California Environmental Protection Agency

Central Coast Regional
Water Quality Control Board

Total Maximum Daily Loads for Toxicity and Pesticides in the Santa Maria River Watershed in Santa Barbara, San Luis Obispo and Ventura Counties, California

Final Project Report

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CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL COAST REGION
895 Aerovista Place, Suite 101, San Luis Obispo, California 93401
Phone • (805) 549-3147
http://www.waterboards.ca.gov/centralcoast/

To request copies of this report please contact
Peter Meertens at (805) 549-3869, or by email at:
pmeertens@waterboards.ca.gov.
Documents also are available at:
http://www.waterboards.ca.gov/centralcoast/TMDL/303dandTMDLprojects.htm

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Michael Thomas***, Assistant Executive Officer***

This report was prepared under the direction of

Chris Rose, *Senior Environmental Scientist*

by

Peter Meertens, *Environmental Scientist*

with the assistance of
Larry Harlan, *Environmental Scientist*
Mary Hamilton, *Environmental Scientist*
Shanta Keeling, *Water Resource Control Engineer*
Katie McNeil, Environmental Scientist
Pete Osmolovsky, *Engineering Geologist*

and support and input provided by

numerous stakeholders, including agencies, organizations, and individuals who have a special interest in the Cuyama, Santa Maria, Orcutt-Solomon, and Oso Flaco watersheds.

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LIST OF ACRONYMS AND ABBREVIATIONS

Ag Order	Agricultural Order No. RB3-2012-0011 (Conditional Waiver of WDR)
CDPR	California Department of Pesticide Regulation
CDFG	California Department of Fish and Game
GC/MS	Gas Chromatography/Mass Spectrometry
CCAMP	Central Coast Ambient Monitoring Program
CCC	Criterion Continuous Concentration
CCWQP	Central Coast Water Quality Preservation, Inc.

CMC	Criterion Maximum Concentration
CMP	Cooperative Monitoring Program for Irrigated Agriculture
CTR	California Toxics Rule
CVRWQCB	Central Valley Regional Water Quality Control Board
CWA	Clean Water Act
DDT	Dichlorodiphenyltrichloroethane
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethylene
DPR	Department of Pesticide Regulations
ELISA	Enzyme-linked immunosorbant assays
GC/MS	Gas Chromatography/Mass Spectrometry
GIS	Geographic Information System
IPM	Integrated Pest Management
LC50	Median lethal concentration
MCL	Maximum Contaminant Level
MS4s	Municipal Separate Storm Sewer Systems
MRP	Monitoring and Reporting Program
NAS	National Acadamy of Sciences
ng/kg	nanogram per kilogram (parts per billion)
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
OAL	Office of Administrative Law
o.c.	Organic Carbon
PEL	Probable Effects Level
POTW	Publicly Owned Treatment Works (Sewage Treatment Plant)
ppb	Parts per billion, ug/kg, ng/g, or ug/L
ppm	Parts per million, mg/kg, ug/g or mg/l
PUR	Pesticide Use Report
QAPP	Quality Assurance Project Plan

SBCFCD	Santa Barbara County Flood Control Districe
SQAGs	Sediment Quality Assessment Guidelines
SWAMP	Surface Water Ambient Monitoring Program
SWRCB	State Water Resource Control Board
TEL	Threshold Effects Level
TIEs	Toxicity Identification Evaluations
TMDL	Total Maximum Daily Load
TUs	Toxicity Units
ug/L	micrograms per liter (parts per billion)
UP3	Urban Pesticide Pollution Prevention
USEPA	United States Environmental Protection Agency
USGS	United States Geologic Survey
Water Board	Regional Water Quality Control Board, Central Coast Region
WDR	Waste Discharge Requirements

1. INTRODUCTION

1.1. Clean Water Act Section 303(d) List

Section 303(d) of the federal Clean Water Act (CWA) requires states to: 1) identify those waters not attaining water quality standards (these waters are referred to as listed and impaired waters); 2) set priorities for addressing the identified pollution problems; and 3) establish a "Total Maximum Daily Load" (TMDL) for each identified water body and pollutant to attain water quality standards. The State is required to incorporate TMDLs into the State Water Quality Management Plan (40 CFR 130.6(c)(1), 130.7). The Water Quality Control Plan-Central Coast Region (Basin Plan), and other applicable plans, serve as the State Water Quality Management Plan that governs impaired waters in the Central Coast Region.

USEPA reviews TMDLs to determine whether TMDL requirements are met. When approved by USEPA, the TMDL is then then applicable (CWA, Section 303(d))

A TMDL represents the maximum load expressed in mass per time, toxicity, or other appropriate measure, of a pollutant that a waterbody can receive and still achieve water quality standards (40 CRF130.2(c)i).

Several waterbodies in the Santa Maria watershed are listed as impaired due to pesticides. This project addresses these listings, as well as other impaired waters in the Santa Maria watershed that have not yet been added to the Clean Water Act section 303(d) list.

1.2. Porter-Cologne Water Quality Control Act

The Porter-Cologne Water Quality Control Act establishes responsibilities and authorities of each of the Regional Water Quality Control Boards, including responsibility and authority for regional water quality control and planning. The Central Coast Water Board establishes water quality objectives and programs by amending the Basin Plan. The Central Coast Water Board also regulates discharges, in order to achieve water quality objectives, through Waste Discharge Requirements (WDRs), waivers of WDRs, and prohibitions of discharge.

1.3. Project Area

The geographic scope of the Santa Maria Watershed TMDL encompasses the 1,856 square mile Santa Maria Hydrologic Unit (HU) located along the border of northern Santa Barbara and southern San Luis Obispo Counties and within the boarder of northwestern Ventura County. The Santa Maria HU is located in the jurisdiction of the Central Coast Regional Water Quality Control Board.

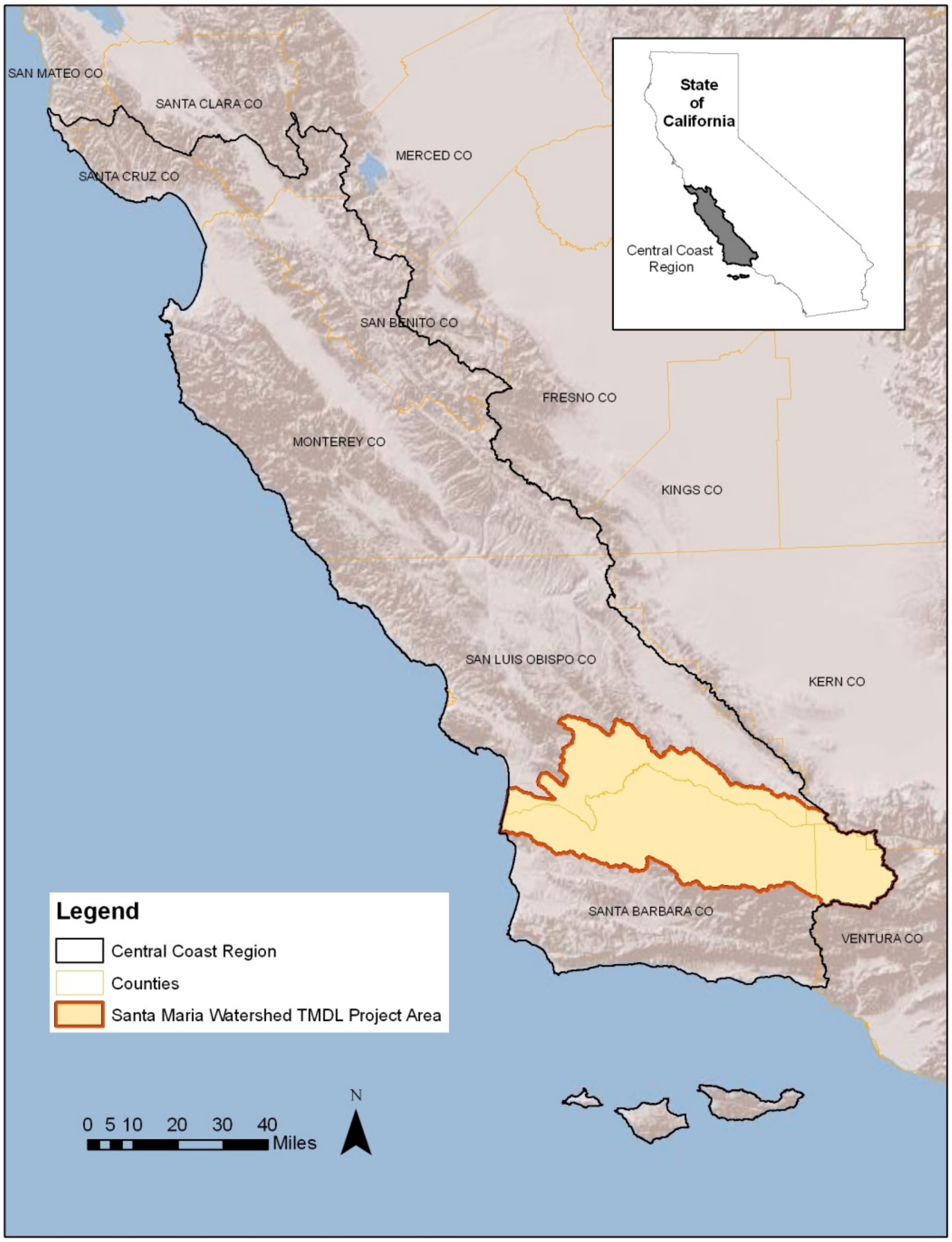

Figure 1-1 General vicinity map of the Santa Maria Watershed

1.4. Pollutants Addressed

The Santa Maria Watershed Toxicity and Pesticide TMDL addresses impairments to surface waters in the Santa Maria Watershed from pesticides, unknown toxicity, and sediment toxicity. In the watershed surface waters are impaired from pesticides that are currently applies to crops and in the urban setting aswell as pesticides that were historically used but are no longer applied, which are often refered to as legacy pesticides due to their persistence in the environment. The currently applied pesticides are in two chemical classifications of pesticides: organophosphates and synthetic pyrethroids (pyrethroids) and legacy pesticides are in the organochlorine pesticide chemical classification.

Currently used pesticides addressed in the TMDL:

- Chlorpyrifos (Organophosphate)
- Diazinon (Organophosphate)
- Malathion (Organophosphate)
- Bifenthrin (Pyrethroid)
- Cyfluthrin (Pyrethoid)
- Cypermethrin (Pyrethroid)
- Esfenvalerate (Pyrethroid)
- Lambda-Cyhalothrin (Pyrethroid)
- Permethrin (Pyrethroid)

Legacy Pesticides addressed in the TMDL:

- Chlordane (Organochlorine)
- DDTs (Organochlorine)
- Dieldrin (Organochlorine)
- Endrin (Organochlorine)
- Toxaphene (Organochlorine)

The pesticides and waterbodies addressed in the TMDL are described in Table 1-1 and the waterbodies are shown in Figure 1-2.

Table 1-1 Waterbodies Assigned a TMDL

Waterbody ID[1]	Waterbody	303(d) Listed Pollutant	Additional Pollutants[2]
CAR3121003020 011121135941	Blosser Channel	Unknown Toxicity	Chlorpyrifos Diazinon Pyrethroids DDT

Waterbody ID[1]	Waterbody	303(d) Listed Pollutant	Additional Pollutants[2]
CAR3121003020 011121144840	Bradley Canyon Creek	Unknown Toxicity	--
CAR3121003020 021002233532	Bradley Channel	Chlorpyrifos Sediment Toxicity Unknown Toxicity	Diazinon Pyrethroids DDT
CAR3121003020 080611165954	Greene Valley Creek	Chlorpyrifos Unknown Toxicity	--
CAR3121003020 080611165546	Little Oso Flaco Creek	Sediment Toxicity Unknown Toxicity	--
CAR3121003020 020819110803	Main Street Canal	Chlorpyrifos Diazinon Unknown Toxicity	Pyrethroids DDT
CAR3121003020 011129154708	Orcutt Creek	Chlorpyrifos DDT Diazinon Dieldrin Sediment Toxicity Unknown Toxicity	Pyrethroids
CAR3121003020 020124122144	Oso Flaco Creek	Sediment Toxicity Unknown Toxicity	Malathion DDT
CAL3121003020 011121102545	Oso Flaco Lake	Dieldrin	Chlordane DDT
CAR3121003020 011228103528	Santa Maria River	Chlorpyrifos DDT Dieldrin Endrin Sediment Toxicity Toxaphene Unknown Toxicity	Diazinon Pyrethroids

[1] State Water Resource Control Board Waterbody ID
[2] Pollutant not listed on the 2010 303(d) list but waterbody identified by staff as impaired

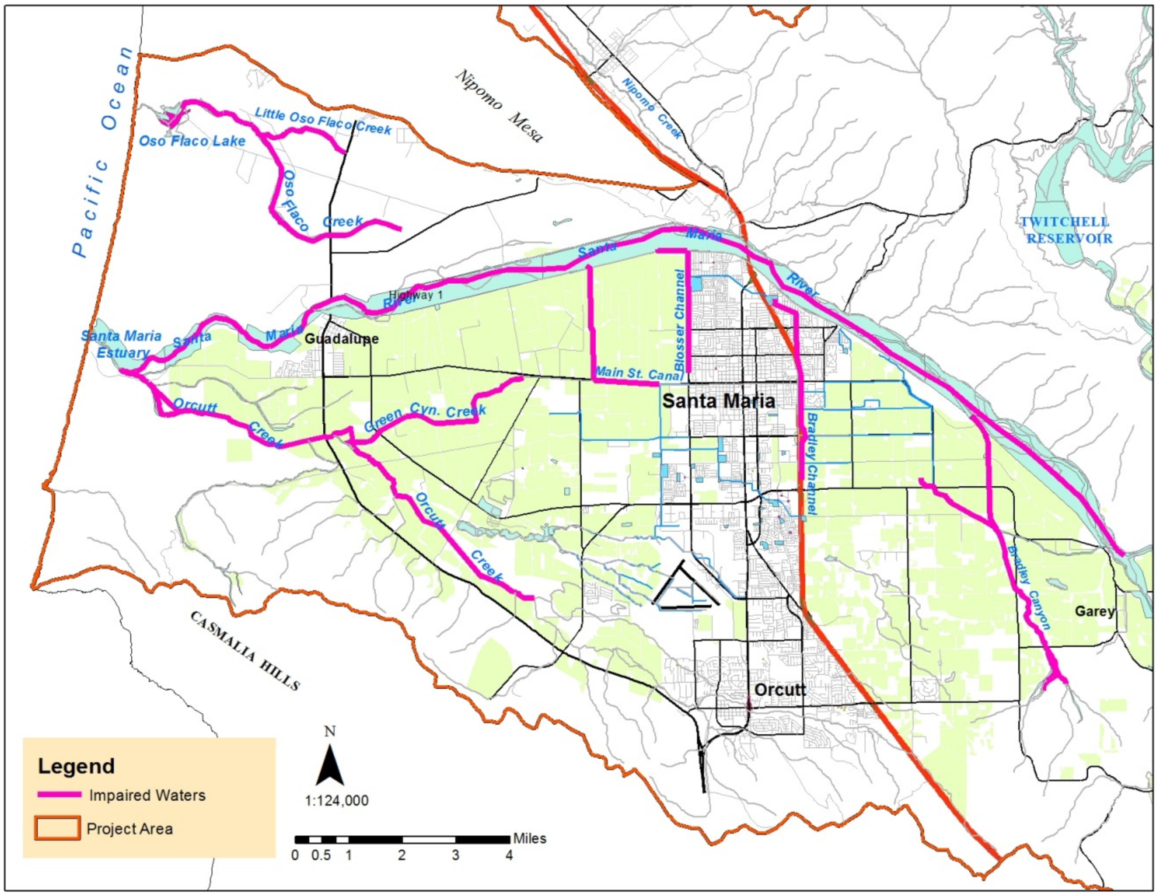

Figure 1-2 Impaired waters addressed in the TMDL

2. PROBLEM IDENTIFICATION

There are surface waters in the Santa Maria watershed that were found to be polluted with pesticides and to be toxic invertebrates. This is in violation of the Basin Plan general narrative objectives for pesticides and toxicity. Surface waters identified as impaired are placed on the EPA 303(d) list of impaired waters. This TMDL addresses toxicity and pesticide impairments on the 2008/2010 303(d) list along with additional toxicity and pesticide impairments identified afterwards.

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2.1. Watershed Description

The Santa Maria Watershed is refered to as the Santa Maria Hydrologic Unit 312 in the Basin Plan and is comprised of the Cuyama, Sisquoc and Guadalupe Hydrologic Areas (refer to Figure 2-1).

The Cuyama Hydrologic area is a large relatively undeveloped inland watershed in the northeastern portion of the Santa Maria watershed. A predominant feature of the watershed is the Cuyama valley, which has two small communities, Cuyama and New Cuyama. The valley is semi-arid with a low annual rainfall (average rainfall 7.89 inches) and with average high summer temperatures in the low to mid 90 F range and average winter lows in low 30 F range. The valley is bordered by mile high mountain ranges, the Caliente Mountains to the north and the Sierra Madre Mountains to the south. The valley floor valley with an elevation of just over 2000 feet has extensive irrigated agriculture that is reliant on groundwater pumping to grow crops such as carrots, alfalfa and apples. The Cuyama River is the major river in the hydrologic area. It flows seasonally from its headwaters near Pine Mountain summit west to Twitchell reservoir. The Huasna River and Alamo Creek are also in the watershed and drain from the north into Twitchell Reservoir. Releases from Twitchell Reservoir are managed by the Santa Maria Water Conservation District to optimize the recharge of groundwater resources and flood control in the Santa Maria Valley.

The Sisquoc Hydrologic Area is located in the southeastern portion of the watershed. The Sisquoc River flows unobstructed from Big Pine Mountain (6800 ft) west across the watershed to the confluence with the Cuyama River. The watershed is bordered by the Sierra Madre Mountains along the northeast edge of the watershed and the San Rafael Mountains to the south. It is a rugged largely undeveloped landscape with a large area within Los Padres National Forest. There are some vineyards and wineries in the lower western portion of the watershed. Sisquoc has an average annual rainfall of 15.10 inches.

The Guadalupe Hydrologic Area encompasses the lower coastal portion of the Santa Maria Watershed. It is bound on the south by the Solomon Hills and the Nipomo Mesa to the north. It is a broad alluvial plane traversed from east to west by the Santa Maria River. The Santa Maria River starts at the confluence of the Sisquoc and Cuyama River, which is at the eastern end of the hydrologic area. A dune complex forms its western boundary along the Pacific Ocean. The upper reach of the Santa Maria River is primarily a dry braided channel contained with flood control levees, which separate the channel from the developed of the valley floor. The lower channel from approximately Highway One to the Estuary has perennial flow and developed riparian habitat. The Santa Maria River outlets into an estuary that is seasonally open to the ocean. Nipomo Creek is a northern tributary of the Santa Maria River that connects with the river near the City of Santa Maria. Orcutt Creek flows along the southern edge of the valley and converges with the Santa Maria River just above the estuary. Oso Flaco Lake and Creek form a small coastal watershed in the northwestern corner of the Hydrologic Area. The watershed drains into Oso Flaco Lake, which is in the coastal dune complex north of the Santa Maria River and estuary.

The Guadalupe Hydrologic Area, excluding the Nipomo Creek watershed is commonly referred to as the Santa Maria Valley and will be referred to as such in this TMDL report. All pesticide 303(d) listings and additional impairments are in the Santa Maria Valley area of the Santa Maria Watershed (and Figure 2-1). The Santa Maria Valley has a Mediterranean climate influenced by summer coastal fog and breezes. Average summer high temperatures are in the middle 70s F.

and the winter lows are in the upper 30 F to low 40F. The average annual rainfall is 13.75 inches.

The Santa Maria Valley has extensive year round vegetable and strawberry production and agriculture is the predominant industry in the valley. The City of Santa Maria has a population of nearly 100,000 residents and is bordered on the south by the unincorporated community of Orcutt (Census 2010). The City of Guadalupe is a small city of approximately 7,000 residents located along the southern side of the Santa Maria River and the western side of the valley.

