[23] Welch, E.B. and J.M. Jacoby. 2004. Pollutant Effects in Freshwater Applied Limnology, Third Edition. Spon Press, London.

[24] Walker, W.W., Jr. 1987. Empirical Methods for Predicting Eutrophication in Impoundments. Report 4–Phase III: Applications Manual. Technical Report E-81-9. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.

[25] Walker, W.W., R. 1996. Simplified Procedures for Eutrophication Assessment and Prediction: User's Manual. U.S. Army Corps of Engineers. Water Operations Technical Support Program. Instruction Report W-96-2.

attainment of the chlorophyll *a* target. Staff anticipates that the chlorophyll *a,* total nitrogen, and total phosphorus targets will be established for both average summer (May – September growing season) and annual mean values.

The NNE BATHTUB spreadsheet tool requires the user to input physical, chemical, and biological parameters. The input parameters are listed below (note that an asterisk denotes the parameters that have been acquired by staff); however, additional monitoring is necessary to obtain the data necessary for the NNE BATHTUB model):

- Lake volume *
- Lake surface area *
- Average depth *
- Mixed depth *
- Net evaporation – precipitation rate *
- Secchi depth at typical chlorophyll *a*
- Typical chlorophyll *a*
- Total phosphorus load
- Ortho – phosphorus load *
- Total nitrogen load
- Inorganic nitrogen load *
- Inflow volume *

The model performs water and nutrient balance calculations under steady-state conditions. Eutrophication related water quality conditions are expressed in terms of total phosphorus, ortho-phosphorus, total nitrogen, inorganic nitrogen, chlorophyll *a*, transparency (Secchi depth), and hypolimnetic oxygen deletion rates. These conditions are predicted using semi-empirical relationships developed and tested on a wide range of reservoirs.

It is important to note that the CA NNE BATHTUB model will also provide the linkage analysis component of the TMDL, whereby the relationship between nutrient loading to Oso Flaco Lake and the numeric targets established to measure attainment of beneficial uses can be demonstrated. The CA NNE BATHTUB model simulates lake response to various nutrient loading scenarios and characterizes eutrophication relationships between phosphorus, nitrogen, and algal biomass. Staff anticipates that assigning wasteload and load allocations for total nitrogen and phosphorus will address the impairments due to excessive nitrate concentrations, low dissolved oxygen concentration, and biostimulatory substances.

Staff will conduct additional lake monitoring in conjunction with existing CCAMP monitoring to obtain the data necessary to develop the CA NNE BATHTUB model. Monitoring will include measurements of transparency (Secchi depth), chlorophyll *a*, total nitrogen, total phosphorus, and dissolved oxygen.

10 Evaluation of Existing Nutrient Loads and Reductions for Future TMDL Development

As mentioned in Section 6, the California Department of Parks and Recreation has funded a study that has produced hourly flow data and occasional nitrate and orthophosphate grab sample results. Staff used this data and the FLUX computer program to estimate annual flow volume, as well as nitrate and orthophosphate loads to Oso Flaco Lake from October 2010 to October 2011. For this one-year period the total inflow into Oso Flaco Lake was calculated as 9.09 hm^3 (cubic hectometers) or 7,369 acre feet. Nitrate (n=51) and orthophosphate (n=5) loads during this period were estimated as 224,624 kg/yr and

1,027 kg/yr, respectively (see figures below for tabular, graphical, and statistical representation of the FLUX analysis).

To estimate annual total nitrogen (TN) and total phosphorus (TP) loads over the same flow period staff used CCAMP mean values obtained from Oso Flaco Lake tributary monitoring stations (sites 312BSR, 312OFC, and 312OFN). In addition, staff applied the U.S. EPA recommended targets of 1.0 mg/L TN and 0.1 mg/L TP to exemplify potential nutrient loading reductions. Existing loads, potential TMDL, and percent load reductions are shown in Table 7.

Load equation:

Load (kg) = 9,090,000 (m3) * 1 (l)/0.001 (m3) * concentration (mg/l) * 1 (kg)/1,000,000 (mg)

Table 7. Example of existing load, potential TMDL, and load reduction

Existing TN Load (kg/yr)	Potential TN TMDL (kg/yr)	Load Reduction (%)
418,140	9,090	98
Existing TP Load (kg/yr)	Potential TP TMDL (kg/yr)	Load Reduction (%)
3,636	909	75

Oso Flaco Lake Tributaries: Mean TN = 46 mg/L (n=43)
Oso Flaco Lake Tributaries: Mean TP = 0.4 mg/L (n=19)
Oso Flaco Lake Total Inflow (Oct. 2010 – Oct 2011) = 9.09 hm^3

During the time that additional lake monitoring data is obtained and the CA NNE BATHTUB model is developed, staff proposes to utilize the proposed stream numeric targets presented in Appendix C Stream Nutrient Numeric Target Development. The proposed Oso Flaco Lake tributary stream numeric targets are 5.7 mg/L for nitrate as nitrogen (NO3-N) and 0.08 mg/L orthophosphate as phosphate (OP-P). With these targets, staff calculated the reductions necessary to achieve them using results of the FLUX program and Oso Flaco Lake total inflow. This data is presented in Table 8 below.

Table 8. Load reductions necessary to achieve Oso Flaco Lake tributary TMDLs

Existing NO3-N Load (kg/yr)[1]	NO3-N TMDL (kg/yr)	Load Reduction (%)
224,624	51,813	77
Existing OP-P Load (kg/yr) [1]	OP-P TMDL (kg/yr)	Load Reduction (%)
1,027	727	30

[1] Loads calculated using FLUX program
Oso Flaco Lake Tributaries: NO3-N TMDL Target = 5.7 mg/L
Oso Flaco Lake Tributaries: OP-P TMDL Target = 0.08 mg/L
Oso Flaco Lake Total Inflow (Oct. 2010 – Oct 2011) = 9.09 hm^3

The information contained below was derived from the BATHTUB model.

FLOW AND LOAD SUMMARIES FOR NO3_N

Method: Average Load (1)