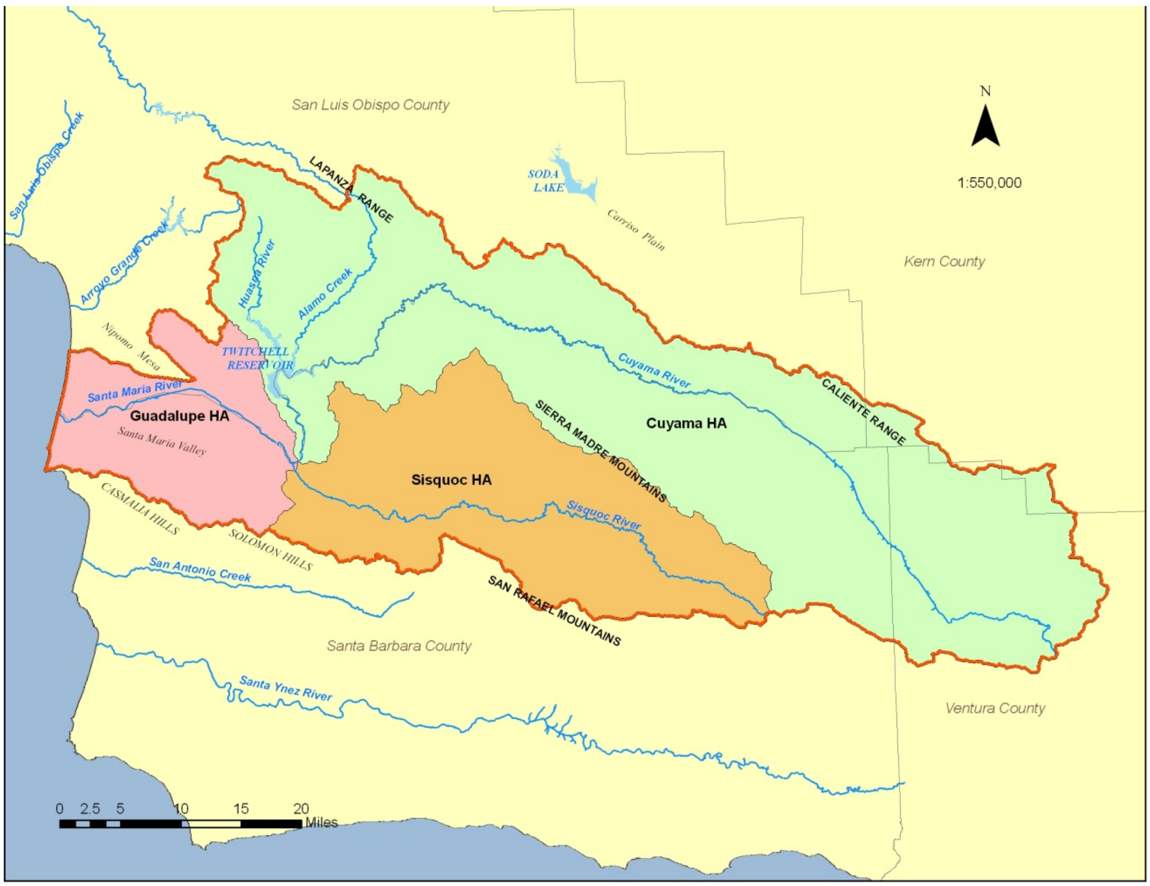

Figure 2-1 Project Area and Watersheds

2.2. Beneficial Uses and Water Quality Objectives

Surface waters in the Santa Maria watershed are polluted with pesticides that are toxic to aquatic life. This is in violation of the The Water Quality Control Plan for the Central Coast Basin – Region 3 (Basin Plan) general narrative objectives for toxicity and pesticides. Aquatic life-related beneficial uses are not being protected, including but not limited to the following: cold fresh water habitat, warm fresh water habitat, estuarine habitat, wildlife habitat, rare threatened or endangered species-migration, spawning, reproduction and/or early development, commercial and sport fishing, and shellfish harvesting. Some of TMDL waterbodies have beneficial uses identified in the Basin Plan and they are listed in Table 2-1. The protection of beneficial uses of water is the foundation of water quality protection and is the basis used to establish water quality objectives, which were adopted by the Regional Board and are described in Chapter 3 of the Basin Plan.

Table 2-1 Impaired Inland Surface Waters with Identified Beneficial Uses

Beneficial Uses	**Waterbody Names**				
	Oso Flaco Lake	**Oso Flaco Creek**	**Santa Maria River Estuary**	**Santa Maria River**	**Orcutt Creek**
MUN		X		X	X
AGR		X		X	X
PRO					
IND				X	
GWR	X	X	X	X	X
REC1	X	X	X	X	X
REC2	X	X	X	X	X
WILD	X	X	X	X	X
COLD				X	X
WARM	X	X	X	X	
MIGR			X	X	
SPWN	X		X		
BIOL	X	X	X		
RARE	X	X	X	X	X
EST			X		X
FRESH		X		X	X
NAV	X				
POW					
COMM	X	X	X	X	X
AQUA					
SAL					
SHELL			X		

The water quality objectives are either specific to a beneficial use or are general objectives for all beneficial uses. The water quality objectives applicable to water toxicity and pesticide detections are general objectives and, therefore, applicable to all inland surface waters, enclosed bays, and estuaries, and are described below:

General Objective for Toxicity:

> *All waters shall be maintained free of toxic substances in concentrations which are toxic to, or which produce detrimental physiological responses in, human, plant, animal, or aquatic life. Compliance with the 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.*

General Objective for Pesticides:

> *No individual pesticide or combination of pesticides shall reach concentrations that adversely affect beneficial uses. There shall be no increase in pesticide concentrations found in bottom sediments or aquatic life.*

Federal regulations state "TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate *measure*."[Emphasis added] (40 CFR § 130.2(i).
To identify the appropriate measure, pesticide concentration levels consistent with the narrative pesticide and toxicity objectives must be identified.

The Basin Plan does not identify numeric objectives for pesticide pollutants addressed in the TMDL. Staff evaluated targets per guidelines for interpretation of narrative water quality objectives. The Central Valley Water Board's Policy for Application of Water Quality Objectives states that the Water Board will consider "relevant numerical criteria and guidelines developed and/or published by other agencies and organizations. When considering such criteria, the Water Board will evaluate whether the specific available numeric criteria are relevant, appropriate, and should be applied in determining compliance with the Basin Plan narrative objective."

2.3. 303(d) Listing Criteria, Additional Impairments and Listing Policy

Listing criteria was developed and approved for the 303(d) listing. Numeric criteria used in the 303(d) listing was used also used for additional screening of monitoring data for impairments. Table 2-4 is a summary of the pesticide and toxicity listings rationale in the Santa Maria Watershed and the listing criteria. Table 2-5 is a summary of additional water body assessment and rationale completed for the TMDL and impairments. For the 2008-2010 303(d) list, surface waters were not evaluated for impairments from pyrethroid pesticides and the pesticide malathion, but they were included in the TMDL assessment because additional impairments and listings are anticipated in the subsequent listing period and would need to be otherwise addressed in a future TMDL. Therefore for the TMDL, staff screened for pyrethroid pesticides in the water column using criteria developed by the UC Davis for the Central Valley Regional Water Quality

Control board and sediments were screened for pyrethroid impairment using published toxicity levels.

The W*ater Quality Control Policy for Developing California's Clean Water Act Section 303(d) List* provides guidance on the minimum number of measured exceedances of water quality objectives needed to place a water segment on the 303(d) list. The policy has guidance for toxicants or conventional pollutants. Pesticides are considered toxicants. The guidance is summarized in Table 2-2.

Table 2-2 Minimum number of measured exceedances needed to place a water segment on the section 303(d) list for toxicants

Sample Size	List if the number of exceedances is equal or greater than
2 – 24	2
25 – 36	3
37 – 47	4
48 – 59	5
60 – 71	6

2.4. Pollutants Addressed

The pollutants addressed in this TMDL are pesticides that were detected in surface waters at concentrations that impair beneficial uses. This section provides a brief description of these pesticides. The pesticides identified are in three general categories:

1. Organochlorine pesticides
2. Organophophate pesticides
3. Pyrethroid pesticides

The pesticides in the three groups are insecticides with a toxic mode of action that affects the central nervous system of an organism.

The legacy pesticides addressed in the TMDL were phased-out of use many years ago but are a persistent problem in the environment. OC pesticides pose risks to wildlife and human and aquatic health. They have bioaccumulative properties and concentrations of the pesticide move up through the food chain from the aquatic environment to wildlife and humans. People who consume fish and shellfish from areas with organochlorine contamination maybe at health risk. The legacy pesticides addressed in the TMDL include: DDTs, dieldrin, endrin, toxaphene, which are described below.

DDT is an organochlorine pesticide that was commonly used in the United States until it was banned by EPA in 1972 over concerns for human health, bioaccumulation and effects on wildlife. DDT has a very long half-life in soil (2 to

15 years) and an extremely long half-life (about 150 years) in an aquatic environment (NPIC, 2000). It has a very high soil sorption coefficient and is considered immobile in most soils. The breakdown products in soil are DDD and DDE, which have similar environmental characteristics and problems to DDT (Muir, 1998 and Extoxnet, 2005). In the Santa Maria Watershed, the Santa Maria River and Orcutt Creek are on the 303(d) list as impaired for DDTs. Since the 303(d) listing, staff identified Blosser Channel, Bradley Channel, Main Street Channel, Oso Flaco Lake and Oso Flaco Creek as having exceedances of DDTs in sediment.

Dieldrin is an organochlorine pesticide that was used on crops such as cotton and corn from the 1950s until 1974 when EPA banned its uses except for termite control. All uses were banned by EPA in 1987 (ATSDR, 2002). Dieldrin is persistent in soil and aquatic environment. Aldrin is a similar organochlorine pesticide to dieldrin and aldrin degrades to dieldrin in the environment.

Dieldrin has a very high soil sorption coefficient and a long half-life. Dieldrin bioacculmates in the food chain and is a human health risk from consumption of fish and shellfish. In the Santa Maria Watershed, the Santa Maria River and Orcutt Creek are listed as impaired for dieldrin based on CTR water quality standards (EPA 2000) and Oso Flaco Creek is listed as impaired based on fish consumption guidelines developed by the Office of Environmental Health Hazard Assessment (OEHHA, 2008a).

Endrin is an organochlorine insecticide, rodenticide and avicide. Sales of endrin were banned in 1986 (OEHHA, 2008b). It has low water solubility, a very high soil sorption coefficient and a long half-life. In the Santa Maria Watershed, the Santa Maria River is listed as impaired for endrinbased on fish tissue concentrations from samples in the Santa Maria Estuary.

Toxaphene is an organochlorine insecticide that was banned from all uses in the 1990 (ATSDR, 2010). It was used primarily in the southern states on cotton and grain crops from 1947 to 1980. After DDT use was canceled in the 70s, the use of toxaphene increased dramatically. Most uses in the United States were canceled in 1982. Toxaphene was also used for treatment of scabies in cattle. It has low water solubility, a very high soil sorption coefficient and a long half-life. It is persistent in the environment and binds to sediments. The Santa Maria River was placed on the 303(d) list as impaired for toxaphene based on concentrations in fish tissue from samples in the Santa Maria Estuary.

Chlordane is an organochlorine insecticide that was banned from all uses in 1988 (ATSDR, 1995). It was used for structural pest control, home and garden applications and applications on agricultural crops. Chlordane is immobile in soil, breaks down slowly in the environment and bioaccumulates (ATSDR, 1995). Oso Flaco Lake is not on the 303(d) list but was subsequently identified as impaired based on high concentrations of chlordane in fish tissue.

OP pesticides are less persistent than OC pesticides. OP pesticides are currently applied as insecticides, primarily on crops. The OP pesticides addressed in this project are: chlorpyrifos, diazinon and malathion. These three OP pesticides share the same mode of action to each other and have additive effects on invertebrates in aquatic environments.

Chlorpyrifos is a broad spectrum OP insecticide that was first registered for use on food and fee crops in 1965. It was a widely used residential pesticide until 2000 when EPA canceled residential use of chlorpyrifos (EPA, 2004). Current registered uses include food and feed crops, golf course turf, greenhouses, non-structural wood treatments, and as an adult mosquiticide. All structural treatments for termites were terminated in 2005. The primary environmental water quality impairment from chlorpyrifos in the Santa Maria Watershed is acute toxicity to aquatic invertebrates in water and sediment (UC Davis, 2010). It has moderate water solubility, a high intermediate soil sorption coefficient and a relatively short half-life. In the Santa Maria Watershed, Bradley Channel, Greene Valley Creek, Main Street Canal and Orcutt Creek are on the 303(d) list as impaired for chlorpyrifos. Since the 303(d) listing, staff identified Blosser Channel as impaired for chlorpyrifos. Chlorpyrifos is a source of sediment and water column toxicity in the Santa Maria Watershed, particularly in drainages with agricultural return flows.

Diazinon is a broad spectrum contact OP insecticide. It was a very widely used home lawn and garden pesticide until residential use was restricted (EPA, 2004). In 2004 all residential sales of diazinon were stopped. Diazinon is a common agricultural insecticide in Santa Barbara County. The primary environmental water quality impairment from diazinon in the Santa Maria Watershed is acute toxicity to aquatic invertebrates in water. In the Santa Maria Watershed, Main Street Canal is on the 303(d) list as impaired for diazinon. Since the 303(d) listing, staff identified the Santa Maria River as impaired for diazinon.

Malathion is a broad spectrum residential and agricultural insecticide. It has a short half-life in soil. It is highly soluble and has a low intermediate soil sorption coeficient, which makes is susceptible to leaching and run-off to surface and ground water. No surface waters were placed on the 303(d) list as impaired for malathion. Since the 303(d) listing, staff identified Oso Flaco Creek as impaired for malathion.

Pyrethroids are synthetic versions of pyrethrins, which are naturally-occurring compounds with insecticidal properties. Pyrethrins are derived from a member of the chrysanthemum plant family. Pyrethoids are structurally similar to natural pyrethrins but are more persistent in the environment and have enhanced biological activity. They have widespread agricultural and urban use; pyrethroid pesticides identified in the TMDL monitoring include:

- bifenthrin,

- cyfluthrin,
- cypermethrin,
- esfenvalerate,
- lambda-cyhalothrin, and
- permethrin.

The non-agricultural use pyrethroids greatly increased after the urban use of organophophate pesticides chlorpyrifos and diazinon was banned by EPA (EPA 2013). The organophosphate pesticides are more acutely toxic to animals than pyrethroids but the ban lead to aquatic toxicity problems to invertebrates from pyrethroids in streams.

Pyrethoids have high soil sorption properties and bind to sediments in surface waters. Soil sorption along with important pesticide environmental behavior properties such as soil half-life, water solubility and water half-life are summarized in Table 2-3. They were detected in sediments in the Santa Maria Valley surface waters and were associated with sediment toxicity to invertebrates. Pyrethroids have additive effects and were grouped as one source of impairment in the TMDL. No surface waters are currently placed on the 2008-2010 303(d) list as impaired for pyrethroids. Since the 2008-2010 303(d) list development, staff identified Orcutt Creek, Santa Maria River, Main Street Channel, Blosser Channel and Bradley Channel as impaired for pyrethroids. The additional impaired waters are summarized in Table 2-5.

Table 2-3 Summary of Pesticide Environmental Behavior Properties

Common Name	Soil Half-life (days)	Water Solubility (mg/l)	Sorption Coefficient (soil Koc)	Water Half-life (days) Neutral pH
Bifenthrin	26	0.1	240,000	
Chlordane (2)	350	0.06	20,000	
Chlorpyrifos	30	0.4	6070	35-78
Cyfluthrin	30	0.002	100,000	
Cypermethrin	30	0.004	100,000	
DDD (TDE) (2)	1000	0.02	100,000	
DDE (2)	1000	0.1	50,000	
DDT (2)	2000	0.0055	2,000,000	
Diazinon	40	60	1000	138
Dieldrin (2)	1000	0.2	12,000	
Endrin (2)	4300	0.23	10,000	
Lambda-cyhalothrin	30	0.005	180,000	
Malathion	1	130	1800	1-17.4

Common Name	Soil Half-life (days)	Water Solubility (mg/l)	Sorption Coefficient (soil Koc)	Water Half-life (days) Neutral pH
Permethrin	30	0.006	100,000	
Toxaphene	600	3	100,000	

Source: National Pesticide Information Center (NPIC) fact sheets

2.5. Data Analysis

This section provides a summary of the 2008-2010 303(d) and 305(b) listings in the Santa Maria Watershed along with a summary of additional impairments.

Summary of Water Quality Impairments

Staff summarized the water bodies and 303(d)/305(b) listings for unknown toxicity, sediment toxicity and pesticides in the Santa Maria Watershed (Table 2-4). Staff also evaluated and summarized pesticide impairments subsequent to the most recent listing cycle (Table 2-5).

Table 2-4 Summary of Pesticide and Toxicity Listings in the Santa Maria Watershed on the 2008-2010 California 303(d)/305(b) List of Impaired Waters

Waterbody	Listing	Exceedances**	Associated Water Quality Objectives /Numeric Criteria	Monitoring Site	Temporal Representation
Blosser Channel	Unknown Toxicity	1/1 samples toxic to plants, 0/1 toxic to vertebrates and 1/1 toxic to invertebrates	Narrative*	312BCD-Blosser Channel d/s of groundwater recharge ponds	2/27/2007
Bradley Canyon Creek	Unknown Toxicity	0/4 samples toxic to plants, 0/3 toxic to vertebrates and 3/5 toxic to invertebrates	Narrative*	312BCC – Bradley Canyon Creek at Culvert, up stream of the Santa Maria River	3/22/2005 – 7/26/2005
Bradley Channel	Unknown Toxicity	0/7 samples toxic to plants, 0/5 samples toxic to vertebrates and 7/8 samples toxic to invertebrates	Narrative*	312BCU-Bradley Channel u/s of ponds at Magellan Drive 2.6. 312BCJ - Bradley Channel Jones	2/27/2007 3/22/2005 – 9/27/2005
Bradley Channel	Sediment Toxicity	2/2 samples toxic to invertebrates	Narrative*	312BCJ - Bradley Channel at Jones Street	4/20/2005 5/16/2006
Bradley Channel	Chlorpyrifos	All three (3/3)of the samples exceeded the Evaluation Guideline	0.025 ug/L as stated in Sipmann and Finlayson (2000).	312BCU-Bradley Channel u/s of ponds 312BCJ - Bradley Channel Jones	2/27/2007 8/22/2006 9/26/2006
Greene Valley Creek	Unknown Toxicity	0/6 samples toxic to plants, 0/5 toxic to vertebrates, and 5/6 toxic to invertebrates	Narrative*	312GVS - Greene Valley Creek at Simas	2/21/2005-9/26/2006
Greene Valley Creek	Chlorpyrifos	Both of the samples exceed the Evaluation	0.025 ug/L as stated in Sipmann and Finlayson (2000).	312GVS - Greene Valley Creek at Simas	8/22/2006-9/26/2006

Waterbody	Listing	Exceedances**	Associated Water Quality Objectives /Numeric Criteria	Monitoring Site	Temporal Representation
		Guideline			
Little Oso Flaco Creek	Unknown Toxicity	0/6 samples toxic to plants, 1/5 toxic to vertebrates, and 2/7 toxic to invertebrates	Narrative*	312OFN-Little Oso Flaco Creek at train Trussel	7/26/2005-8/23/2006
Little Oso Flaco Creek	Sediment Toxicity	2/2 samples toxic to invertebrates	Narrative*	312OFN-Little Oso Flaco Creek at train Trussel	4/19/2005-5/15/2006
Main Street Canal	Unknown Toxicity	2/7 samples toxic to plants, 1/5 toxic to vertebrates, and 3/5 toxic to invertebrates	Narrative*	312MSD-Main Street Canal at Highway 166 312MSS- Main Street Canal at South-Daylight Location 312MSD-Main Street Canal u/s Ray Road at Highway 166	2/27/2007, 2/23/2006 and 2/23/2006-9/26/2006
Main Street Canal	Chlorpyrifos	Four of the 4 samples (water) exceed the Evaluation Guideline	0.025 ug/L as stated in Sipmann and Finlayson (2000).	312MSD-Main Street Canal at Highway 166 312MSS- Main Street Canal at South-Daylight Location 312MSD-Main Street Canal u/s Ray Road at Highway 166	2/27/200 and 8/22/2006-9/26/2006
Main Street Canal	Diazinon	Two of the 4 samples exceed the Evaluation Guideline	0.16 ug/L as stated in Sipmann and Finlayson (2000).	312MSS- Main Street Canal at South 312MSD-Main Street Canal u/s Ray Road at Highway 166	8/22/2006-9/26/2006
Orcutt Creek	Unknown Toxicity	3/14 samples toxic to plants, 0/14 samples toxic to vertebrates and 13/18 samples toxic to invertebrates	Narrative*	312OR1 - Orcutt Creek at Highway 1, 312ORC-Orcutt Solomon Creek u/s Santa Maria River 312ORC001 - Orcutt Creek upstream of Santa Maria River at Sand Plant, 312GVT-Orcutt Creek at Brown Road, 312ORB-Orcutt Solomon Creek at Black Road	2/21/2005-9/27/2006 2/28/2007
Orcutt Creek	Sediment Toxicity	4/4 samples toxic to invertebrates	Narrative*	312OR1 - Orcutt Creek at Highway 1, 312ORC-Orcutt Solomon Creek u/s Santa Maria River	4/19/2005-4/20/2005 5/15/2006-5/16/2006
Orcutt Creek	DDT	Two of 2 samples (2002 and 2003) exceeded the total DDT, 2 of 2 samples exceeded 4,4' DDD, and 2 of 2 samples exceeded the 4,4' DDE Human Health (water consumption)	CTR criteria for: Human Health (water consumption) = 0.00083 ppb for 4,4'-DDD CTR criteria for: Human Health (water consumption) = 0.00059 ppb for 4,4'-DDE Freshwater Sediment Criteria (Policy): DDE(sum) = 31.3 ppb	312ORC – Orcutt Creek	6/28/2002 5/28/2003
Orcutt Creek	Dieldrin	Two of 2 water samples were in exceedance of the CTR Human Health water and	CTR Human Health Criterion for consumption of Water & Organisms = 0.00014 ppb. In fresh water	312ORC – Orcutt Creek	9/3/2002 5/28/2003 Sediment was collected in 5/28/2003.