DISTRIBUTION OF SAMPLES VS. DAILY FLOWS

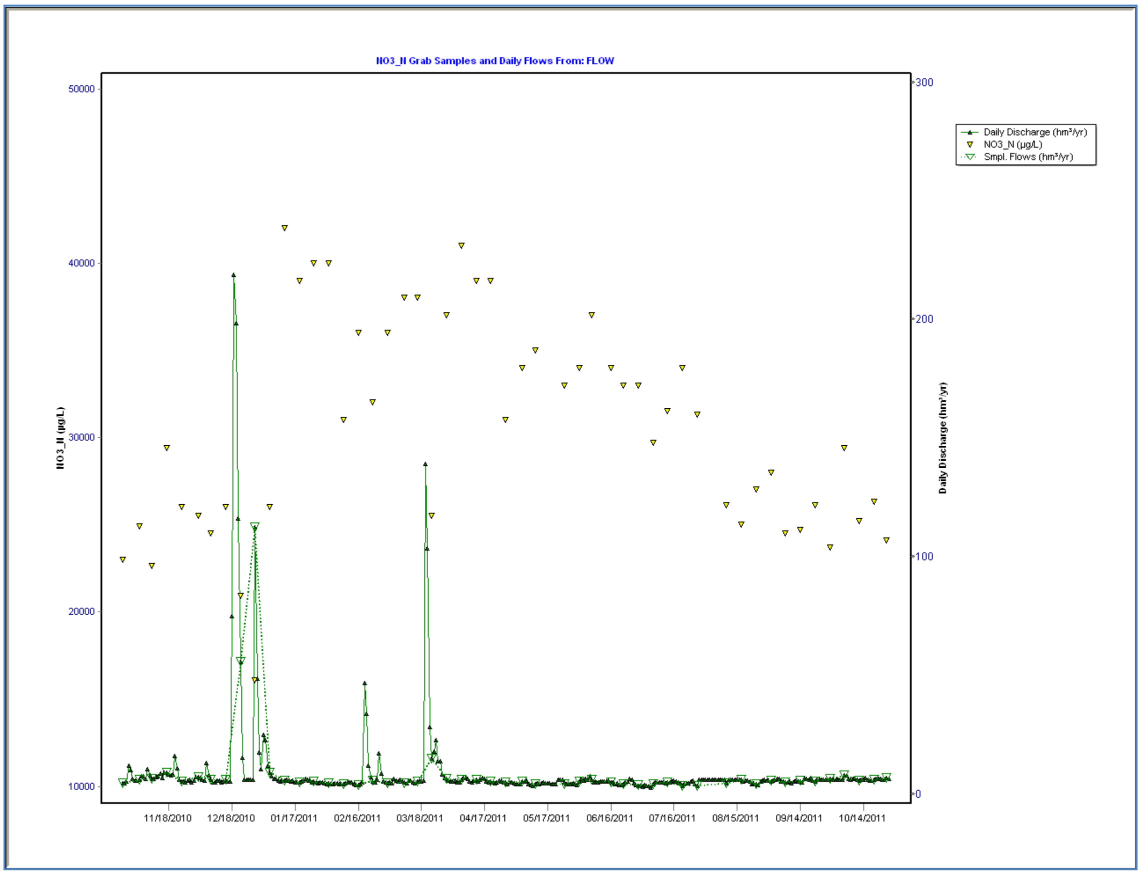
Stratum	Flows	Smpls	Evnts	Vol %	Daily Flow (hm^3/yr)	Smpl Flow (hm^3/yr)	NO3_N (µg/L)	FLUX (kg/y)	SLOPE LgC/LgQ	R^2	p > C/Q
Overall	365	51	51	100.0	9.09014	8.739803	30569	224624	-0.1989	0.32	0.0001

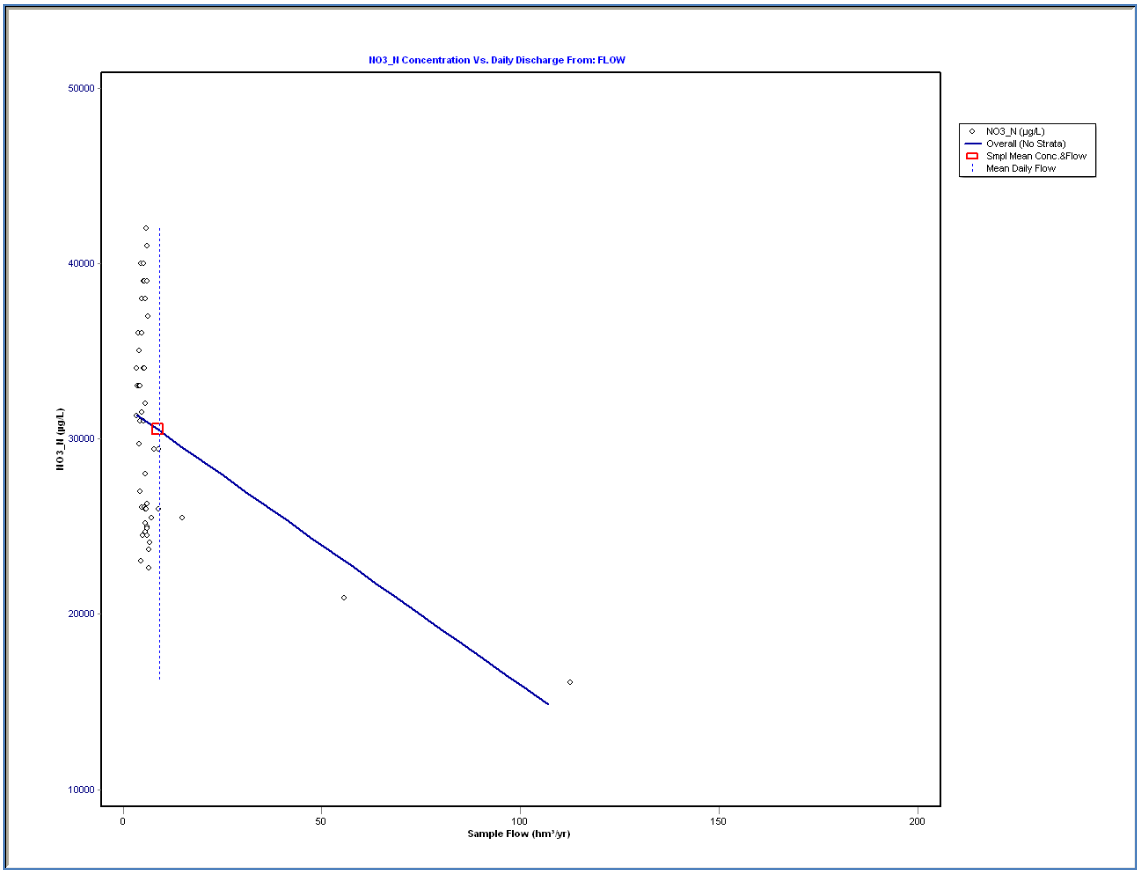
DAILY FLOW STATISTICS

Daily Flow Duration	365 Days = 0.999 Years
Daily Mean Flow Rate	9.09 (hm^3/yr)
Daily Total Flow Volume	9.08 (Mega m^3)
Daily Flow Date Range	10/27/2010 to 10/26/2011
Samples Date Range	10/27/2010 to 10/25/2011

LOAD ESTIMATES FOR NO3_N

	Method	Mass(kg)	Flux(kg/y)	Flux Variance	Flw Wgted Conc.(µg/L)	C.V.
1	Average Load	224469.99	224623.7	1.43483E09	2.47E4	0.1686
2	Flw Wghted Conc.	233467.92	233627.8	9.25311E08	2.57E4	0.1302
3	Flw Wghted IJC.	227824.27	227980.3	1.14341E09	2.51E4	0.1483
4	C/Q Reg1	231649.64	231808.3	2.91982E08	2.55E4	0.07371
5	C/Q Reg2(VarAdj)	199988.39	200125.4	6.91468E08	2.2E4	0.1314
6	C/Q Reg3(daily)	233592.61	233752.6	4.00739E07	2.57E4	0.02708
8	Time Series	214411.82	214558.7	N/A	2.36E4	N/A






```
Linear Regression: NO3_N (µg/L) on Sample Flow (hm³/yr)
Flux Estimation Method: 1 (Average Load)
------------------------------------
Overall (No Strata)
  INTERCEPT          = 3.196E4
  SLOPE              = -159.441
  R²                 = 0.184
  MEAN SQUARED ERROR = 3.1275E7
  STD. ERR. OF SLOPE = 47.94
  DEGREES OF FREEDOM = 49
  T STATISTIC        = -3.326
  PROBABILITY(>|T|)  = 0.00203
  Y MEAN             = 30569
  Y STD DEVIATION    = 6129
  X MEAN             = 8.7398000
  X STD DEVIATION    = 16.50
------------------------------------
 RESIDUALS ANALYSIS:
  RUNS TEST Z        = -3.950
  PROBABILITY (>|Z|) = 0.00004
  LAG-1 AUTOCORREL.  = 0.6289
  PROBABILITY (>|r|) = 0.00000
  EFFECT. SMPL SIZE  = 12.00
  SLOPE SIGNIFICANCE = 0.13517
------------------------------------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               R E G R E S S I O N   O F   L O A D   O N   F L O W
                            Log(Load) vs. Log(Flow)
                  (used by flux for load estimate in method 6)

-------------------------------
OVERALL FIT
Intercept      = 4.351E4
Log Intercept  = 4.639
Slope          = 0.8011
R²             = 0.882
```