Waterbody	Listing	Exceedances**	Associated Water Quality Objectives /Numeric Criteria	Monitoring Site	Temporal Representation
		organism consumption criterion. 0/1 Sediment sample exceeded evaluation criteria.	sediments the probable effects level (predictive of sediment toxicity) for dieldrin is 61.8 ug/Kg dry weight (MacDonald et al. 2000).		
Orcutt Creek	Chlorpyrifos	12/13 exceedances: 1/1 sediment, 11/12 water	1.77 ug/g o.c. as stated in Amweg and Weston and 0.025 ug/L as stated in Sipmann and Finlayson (2000).	312ORC001 312GVT 312ORB	8/22/2006-9/27/2006 2/28/2007 9/3/2002 5/28/2003 Sediment was collected in 5/28/2003.
Orcutt Creek	Diazinon	Four of the 7 samples exceed the Evaluation Guideline	0.16 ug/L as stated in Sipmann and Finlayson (2000).	312ORC001 312GVT 312ORB	2/28/2007 8/22/2006-9/27/2006
Oso Flaco Creek	Sediment Toxicity	2/2 samples toxic to invertebrates	Narrative*	312OFC-Oso Flaco Creek at Oso Flaco Lake Road	4/19/2005-5/15/2006
Oso Flaco Creek	Unknown Toxicity	1/6 samples toxic to plants, 0/5 samples toxic to vertebrates and 3/7 toxic to invertebrates	Narrative*	312OFC-Oso Flaco Creek at Oso Flaco Lake Road	2/21/2005 – 9/26/2006
Oso Flaco Lake	Dieldrin	Three out of 3 Tissue samples exceeded the OEHHA Screening Value	2 ng/g (OEHHA Screening Value) (Brodberg & Pollock, 1999).	One station located in lake at foot of Oso Flaco Road.	Bluegill collected in 1993. Hitch collected 2001. Guideline exceeded in all samples.
Santa Maria River	Sediment Toxicity	3/6 samples toxic to invertebrates	Narrative*	312SMA-Santa Maria River above Estuary , 312SMI-Santa Maria River at Highway 1	4/1/2004 – 5/15/2006 4/19/2005
Santa Maria River	Unknown Toxicity	1/11 samples toxic to plants, 0/9 samples toxic to vertebrates and 7/13 toxic to invertebrates	Narrative*	312SMA-Santa Maria River above Estuary , 312SMI-Santa Maria River at Highway 1	2/21/2005-9/27/2006
Santa Maria River	Chlorpyrifos	Five of 6 samples exceed the Evaluation Guideline	0.025 ug/L as stated in Sipmann and Finlayson (2000).	312SMA-Santa Maria River above Estuary , 312SMI-Santa Maria River at Highway 1	4/1/2004 9/3/2002 and 5/28/2003 8/23/2006-9/27/2006
Santa Maria River	Dieldrin	Two of 2 water samples were in exceedance of the CTR Human Health water and organism consumption criterion. 0/1 Sediment sample exceeded evaluation criteria.	CTR Human Health Criterion for consumption of Water & Organisms = 0.00014 ppb. In fresh water sediments the probable effects level (predictive of sediment toxicity) for dieldrin is 61.8 ug/Kg dry weight (MacDonald et al. 2000).	Lower Santa Maria River	water samples collected 9/3/2002, 5/28/2003. Sediment Data collected 4/1/2004
Santa Maria River	Endrin	2/2 tissue evaluation criteria exceedances, 0/1 sediment	100 ng/g NAS guideline (whole fish) (NAS, 1972). In fresh water sediments the probable effects level (predictive of sediment	One station located just above the beach area at the mouth of the river.	Tissue samples collected in 1992, 1999sediment collected in 4/1/2004

Waterbody	Listing	Exceedances**	Associated Water Quality Objectives /Numeric Criteria	Monitoring Site	Temporal Representation
			toxicity) for endrin is 207 ug/Kg dry weight (MacDonald et al. 2000).		
Santa Maria River	Toxaphene	Two out of 2 fish samples	100 ug/kg - NAS guideline (whole fish).	Lower Santa Maria River	Samples collected in 1992, 1999
Santa Maria River	DDT	Two of 2 total DDTs and 4,4'-DDT samples were below freshwater acute criteria, 1 of 2 measurements for 4,4'-DDD exceeded the human health criteria for water consumption, and 2 of 2 measurements for 4,4'-DDE exceeded the human health criteria for water consumption.	CTR criteria for: Human Health (water consumption) = 0.00083 ppb for 4,4'-DDD CTR criteria for: Human Health (water consumption) = 0.00059 ppb for 4,4'-DDE	Samples were collected at 4 sites at the mouth of the Santa Maria River:	August 2000 and February 2001.

*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
**Table 3.1 of the Listing Policy specifies the minimum number of measured exceedances needed to place a water segment on the Section 303(d) list for toxicants (SWRCB, 2004, pg. 9).

To determine the presence of additional pesticide impairments in the Santa Maria Watershed, staff evaluated data from CCAMP along with data from three separate monitoring studies (Table 2-5). One of the studies, referred to as the UC Davis TMDL Monitoring Study, was conducted specifically for the development of the TMDL. UC Davis monitored water and sediment toxicity along with pesticide concentrations in water column and sediment in surface waters in the Santa Maria Valley (Figure 2-2). The monitoring was for both legacy and currently applied pesticides. Concurrent to the TMDL monitoring, UC Davis was also monitoring the Santa Maria Estuary for pesticides as part of a BMP Effectiveness study. SWAMP also conducted sampling during this period for legacy pesticides in Oso Flaco Lake as part of a statewide screening survey of lakes and reservoirs for contaminants in fish, referred to as the SWAMP Lakes Study.

Table 2-5 Summary of significant pesticide pollution exceedances and impairments in addition to 2008-2010 303(d)/305(b) listings in the Santa Maria Watershed

Waterbody	Pollutant	Exceedances	Associated Water Quality Objectives/Guideline	Monitoring Site	Temporal Representation

Waterbody	Pollutant	Exceedances	Associated Water Quality Objectives/Guideline	Monitoring Site	Temporal Representation
Blosser Channel	Chlorpyrifos	3 of 7 samples exceeded the guidelines	0.025 ug/L as stated in Sipmann and Finlayson (2000).	312BCD- Blosser Channel d/s of basin	2/27/2007 - 8/27/2009
Blosser Channel	Diazinon	3 of 7 samples exceeded the guidelines	0.16 ug/L as stated in Sipmann and Finlayson (2000).	312BCD- Blosser Channel d/s of basin	2/27/2007- 8/27/2009
Blosser Channel	Pyrethroids	2 of 2 samples exceeded the guidelines	Sediment toxicity assessed with Toxicity Units based on LC50s (Amweg 2005), 0.6 ng/L Bifenthrin as stated in Fojut, T.L., Tjeerdema R.S. 2010	312BCD- Blosser Channel d/s of basin	2/3/2009-6/29/2009
Bradley Channel	Diazinon	3 of 9 samples exceeded the guidelines	0.16 ug/L as stated in Sipmann and Finlayson (2000).	312BCJ - Bradley Channel at Jones Street, 312BCU- Bradley Channel u/s of ponds at Magellan Drive, 312BRO - Bradley Channel at River Oaks	2/13/2007 - 8/27/2009
Bradley Channel	Pyrethroids	2 of 3 samples exceeded the guidelines	Sediment toxicity assessed with Toxicity Units based on LC50s (Amweg 2005), 0.6 ng/L Bifenthrin as stated in Fojut, T.L., Tjeerdema R.S. 2010	312BRO - Bradley Channel at River Oaks, 312BRJ Bradley Channel at Jones Street	6/12/2009 – 5/25/2010
Bradley Channel	DDT	2 of 2 sediment samples exceeded the guideline for toxicity	In fresh water sediments the probable effects level (predictive of sediment toxicity) for Sum DDE is 31.3 ug/Kg dry weight (MacDonald et al. 2000). Samples exceed SQAGs (Table 3-8 and Appendix C)	312BRO - Bradley Channel at River Oaks	6/19/2009
Main Street Channel	Pyrethroids	2 of 2 sediment samples exceeded toxicity units threshold and 1 of 1 samples exceed water guideline	Sediment toxicity assessed with Toxicity Units based on LC50s (Amweg 2005), 0.05 ng/L Cyflutthrin as stated in Fojut, T.L., Tjeerdema R.S. 2010	312MSS- Main Street Canal at South-Daylight Location	6/19/2009 – 8/27/2009
Main Street Channel	DDT	2 of 2 sediment samples exceeded the guideline for toxicity	In fresh water sediments the probable effects level (predictive of sediment toxicity) for Sum DDD is 28.0 ug/Kg and for Sum DDE is 31.3 ug/Kg dry weight (MacDonald et al. 2000). Samples exceed SQAGs (Table 3-8 and Appendix C)	312MSS- Main Street Canal at South-Daylight Location	6/19/2009

Waterbody	Pollutant	Exceedances	Associated Water Quality Objectives/Guideline	Monitoring Site	Temporal Representation
Orcutt Creek	Pyrethroids	1 of 2 sediment samples exceeded toxicity units threshold and 2 of 2 samples exceed water guideline	Sediment toxicity assessed with Toxicity Units based on LC50s (Amweg 2005), 0.05 ng/L Cyflutthrin as stated in Fojut, T.L., Tjeerdema R.S. 2010	312ORC 312ORI 312GVT	5/25/2009 – 8/27/2009
Oso Flaco Creek	Malathion	2 of 4 samples exceeded the Evaluation Guideline	0.17 ug/L as stated in Faria, Palumbo, Fojut and Tjeerdema (2010).	312OFC – Oso Flaco Creek	2/14/2007-6/12/2009
Oso Flaco Creek	DDT	2 of 2 sediment exceeded the evaluation guidelines	In fresh water sediments the probable effects level (predictive of sediment toxicity) for Sum DDD is 28.0 ug/Kg and for Sum DDE is 31.3 ug/Kg dry weight (MacDonald et al. 2000). Samples exceed SQAGs (Table 3-8 and Appendix C)	312OFC – Oso Flaco Creek	6/19/2009
Oso Flaco Lake	Chlordane	2 fish tissue samples exceeded the evaluation guideline (Swamp Lake Study)	30.0 ug/kg (wet tissue) (OEHHA Screening Value)	312OFL – Oso Flaco Lake	2007 Fish sample
Oso Flaco Lake	DDT	2 fish tissue samples exceed the evaluation guideline (SWAMP Lake Study), 2 of 2 sediment samples exceeded the guideline for toxicity	100 ng/g NAS guideline (whole fish) (NAS, 1972). 30 ng/g (wet tissue) (OEHHA Screening Value) (Brodberg & Pollock, 1999). In fresh water sediments the probable effects level (predictive of sediment toxicity) for Sum DDD is 28.0 ug/Kg and for Sum DDE is 31.3 ug/Kg dry weight (MacDonald et al. 2000). Samples exceed SQAGs (Table 3-8 and Appendix C)	312OFL – Oso Flaco Lake	2007 Fish sample 12/9/2008-6/19/2009
Santa Maria River	Diazinon	5 of 8 samples exceeded the guidelines	0.16 ug/L as stated in Sipmann and Finlayson (2000).	312SMA-Santa Maria River above Estuary	2/14/2007 - 8/27/2009
Santa Maria River	Pyrethroids	1 of 2 sediment samples exceeded toxicity units threshold and 1 of 1 samples exceed water guideline	Sediment toxicity assessed with Toxicity Units based on LC50s (Amweg 2005), 0.05 ng/L Cyflutthrin as stated in Fojut, T.L., Tjeerdema R.S. 2010	312SMA-Santa Maria River above Estuary	12/9/2008 – 6/19/2009

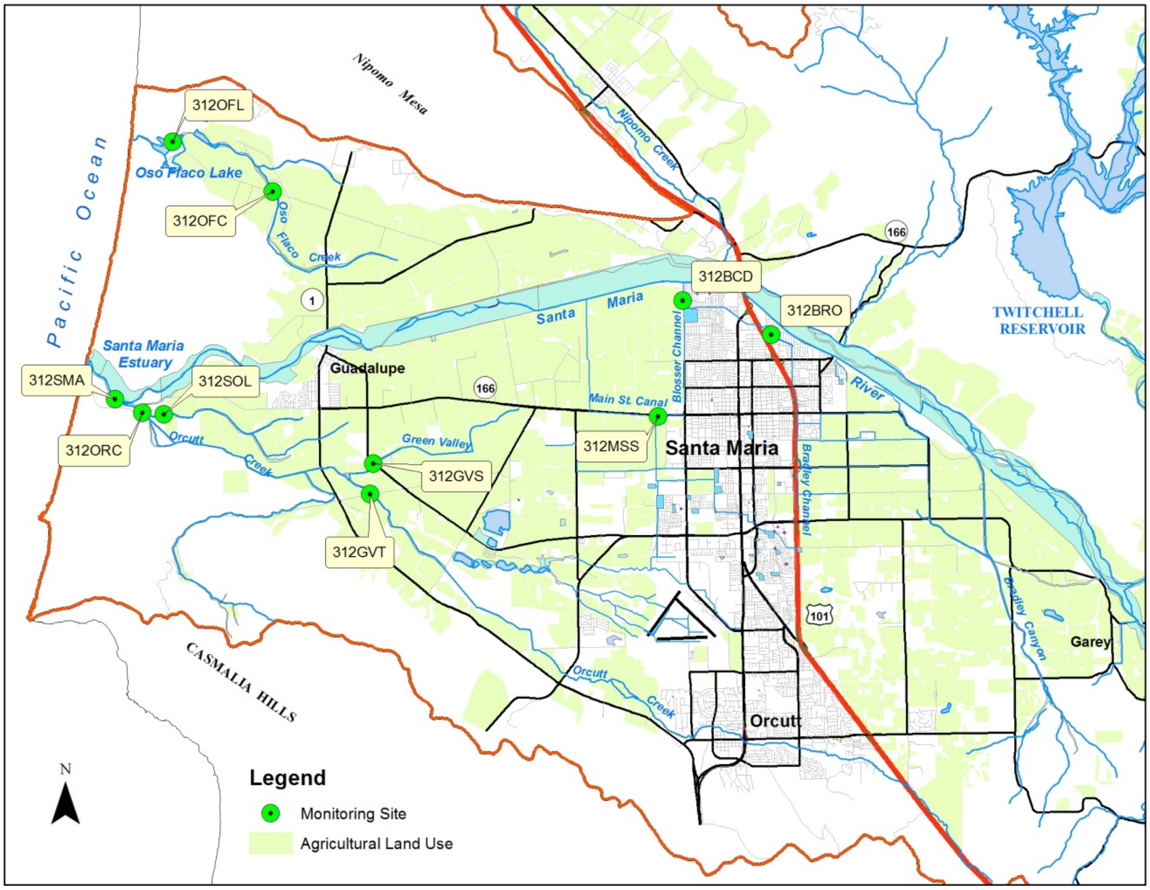

Figure 2-2 TMDL Monitoring Study Monitoring Sites

3. Numeric Targets

The Basin Plan contains narrative objectives for toxic chemicals and pesticides to protect beneficial uses of water (see Section 2.3) and for the TMDL numeric targets are developed using appropriate water quality criteria. Numeric targets are water quality targets developed to ascertain when and where the narrative water quality objectives are achieved, and hence, when beneficial uses are protected. The numeric targets are for organophophate, pyrethroid and organochlorine pesticides, as well as numeric targets for toxicity.

3.1. Organophosphate Pesticide Numeric Targets

Three OP pesticides, chlopyrifos, diazinon and malathion are associated with water column toxicity to invertebrates in Central Coast surface waters.

Organophosphate Pesticide Water Column Targets

In 2000, CDFG published freshwater water quality criteria for diazinon and chlorpyrifos (CDFG, 2000) using USEPA methodology (USEPA, 1985). The Central Valley Regional Water Quality Control Board (CVRWQCB) developed draft freshwater invertebrate toxicity criteria for malathion through a contract with UC Davis (Faria et al., 2010). Staff selected the CDFG and the CVRWQCB water quality criteria as numeric targets for these TMDLs. These targets are used as TMDL targets in several approved TMDLs, including the Lower Salinas Watershed Chlorpyrifos and Diazinon TMDL and the San Antonio Creek Chlorpyrifos TMDL. Additional information regarding the derivation of water column numeric targets is provided in Appendix B and the water column numeric targets are presented in Table 3-1.

Table 3-1 Organophosphate Water Column Numeric Targets

Chemical	**CMC [A] ug/L (ppb)**	**CCC [B] ug/L (ppb)**	**Reference**
Chlorpyrifos[C]	0.025	0.015	(CDFG, 2000)
Diazinon[C]	0.16	0.10	(CDFG, 2000)
Malathion	0.17	0.028	(Faria et al., 2010)

A . CMC – Criterion Maximum Concentration (Acute: 1- hour average). Not to be exceeded more than once in a three year period

B. CCC – Criterion Continuous Concentration (Chronic: 4-day (96-hour) average). Not to be exceeded more than once in a three year period

C. A toxicity ratio is used to account for the additive nature of these compounds. The ratio calculation is provided in this section

Additive Toxicity Numeric Target for Organophosphate Pesticides

Diazinon and chlorpyrifos have the same mechanism of toxic action and exhibit additive toxicity to aquatic invertebrates when they co-occur (Bailey et al., 1997; CDFG, 2000). Mixtures of compounds acting through the same mechanism suggest there is no concentration below which a compound will no longer contribute to the overall toxicity of the mixture (Deneer et al., 1988). Therefore, the total potential toxicity of co-occurring diazinon and chlorpyrifos needs to be assessed, even when one or both of their individual concentrations would otherwise be below thresholds of concern. Technical guidance developed by staff of the Central Valley Regional Water Quality Control Board (CVRWQCB) ("Policy for Application of Water Quality Objectives" and policy on "Pesticide Discharges from Nonpoint Sources") include formulas for addressing additive toxicity. Additive toxicity can be evaluated by the following formula from Basin Plan Amendments to the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins for Diazinon and Chlorpyrifos Runoff into the Sacramento and Feather Rivers (CVRWQCB, 2007); the following additive toxicity numeric target formula is a numeric target of this TMDL:

$$\frac{C\ (diazinon)}{NT(diazinon)} + \frac{C\ (chlopyrifos)}{NT\ (chlorpyrifos)} = S;\ where\ S\ \leq 1$$

Where:

C = the concentration of a pesticide measured in the receiving water.

NT = the numeric target for each pesticide present.

S = the sum; a sum exceeding one (1.0) indicates that beneficial uses may be adversely affected.

The additive toxicity numeric target formula shall be applied when both diazinon and chlorpyrifos are present in the water column.

3.2. Pyrethroid Pesticide Numeric Targets

Surface waters in the Santa Maria watershed are impaired due to elevated concentrations of pyrethroids in the water column and the sediment.

Pyrethroid Water Column Numeric Targets
UC Davis developed the water column criteria that are the basis of the water column targets for the pyrethroids addressed in the TMDL: bifenthrin, cyfluthrin and lambda-cyhalothrin; refer to Table 3-2. Staff also used the pyrethroid water column criteria to evaluate surface water quality monitoring for pyrethroid impairments (Table 2-5).

The UC Davis Criteria were developed as criteria protective of aquatic life using a transparent and scientific methodology of statistically evaluating toxicity data for multiple species. The criteria were established for freely dissolved concentrations of the pyrethroids and not concentrations bound to suspended solids and dissolved organic material. The UC Davis researchers noted that pyrethroids toxicity is inversely proportional to temperature, lower temperatures increase the sensitivity of organisms to pyrethroids, but it was unfeasible for them to incorporate temperature into the criteria. There was a lack of exposure data to develop pyrethroids and temperature water quality criteria.

Table 3-2 Synthetic Pyrethroid Water Column Numeric Targets

Chemical	UC Davis Acute Criteria ug/L (ppb)	UC Davis Chronic Criteria ug/L (ppb)	Reference
Bifenthrin	0.004	0.0006	(Palumbo et al., 2010)
Cyfluthrin	0.0003	0.00005	(Fojut et al., 2010)

Lambda-cyhalothrin	0.001	0.0005	(Fojut et al., 2010)

UC Davis prepared for the Central Valley Regional Water Quality Control Board (CVRWQCB) water column criteria for three pyrethroids (Bifenthrin, cyfluthrin, lambda-cyhalothrin).

<u>Synthetic Pyrethoid Sediment Toxicity Guidelines</u>
As found in water quality monitoring, sediment toxicity in Santa Maria Valley surface waters appears to correspond in part to concentrations of synthetic pyrethroids in sediments (Phillips, 2010). Staff developed sediment numeric guidelines for impairment assesent from published median lethal concentrations (LC50) for Hylela azteca.The LC50s were developed by the University of California (Amweg, 2007). The guidelines are based on chronic toxicity values since pyrethroids are persistent in the aquatic environment.

Table 3-3 Pyrethroid Sediment Numeric Guidelines

Chemical	**LC 50 ng/g (ppb)**	**LC50 ug/g OC*(ppm)**	**Reference**
Bifenthrin	12.9	0.52	(Amweg et al., 2005)
Cyfluthrin	13.7	1.08	(Amweg et al., 2005)
Cypermethrin	14.87	0.38	(Maund et al., 2002) mean value
Esfenvalerate	41.8	1.54	(Amweg et al., 2005)
Lambda-Cyhalothrin	5.6	0.45	(Amweg et al., 2005)
Permethrin	200.7	10.83	(Amweg et al., 2005)

*Median lethal concentration (LC50) for amphipods (Hyalella azteca) organic carbon normalized concentrations (ug/g OC)

<u>Additive Toxicity Numeric Target for Pyrethroid Pesticides</u>
Mixtures of pyrethroid pesticides were detected in sediments at monitoring sites in the Santa Maria watershed (Phillips, 2010) and mixtures of pyrethroids pesticides are found to have additive toxicity to invertebrates (Weston and Jackson, 2009) (Lydy et al., 2004). The following additive toxicity numeric target formula is a numeric target of this TMDL:

$$\frac{C\ (Pyrethroid\ 1)}{NLC(Pyrethroid\ 1)} + \frac{C\ (Pyrethroid\ 2)}{NLC\ (Pyrethoird\ 2)} = S;\ where\ S\ \leq 1$$

Where:

C = the concentration of a pesticide measured in sediment.

NLC = the numeric LC50 for each pesticide present (Table 3-3).

S = the sum; a sum exceeding one (1.0) indicates that beneficial uses may be adversely affected.

3.3. AquaticToxicity Numeric Targets

The aquatic toxicity numeric target is the evaluation of the Basin Plan general objective for toxicity using standard aquatic toxicity tests to determine toxicity in the water column and sediment. The general objective for toxicity is:

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.

To determine compliance, staff proposes aquatic toxicity targets to identify and address impairments from both water column and sediment toxicity. These toxicity targets utilize standard EPA test species and methods, which measure the aggregate effects of pollutants (including pesticides) in the water. The utility of having the target be a toxicity-based metric is that the TMDL will address pesticides currently identified as causing the impairment, and will also identify future toxicants. It is important to use toxicity as an indicator because the approach incorporates the potential effects of the pesticide active ingredient (e.g., diazinon), the other chemicals in the formulated product, breakdown products, and the interaction among these chemicals in addition to other chemicals in the receiving water. It also addressed any alternative pesticides which may be used in the future. The toxicity target assessment is an interpretation of the Basin Plan toxicity narrative objective.

Species and methods identified in Table 3-4 will be used to assess whether the toxicity target is achieved. Assessments will be conducted with receiving water(s) sampled at key integrator sites which will be defined in proper sampling plans with QA/QC consistent with SWAMP. Toxicity to invertebrates shall be tested using chronic toxicity tests for two species: 1) the 6-8-day water column exposures with the water flea, Ceriodaphnia dubia, (USEPA, 2002), and; 2) the 10-day sediment exposures with Hyalella azteca (USEPA, 2000). A toxicity determination is based on a comparison of the test organisms' response to the receiving water sample compared the control using the Test of Significant Toxicity (TST) statistical approach (USEPA 2010; Denton et al., 2011). If a sample is declared "fail" (i.e., toxic), then additional receiving water sample(s) should be collected and evaluated for this specific receiving water to determine the pattern of toxicity and whether a TIE needs to be conducted to determine the causative toxicant(s). If the causative toxicant(s) is already known (e.g., based on land use patterns and similar responses in sub-watersheds) then implementation of BMPs, management plans etc. should be examined for effectiveness if already in place, or implemented to reduce the toxicant(s).

Table 3-4 EPA Standard Aquatic Toxicity Tests

Parameter	Test	Biological Endpoint Assessed	Test Method #
Water Column Toxicity	Water Flea – *Ceriodaphnia* *(6-8 day chronic)*	Survival and reproduction	EPA-821-R-02-013 using alpha of 0.20
Sediment Toxicity	*Hyalella azteca* (10-day chronic)	Survival	EPA 100.1 using alpha of 0.25

3.4. Legacy Organochlorine Pesticide Numeric Targets

In the Santa Maria watershed fish were found to be contaminated with organochlorine pesticides along with sand crabs on the coast at the Santa Maria River mouth. Sand crabs are an ecosystem health indicator species and are a source of food for fish and wildlife. The Santa Maria River and Orcutt Creek are listed as impaired based on concentrations of organochlorine pesticides in the water column. In addition, the UC Davis TMDL Study found elevated concentrations of legacy pesticides in drainage sediment throughout the Santa Maria Valley. The organochlorine pesticide numeric targets for tissue, water and sediment are discussed below.

Fish Tissue Targets

California State Office of Environmental Health Hazard Assessment (OEHHA) developed Fish Contaminant Goals (FCGs) for chlordane, DDTs, dieldrin and toxaphene (OEHHA, 2008). FCGs are estimates of contaminant levels in fish that pose no significant health risk to individuals consuming sport fish at a standard consumption rate of eight ounces per week (32 g/day), prior to cooking, over a lifetime (Table 3-5). The FCGs are designed to assist in the development of fish tissue-base criteria for the mitigation or elimination of pollution and are the TMDL numeric targets protective of beneficial uses.

Table 3-5 TMDL Fish Tissue Numeric Targets

Chemical	Fish Contaminant Goal (ng/g*)
Chlordanes	**5.6**
DDTs	**21**
Dieldrin	**0.46**
Toxaphene	**6.1**

*ng/g: i.e. nanograms of pollutant per grams of fish tissue (e.g. a fillet)

Water Chemistry Numeric Targets

Section 303(2)(B) of the Federal Clean Water Act (CWA) requires that states adopt numeric criteria for priority pollutants as part of the states' water quality standards. In 2000 EPA published and established numeric standards for priority pollutants for the State of California, referred to as the California Toxic Rule (CTR). The CTR has aquatic life and human health base standards. The human health based standards were selected as the targets for the TMDL.

Table 3-6 Organochlorine Water Chemistry Numeric Targets

Chemical	Human Health (risk for

	carcinogens) for consumption of : Water & Organisms ug/L
Chlordane	**0.00057**
DDD, 4,4- (p,p-DDD, TDE)	**0.00083**
DDE, 4,4- (p,p-DDE)	**0.00059**
DDT, 4,4- (p,p-DDT)	**0.00059**
Dieldrin	**0.00014**
Toxaphene	**0.00073**

Sediment Chemistry Numeric Targets

Since listings are based on human health risks from the consumption of fish, staff recommends the use of human health based criteria as sediment numeric targets. Sediment quality assessment guidelines (SQAGs) were developed by the Florida Department of Environmental Protection. The select SQAGs are bioaccumulation pollutant concentrations in sediment for inland waters protective of human health. They are based on assessments done in New York and Washington State (WDOH, 1995), where they identified sediment chemistry concentrations that are unlikely to be associated with adverse effects on human health. They were recommended as interim guidelines in Florida until sufficient data are available to evaluate the reliability of these bioaccumulation guidelines (refer toTable 3-7).

Table 3-7 Sediment Chemistry Numeric Targets

Chemical	**Human Health-based Targets SQAGs (ug/kg, ppb) o.c.[1]**
Chlordane	1.7
DDD, 4,4- (p,p-DDD)	9.1
DDE, 4,4- (p,p-DDE)	5.5
DDT, 4,4-(p,p-DDT)	6.5
Total DDT	10
Dieldrin	0.14
Endrin	550
Toxaphene	20

[1] **o.c.** is organic carbon corrected concentrations

3.5. Summary of Chemistry Numeric Targets

The TMDL numeric targets are summarized in the following tables: water chemistry targets (Table 3-8), sediment chemistry targets (Table 3-9) and fish tissue chemistry targets (Table 3-10).

Table 3-8 Summary of Water Chemistry Numeric Targets

Chemical Group	Chemical	Conc.	Units	Type	Reference
Organophosphate	Chlorpyrifos	0.025	ug/L (ppb)	CMC	(CDFG, 2000), (CCRWQCB, 2011) Appendix B Page 86
Organophosphate	Chlorpyrifos	0.015	ug/L (ppb)	CCC	(CDFG, 2000), (CCRWQCB, 2011) Appendix B Page 86
Organophosphate	Diazinon	0.16	ug/L (ppb)	CMC	(CDFG, 2000), (CCRWQCB, 2011) Appendix B Page 86
Organophosphate	Diazinon	0.10	ug/L (ppb)	CCC	(CDFG, 2000), (CCRWQCB, 2011) Appendix B Page 86
Organophosphate	Malathion	0.17	ug/L (ppb)	CMC	(Faria et al., 2010), Page 16
Organophosphate	Malathion	0.028	ug/L (ppb)	CCC	(Faria et al., 2010), Page 16
Synthetic Pyrethroid	Bifenthrin	0.004	ug/L (ppb)	CMC	(Palumbo et al., 2010), Page 22
Synthetic Pyrethroid	Bifenthrin	0.0006	ug/L (ppb)	CCC	(Palumbo et al., 2010), Page 22
Synthetic Pyrethroid	Cyfluthrin	0.0003	ug/L (ppb)	CMC	(Fojut et al., 2010) Page 19
Synthetic Pyrethroid	Cyfluthrin	0.00005	ug/L (ppb)	CCC	(Fojut et al., 2010) Page 19
Synthetic Pyrethroid	L-Cyhalothrin	0.001	ug/L (ppb)	CMC	(Fojut and Tjeerdema, 2010), Page 22
Synthetic Pyrethroid	L-Cyhalothrin	0.0005	ug/L (ppb)	CCC	(Fojut and Tjeerdema, 2010), Page 22

Chemical Group	Chemical	Conc.	Units	Type	Reference
Organochlorine	Chlordane	0.00057	ug/L (ppb)	Human Health Consumption	(EPA 2000) Page 31715
Organochlorine	DDD, 4,4-(p,p-DDD)	0.00083	ug/L (ppb)	Human Health Consumption	(EPA 2000) Page 31715
Organochlorine	DDE, 4,4-(p,p-DDE)	0.00059	ug/L (ppb)	Human Health Consumption	(EPA 2000) Page 31715
Organochlorine	DDT, 4,4-(p,p-DDT)	0.00059	ug/L (ppb)	Human Health Consumption	(EPA 2000) Page 31715
Organochlorine	Dieldrin	0.00014	ug/L (ppb)	Human Health Consumption	(EPA 2000) Page 31715
Organochlorine	Toxaphene	0.00073	ug/L (ppb)	Human Health Consumption	(EPA 2000) Page 31715

Table 3-9 Summary of Sediment Chemistry Numeric Targets

Chemical Group	Chemical	Conc.	Units	Endpoint	Reference
Organochlorine	Chlordane	1.7	ug/kg o.c. (ppb)	Human Health-Based	(WDOH, 1995)Page 24, (MacDonald et al. 2003) Page 109
Organochlorine	DDD, 4,4-(p,p-DDD)	9.1	ug/kg o.c. (ppb)	Human Health-Based	(WDOH, 1995)Page 24, (MacDonald et al. 2003) Page 109
Organochlorine	DDE, 4,4-(p,p-DDE)	5.5	ug/kg o.c. (ppb)	Human Health-Based	(WDOH, 1995)Page 24, (MacDonald et al. 2003) Page 109
Organochlorine	DDT, 4,4-(p,p-DDT)	6.5	ug/kg o.c. (ppb)	Human Health-Based	(WDOH, 1995)Page 24, (MacDonald et al. 2003) Page 109
Organochlorine	Total DDT	10	ug/kg o.c. (ppb)	Human Health-Based	(MacDonald et al. 2003) Page 109
Organochlorine	Dieldrin	0.14	ug/kg o.c. (ppb)	Human Health-Based	(WDOH, 1995)Page 25, (MacDonald et al. 2003) Page 109

Chemical Group	Chemical	Conc.	Units	Endpoint	Reference
Organochlorine	Endrin	550	ug/kg o.c. (ppb)	Human Health-Based	(WDOH, 1995)Page 25, (MacDonald et al. 2003) Page 109
Organochlorine	Toxaphene	20	ug/kg o.c. (ppb)	Human Health-Based	(MacDonald et al. 2003) Page 109

Table 3-10 Summary of Fish Tissue Chemistry Numeric Targets

Chemical Group	Chemical	Conc.	Units	Endpoint	Reference
Organochlorine	Chlordanes	5.6	ng/g (ppb)	Fish Contaminant Goal	(OEHHA, 2008) Page 42
Organochlorine	DDTs	21	ng/g (ppb)	Fish Contaminant Goal	(OEHHA, 2008) Page 42
Organochlorine	Dieldrin	0.46	ng/g (ppb)	Fish Contaminant Goal	(OEHHA, 2008) Page 42
Organochlorine	Toxaphene	6.1	ng/g (ppb)	Fish Contaminant Goal	(OEHHA, 2008) Page 42

4. Source Analysis

The sources of pesticide pollution were investigated by using several methods including: analysis of pesticide use data and watershed landuse data. Also for development of the TMDL, additional toxicity and pesticide water quality monitoring was conducted by UC Davis that confirmed the association of toxicity to currently applied pesticides (Phillips, 2010). Therefore, the focus of the toxicity source analysis for toxicity was on on currently applied pesticide classes and not on organochlorine pesticides.

The monitoring study also did valuable water quality analysis using toxicity testing, chemical analyses and TIEs, which determined that water toxicity was due to concentrations of organophaphate pesticides in the water and sediment toxicity was due to the levels of chlorpyrifos and pyrethroids in sediment. UC Davis also found spatial variance within the pesticide toxicity analysis. They found that the highest concentrations of pyrethroid pesticides were detected at monitoring sites with urban inputs. The highest sediment toxicity levels were near the city and in the lower Santa Maria river; the toxicity was from a mix of pyrethroids and chlorpyrifos. 75% of water column toxicity in the drainages adjacent to the city and in the Santa Maria River are could be attributed to concentrations of diazinon and chlopyrifos. There was also toxicity in the Oso

Flaco watershed but the sources were unknown and not attributable to organophophate pesticides

4.1. Source Analysis of Organophosphate Pesticide Pollution

Three OP pesticides: chlorpyrifos, diazinon and malathion, were detected in surface waters at levels of impairment in the Santa Maria Watershed. There are two general catagories of pesticide use, agricultural and non-agricultural uses. Non-agricultural uses include: professional residential and homeowner residential use products.

In 2000, pesticide registrant agreed with EPA to phase out residential (non-agricultural) uses of chlorpyrifos and diazinon. The timing of the residential product phase-out is summarized below:

1. Residential phase-outs announced of chlorpyrifos and diazinon 2000)
2. Formulation of chlorpyrifos stopped (December 1, 2000)
3. Retail sales of chlorpyrifos stopped (December 31, 2001)
4. Retail sales on diazinon for indoor use stopped (December 31, 2002)
5. Formulation of diazinon for outdoor use stopped (June 30, 2003)
6. Retail sales of diazinon for outdoor use stopped (December 31, 2004)

Since non-agricultural use of chlorpyrifos and diazinon was stopped many years ago and these pesticides have relatively short half-lives (refer to Table 2-3) and the detections correspond to agricultural applications, staff determined that residential consumer use and urban land uses are not sources.

Chlorpyrifos

Bradley Channel, Green Valley Creek , Orcutt Creek and the Santa Maria River are on the 303(d) list as impaired for the pesticide chlorpyrifos (refer to Table 2-4). Since the 2008-2010 303(d) listing, additional monitoring data indicates that Blosser Channel is also impaired (refer to Table 2-5). Staff determined based on pesticide use analysis that the primary source of chlorpyrifos impairments were agricultural applications of granular chlorpyrifos to cole crops (broccoli and cauliflower).

Since residential sales of chlopyrifos were stopped in 2001, staff concluded that residential use of chlorpyrifos would not be a significant source of chlorpyrifos contamination in surface waters. Agricultural crop uses are significant in the Santa Maria Watershed and were assessed by summarizing DPR pesticide use reports. Table 4-1 summarizes the pounds of chlorpyrifos active ingredient applied to crops in 2008. Chlorpyrifos was primarily applied to broccoli and other cole crops such as cauliflower and cabbage. It was also readily applied on wine grapes and strawberries.

Table 4-1 2008 Chlorpyrifos use on crops in the Santa Maria Watershed

Crop	**Lbs. Applied**	**Percent of Total**
Broccoli	16565	62%
Wine Grapes	4223	16%
Strawberries	3418	13%
Cauliflower,Cabbages, Bok Choy	2525	9%
All Others	83	<1%
All Crops	26814	100%

Staff evaluated chlorpyrifos use for sub-watersheds in the lower Santa Maria River watershed. These sub-watersheds are the primary drainages for Lower Orcutt Creek and the Santa Maria Estuary. In 2008, almost all applications of chlorpyrifos in this area were granular applications on broccoli crops. Granular applications are applied into the soil at planting for control of root maggots on cole crops. DPR is reevaluating the use of chlorpyrifos due, in part, to detections of the pesticide in Central Coast surface waters. Granular applications of chlorpyrifos were identified by the pesticide registrant, Dow AgroSciences, as the primary source of chlorpyrifos in Central Coast waters in the reevaluation reports submitted to DPR (Dow 2008). Table 4-2 shows the formulation use by subwatershed. Note that the granular formation has a higher application relative to the emulsifiable formulation, particularly for broccoli.

Table 4-2 2008 Reported Chlorpyrifos Use by Crop and Formulation in the Lower Santa Maria Watershed

Monitoring site ID and Subwatershed	**Commodity**	**Pesticide Formulation**		**Grand Total**
		Emulsifiable Concentrate (lbs.)	**Granular/ Flake (lbs.)**	
312GVS Green Valley	BROCCOLI		1383	1383
	CAULIFLOWER	51	44	94
312GVS Total		51	1427	1478
312GVT Mid Orcutt Creek	BROCCOLI		466	466
	CAULIFLOWER		100	100
312GVT Total			566	566
312ORC Lower Orcutt Creek	BROCCOLI	7	3729	3736
	CAULIFLOWER		227	227
Lower 312ORC Total		7	3956	3963
Sub-watershed	BROCCOLI	7	5578	5585

Monitoring site ID and Subwatershed	Commodity	Pesticide Formulation		Grand Total
		Emulsifiable Concentrate (lbs.)	Granular/ Flake (lbs.)	
Totals	CAULIFLOWER	51	370	421
Total		58	5949	6006

Pesticide use data for 2006 and 2008, indicates significant reductions in chlorpyrifos use, particularly in the lower Santa Maria watershed, which are sub-watersheds: Green Valley Creek and Orcutt Creek (Table 4-3).

Table 4-3 2006 and 2008 Pounds of Chlorpyrifos Application to Broccoli

Sub-watershed	2006 (lbs.)	2008 (lbs.)
312GVS Greene Valley Creek	2368	1383
312GVT Mid Orcutt Creek	548	465
Bradley Channel	1891	1512
312ORC Lower Orcutt Creek	6100	3736
Oso Flaco	2175	1920
Total	13084	9018

Bradley Channel is on the 303(d) list as impaired for the pesticide chlorpyrifos. Chlorpyrifos pesticide use for 2008 in the Bradley Channel Sub-watershed is summarized in Table 4-3. Chlorpyrifos was mainly applied as a granular formulation to broccoli and cauliflower in Bradley Channel sub-watershed. There were also significant emulsifiable concentrate applications to strawberries. The timing and pests treated, with chlorpyrifos applications on strawberries is unknown. Staff considers strawberries a lower risk source of chlorpyrifos since the crops are watered primarily on drip irrigation, which has low run-off potential. However, strawberries can be a significant source of stormwater run-off and chlorpyrifos applications during the rainy season could enter surface water attached to sediment. Table 4-4 shows the chlorpyrifos use in Bradley Channel by formulation; note the granular application on cole crops compared to the emulsifiable formulation on strawberries.

Table 4-4 2008 Pounds of Chlorpyrifos Use in the Bradley Channel Sub-watershed

Subwatershed	Commodity	Pesticide Formulation		Grand Total (lbs.)
		Emulsifiable Concentrate	Granular/ Flake (lbs.)	

		(lbs.)		
Bradley Channel	BROCCOLI		1512	1512
	CAULIFLOWER	49	227	276
	STRAWBERRY	798		798
Bradley Channel Total		847	1739	2587

Blosser Channel is not on the 303(d) list as impaired for chlorpyrifos but additional monitoring data indicates that it is impaired. Blosser Channel receives water from urban areas adjacent to the channel and possibly some farms along the channel. In addition, water is seasonally directed from Bradley Channel and Bradley Lake into Blosser Channel by Santa Barbara County Flood Control. The primary sources of clorpyrifos in Blosser Channel are irrigated farms in the Bradley Channel sub-watershed.

Staff evaluated chlorpyrifos application trends for granular applications of chlorpyrifos using data available from the Santa Barbara County Agricultural Commissioner's office, since adoption of the initial Agricultural Order in 2004 and the recent Ag Order on March 15, 2012, which has more stringint Tiered monitoring requirements for growers applying chlorpyrifos. Granular formulations were identified above as a common application formula to broccoli crops in watersheds with impairments. Data in Table 4-5 indicates a sharp decline in granular applications in Santa Barbara County (County of Santa Barbara, 2013). The discontinuing of chlorpyrifos use appears to be the primary method of compliance with the Ag Order requirements. Use has consistently declined since 2006 with a sharp drop in 2012. Broccoli is the second most valuable crop in Santa Barbara County and the crop value and crop acres remained relatively constant from 2006 to 2012.

Table 4-5 Pounds of Lorsban 15G granular insecticide product applied to broccoli crops in Santa Barbara County along with broccoli crop acres and crop value in millions of dollars from 2006 to 1012

Year	**Number of Applications****	**Pounds of Product Applied****	**Harvested Acreage***	**Yield Per Acre***	**Crop Value in Millions of Dollars***
2006	773	85,724	28,250	598	128
2007	653	75,596	28,376	608	131
2008	516	55,313	27,954	684	159
2009	477	44,738	26,293	671	149
2010	223	22,277	26,395	622	122
2011	244	35,002	27,248	642	126
2012	65	9,448	27,220	634	131

Source: * County Agricultural Production Report, ** County of Santa Barbara Pesticide Use Data
Notes: Yield unit measured as 22lb. cartons of broccoli

Malathion

No waterbodies are on the 2008-2010 303(d) list as impaired for the pesticide malathion but since development and approval of the the 2008-2010 303(d) list, additional monitoring data indicates malathion impairment in the Oso Flaco sub-watershed. Table 4-1and Figure 4-1 summarize malathion applications in the Oso Flaco sub-watershed from 2005 to 2008. Based on the following evidence staff determined that agricultural applications were the primary source of malathion impairments. The specific crop or application type could not be determined.

Malathion was primarily applied to four main crops: broccoli, celery, lettuce and strawberries. The total annual pounds of malathion increased from 11,771 pounds in 2005 to 19,134 pounds in 2008, a 63% increase. The increases were greatest for broccoli and strawberry crops. The source of impairment was application to cultivated crops such as strawberries, broccoli, celery, lettuce and some other commodities. Malthion is sold as a home use insecticide but there is minimal non-agricultural land use in the watershed. Malathion is used as a spray to control foliar pests and soil applications are not likely.