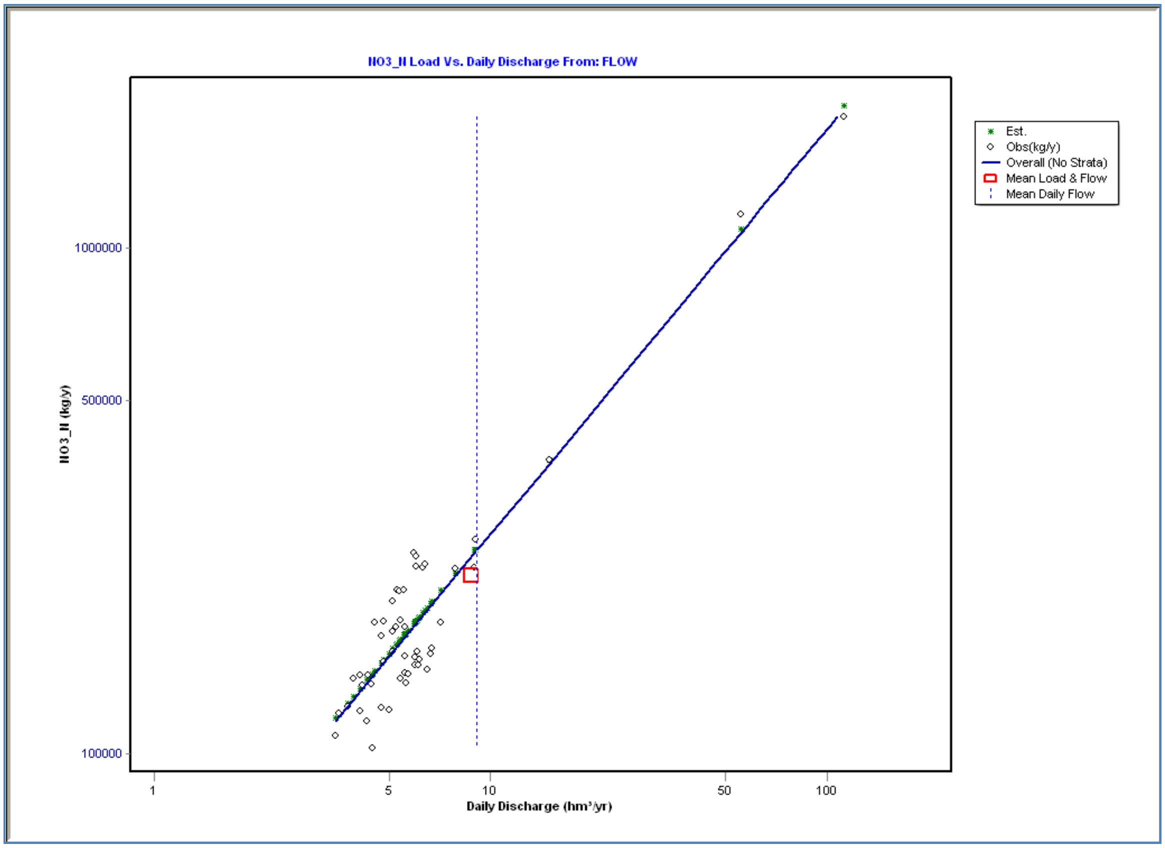


```
Log-Log Regression: Log(NO3_N (kg/y)) on Log(Daily Discharge (hm³/yr))
Flux Estimation Method: 6 (C/Q Reg3(daily))
------------------------------------
Overall (No Strata)
  INTERCEPT          = 4.632
  SLOPE              = 0.80107
  R²                 = 0.882
  MEAN SQUARED ERROR = 0.00566
  STD. ERR. OF SLOPE = 0.0418
  DEGREES OF FREEDOM = 49
  T STATISTIC        = 19.160
  PROBABILITY(>|T|)  = 0.00000
  Y MEAN             = 5.259
  Y STD DEVIATION    = 0.217
  X MEAN             = 0.7827600
  X STD DEVIATION    = 0.254
------------------------------------
 RESIDUALS ANALYSIS:
  RUNS TEST Z        = 0.0700
  PROBABILITY (>|Z|) = 0.47205
  LAG-1 AUTOCORREL.  = -0.0428
  PROBABILITY (>|r|) = 0.37985
  EFFECT. SMPL SIZE  = 51.00
  SLOPE SIGNIFICANCE = 0.00000
------------------------------------


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               R E G R E S S I O N   O F   L O A D   O N   F L O W
                            Log(Load) vs. Log(Flow)
                  (used by flux for load estimate in method 6)

-------------------------------
OVERALL FIT
Intercept      = 4.351E4
Log Intercept  = 4.639
Slope          = 0.8011
R²             = 0.882
```

FLOW AND LOAD SUMMARIES FOR OP_P

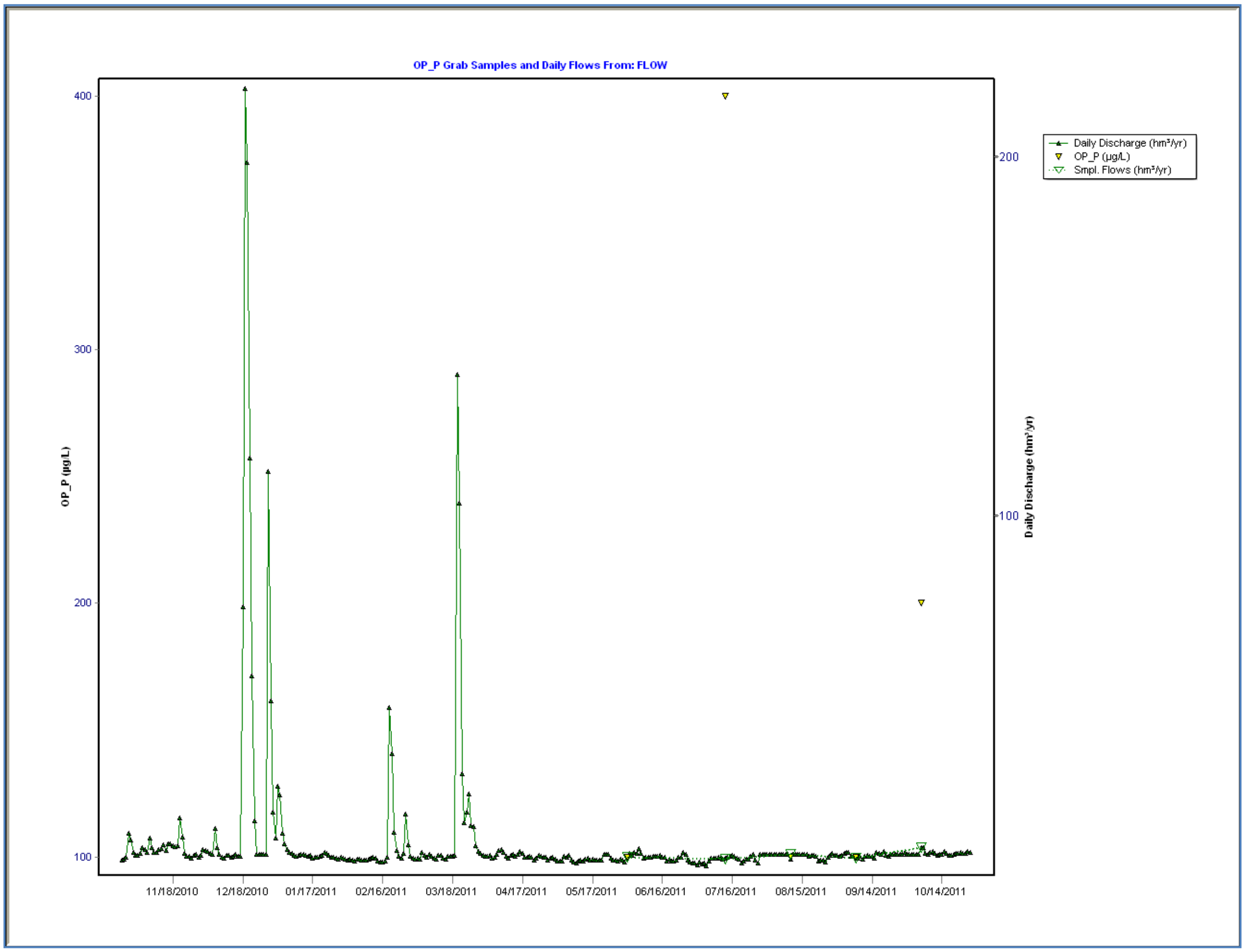
Method: Average Load (1)
DISTRIBUTION OF SAMPLES VS. DAILY FLOWS

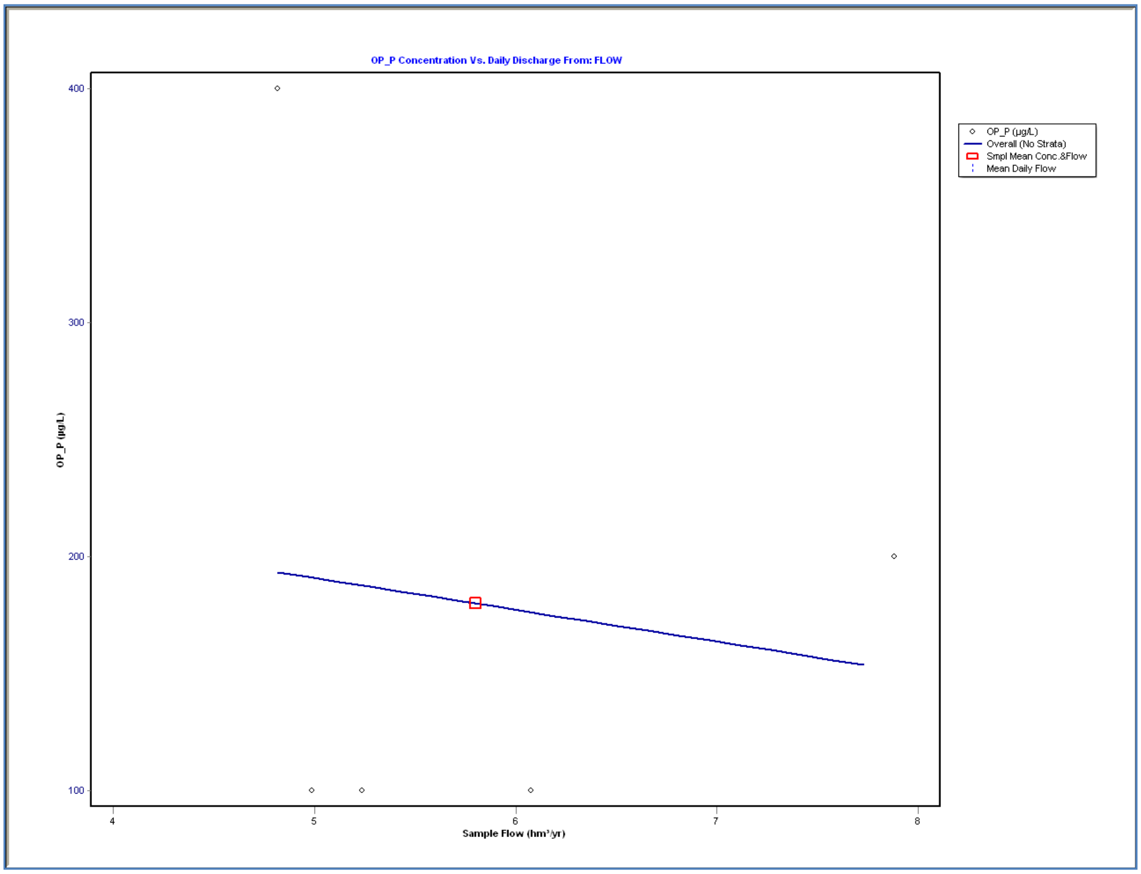
Stratum	Flows	Smpls	Evnts	Vol %	Daily Flow (hm³/yr)	Smpl Flow (hm³/yr)	OP_P (µg/L)	FLUX (kg/y)	SLOPE LgC/LgQ	R^2	p > C/Q
Overall	365	5	5	100.0	9.09014	5.800308	180	1026.7	-0.05707	0.00	0.9752

DAILY FLOW STATISTICS
Daily Flow Duration 365 Days = 0.999 Years
Daily Mean Flow Rate 9.09 (hm³/yr)
Daily Total Flow Volume 9.08 (Mega m³)
Daily Flow Date Range 10/27/2010 to 10/26/2011
Samples Date Range 06/01/2011 to 10/05/2011