Table 4-6 Malation Use in the Oso Flaco Watershed

Commodity	**2005**	**2006**	**2007**	**2008**
BROCCOLI	787	503	2212	1844
CELERY	1219	2311	3263	1394
LETTUCE	9577	12081	9687	9129
STRAWBERRY		268	1135	6322
All Other Commodities	187	163	455	444
Total	11771	15328	16755	19134

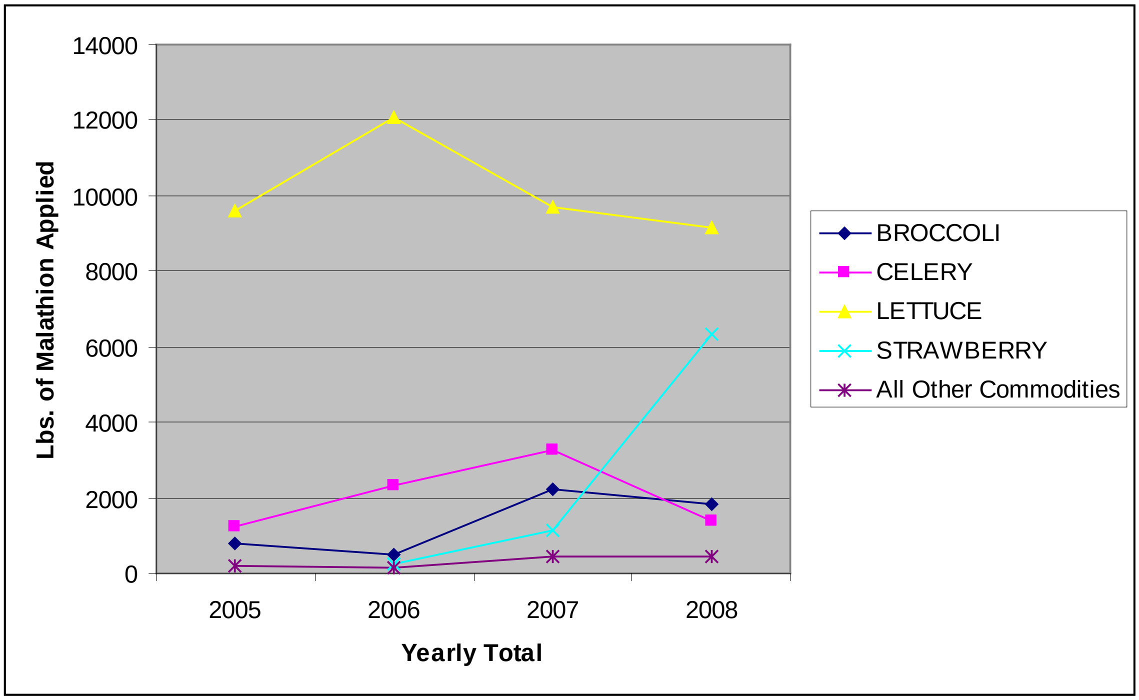

Figure 4-1 Annual Malathion Applications in the Oso Flaco Watershed

Diazinon

Main Street Channel and Orcutt Creek are on the 303(d) list as impaired for the pesticide diazinon. Since the 2008-2010 303(d) listing, additional monitoring data indicates that Blosser Channel, Bradley Channel and the Lower Santa Maria River are also impaired. Staff determined that the primary source of diazinon impairments in the watershed were agricultural applications of diazinon to lettuce and broccoli crops (Table 4-7).

Diazinon is an agricultural use pesticide only. In 2004 all residential sales of diazinon were stopped. Table 4-7 summarizes the pounds of reported active ingredient applied in 2006, 2007 and 2008 in the Santa Maria Watershed. Figure 4-2 illustrates the diazinon applications. There were only agricultural applications in 2007 and 2008. In 2006, the applications were primarily agricultural along with minor applications for invertebrate pest control. In the Santa Maria watershed, diazinon was mainly applied to vegetable crops (refer to Figure 4-2). In 2008, 44% of diazinon applied was to lettuce crops and spinach, 30% to cole crops and 14% to carrots. Strawberries are commonly grown in the sub-watersheds impaired with diazinon, but a small percent of the applications in the entire watershed were to strawberries. Carrots are a common crop in Cuyama Valley sub-watershed and it is unlikely that diazinon applications to carrot are a source of water quality problems in the impaired waters. While the Cuyama Valley is part of the Santa Maria watershed, it is a substantial distance from any of the impaired waters and hydrologically isolated from all impaired waters except the lower Santa Maria river but connectivity to the lower water body is intermittent at best. Staff reviewed the reported formulations in 2008, and 95% of the total mass applied was as emulsifiable concentration formulations with the remaining 5% primarily wetable powder applications, these are likely spray applications.

Table 4-7 Diazinon Use in the Santa Maria Watershed

Crop Type	Pounds Applied		
	2006	**2007**	**2008**
BOK CHOY	17	26	7
BROCCOLI	2134	1686	1700
CABBAGE		<1	2
CARROT	480		881
CAULIFLOWER	404	416	114
CHINESE CABBAGE (NAPPA)	68	66	58
CORN, HUMAN CONSUMPTION	28		
GRAPE, WINE	83	260	347
KALE	1	<1	
LETTUCE, HEAD	1606	1518	2189
LETTUCE, LEAF	530	623	471
N-GRNHS FLOWER	2		<1
N-GRNHS PLANTS IN CONTAINERS	254	240	81
N-GRNHS TRANSPLANTS	<1		
N-OUTDR FLOWER		3	0
N-OUTDR TRANSPLANTS	23	9	11
ONION, DRY	16		311
PEAS	64	101	42
RADISH	<1	<1	<1
RASPBERRY			1
SPINACH	56		98
STRAWBERRY	12		10
VERTEBRATE CONTROL	10		
Grand Total	5789	4949	6322

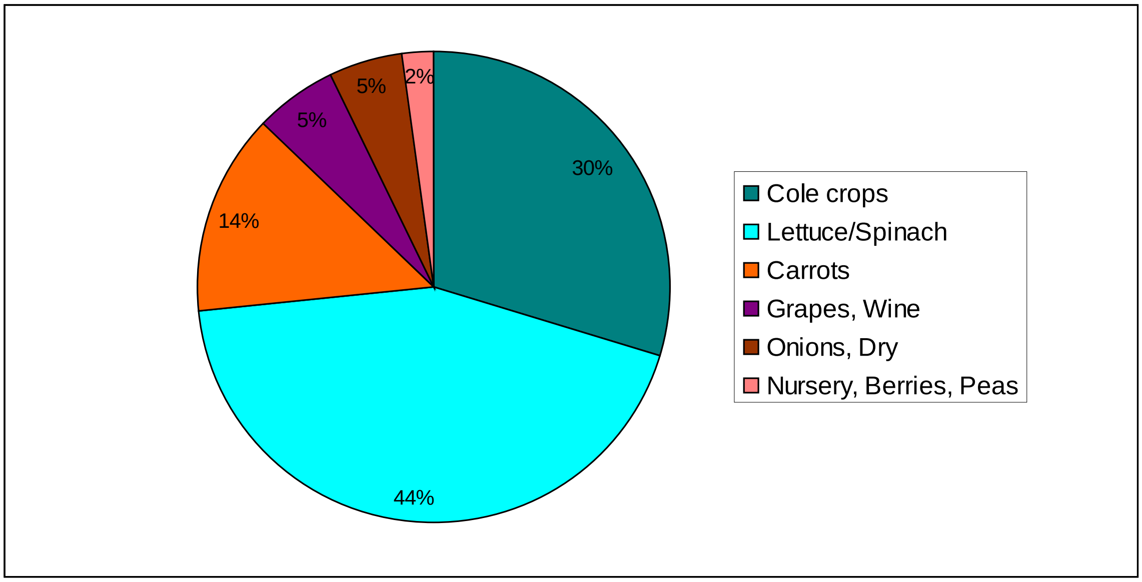

Figure 4-2 2008 Diazinon applications in the Santa Maria watershed (percent of total mass applied).

Summary of Organophosphate Pesticide Sources

Irrigated agricultural pesticide applications are the sources of organophosphate pesticide surface water impairments in the Santa Maria watershed. The sources of specific chemicals is summarized in (Table 4-8).

Table 4-8 Summary of Organophosphate Pesticide Surface Water Impairments

Chemical	**Applications**
Chlorpyrifos	Granular application to cole crops
Diazinon	Spray application to broccoli and lettuce crops
Malathion	Foliar spray applications to broccoli, celery, lettuce and strawberries crops

4.2. Source Analysis of Pyrethoid Pesticide Pollution

No surface waters were listed as impaired on the 2008 303(d) list for pyrethroids but since the listing, several pyrethroid surface waters were identified as impaired and included in the TMDL. These same surface waters were impaired for sediment toxicity and the UC Davis TMDL found an association of pyrethroid pollution to some sediment toxicity in the watershed (Phillips et al. 2010). Agricultural and urban pesticide uses were identified as sources of the pyrethroid pollution in the TMDL.

The UC Davis TMDL Study monitored surface waters in the Santa Maria Valley for concentration of pyrethroids in the water column and sediment and impairments were at Blosser Channel, Bradley Channel, Main Street Canal, Orcutt Creek and the Lower Santa Maria River. The UC Davis TMDL Study sampled sites in proximity to urban areas to evaluate the level of urban contribution pesticide contamination; the level of sediment toxicity was generally greater in drainages with urban runoff. The magnitude of sediment toxicity was evaluated based on pyrethroid toxicity units. Toxicity units are calculated based on established LC50s for pesticides in sediment median lethal concentrations and provide a useful indicator to compare the magnitude of detected pesticides. The detections were corrected for concentrations of organic carbon and the LC50s were based on organic carbon corrected concentrations. The toxicity units (Table 4-9) were calculated by dividing the detected concentration in the sediment by the LC50. The various pyrethroid's have similar toxicity mechanisms that are additive. Toxicity units were totaled for each site in Table 4-9 to provide an indication on the combined toxicity detected in the sediment at the site.

Table 4-9 Summary of Pyrethroid Toxicity Units Detected in Sediment from the TMDL Monitoring Study

Chemical	**Bradley Channel***	**Blosser***	**Main St***	**Orcutt Creek**	**Santa Maria River above the Estuary**		**Greene Valley**	**Orcutt Creek Brown Road**
Monitoring Site Id.	312BRO	312BCD	312MSS	312ORC	312SMA	312SMA	312GVS	312GVT
Date	6/19/2009	6/19/2009	6/19/2009	12/9/2008	12/9/2008	6/19/2009	6/19/2009	6/19/2009
Bifenthrin	4.83	9.35	1.17					
Cyfluthrin		0.44	5.78				0.08	0.46
Cypermethrin	2.84	1.97	38.29	1.18	0.82	0.97	0.53	0.18
Esfenvalerate		0.02	0.08	0.23	0.18	0.06	0.06	0.16
L-Cyhalothrin	0.11	0.42	8.11	0.82	1.53	0.18	0.13	0.24
Permethrin	0.34	1.53	1.45					0.96
Total TUs**	**8.12**	**13.74**	**54.88**	**2.24**	**2.52**	**1.21**	**0.80**	**2.00**

*Monitoring sites in watersheds with significant urban land use
**Note: TU value equal to 1 implies toxicity to 50% of test organisms. TU values greater than 1 indicate toxicity greater than that which is lethal to 50% of test organisms.

Pyrethroids are commonly applied urban pesticides. Commercial use is reported as structural applications at the county level. Staff estimated the use in the Santa Maria based on population the county and the cities in the Santa Maria Valley. Staff assumed that pesticide use would be in proportion to the population based on the 2000 U.S. census. In 2000, Santa Barbara County had a population of 399,347. The Santa Maria Valley (City of Santa Maria, Orcutt and Guadalupe) had a population of 111,912, or 28 % of the county population.

Table 4-10 2006-2008 Average Reported Structural Pyrethroid Pesticide Use

Pesticide	**Santa Barbara County (Lbs. active ingredient)**	**Santa Maria Valley* (Lbs. active ingredient)**

BIFENTHRIN	959.87	259.17
CYFLUTHRIN	159.36	43.03
CYPERMETHRIN	637.72	172.19
ESFENVALERATE	1.36	0.37
LAMBDA-CYHALOTHRIN	214.53	57.92
PERMETHRIN	1560.33	421.29

* Estimated based on the Santa Maria Valley having 28% of the population in Santa Barbara County

In terms of sediment toxicity, Cypermethrin is 29 times more toxic, relative to the other species of pyrethroids.

Staff surveyed the insecticides for sale in the San Luis Obispo Home Depot home and garden center December 12, 2010 to understand consumer pyrethroid use. Staff investigated home and garden insecticides and active ingredients and found pyrethroids were commonly available for consumer home use. See Table 4-11. Staff concluded based on detections in drainages with urban run-off (Table 4-9) that pyrethroids are commonly used in the urban environment and consumer home and garden applications are likely a source of surface water impairment.

Table 4-11 Home and Garden Pesticides Sold in San Luis Obispo

Insecticide	Active Ingredient
Ortho Home Defense Max	Bifenthrin
Ortho Bug B Gone Max Insect Killer for Lawn	Bifenthrin
Ortho Total Kill Lawn and Garden Insect Killer	Bifenthrin
Ortho Home Defense Max Termite and Destructive Bug Killer	Bifenthrin
Ortho Bug B Bone Max Insect Killer for Lawns	Bifenthrin
Bayer Complete Insect Killer	Cyfluthrin
Ortho Total Kill Brand Lawn and Garden Insect Killer	Permethrin
Spectracide Termite and Carpinter Ant Killer	Lambda-Cyhalothrin
Spectacide Bug Stop Indoor Plus Outdoor	Lambda-Cyhalothrin
Hotspot Roach and Ant	Lambda-Cyhalothrin
Bayer Home Pest Control	B-Cyfluthrin

Insecticide	Active Ingredient
Bayer Complete Insect Killer for Soil and Turf	B-Cyfluthrin

Staffs considered whether publicly owned treatment works (POTWs) or treated waste water were potential sources of pyrethroid pollution. Staff found them not to be a significant source because in the Santa Maria watershed they discharge to land and not surface waters. In other parts of the state POTWs have been found to be a source of pollution. Researchers in the Sacramento and San Joaquin Delta areas of California identified municipal waste water treatment plants as possible sources of pyrethroids in surface waters (Weston 2010). In the Santa Maria Valley there are three POTWs, but they discharge treated effluent to land through percolation ponds or spray fields. Effluent from the largest POTW, the Santa Maria Waste Water Treament plant, percolates to groundwater from retention ponds and is not considered a source of pyrethroids in surface waters. Laguna Sanitation and the Guadalupe treatment plants discharge treated effluent to spray fields. Run-off from the spray fields could possibly contaminate adjacent surface waters with pyrethroids in run-off, but based on available monitoring data and the nature of discharges, they were not considered significant sources in the Santa Maria watershed. Pyrethroid pesticides are transported in runoff bound to sediment and given the vegetation in the spray fields, and low gradient soil erosion did not appear likely. Also vegetation buffered the adjacent surface waters from the spray fields.

Sources of Specific Pyrethroid Pesticides in Surface Waters

Bifenthrin

Bifenthrin was detected at high levels in drainages with both urban and agricultural influence. It was detected above one toxicity unit in Bradley Channel, Blosser Channel and Main Street Canal. It was not detected in the Lower Orcutt Creek, Green Valley Creek, the Santa Maria River and Oso Flaco Lake and Creek, which are drainages with primarily agricultural use. Structural and landscape pest control applications of Bifenthrin are reported at the county level. Staff summarized the three year average (2006-2008) reported agricultural and non-agricultural use for San Luis Obispo and Santa Barbara Counties (Table 4-12). Forty-eight percent of the applications were structural pest control applications and 47 percent were to strawberries.

Distribution of bifenthrin strawberry applications in the Santa Maria Valley are shown in Figure 4-5. In 2008 approximately 583 pounds of were applied in the Santa Maria Valley east of the city, another 452 pounds were applied west of the city and 314 pounds in the Oso Flaco watershed.

The estimated reported structural use in the Santa Maria Valley was 259 pounds in 2008 (refer to Table 4-10). The annual average of unreported urban use in California was determined by the Urban Pestcide Pollution Prevention UP3 project to be approximately 20% of the total urban bifenthrin use (TDC 2010).

Structural pest control applications may include the treatment of impervious surfaces to control pests such as ants and spiders. Bifenthrin is a common home and garden insecticide active ingredient; the primary manufacture is Scotts Miracle-Gro and it is sold under the Ortho Label. Staff surveyed the bifenthrin products on the local Home Depot retail home improvement center and found several broadcast and spray formulations available. The broadcast granular formulas were for soil and lawn treatment and spray formulas were for killing ants and spiders around structures. Strawberry applications in 2006-2008 were all wettable powder formulations. Reported structural pest control applications in Santa Barbara County were 80% flowable or liquid concentrate formulations, 18% granular/flake formulation and 2% were unknown.

Table 4-12 2006-2008 Average Pounds of Reported Bifenthrin Use in San Luis Obispo and Santa Barbara Counties

Crop	Average Lbs. AI	Percent
ARTICHOKE, GLOBE	37.88	2%
LANDSCAPE MAINTENANCE	20.98	1%
STRAWBERRY	958.31	47%
STRUCTURAL PEST CONTROL	959.87	48%
Other Crops	42.42	2%
Total	2019.46	

Staff met with Surrenda Dara Phd., a UC Cooperative Extension vegetable and strawberry crop advisor in Santa Barbara and San Luis Obispo Counties to better understand crop production and pest management. Strawberries are generally an annual crop in the Santa Maria watershed. Strawberries are typically planted in October and November. They are grown from transplants in raised beds with plastic mulch. They are sprinkler irrigated for four to six weeks after planting to establish the transplants and then they are drip irrigated. There is a high potential for irrigation and storm water runoff from fields during the winter establishment period.

Common strawberry insect pests are mites and lygus bugs. Bifenthrin is used to control these pests. These pests are generally not a problem during the establishment period. The DPR pesticide use data was used by staff to analyze temporal trends in application of bifenthrin on strawberries in San Luis Obispo and Santa Barbara counties. Figure 4-3 illustrates the bifenthrin use on strawberries in San Luis Obispo and Santa Barbara Counties. Applications were lowest during the winter and early spring establishment period and highest during early summer and fall. Bifenthrin has a half-life 26 days in soil and residues in soil after applications could leave the fields in run-off discharge, thereby contaminated surface waters. The month of October was the highest application, which is immediately prior to the rainy season in the project area.

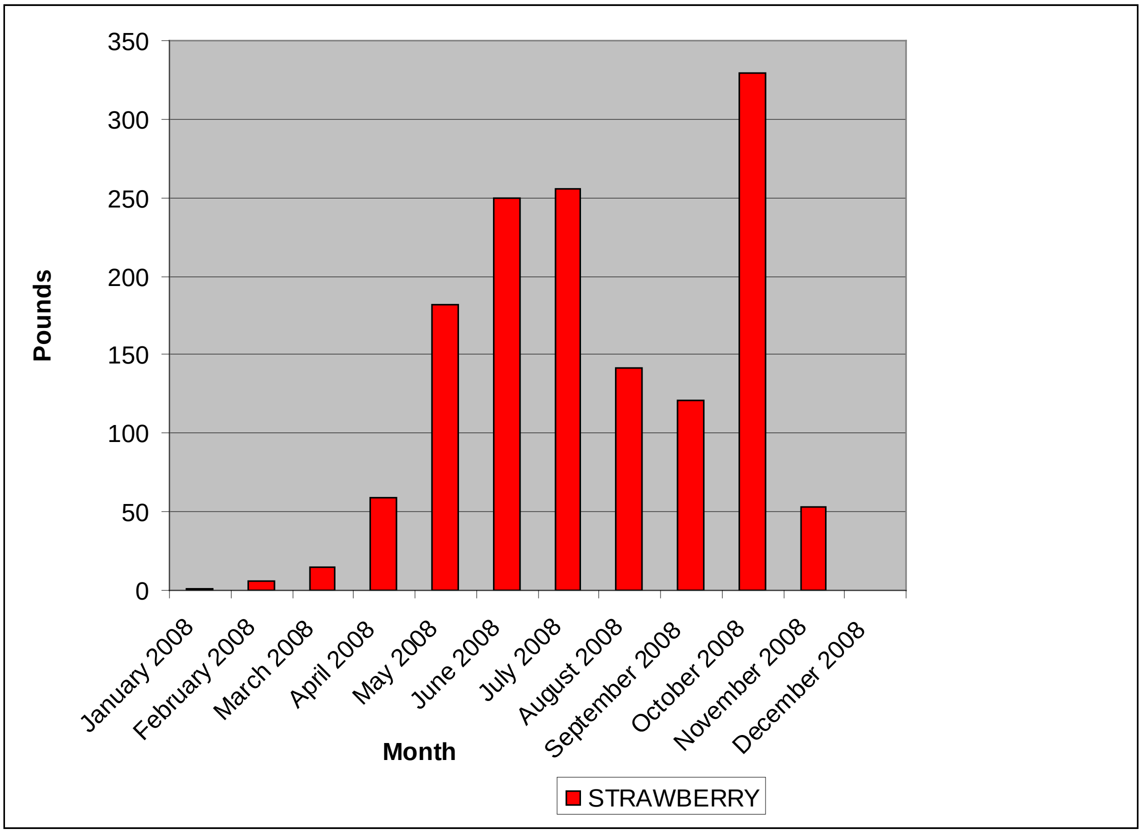

Figure 4-3 Monthly Bifenthrin Use on Strawberries in San Luis Obispo and Santa Barbara Counties in 2008

Table 4-13 shows the combined bifenthrin applications for strawberries and structural pest control in San Luis Obispo and Santa Barbara Counties in 2008. The structural applications were about half the total mass of the strawberry applications. Like applications to strawberries, structural pest control peaked in July, a non-rainy month. Structural applications have a second peak application period during the rainy season in December (refer to Figure 4-4).