LOAD ESTIMATES FOR OP_P

	Method	Mass (kg)	Flux (kg/y)	Flux Variance	Flw Wgted Conc. (µg/L)	C.V.
1	Average Load	1026.0143	1026.717	90997.4	113	0.2938
2	Flw Wghted Conc.	1607.9515	1609.053	198780	177	0.2771
3	Flw Wghted IJC.	1604.3553	1605.454	176852	177	0.2619
4	C/Q Reg1	1580.0462	1581.128	1.28424E06	174	0.7167
5	C/Q Reg2 (VarAdj)	1310.8166	1311.714	2.83166E08	144	12.83
6	C/Q Reg3 (daily)	1764.1473	1765.356	953833	194	0.5532
8	Time Series	1013.0421	1013.736	N/A	112	N/A






```
Linear Regression: OP_P (µg/L) on Sample Flow (hm³/yr)
Flux Estimation Method: 1 (Average Load)
------------------------------------
Overall (No Strata)
  INTERCEPT           = 259.1
  SLOPE               = -13.6349
  R²                  = 0.017
  MEAN SQUARED ERROR  = 22273
  STD. ERR. OF SLOPE  = 59.19
  DEGREES OF FREEDOM  = 3
  T STATISTIC         = -0.230
  PROBABILITY(>|T|)   = 0.82517
  Y MEAN              = 180.0
  Y STD DEVIATION     = 130.4
  X MEAN              = 5.8003000
  X STD DEVIATION     = 1.261
------------------------------------
 RESIDUALS ANALYSIS:
  RUNS TEST Z         = 0.109
  PROBABILITY (>|Z|)  = 0.45652
  LAG-1 AUTOCORREL.   = -0.4688
  PROBABILITY (>|r|)  = 0.14723
  EFFECT. SMPL SIZE   = 5.000
  SLOPE SIGNIFICANCE  = 0.82517
------------------------------------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               R E G R E S S I O N   O F   L O A D   O N   F L O W
                            Log(Load) vs. Log(Flow)
                  (used by flux for load estimate in method 6)

-------------------------------
OVERALL FIT
Intercept       = 216.3
Log Intercept   = 2.335
Slope           = 0.9429
R²              = 0.086
```

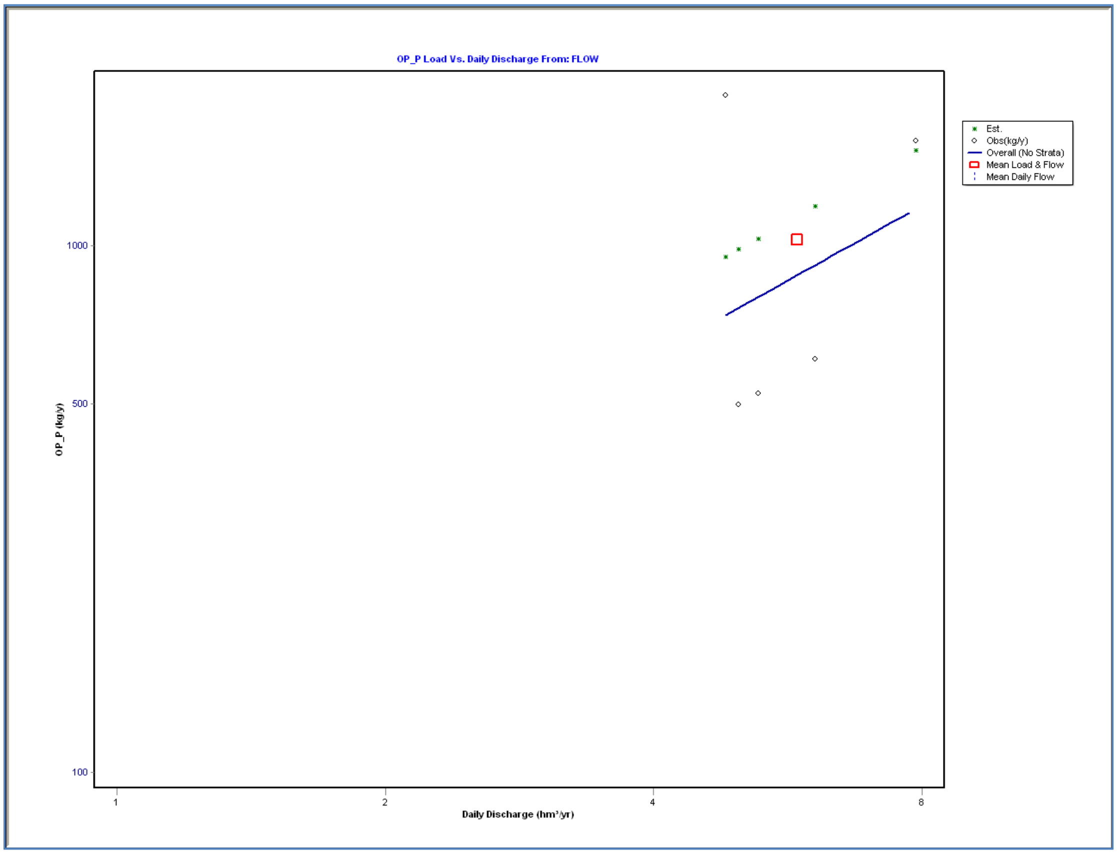


```
Log-Log Regression: Log(OP_P (kg/y)) on Log(Daily Discharge (hm³/yr))
Flux Estimation Method: 6 (C/Q Reg3(daily))
------------------------------------
Overall (No Strata)
  INTERCEPT          = 2.224
  SLOPE              = 0.94293
  R²                 = 0.086
  MEAN SQUARED ERROR = 0.0966
  STD. ERR. OF SLOPE = 1.775
  DEGREES OF FREEDOM = 3
  T STATISTIC        = 0.531
  PROBABILITY(>|T|)  = 0.63266
  Y MEAN             = 2.937
  Y STD DEVIATION    = 0.282
  X MEAN             = 0.7560300
  X STD DEVIATION    = 0.0876
------------------------------------
 RESIDUALS ANALYSIS:
  RUNS TEST Z        = 0.109
  PROBABILITY (>|Z|) = 0.45652
  LAG-1 AUTOCORREL.  = -0.4886
  PROBABILITY (>|r|) = 0.13727
  EFFECT. SMPL SIZE  = 5.000
  SLOPE SIGNIFICANCE = 0.63266
------------------------------------


-----------------------------------------------------------------------------------

               R E G R E S S I O N   O F   L O A D   O N   F L O W
                          Log(Load) vs. Log(Flow)
                 (used by flux for load estimate in method 6)

-------------------------------
OVERALL FIT
Intercept     = 216.3
Log Intercept = 2.335
Slope         = 0.9429
R²            = 0.086
```

Appendix E STEPL Spreadsheet Results

STEPL Spreadsheets for Lower Santa Maria River and Oso Flaco Lake Subwatersheds

STEPL Input Sheet: Values in RED are required input. Change worksheets by clicking on tabs at the bottom. You entered 15 subwatershed(s).

This sheet is composed of eight input tables. The first four tables require users to change initial values. The next four tables (initially hidden) contain default values users may choose to change.