Table 4-13 2008 Monthly Reported Bifenthrin Use on Strawberry and for Structural Pest Control in San Luis Obispo and Santa Barbara Counties

	Bifenthrin (Lbs.)	
Month	**Strawberries**	**Structural Pest Control**
January 2008	1.20	31.77
February 2008	6.00	31.97
March 2008	15.10	41.66
April 2008	59.05	39.58
May 2008	181.52	43.60

Month	Bifenthrin (Lbs.)	
	Strawberries	**Structural Pest Control**
June 2008	250.17	37.51
July 2008	**255.86**	**205.41**
August 2008	141.11	47.78
September 2008	121.29	58.75
October 2008	**329.12**	57.64
November 2008	52.85	25.33
December 2008		**113.67**
Total 2008	1413.26	734.66

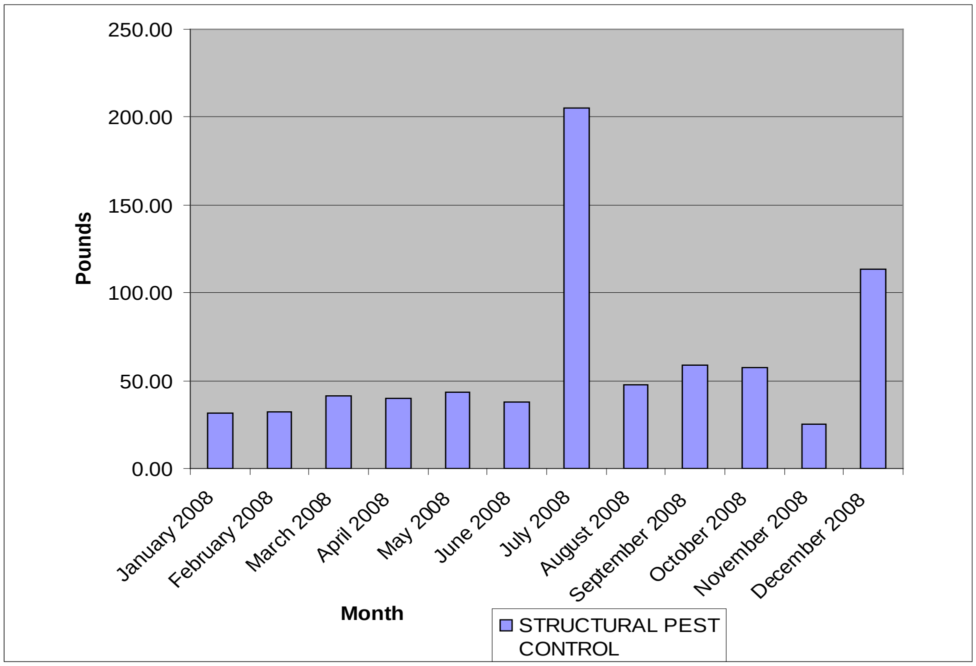

Figure 4-4 Monthly Bifenthrin Structural Pest Control Use in San Luis Obispo and Santa Barbara Counties

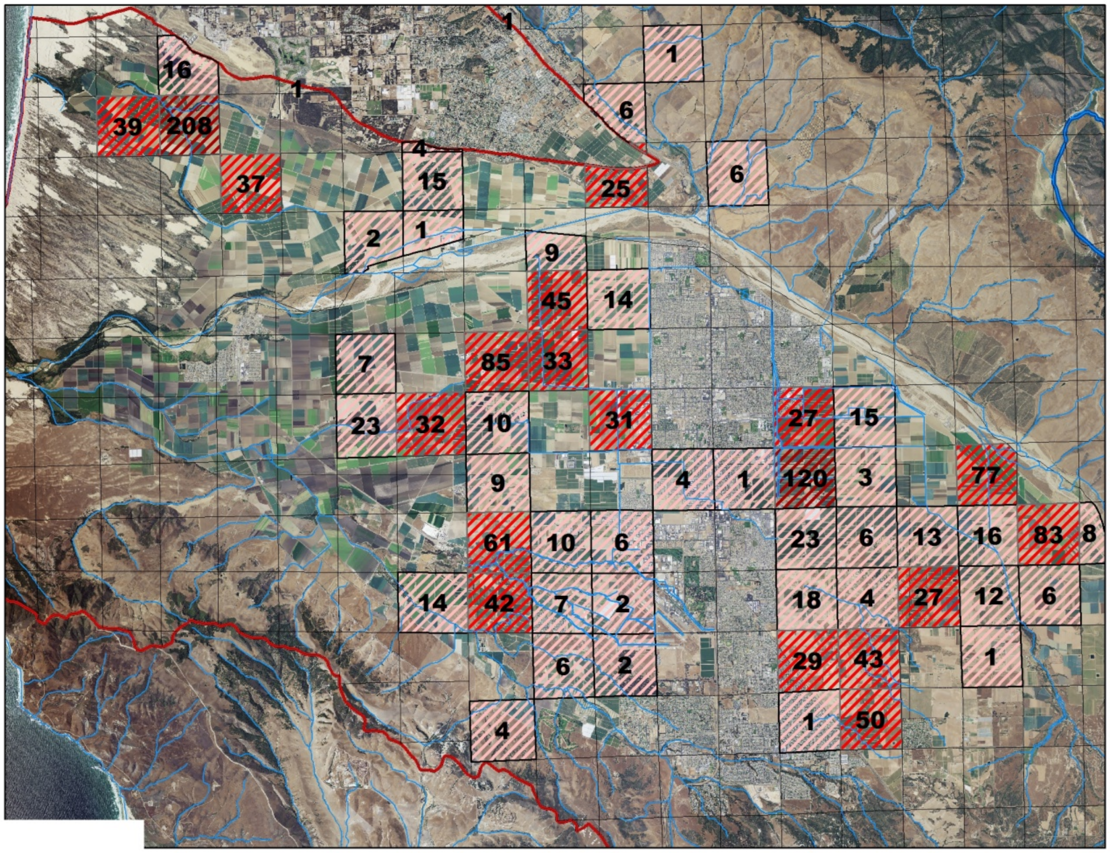

Figure 4-5 Pounds of Bifenthrin applied to Strawberries in 2008.

Summary of Bifenthrin Sources

The primary source of bifenthrin impairments is from urban land use (Table 4-9), but applications to strawberries are also a source. Figure 4-5 illustrates the proximity of strawberry production to urban areas and the potential contribution from applications of bifenthrin to strawberries to contribute to water quality problems.

Cypermethrin

The highest levels of cypermethrin were detected in drainages with urban contributions (Table 4-9). The TMDL study found over 38 TUs of cypermethrin in sediment at the Main Street Channel monitoring site which is a site with urban run-off.ypermethrin was detected in agricultural drainages at concentration known to cause toxicity but at much lower TUs than in the urban drainages.

The estimated reported structural use of cypermethrin in the Santa Maria Valley was 172 pounds in 2008 (refer to Table 4-10). In 2008, 18% of the structural applications were reported as wettable powder formulations and 82% were emulsifiable or liquid concentrates in Santa Barbara County. Staff surveyed the cypermethrin products on the local San Luis Obsipo Home Depot retail home improvement center and found predominantly aerosol can, ready to use formulations of ant and roach sprays. In a study of urban pyrethroid use in the Sacramento and San Joaquin Delta areas, toxicologically significant concentrations of cypermethrin were detected in urban run-off (Weston, 2010). The researchers considered the urban run-off samples from the delta study area to be representative of general urban run-off throughout California.

The agricultural use of cypermethrin in the Santa Maria Watershed was predominantly on rotational vegetable crops. Applications to dry onions were exclusively in the Cuyama Valley. Over 99% of the remaining applications were to vegetables in the Santa Maria Valley. Table 4-14 shows the application of cypermethrin to agricultural crops in the Santa Maria watershed.

Table 4-14 2008 Pounds of Cypermethrin Applied to Agricultural Crops in the Santa Maria Watershed

Crops	Lbs. A.I.	Percent
BROCCOLI	95.42	26%
CAULIFLOWER	54.33	15%
CELERY	58.20	16%
LETTUCE (Head and Leaf) and SPINACH*	84.69	23%
ONION, DRY	55.80	15%
OTHER VEGETABLES*	22.77	6%
Total	371.22	

*A summary of more than one reported crop type

Summary of Cypermethrin Sources

Due to the high levels of cypermethrin detected in drainages with urban run-off (Table 4-9) and findings from representative urban pesticide run-off studies, the primary sources of cypermethrin are urban structural and consumer home use applications. Irrigated agricultural applications were also a source particularly in drainages such as Orcutt Creek and the Lower Santa Maria River, with minimal urban influence.

Cyfluthrin

Cyfluthrin was only detected in drainages with urban run-off and was not dected in drainages dominated with irrigated agricultural land use. The TMDL study found over 5.78 TUs of cyfluthrin in sediment at the Main Street Channel monitoring site and .44 TUs at the Blosser Channel monitoring site (Table 4-9).

The estimated reported structural use of cyfluthrin in the Santa Maria Valley was 43 pounds in 2008 (refer to Table 4-10). In 2008, 97% of the structural applications were reported as liquid concentrate formulations in Santa Barbara County. Staff surveyed the cyfluthrin products on the local San Luis Obispo Home Depot retail home improvement center and found liquid concentrate and ready to use liquid formulations (Table 4-11). The concentrate product was for soil and lawn insect control and the ready to use formula was for indoor and outdoor home use on insects such as ants and roaches. In a study of urban pyrethroid use in the Sacramento and San Joaquin Delta, toxicologically significant concentrations of cyfluthrin were detected in urban run-off (Weston, 2010). The urban run-off was considered representative of urban run-off in California.

Table 4-15 2008 Pounds of Cyfluthrin Applied to Agricultural Crops in the Santa Maria Watershed

Crops	Lbs. a.i.	Percent
POTATO	48.24	29%
CARROT	40.74	24%
LETTUCE, (Head and Leaf)*	30.87	18%
CELERY	23.98	14%
NURSERY CROPS	11.79	7%
OTHER VEGETABLES*	13.71	8%
Total	169.32	

*A summary of more than one reported crop type

In 2008, the agricultural use of cyfluthrin in the Santa Maria Watershed was predominantly on irrigated field crops. Applications to carrots and potatoes were exclusively in the Cuyama Valley.

Summary of Cyfluthrin Sources

Based on the high levels detected at monitoring sites with urban run-off and the absence at sites with predominantly irrigated agricultural land use, urban structural and consumer home applications are the primary source of cyfluthrin pesticide surface water impairments in the Santa Maria watershed.

Esfenvalerate

Esfenvalerate was detected in sediment at sub-toxic levels at most sites sampled in the Santa Maria Valley. For the TMDL monitoring, the highest levels were in the lower Orcutt Creek watershed (312ORC) and in the Santa Maria River above the estuary (312SMA); the sites have 0.23 and 0.18 TUs respectively. The levels were lowest in the drainages with urban run-off.

In 2008 only 1.36 pounds of esfenvalerate were applied as structural pest control applications in Santa Barbara County. Staff surveyed pesticides at the San Luis Obsipo Home Depot and no products with esfenvalerate were found.

In 2008, esfenvalerate was used on a wide range of irrigated crops in the Santa Maria Watershed (Table 4-16). Applications to carrots, potatoes, and fruit trees occurred in the Cuyama Valley. The remaining applications were to irrigated vegetable crops in the Santa Maria Valley, with the largest amount applied to broccoli.

Table 4-16 2008 Pounds of Esfenvalerate Applied to Agricultural Crops in the Santa Maria Watershed

Crops	Lbs. a.i.	Percent
CARROT	422.68	47%
BROCCOLI	218.34	24%
CORN, HUMAN CONSUMPTION	80.38	9%
POTATO	73.04	8%
CAULIFLOWER	38.74	4%
LETTUCE, (head and leaf)*	33.79	4%
ARTICHOKE, GLOBE	13.24	1%
FRUIT TREES (Peaches and Nectarines)*	10.87	1%
OTHER VEGETABLES*	9.57	1%
Total	900.64	

*A summary of more than one reported crop type

Summary of Esfenvalerate Sources

Based on detections in drainages with predominantly irrigated agricultural land use and the lack of reported non-agricultural use and consumer products, irrigated agricultural applications were determined to be the primary source of surface water pollution in the Santa Maria watershed. The primary agricultural application was to broccoli and cauliflower crops (Table 4-16).

Lambda-Cyhalothrin

The UC Davis TMDL Study detected lambda-cyhalothrin at all sites monitored in the Santa Maria Valley except the monitoring sites in the Oso Flaco sub-watershed. The highest level of lambda-cyhalothrin (8.11 TUs) was in Main Street Canal (312MSS), which has urban contributions. The study also detected 0.82 TUs of lambda-cyhalothrin in sediment at the lower Orcutt Creek monitoring site (312ORC) and 1.53 TUs at the Santa Maria River above the estuary (312SMA) which have predominantly irrigated agricultural land uses in the sub-watersheds.

The estimated reported structural use of lambda-cyhalothrin in the Santa Maria Valley was 58 pounds in 2008 (refer to Table 4-10). In 2008, 100% of the structural applications were reported as liquid or liquid concentrate formulations in Santa Barbara County. Staff surveyed the lambda-cyhalothrin products in the San Luis Obsipo Home Depot retail home improvement center and found predominantly liquid spray and aerosol spray formulation products for termite, roach and ant control. The UP3 project estimated that the unreported statewide consumer use of lambda-cyhalothrin was 69% of total urban use in California (TDC, 2010). In a study of urban pyrethroid use in the Sacramento and San Joaquin Delta, toxicologically significant concentrations of lambda-cyhalothrin were detected in urban run-off (Weston, 2010).

Table 4-17 2008 Pounds of Lambda-Cyhalothrin Applied to Agricultural Crops in the Santa Maria Watershed

Crops	Lbs. a.i.	Percent
LETTUCE, (Head and Leaf)	329.56	62%
BROCCOLI	124.69	24%
OTHER COLE CROPS*	31.13	6%
ALFALFA	21.58	4%
VEGETABLES,	8.96	2%
BEAN, SUCCULENT	8.09	2%
NURSERY,	2.49	0%
CORN, HUMAN CONSUMPTION	1.96	0%
Total	528.46	

*A summary of more than one reported crop type

In 2008, 528 pounds of lambda-cyhalothrin were used on irrigated crops in the Santa Maria Watershed, and of this 490 pounds were used in the Santa Maria Valley on primarily lettuce, broccoli and other cole crops.

Summary of Lambda-cyhalothrin Sources

The primary source of L-cyhalothrin pollution is urban structural and consumer home use but due to detections in predominately agricultural drainages, irrigated agriculture is also a potential source. The primarily irrigated agricultural applications were to lettuce and broccoli (Table 4-17).

Permethrin

The highest levels of permethrin were detected in drainages with urban contributions (Table 4-9). The TMDL study detected over 1.45 TUs of permethrin in sediment at the Main Street Channel monitoring site (312MSS), 1.53 TUs at Blosser Channel and .34 TUs in Bradley Channel. Permethrin was not detected in the sediment at the other TMDL study monitoring sites with primarily agricultural runoff.

The estimated reported structural use of cypermethrin in the Santa Maria Valley was 421 pounds in 2008 (refer to Table 4-10). In 2008, 99% of the structural applications were reported as emulsifiable concentrate formulations in Santa Barbara County. Staff surveyed the pyrethroid consumer pesticide products at the local San Luis Obsipo Home Depot retail home improvement center and found one lawn and garden product was for sale (Table 4-11). In a study of urban pyrethroid use in the Sacramento and San Joaquin Delta, toxicologically significant concentrations of permethrin were detected in urban run-off (Weston, 2010). The urban run-off in the study was considered representative of urban run-off in California.

In 2008, 6114 pounds of permethrin were used on irrigated crops in the Santa Maria Watershed. In the Cuyama Valley permethrin was only applied to potatoes. Permethrin was used extensively in the Santa Maria Valley on lettuce and celery crops. Table 4-18 identifies the permethrin usage on crops in the project area.

Table 4-18 2008 Pounds of Permethrin Applied to Agricultural Crops in the Santa Maria Watershed

Crops	Lbs. a.i.	Percent
LETTUCE, (Head and Leaf)*	4439.44	72%
CELERY	993.22	16%
POTATO	251.90	4%
SPINACH	215.84	4%
BROCCOLI	70.84	1%
ARTICHOKE, GLOBE	40.65	1%
NURSERY, MISC.*	54.61	1%
OTHER VEGETABLES*	47.80	1%
Total	6114.31	

*A summary of more than one reported crop type

Summary of Permethrin Sources

The primary source of permethrin in the Santa Maria watershed is urban applications but due to the extensive irrigated agricultural use (Table 4-18), applications to lettuce and celery are also a potential source.

Summary of Pyrethroid Pesticides Sources

The primary sources pyrethroid pesticide pollution of surface waters in the Santa Maria watershed are urban structural and consumer applications and applications to irrigated agricultural crops. The source vary depending on the specific pyrethroid chemical and the sources are summarized in

Table 4-19 Summary of Pyrethroid Pesticides and Sources in the Watershed

Chemical	Sources
Bifenthrin	Urban structural and consumer home applications and agricultural applications to strawberries
Cypermethrin	Urban structural and consumer home applications and agricultural applications to cole crops and lettuce.
Cyfluthrin	Urban structural and consumer home applications
Esfenvalerate	Irrigated agricultural applications to broccoli and cauliflower
L-Cyhalothrin	Urban structural and consumer home applications and agricultural applications to lettuce and broccoli
Permethrin	Urban structural and consumer home applications along with irrigated agricultural applications to lettuce and celery

4.3. Source Analysis of Organochlorine Pesticide Pollution

This section describes the historic use in relation to potential current sources of organochlorine pesticides in the Santa Maria Watershed. Since organochlorine pesticides are no longer used, they are entering surface waters from sites of past use and from drainage areas with polluted sediment.

Organochlorine Pesticide Timeline

1874 – DDT was first synthesized (EPA, 1975)

1915 - The Mosquito Abatement Districts Act was passed. The bill authorized the formation of mosquito control districts in the State of California.

1939 – DDT's insecticidal properties were discovered by Dr. P. Muller working for the J.R. Geigy Chemical Co. (EPA, 1975).

1945 – Widespread agricultural and commercial use of DDT in the U.S. (EPA, 1975).

1948 – The Noble Prize was awarded to Dr. Muller for the discovery of DDT's insecticidal properties (Muir, 1998).

1947 to 1980 – Toxaphene was used as an insecticide mainly on cotton in the U.S. and on crops such as broccoli, celery, lettuce and cauliflower in California (USFWS, 1985).

1948 to 1988 – Chlordane was used as a pesticide on crops such as corn and citrus, as a home and garden pesticide and as termite control (ATSDR, 1995).

1950 – Start of limited pesticide use reporting in California through the county agricultural commissioners (CDPR 2011).

1950s to 1970 - Dieldrin was widely used as a crop pesticide on corn and cotton (OEHHA, 2010).

1954 - Major Pests and vector mosquitoes developed resistance to DDT in California (Fountaine, 1980).

1962 – Publication of *Silent Spring* by Rachell Carson and the beginning of public concern over the possible hazards from the use of DDT (EPA 1975).

1972 - DDT use was banned in the United States (ATSDR 2002).

1974 – All uses of aldrin and dieldrin except to control termites were banned (ATSDR, 2002).

1982 - Most uses of Toxaphene canceled in United States (ATSDR, 2011).

1983 – All uses of chlordane were banned except control of termites which was banned in 1988 (ATSDR, 1995).

1984 - State Assembly adopted HR 52, which directed the Department of Food and Agriculture (CDFA) to investigate sources of DDT in the environment (CDFA, 1995).

1985 – CDFA study of agricultural sources of DDT residues. Analysis DDT concentrations in soil samples from agricultural sites historically treated with DDT (CDFA, 1995).

1987 – EPA banned use of dieldrin (ATSDR, 2002).

1990 – All registered uses of Toxaphene banned (ATSDR, 2011).

1990 – DPR began full pesticide use reporting. Reports include data and location of application and information on the crop and amount of pesticide applied. Non-professional home and garden application reporting was not required (CDPR, 2011).

1998 – Study of chemical and biological measures of sediment quality in the Central Coast Region. Study found that sediment values in the Santa Maria River were amongst the highest measured in the regional study (CSWQCB, 1998).

2005 –Sand crabs sampled from Central Coast beaches for concentrations of legacy pesticides in tissue (Dugan, 2005). High concentrations of pesticides detected near the Santa Maria River.

2007 to 2008 – Two year screening survey of contaminants in fish from California lakes and reservoirs referred to as the SWAMP Lake Study. Fish from Oso Flaco and Little Oso Flaco Lakes were sampled for the study and had the highest levels of pesticides detected in the statewide survey (SWAMP, 2010).

2008 to 2009 – A UC Davis TMDL Study samples the sediment of main channels and tributaries in the Santa Maria Valley for organochlorine pesticides in sediment (Phillips, 2010).

2010 – The UC Davis BMP Study monitors the Santa Maria Estuary for concentrations of OC pesticides in sediment and concentrations of OCs in tissue from sand crabs caught outside the estuary (Anderson, 2010).

DDT Source Analysis

This section describes the results of a 1984 source analysis study of DDT in California and the results of the recent UC Davis TMDL Study monitoring of OC pesticides in sediment in the Santa Maria Valley.

CDFA Investigation of Sources of DDT

In 1984, the California State Assembly adopted HR 53, which directed the Department of Food and Agriculture to investigate possible sources of DDT in the environment. The study was initiated by State Board findings of concerning levels of DDT and metabolites in fish tissue well over a decade after the ban on DDT. CDFA summarized its conclusions in a report titled; *Agricultural Sources of DDT Residues in California' Environment* (CDFA, 1985). Possible sources of DDT investigated in the study were new illegal uses and other pesticides with residues of DDT. Specific findings from the study are listed below:

1. "Before its ban, DDT was widely used in California in agriculture and for control of mosquitoes and other disease-carrying insects."
2. There was no evidence of any illegal use of DDT since its ban. In 1983, 87,000 pesticide use enforcement inspections and 3,501 investigations of possible violations were made by California County Agricultural Commissioners. None of these involved DDT. Also in 1983, about 1300 pesticide samples were analyzed to determine what chemicals they actually contained.

   The results show 97.5% of these samples met registration and labeling requirements. The remaining 2.5% did not involve DDT. Even before its ban, agricultural use of DDT was declining as more insects became resistant to DDT.

3. Contamination of other pesticides by DDT could not account for the residues. There have been reports that dicofol (Kelthane®) contained large amounts of DDT. Samples of dicofol sold in California examined in 1983-84 contained very low levels of DDT, usually less than 1%, too low to account for DDT residues found.

4. Detectable levels of DDT found on some California produce were, in most cases, well below acceptable levels. Nearly all produce samples found with residues of DDTr have an edible portion which grows in or close to the ground, such as carrots, beets, lettuce, or spinach. DDTr (Note for the purposes of this report DDTr: refers to the parent compound DDT and all its degradation products DDD and DDE, this is also refered to as Total DDT) residues found on produce are probably the result of contamination from soil containing DDTr.