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
Betteravia Area	5196.5	2732.7	1568.9	703.4	0	0	0-24%	10201.5872	18.68	42.3	0.914
Blosser Street	1900.4	0.0	0.0	66.3	0	0	0-24%	1966.65978	18.68	42.3	0.914
Bradley Channel	913.4	5723.2	390.4	379.3	0	0	0-24%	7406.27867	18.68	42.3	0.914
Bradley Cyn	0.0	3712.3	2651.7	1318.5	0	0	0-24%	7682.49493	18.68	42.3	0.914
Corralitos Cyn	0.0	184.1	2751.1	0.0	0	0	0-24%	2935.25813	18.68	42.3	0.914
Greene Cyn	2622.2	11100.2	1020.2	552.4	0	0	0-24%	15295.0151	18.68	42.3	0.914
Guadalupe Area	165.7	1694.1	0.0	0.0	0	0	0-24%	1859.85615	18.68	42.3	0.914
Guadalupe Dunes	0.0	29.5	1252.2	9895.9	0	0	0-24%	11177.5513	18.68	42.3	0.914
Ineffective WA	3.7	898.6	2869.0	408.8	0	0	0-24%	4180.07274	18.68	42.3	0.914
Main Street	1057.0	2515.4	0.0	33.1	0	0	0-24%	3605.54292	18.68	42.3	0.914
Nipomo Cr	578.2	7619.9	4673.6	515.6	0	0	0-24%	13387.2814	18.68	42.3	0.914
Oso Flaco	324.1	8135.5	11.0	1134.3	0	0	0-24%	9604.9601	18.68	42.3	0.914
Orcutt Cr	2051.4	4566.8	15416.6	1642.6	0	0	0-24%	23677.2579	18.68	42.3	0.914
Santa Maria R	1451.1	14945.1	13019.0	3550.3	0	0	0-24%	32965.49	18.68	42.3	0.914
Santa Maria R Cha	58.9	626.1	666.6	4275.8	0	0	0-24%	5627.44595	18.68	42.3	0.914

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, %
Betteravia Area	0	2.43	2	0	0
Blosser Street	0	2.43	2	0	0
Bradley Channel	0	2.43	2	0	0
Bradley Cyn	0	2.43	2	0	0
Corralitos Cyn	0	2.43	2	0	0
Greene Cyn	0	2.43	2	0	0
Guadalupe Area	0	2.43	2	0	0
Guadalupe Dunes	0	2.43	2	0	0
Ineffective WA	0	2.43	2	0	0
Main Street	0	2.43	2	0	0
Nipomo Cr	28	2.43	2	0	0
Oso Flaco	0	2.43	2	0	0
Orcutt Cr	0	2.43	2	0	0
Santa Maria R	0	2.43	2	0	0
Santa Maria R Cha	0	2.43	2	0	0

Input | General Input Data | Total Load | Land&Rain | Animal | BMPs | Urban | Feedlots | Septic | Sediment | Gully&Streambank | Graphs | SMOF_Animals | Reference

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
Betteravia Area	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
Blosser Street	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
Bradley Channel	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
Bradley Cyn	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
Corralitos Cyn	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
Greene Cyn	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
Guadalupe Area	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
Guadalupe Dunes	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
Ineffective WA	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
Main Street	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
Nipomo Cr	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
Oso Flaco	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
Orcutt Cr	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
Santa Maria R	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
Santa Maria R Cha	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.%
Betteravia Area					B	0.080	0.031	0.160
Blosser Street					B	0.080	0.031	0.160
Bradley Channel					B	0.080	0.031	0.160
Bradley Cyn					B	0.080	0.031	0.160
Corralitos Cyn					B	0.080	0.031	0.160
Greene Cyn					B	0.080	0.031	0.160
Guadalupe Area					B	0.080	0.031	0.160
Guadalupe Dunes					B	0.080	0.031	0.160
Ineffective WA					B	0.080	0.031	0.160
Main Street					B	0.080	0.031	0.160
Nipomo Cr					B	0.080	0.031	0.160
Oso Flaco					B	0.080	0.031	0.160
Orcutt Cr					B	0.080	0.031	0.160
Santa Maria R					B	0.080	0.031	0.160
Santa Maria R Cha					B	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
Transportatio	98	98	98	98
Multi-Family	77	85	90	92
Single-Family	57	72	81	86
Urban-Cultiva	67	78	85	89
Vacant-Deve	77	85	90	92
Open Space	49	69	79	84

7. Nutrient concentration in runoff (mg/l)

Land use	N	P	BOD
1. L-Cropland	**11.4**	**0.64**	**4**
1a. w/ manure	0	0	12.3
2. M-Cropland	**11.4**	**0.64**	**6.1**
2a. w/ manure	0	0	18.5
3. H-Cropland	**11.4**	**0.64**	**9.2**
3a. w/ manure	0	0	24.6
4. Pastureland	**0.25**	**0.27**	**13**
5. Forest	**0.2**	**0.1**	**0.5**
6. User Defined	**0**	**0**	**0**

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

Landuse	N	P	BOD
Urban	12.7	0.127	0
Cropland	12.7	0.127	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 (develope	Open Space %	Total % Area
Betteravia Area	5197	15	10	10	10	10	30	5	5	5	100
Blosser Street	1900	15	10	10	10	10	30	5	5	5	100
Bradley Channel	913	15	10	10	10	10	30	5	5	5	100
Bradley Cyn	0	15	10	10	10	10	30	5	5	5	100
Corralitos Cyn	0	15	10	10	10	10	30	5	5	5	100
Greene Cyn	2622	15	10	10	10	10	30	5	5	5	100
Guadalupe Area	166	15	10	10	10	10	30	5	5	5	100
Guadalupe Dunes	0	15	10	10	10	10	30	5	5	5	100
Ineffective WA	4	15	10	10	10	10	30	5	5	5	100
Main Street	1057	15	10	10	10	10	30	5	5	5	100
Nipomo Cr	578	15	10	10	10	10	30	5	5	5	100
Oso Flaco	324	15	10	10	10	10	30	5	5	5	100
Orcutt Cr	2051	15	10	10	10	10	30	5	5	5	100
Santa Maria R	1451	15	10	10	10	10	30	5	5	5	100
Santa Maria R Cha	59	15	10	10	10	10	30	5	5	5	100