5. On average, about half the DDTr detected was present as DDT in the environment. However, the composition of DDT found in soil was more

stable than previously thought; therefore the kinds of DDT residues present in soil did not necessarily indicate new use.

6. Soil contaminated with DDTr may be moved into drains as a result of normal field work such as land leveling. Fish and shellfish pick up DDTr from the soil particles in the water.

7. DDTr residues were present in soil wherever DDT was used legally in the past. In 1985, CDFA collected 99 soil samples in 32 California counties from locations where DDT had been used in the past. All samples contained DDTr."

In the study, CDFA, with assistance from county agricultural commissioners, sampled soils for DDT from fields in counties with high historic DDT use. The report had a statewide map of the sample sites. Samples were taken from 3 sites in Northern Santa Barbara County and 4 sites in southern San Luis Obispo County. The results of the sampling are shown in Table 4-20. The ratio of sum DDT to total DDT was analyzed in the study to evaluate the extent that the applied DDT had broken down. In 1984 the statewide average from the survey was 49% sum DDT isomers out of the total DDT detected. It is important to note that in 1988 almost half of the detected in the statewide sampling was the parent product (DDT). The ratios were even higher in the samples from San Luis Obispo and Santa Barbara Counties. Current stream sediment samples have much less parent material, which leads staff to conclude that the pesticide is breaking down in the environment. Refer to the sum DDT to total DDT ratios in Table 4-20 and Table 4-22.

Table 4-20 Data from 1985 Soil Monitoring Survey for DDT

County Name	Site No.	o.p' DDT (ppb)	p,p' DDT (ppb)	o,p' DDD (ppb)	p,p' DDD (ppb)	o,p' DDE (ppb)	p,p' DDE (ppb)	Ratio DDT / Total DDT
San Luis Obispo	1	72	322	13	41	7	258	55
	2	144	605	21	82	10	384	60
	3	606	2,661	124	370	52	1,688	59
	4	880	3,484	220	455	105	3,326	52
Santa Barbara	1	289	1,602	35	106	11	494	75
	2	444	2,121	47	179	11	627	75
*		-361	-1,706	-34	-133	-15	-516	-75
	3	19	101	2	5	2	84	56
*		-21	-116	-2	-10	-2	-94	-56

*Duplicate samples

The report also summarized reported DDT use in California from 1970 to 1980 (Table 4-21). Reported use of DDT dropped sharply after 1970.

Table 4-21 DDT Use in California from 1970 to 1980a (Mischke et al, 1985)

Year	Pounds Used	Main Use
1970	1,164,699	agricultural

1971	111,058	agricultural
1972	80,800	agricultural
1973b	NURb,c	--
1974	160	residential pest control (SLN)
1975-1980	less than 200 lbs per year	Vector control (SLN)

a. 1970 was the first year in which the amount of restricted pesticides used in California was reported. In 1980, the introduction of new pesticides replaced the need to use DDT for vector control.
b. Year all use banned except for special local needs (SLN)
c. NUR - no use reported

TMDL Monitoring of DDT in Sediment

In 2008 and 2009 UC Davis sampled sediment at monitoring sites in drainages throughout the Santa Maria Valley for concentrations of DDT (Figure 4-6). The samples were analyzed for concentrations of the isomers of DDT and the derivatives DDD and DDE. The results of the sampling are shown in Table 4-22 . The most prevalent isomer was the DDT breakdown product 4', 4' DDE isomer. The percent of the sum DDT isomers to the total DDTs was low with an average of 4% at all sites. This was much lower than the soil levels detected in 1984 (Table 4-21), which indicates that DDT is breaking down in the environment. Technical grade DDT (undiluted) is comprised of a mixture of 70 to 80% 4'4' DDT and 20 to 30 % 2'4' DDT (Mischke, 1985). The sediment samples were comprised of primarily DDT breakdown products DDD and DDE. The samples averaged 18% sum DDD to total DDT and 78% DDE to total DDT.

Table 4-22 Summary of DDT Sediment Monitoring Data(Sum and Total DDT)

				Detected Chemicals in Sediment (ng/g or ppb)						
Station	**Station Name**	**Primary Source of Surface Flow**	**Analysis Date**	**Sum DDT**	**Sum DDD**	**Sum DDE**	**Total DDTs**	**% Sum DDT to Total DDT**	**% Sum DDD to Total DDT**	**% Sum DDE to Total DDT**
312SOL	Solomon Crk	Agriculture	6/19/2009	5.8	**50.6**	**211.9**	268.3	2%	19%	79%
312ORC	Orcutt Ck. At Sand Plant	Agriculture	12/9/2008	3.2	**31.3**	**132.6**	167.1	2%	19%	79%
312SMA	Santa Maria River above the estuary	Agriculture	12/9/2008	13.1	**98.4**	**344.1**	455.6	3%	22%	76%
312SMA	Santa Maria River river above the estuary	Agriculture	6/19/2009	7.6	**51.6**	**281.4**	340.6	2%	15%	83%
312GVS	Green Valley Creek at Simas Rd.	Agriculture	6/19/2009	9.8	**41.9**	**170.2**	221.9	4%	19%	77%
312GVT	Orcutt Ck. at Brown Rd.	Agriculture	6/19/2009	9.3	**35.5**	**63.7**	108.5	9%	33%	59%
312OFC	Oso Flaco Ck. at Oso Flaco Rd.	Agriculture	6/19/2009	6.2	**35.3**	**201.5**	243	3%	15%	83%
312OFL	Oso Flaco Lake	Agriculture	12/9/2008	2.4	11.1	**66.1**	79.6	3%	14%	83%

Station	Station Name	Primary Source of Surface Flow	Analysis Date	Detected Chemicals in Sediment (ng/g or ppb)						
				Sum DDT	Sum DDD	Sum DDE	Total DDTs	% Sum DDT to Total DDT	% Sum DDD to Total DDT	% Sum DDE to Total DDT
312OFL	Oso Flaco Lake	Agriculture	6/19/2009	6.9	26.2	**148.3**	181	4%	14%	82%
312BRO	Bradley Channel at River Oaks	Urban and Agriculture	6/19/2009	5.1	18.5	**93.4**	117	4%	16%	80%
312BCD	Blosser Channel	Urban and Agriculture	6/19/2009	55.1	**72.9**	**344.7**	473	12%	15%	73%
312MSS	Main Street Channel	Urban	6/19/2009	11.3	**83.3**	**333.8**	428	3%	19%	78%
Average				11.3	46.4	199.3	257	4%	18%	78%

Note: The numbers highlighted are above the Probable Effects Level (PEL) and the 303(d) listing criteria. The PELs are as follows: Sum DDD = 28 ug/kg, Sum DDE = 31.2 ug/kg, Sum DDT = 62.9 ug/kg and the Total DDTs = 572 ug/kg. The PEL is not a bioaccumulation protective criteria.

An objective of the TMDL monitoring was to characterize the geographic distribution of pesticide contamination in the Santa Maria Valley. The monitoring sites were broadly distributed in the watershed (refer to Figure 4-9). Concentrations do not appear to be greater at receiving water monitoring sites such as Oso Flaco Lake, Santa Maria River above the estuary and lower Orcutt Creek than at sites further up in the watershed with more discrete sources of flow such as Oso Flaco Creek, Green Valley and a site adjacent to the City of Santa Maria. There also did not appear to be greater concentrations of pollutants at sites with urban or agricultural land use. This phenomenon could be due to the fact that DDT was historically applied in the urban and agricultural areas, as well as possibly within drainage and retention ponds for vector mosquito control. Consequently, sources of DDT and its isomers are distributed broadly across the land uses in the project area.

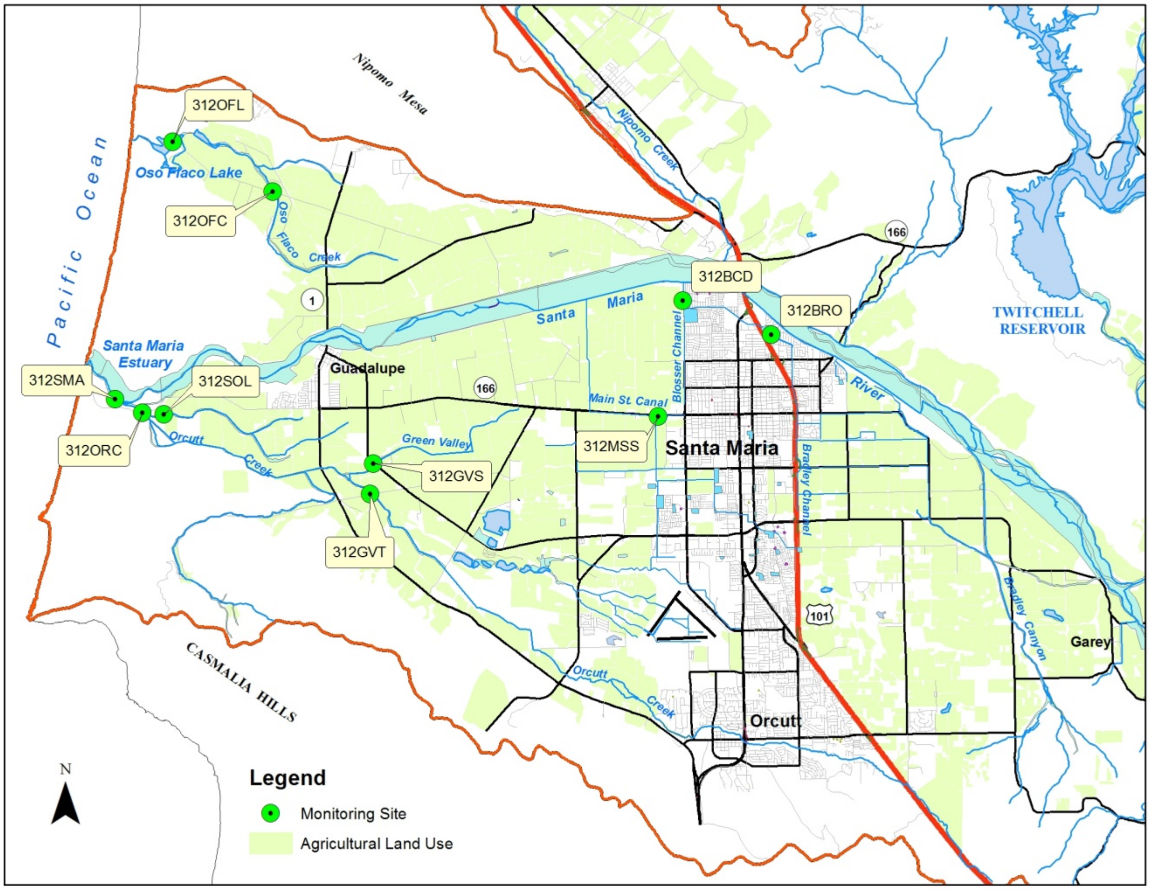

Figure 4-6 Map of Monitoring Sites in the Santa Maria Valley

Coastal Sources of DDT

As part of a special study, levels of DDTs were monitored on the central coast using sand crabs, *Emerita analoga*, and the highest levels of DDT were detected in sand crabs near the Santa Maria River mouth (Dugan et al., 2005). Sand crabs are good coastal biological indicator species: they are abundant, live in the surf and are suspension feeders. They are also important indicators of the ecosystem health, since they are lower in the food chain and are important prey for many predators. In the study high levels of DDT near the Santa Maria river were linked to the agricultural land use in the Santa Maria watershed compared to the other monitoring sites in other watersheds.

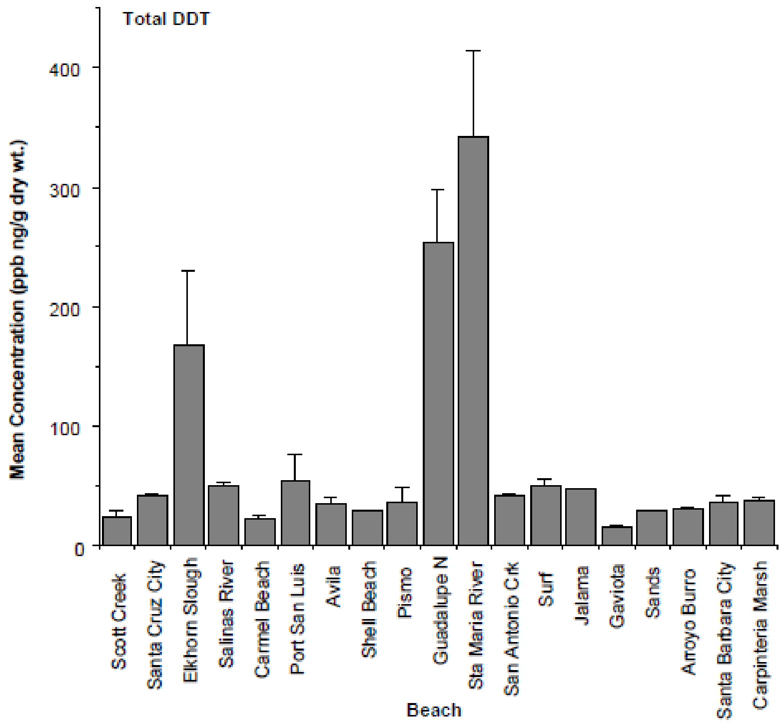

Figure 4-7 Mean dry wt. concentrations ng/g (ppb) of total DDTs (DDD, DDE & DDT) in tissues of sand crabs collected at 19 Beaches in August-September 2000)

Summary of DDT Sources

Based on the broad historic use of DDT and the recent UC Davis monitoring of DDT indicating ubiquitous distribution of DDT and its derivatives in the watershed, it is impossible to determine discrete DDT sources. Therefore, staff concludes that all sediment from urban and irrigated agricultural landscapes are potential sources of DDT in surface waters. The predominant land use is irrigated agriculture and predominance of this land use is associated with greater concentrations of DDT in coastal indicator species (Figure 4-7). In addition, contaminated stream and channel sediments are stores of DDT and a source of DDT to downstream receiving water such as Oso Flaco Lake, the Santa Maria Estuary and the coastal confluences.

Additional Legacy Pesticide Source Analysis

For the UC Davis TMDL Study, sediment concentrations of the legacy pesticides, chlordane, dieldrin, endrin and toxaphene were sampled at monitoring sites in the Santa Maria Valley. Only dieldrin and were detected; Table 4-23 shows the monitoring results.

Table 4-23 2008-2009 Additional Organochlorine Pesticide Detections

Site ID	Station Name	Analysis Date	Dieldrin(ng/g or ppb)	Toxaphene (ng/g or ppb)
312SOL	Blosser Channel	6/19/2009	ND	ND
312ORC	Orcutt Ck. At Sand Plant	12/9/2008	ND	88.63
312SMA	Santa Maria River above the estuary	12/9/2008	ND	551.92
312SMA	Santa Maria River river above the estuary	6/19/2009	ND	ND
312GVS	Green Valley Creek at Simas Rd.	6/19/2009	10.5	ND
312GVT	Orcutt Ck. at Brown Rd.	6/19/2009	ND	ND
312OFC	Oso Flaco Ck. at Oso Flaco Rd.	6/19/2009	ND	ND
312OFL	Oso Flaco Lake	12/9/2008	ND	72.8
312OFL	Oso Flaco Lake	6/19/2009	11.6	ND
312BRO	Bradley Channel at River Oaks	6/19/2009	ND	ND
312BCD	Blosser Channel	6/19/2009	ND	ND
312MSS	Main Street Channel	6/19/2009	ND	4.4

* Monitoring data from the UC Davis TMDL Study

Dieldrin Source Analysis

In 2008 dieldrin was detected in fish tissue from fish caught in Oso Flaco Lake at concentrations that exceded levels for safe consumption in (SWAMP, 2010). The UC Davis TMDL Study monitored Oso Flaco Lake twice and Oso Flaco Creek once for concentrations of dieldrin in sediment (Table 4-23). Dieldrin was detected in one of the lake sediment samples but not in the creek sample. It was detected at 11.6 ppb, which is below the State Board 303(d) listing criteria for sediment concentrations of 61.8 ppb, which is protective of benthic invertebrates. There are published human health based sediment assessment guidelines protective of bioaccumulation of dieldrin. The guidelines are for organic carbon (o.c.) corrected concentrations of dieldrin in sediment and the samples in the study were reported as a total concentration. The UC Davis researchers corrected the Oso Flaco Lake dieldrin sediment sample for organic carbon from the 11.6 ng/g total concentration to 0.316 ug/g o.c., based on 3.67% total organic carbon. The o.c. corrected sediment sample exceeds the human health based SQAG of 62.9 ug/kg or 0.0000629 ug/g.

In 2002 and 2003 SWAMP monitored the Lower Santa Maria River and Orcutt Creek for dieldrin. Dieldrin was detected in the water at concentrations that exceeded human consumption criteria. The TMDL Study sampled sediment in the lower Santa Maria River in 2008 and 2009, Orcutt Creek in 2008 and Green Valley Creek in 2009 for concentrations of dieldrin. Dieldrin was not detected in the Lower Santa Maria River and Orcutt Creek but was detected in Green Valley Creek, a tributary of Orcutt Creek.

All uses of dieldrin, except termite control, were canceled in 1974 (ATSDR, 2002). It was used for termite control until the use was banned in 1987. In the United States, dieldrin was historically used extensively on corn and cotton. Specific historic agricultural use of dieldrin in the Santa Maria Watershed is unknown. Dieldrin could be deposited in the existing stream and drainage channels and residue could be present on farms. The current sources of dieldrin in the watershed are unknown.

Toxaphene Source Analysis

The Santa Maria River was placed on the 303(d) list based on two fish tissue samples that exceeded the National Academy of Sciences (NAS) whole fish guideline of 100 ug/kg. A flounder was collected in 1992 and a stickleback was collected in 1999. The samples were collected at a station near the Santa Maria River mouth. The UC Davis TMDL Study monitored sediment for toxaphene in 2008 and 2009 and it was detected in the Santa Maria River above the estuary and in Lower Orcutt Creek (Table 4-23). Sediment guidelines are not available for toxaphene and the magnitude of sediment concentrations could not be assessed.

Toxaphene use was restricted in 1981 and all uses of toxaphene were baned in 1990 (OEHHA, 2003). Pesticide use records are available from DPR beginning in 1974 for commercial pesticide applications in California. Staff reviewed the pesticide use report records for toxaphene for the 1974 annual applications in Santa Barbara County in 1974. The 1974 records indicate that it was applied to a variety of agricultural commodities in the county including: carrots, head lettuce, broccoli, cabbage, cauliflower, celery, artichoke and chickens. Staff was not able to summarize the pounds of pesticide active ingredient applied in the Santa Maria Watershed. It was not used for structural applications in 1974. Historic applications to agricultural crops are the likely source of impairments in the watershed.

Endrin Source Analysis

The Santa Maria River was placed on the 303(d) list based on two of two whole fish tissue samples that exceeded the NAS whole fish guideline of100 ug/kg. A flounder was collected in 1992 and a stickleback was collected in 1999. The samples were collected at a monitoring station near the Santa Maria River mouth.

The UC Davis TMDL Study sampled sediment in the Santa Maria watershed for OC pesticides in 2008 and 2009 but did not include endrin. Endrin was most commonly used as an insecticide but was also used as a rodenticide and avicide. It is a broad spectrum insecticide including termite control. It is persistent in soils and very insoluable in water. Sales of were banned by EPA in 1986. It is persistent in the environment and bioaccumulates. It may be present in soils of sites with historic agricultural applications and in the sediment of agricultural and urban drainage ways. The current sources of endrin in the watershed are unknown.

Chlordane Source Analysis

In 2008 chlordane was detected in fish tissue from fish caught in Oso Flaco Lake at concentrations that exceeded levels for safe consumption in (SWAMP, 2010). Chlordane is an insecticide that was used from 1948 to 1988 when use was canceled due to human health and environmental concerns (NPIC, 2001). It was used on agricultural crops and for home and garden pest control (ATSDR, 1995). All uses except termite applications were banned in 1983. Chlordane is persistent in the environment and bioaccumulates. Historic crop applications in the Oso Flaco watershed are the likely source chlordane in Oso Flaco Lake given the lack of urban land use in the watershed.

Summary of Sources of Additional Legacy Pollutants

The sources of additional legacy pesticides are historic pesticide applications. The distribution of the pesticides in the watershed is unknown. Based on limited sediment samples from the UC Davis TMDL monitoring the presence of additional legacy pesticides (dieldrin and toxaphene) did not appear to be wide spread in the watershed. The levels of dieldrin in Oso Flaco Lake sediment are a concern and the existing lake sediments may be a long-term source of dieldrin contamination of fish. Additional sediment monitoring is needed to determine the extent of contamination in the watershed. Monitoring in Oso Flaco Lake is needed to understand the extent of legacy pesticides stored in the lake sediments. Since additional legacy pesticides have similar fate and transport properties to DDT and its derivatives, measures to address DDT impairments would also mitigated problems from these pesticides.

4.4. Land Use/ Land Cover Watershed Pesticide Source Analysis and Conclusions

The two predominant human uses of the land in the Santa Maria Watershed that influence surface water quality from pesticides are developed urban and irrigated agricultural land uses. These land uses in the Santa Maria Watershed have distinct current and historic pesticide usage. For example, pesticides such as diazinon and chlorpyrifos are currently only applied to agricultural crops and are no longer available for non-agricultural use. Synthetic pyrethroid pesticides have both urban and agricultural applications.

Land cover analysis using remote sensing tools such as the National Land Cover Data (NLCD) provides a means of interpreting the land use from land areas. Staff used GIS to summarize the NLCD by watershed land areas for analysis of land use in watershed upstream of water quality monitoring sites (MRLC, 2001). Staff developed a watershed boundary GIS layer for the Santa Maria Watershed using GIS hydrology tools and digital elevation models (DEM) and by digitizing a

Santa Maria Valley Watershed Map developed in 1985 by the Santa Barbara County Flood Control and Water Conservation District. The pesticide impairments are in the Santa Maria Valley portion of the Santa Maria Watershed and the Santa Maria valley watershed map provides detailed mapping of the flat and modified valley floor. The valley floor hydrology was modified for cultivated crops, urban development and flood. The following sections provide summaries of watersheds, monitoring sites, impairments, land use, and sources of pesticides.