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	%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	%	%	%	%
Betteravia Area	140268.5	14252.9	139795.4	7365.0	0.0	0.0	0.0	0.0	140268.5	14252.9	139795.4	7365.0	0.0	0.0	0.0	0.0
Blosser Street	16157.7	1098.9	25049.9	150.5	0.0	0.0	0.0	0.0	16157.7	1098.9	25049.9	150.5	0.0	0.0	0.0	0.0
Bradley Channel	199410.6	21599.4	124628.4	13289.4	0.0	0.0	0.0	0.0	199410.6	21599.4	124628.4	13289.4	0.0	0.0	0.0	0.0
Bradley Cyn	132414.6	15777.0	103687.4	9704.5	0.0	0.0	0.0	0.0	132414.6	15777.0	103687.4	9704.5	0.0	0.0	0.0	0.0
Corralitos Cyn	14995.2	2953.3	38013.8	1673.9	0.0	0.0	0.0	0.0	14995.2	2953.3	38013.8	1673.9	0.0	0.0	0.0	0.0
Greene Cyn	394768.9	42580.4	256132.1	25955.0	0.0	0.0	0.0	0.0	394768.9	42580.4	256132.1	25955.0	0.0	0.0	0.0	0.0
Guadalupe Area	57728.6	6225.6	34007.8	3869.1	0.0	0.0	0.0	0.0	57728.6	6225.6	34007.8	3869.1	0.0	0.0	0.0	0.0
Guadalupe Dunes	8355.4	2191.9	21257.1	976.7	0.0	0.0	0.0	0.0	8355.4	2191.9	21257.1	976.7	0.0	0.0	0.0	0.0
Ineffective WA	39297.4	5681.9	53163.7	3368.2	0.0	0.0	0.0	0.0	39297.4	5681.9	53163.7	3368.2	0.0	0.0	0.0	0.0
Main Street	92610.8	9713.1	61185.7	5809.1	0.0	0.0	0.0	0.0	92610.8	9713.1	61185.7	5809.1	0.0	0.0	0.0	0.0
Nipomo Cr	273498.7	31851.9	209782.7	19538.7	0.0	0.0	0.0	0.0	273498.7	31851.9	209782.7	19538.7	0.0	0.0	0.0	0.0
Oso Flaco	273635.4	29754.3	157791.2	18587.1	0.0	0.0	0.0	0.0	273635.4	29754.3	157791.2	18587.1	0.0	0.0	0.0	0.0
Orcutt Cr	219518.0	30692.9	307231.0	17642.2	0.0	0.0	0.0	0.0	219518.0	30692.9	307231.0	17642.2	0.0	0.0	0.0	0.0
Santa Maria R	552361.5	66111.5	465111.3	40190.5	0.0	0.0	0.0	0.0	552361.5	66111.5	465111.3	40190.5	0.0	0.0	0.0	0.0
Santa Maria R Chann	24906.7	3304.8	22990.4	1880.0	0.0	0.0	0.0	0.0	24906.7	3304.8	22990.4	1880.0	0.0	0.0	0.0	0.0
Total	2439928.0	283789.9	2019827.8	170000.0	0.0	0.0	0.0	0.0	2439928.0	283789.9	2019827.8	170000.0	0.0	0.0	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	55499.23	8547.87	214880.47	1272.93
Cropland	1244934.52	224352.84	1211555.66	146777.83
Pastureland	76140.89	35279.16	581412.70	21111.96
Forest	5299.00	2341.40	11907.92	837.24
Feedlots	0.00	0.00	0.00	0.00
User Defined	0.00	0.00	0.00	0.00
Septic	17.41	6.82	71.09	0.00
Gully	0.00	0.00	0.00	0.00
Streambank	0.00	0.00	0.00	0.00
Groundwater	1058036.92	13261.76	0.00	0.00
Total	2439927.97	283789.86	2019827.83	169999.96

Input / General Input Data / **Total Load** / Land&Rain / Animal / BMPs / Urban / Feedlots / Septic / Sediment / Gully&Streambank / Graphs / SMOF_Anima

Appendix F − Alternative Pollutant Load Expressions to Facilitate Implementation of Concentration-based Allocations

The purpose of this Appendix is to provide alternative, non-daily pollutant load expressions to facilitate implementation of the daily allocations. Daily allocations, as expressed in this TMDL, are on the basis of daily time-step concentrations (e.g., instantaneous water quality concentrations represented in grab and field samples). Relevant guidance published by the U.S. Environmental Protection Agency pertaining to alternative load expressions is presented below:

Facilitating Implementation of Wasteload Allocations and Load Allocations

*"**TMDL submissions may include alternative, non-daily pollutant load expressions in order to facilitate implementation of the applicable water quality standards*.** To facilitate implementation of such a load in water bodies where the applicable water quality standard is expressed in non-daily terms, it may be appropriate for the TMDL documentation to include, in addition to wasteload allocations expressed in daily time increments, wasteload allocations expressed as weekly, monthly, seasonal, annual, or other appropriate time increments. The TMDL and its supporting documentation should clearly explain that the non-daily loads and allocations are implementation-related assumptions of the daily wasteload allocations and are included to facilitate implementation of the daily allocations as appropriate in NPDES permits and nonpoint source directed management measures."*

From: U.S. Environmental Protection Agency, Memorandum, Nov. 15, 2006. Subject: Establishing TMDL "Daily" Loads in Light of the Decision by the U.S. Court of Appeals for the D.C. Circuit in Friends of the Earth, Inc. v. EPA, et al., No. 05-5015, (April 25, 2006) and Implications, for NPDES Permits

***** *emphasis added by Water Board staff*

In addition, non-daily and alternative load expressions of the concentration-based allocations may be needed to provide a meaningful connection with implementation efforts, such as nonpoint source best management practices, where averaging periods other than daily time steps or other than receiving water concentration allocations provide the basis for water quality-based control strategies. However, all final TMDL submissions must contain a daily time step load component which is satisfied by the concentration-based TMLDs and allocations.

To facilitate implementation of the TMDLs, Tables 1 through 4 below present alternative, non-daily load expressions that estimate annual and dry season (May – October) load reductions for nitrate and orthophosphate. These alternative load expressions shall be considered implementation-related assumptions of the daily time step, concentration-based allocations. Figure 1 depicts the monitoring stations and subwatersheds related to the alternative, non-daily load expressions and estimated load reductions.

Table 1. Alternative, non-daily load expressions and estimated load reductions to facilitate implementation of TMDLs and allocations (Mean Annual Nitrate).

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)
Santa Maria River	312SMA	61.98	28.3	3,453,121	976,147	72%	Wet Season Biostim (8.0)
	312SMI	29.90	30.8	1,813,117	588,674	68%	MUN (10)
Orcutt Creek	312ORC	7.20	35.5	503,228	113,403	77%	Wet Season Biostim (8.0)
	312GVT	4.08	36.4	292,726	64,335	78%	Wet Season Biostim (8.0)
	312ORB	2.35	13.5	62,574	37,081	41%	Wet Season Biostim (8.0)
Green Valley Creek	312GVS	0.89	54.7	95,848	14,018	85%	Wet Season Biostim (8.0)
Main Street Canal	312MSD	3.86	21.6	164,303	76,066	54%	MUN (10)
Blosser Channel	312BCD	1.44	5.4	15,308	28,348	0%	MUN (10)
Bradley Channel	312BCU	0.49	11.9	11,460	9,630	16%	MUN (10)
	312BCJ	4.20	19.6	162,181	82,746	49%	MUN (10)
Nipomo Creek	312NIP	0.36	1.2	850	7,082	0%	MUN (10)
Bradley Canyon Creek	312BCC	0.17	11.0	3,602	2,620	27%	Wet Season Biostim (8.0)
Little Oso Flaco Creek	312OFN	1.68	41.0	135,853	18,887	86%	Year-Round (5.7)
Oso Flaco Creek	312OFC	2.44	38.6	185,430	27,382	85%	Year-Round (5.7)

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

Table 2. Alternative, non-daily load expressions and estimated load reductions to facilitate implementation of TMDLs and allocations (Dry Season Nitrate).

Water body	Site ID	Estimated Mean Dry Flow (cfs)	Mean Dry Season Conc. (mg/L)	Est. Existing Mean Dry Load (lbs.)	Mean Dry Loading Capacity (lbs.)	% Reduction Goal [A]	NO3-N Numeric Target Used for Loading Capacity (mg/L)
Santa Maria River	312SMA	10.00	28.84	567,709	84,659	85%	Dry Season Biostim (4.3)
	312SMI	0.54	34.42	36,589	10,632	71%	MUN (10)
Orcutt Creek	312ORC	7.72	32.8	497,833	65,357	87%	Dry Season Biostim (4.3)
	312GVT	1.36	41.00	109,781	11,514	90%	Dry Season Biostim (4.3)
	312ORB	0.21	16.0	6,600	1,778	73%	Dry Season Biostim (4.3)
Green Valley Creek	312GVS	1.10	54.43	117,873	9,312	92%	Dry Season Biostim (4.3)
Main Street Canal	312MSD	0.69	18.82	25,560	13,585	47%	MUN (10)
Blosser Channel	312BCD	0.41	2.60	2,096	8,072	0%	MUN (10)
Bradley Channel	312BCU	0.20	15.93	6,273	3,938	37%	MUN (10)
	312BCJ	0.78	33.26	51,079	15,357	70%	MUN (10)
Nipomo Creek	312NIP	0.002	0.35	1	39	0%	MUN (10)
Bradley Canyon Creek	312BCC	0.19	6.66	2,491	1,609	0%	Dry Season Biostim (4.3)
Little Oso Flaco Creek	312OFN	0.87	36.39	62,378	9,772	84%	Year-Round (5.7)
Oso Flaco Creek	312OFC	2.63	33.32	172,622	29,530	83%	Year-Round (5.7)

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

Table 3. Alternative, non-daily load expressions and estimated load reductions to facilitate implementation of TMDLs and allocations (Mean Annual Orthophosphate).

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	Orthophosphate-P Numeric Target Used for Loading Capacity (mg/L)
Santa Maria River	312SMA	61.98	0.295	35,995	36,606	0%	Wet Season Biostim (0.3)
	312SMI	29.90	0.284	16,737	17,660	0%	Wet Season Biostim (0.3)
Orcutt Creek	312ORC	7.20	0.344	4,876	4,253	13%	Wet Season Biostim (0.3)
	312GVT	4.08	0.306	2,461	2,413	2%	Wet Season Biostim(0.3)
	312ORB	2.35	0.648	3,004	1,391	54%	Wet Season Biostim (0.3)
Green Valley Creek	312GVS	0.89	0.195	342	526	0%	Wet Season Biostim(0.3)
Bradley Canyon Creek	312BCC	0.17	1.474	483	98	80%	Wet Season Biostim (0.3)
Little Oso Flaco Creek	312OFN	1.68	0.139	461	265	42%	Year-Round (0.08)
Oso Flaco Creek	312OFC	2.44	0.257	1,235	384	69%	Year-Round (0.08)

Table 4. Alternative, non-daily load expressions and estimated load reductions to facilitate implementation of TMDLs and allocations (Dry Season Orthophosphate).

Water body	Site ID	Estimated Mean Dry Flow (cfs)	Mean Dry Season Conc. (mg/L)	Est. Existing Mean Dry Load (lbs.)	Mean Dry Loading Capacity (lbs.)	% Reduction Goal	Orthophosphate-P Numeric Target Used for Loading Capacity (mg/L)
Santa Maria River	312SMA	10.00	0.310	6,106	3,741	39%	Dry Season Biostim (0.19)
	312SMI*	0.54	0.358	380	202	47%	Dry Season Biostim (0.19)
Orcutt Creek	312ORC	7.72	0.357	5,428	2,888	47%	Dry Season Biostim (0.19)
	312GVT	1.36	0.218	584	509	13%	Dry Season Biostim (0.19)
	312ORB*	0.21	0.743	307	79	74%	Dry Season Biostim (0.19)
Green Valley Creek	312GVS	1.10	0.140	302	411	0%	Dry Season Biostim (0.19)
Bradley Canyon Creek	312BCC	0.19	1.558	583	71	0%	Dry Season Biostim (0.19)
Little Oso Flaco Creek	312OFN	0.87	0.116	199	137	31%	Year-Round (0.08)
Oso Flaco Creek	312OFC	2.63	0.227	1,174	414	65%	Year-Round (0.08)

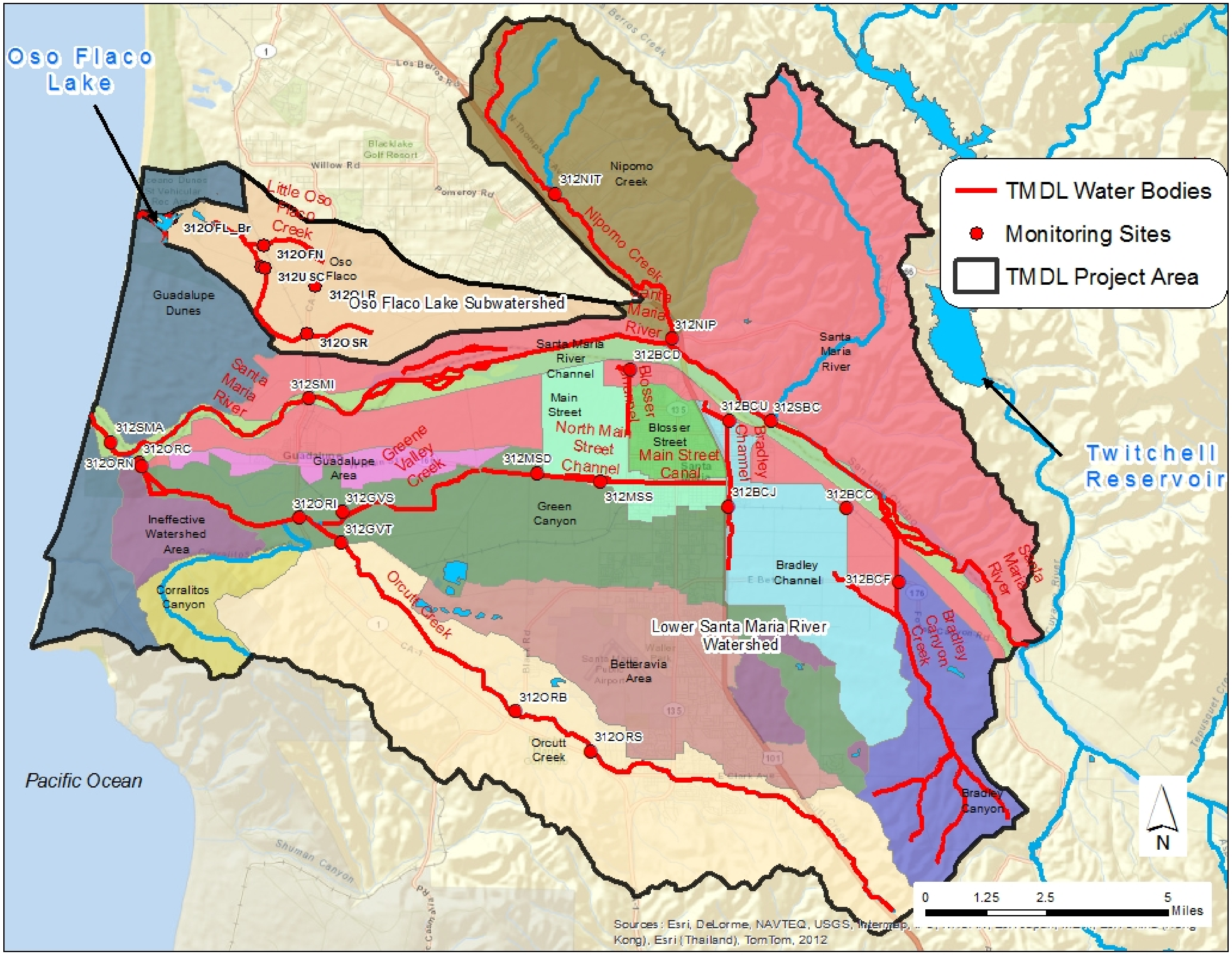

Figure 1. Project area monitoring stations and subwatersheds.