Oso Flaco Watershed Analysis and Conclusion

The Oso Flaco Watershed is located in the northwest portion of the Santa Maria Watershed. Oso Flaco Lake has a 303(d) listing for dieldrin and has an additional impairment for DDT. Oso Flaco Creek does not have any pesticides listings, but staff determined that there are DDT and malathion impairments. 2001 NLCD land use watershed analysis indicated that 64% of the land cover was cultivated crops. Analysis of pesticide use reports lead staff to conclude that malathion was applied to irrigated cultivated crops in the watershed. Chlordane, dieldrin and DDT were applied to cultivated crop types historically grown in the watershed. There is minimal urban developed land in the Oso Flaco watershed and based on field visits to the watershed, the developed land does not appear to be a source of pesticide water quality impairment. *Therefore irrigated agricultural land use is the primary source of unkown toxicity and sediment toxicity along with impairments for currently applied pesticide such as malation. The movement of sediment off of irrigated land is a source of DDTs in Oso Flaco Lake. In addition the lake, creek and drainage channels are stores of these pesticides.*

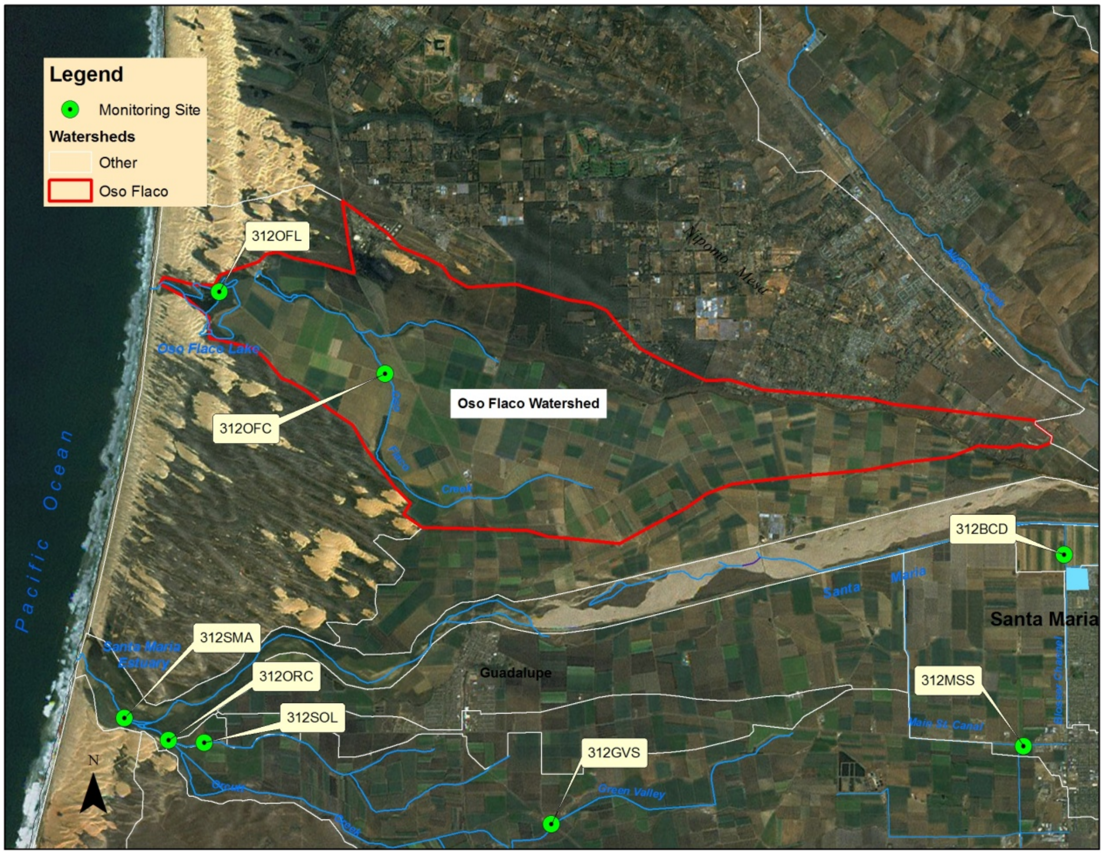

Figure 4-8 Oso Flaco Watershed and Monitoritng Site

Table 4-24 Oso Flaco Watershed Land Cover Analysis

Oso Flaco Watershed (OF)

Land Cover	**Acreage**	**Percent**
Open Water	67	1%
Developed, Open Space	596	6%
Developed, Low Intensity	328	3%
Developed, Medium Intensity	118	1%
Developed, High Intensity	9	0.09%
Barrens Land	41	0.43%
Deciduous Forrest	0	0%
Evergreen Forrest	393	4%
Mixed Forrest	3	0.04%
Shrub/ Scrub	831	9%
Grassland/ Herbaceous	217	2%
Pasture Hay	628	7%
Cultivated Crops	6166	64%
Woody Wetlands	81	1%
Emergent Herbaceous Wetlands	132	1%
Total Acreage	9610	100%

Source: 2001 National Land Cover Data Set

City of Santa Maria Area Watershed Analysis

Main Street Canal, Blosser Channel and Bradley Channel are impaired waters that flow through the City of Santa Maria. The City of Santa Maria watershed area includes urban land use as well as agricultural lands outside the city that drain into the channels (Figure 4-9). These surface waters are manmade channels that outlet north of the city through the Santa Maria levee to the Santa Maria River Channel where the water supports perennial wetlands along the normally dry Santa Maria riverbed. The riverbed is an area of groundwater recharge. Main Street Canal is on the 303(d) list as impaired for chlorpyrifos and diazinon. In addition to the 303(d) listings, Main Street is impaired for pyrethroid and DDT pesticides. Blosser Channel is not on the 303(d) list as impaired for pesticides; however, staff determined with recent data that it is impaired for chlorpyrifos, diazinon, pyrethroids and DDT. Bradley Channel is on the 303(d) list as impaired for chlorpyrifos. In addition to the 303(d) listing Bradley Channel is impaired for diazinon, pyrethroids and DDT.

GIS analysis of the watersheds indicated that there is a mix of developed urban and cultivated crop land uses in the watersheds (Table 4-25). Pesticide use report analysis indicates that chlorpyrifos and diazinon were applied on agricultural crops in the watershed. Pyrethroids were used for agricultural and non-agricultural urban applications. DDT was historically used on cultivated crops in the watersheds, in urban areas, and possibly for vector control.

Therefore, urban and agricultural land uses were sources of pesticide pollutants in the surface waters of the City of Santa Maria area watersheds, including Main Street Canal, Blosser and Bradley Channels (see Figure 4-9). *Specifically since chlorpyrifos and diazinon are not available for non-agricultural uses they are only associated with agricultural land use, since DDT is tied to sediment and erosion it is primarily associated with agricultural landuse, and since pyrethroids are used for agriculture and urban pest control it is associated with both land uses.*

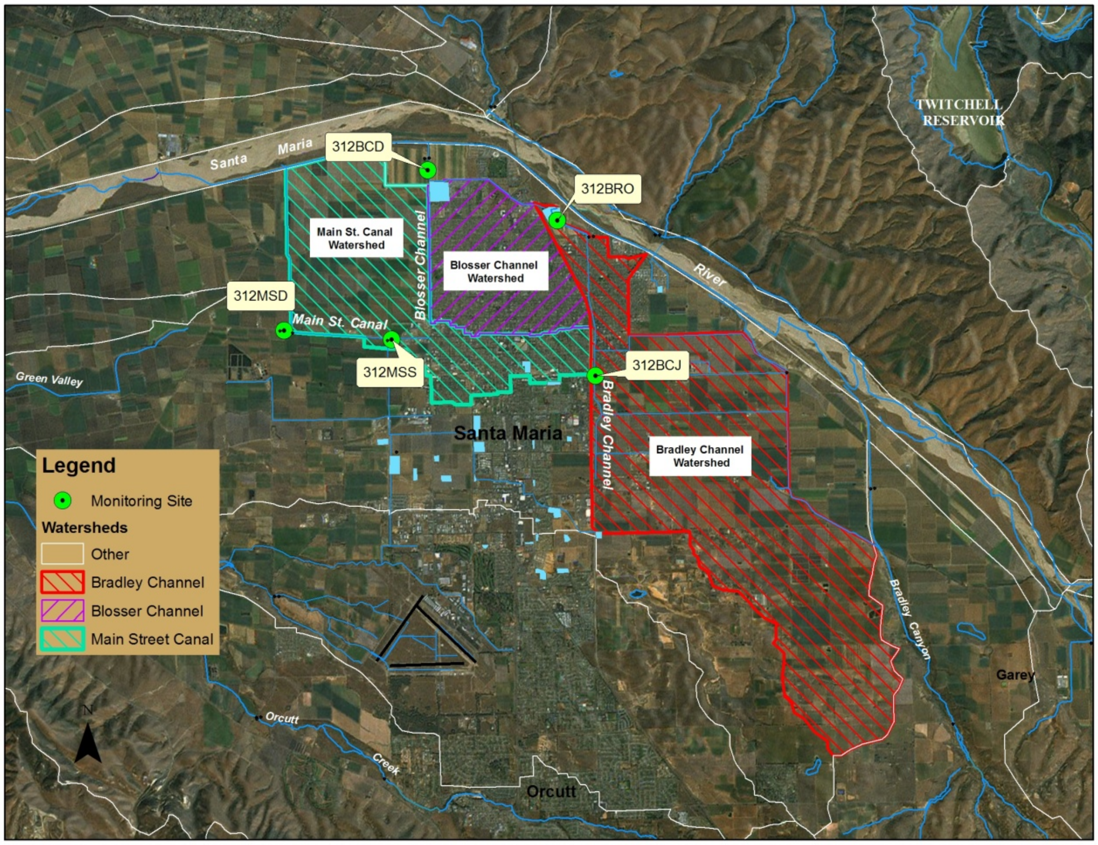

Figure 4-9 Santa Maria City Area Watersheds and Monitoring Sites

Table 4-25 Santa Maria City Area Land Cover Analysis

	Main Str.		**Blosser**		**Bradley**	
Land Cover	**Acreage**	**Percent**	**Acreage**	**Percent**	**Acreage**	**Percent**
Open Water	0	0%	3	0.14%	9	0.12%
Developed, Open Space	191	5%	141	7%	894	12%
Developed, Low Intensity	509	14%	837	42%	579	8%
Developed, Medium Intensity	515	14%	988	49%	259	4%
Developed, High Intensity	13	0%	10	1%	2	0.02%
Barrens Land	1	0.04%	0	0%	10	0.14%
Deciduous Forrest	0	0%	0	0%	0	0%
Evergreen Forrest	0	0%	0	0%	1	0.02%
Mixed Forrest	0	0%	0	0%	2	0.03%
Shrub/ Scrub	0	0%	0	0%	45	1%
Grassland/ Herbaceous	2	0.06%	6	0.28%	124	2%
Pasture Hay	132	4%	7	0.37%	1362	18%
Cultivated Crops	2222	62%	9	0.46%	4108	56%
Woody Wetlands	0	0%	0	0%	0	0%
Emergent Herbaceous Wetlands	0	0%	0	0%	0	0%
Total Acreage	3585	100%	2001	100%	7395	100%

Orcutt Creek/ Green Canyon Watershed Areas Land Use Analysis

The Orcutt Creek/ Green Valley watershed areas include five sub-watersheds: Lower Green/ Orcutt Creek, Upper Green Creek, Orcutt Creek, Betteravia and Corralittos Canyon. All are located on the southern side of the Santa Maria Valley (see Figure 4-10). The watershed boundaries were delineated in the 1985 Santa Barbara County Flood Control (SBCFC) map of the Santa Maria valley. Staff digitized the SBCFC map into a GIS format and made minor modifications to the Green Valley boundaries. Staff modified the Green Valley watershed boundaries by dividing it into upper and lower watershed at the 312GVS monitoring site to provide a more accurate characterization of land use above the site. The predominant water body in the watershed area is Orcutt Creek, which is a perennial stream fed from groundwater and surface runoff. Orcutt Creek has several tributaries including Green Creek, Corralitos Canyon and drainage from the Betteravia area. Orcutt Creek converges with the Santa Maria River just upstream of the Santa Maria Estuary near the Pacific Ocean.

The Orcutt Creek and Green Creek are on the 303(d) list as impaired for several pesticides. Orcutt Creek was listed for chlorpyrifos, diazinon, DDT and dieldrin and Green Valley was listed for chlopyrifos. In addition to the 303(d) listings, staff concluded that Orcutt Creek is impaired for pyrethroid pesticides.

GIS analysis of the 2001 NLCD data indicated that cultivated crops were the predominant land cover in the watershed area with some drainage from urban areas including: portions of the City of Santa Maria and the community of Orcutt in the eastern portion of the watershed area. Pesticide water quality impairments were predominantly at monitoring sites with irrigated agricultural land use adjacent to the surface waters. In addition the pesticides chlorpyrifos and diazinon were banned for non-agricultural use.

Therefore, irrigated agriculture was the primary source of water quality impairments of chlorpyrifos, diazinon and pyrethoids in the Green Canyon and Orcutt Creek watershed areas with possible contribution from urban areas for pyrethroid pesticides.

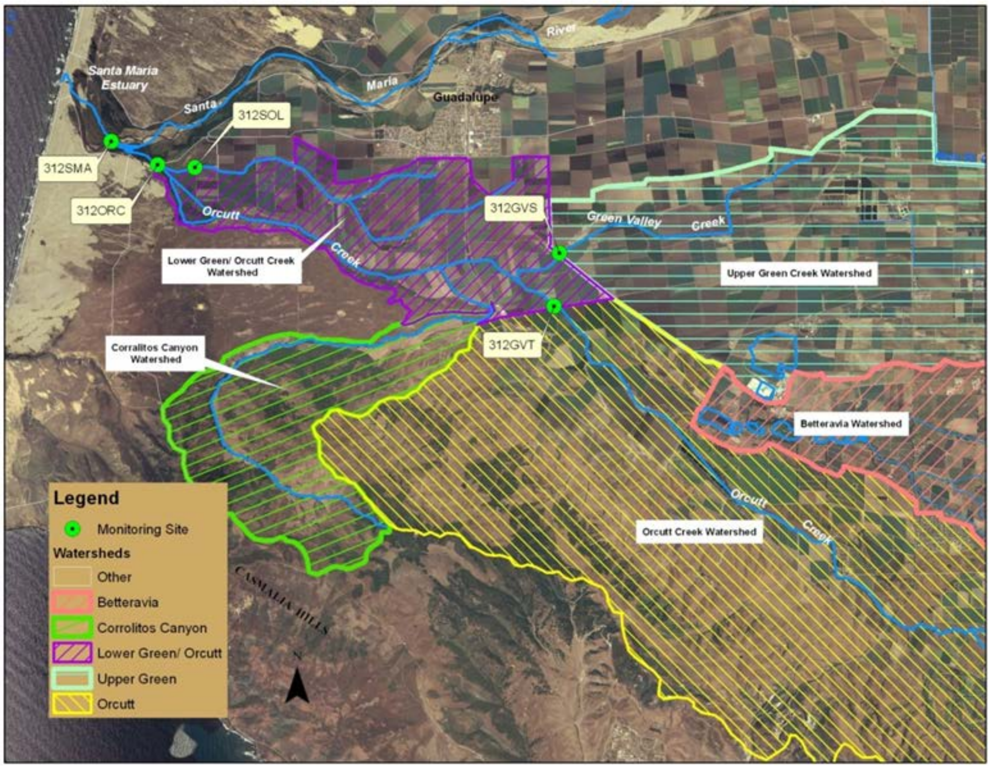

Figure 4-10 Lower Orcutt Creek and Green Canyon Area Watersheds

Table 4-26 Green Canyon and Orcutt Creek Area Watersheds' Land Cover

	Upper Green	Lower Green / Orcutt	Orcutt	Betteravia	Corralitos Cyn.	Total	
Land Cover	Acres	Acres	Acres	Acres	Acres	Acres	**Percent**
Open Water	54	0	26	3	0	84	0.2%
Developed, Open Space	1212	84	2049	1935	154	5434	10%
Developed, Low Intensity	1026	108	1170	2596	0	4901	9%
Developed, Medium Intensity	831	60	133	757	0	1781	3%
Developed, High Intensity	56	0	0	47	0	104	0.2%
Barrens Land	10	0	1	6	0	18	0.03%
Deciduous Forrest	0	0	0	0	0	0	0%
Evergreen Forrest	0	3	903	70	11	987	2%
Mixed Forrest	12	4	775	5	88	883	2%
Shrub/ Scrub	40	174	5925	201	1470	7809	15%
Grassland/ Herbaceous	1022	96	8175	1805	1220	12318	23%
Pasture Hay	1639	441	794	1248	3	4124	8%
Cultivated Crops	6802	2097	3747	2566	2	15214	28%
Woody Wetlands	3	31	10	13	0	57	0.1%
Emergent Herbaceous Wetlands	14	37	4	28	0	82	0.2%
Total Acreage	12721	3135	23712	11279	2949	53795	100%

Lower Santa Maria River Land Use Analysis

The Santa Maria River watershed is a large coastal watershed, which includes two large tributaries the Cuyama and the Sisquoc Rivers (see Figure 4-11). The Santa Maria River forms at the confluence of the Cuyama and Sisquoc at Fulger point east of the City of Santa Maria and flows to the Santa Maria Estuary on the Pacific Ocean. The hydrology of the river varies between the upper and lower reaches (SAIC 2004). The upper reach from Highway 1 to Fulger point is esentially a dry river, which flows shortly after large rain events and during releases from Twitchel Dam on the Cuyama River. The lower river from Highway 1 to the estuary has perennial flow from emerging subsurface flows and surface run-off. The Santa Maria River is listed as impaired for several pesticides based on sampling in the lower reaches with perennial flow. Many of the samples were from the 312SMA CCAMP monitoring site, which is immediately upstream of the Santa Maria Estuary. The effective watershed areas with drainage to the Lower Santa Maria River are the Lower Orcutt and Green Canyon Watershed area and the Santa Maria Watershed areas along the lower river channel. The flows in the upper river channel generally percolate to deep groundwater and have minimal influence on the water quality of the lower river particularly during the dry season.

The Santa Maria River was listed for the pesticide chlorpyrifos and legacy pesticides DDT, dieldrin, endrin and toxaphene. In addition to the 303(d) listings, the Santa Maria River was impaired with diazinon and pyrethroid pesticides.

GIS analysis of the 2001 NLCD data indicated that cultivated crops were the predominant land cover in the watershed area with additional drainage from urban areas including: portions of the City of Santa Maria, Orcutt and the City of Guadalupe. In addition the pesticides chlorpyrifos and diazinon were banned for non-agricultural use.

For currently applied pesticides, irrigated agriculture was the primary source of water quality impairments of chlorpyrifos, diazinon and pyrethoids in the lower Santa Maria river watershed area with contribution from urban areas for pyrethroid pesticides.

For the legacy organochlorine pesticides, historic applications to agricultural lands are likely the largest source of pollution in the lower watershed along with contributions from historic urban applications and possibly vector control applications directly in the drainage system of the valley.

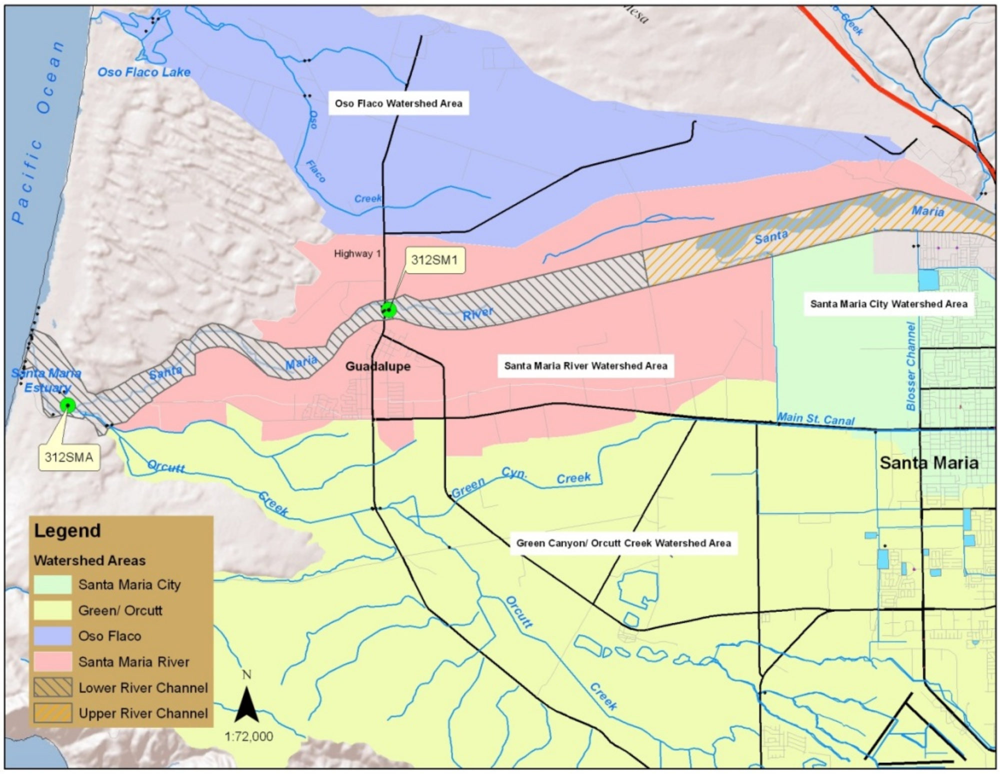

Figure 4-11 Lower Santa Maria river area watersheds

Table 4-27 Lower Santa Maria River watershed land cover

	Lower Santa Maria River Channel Watersheds		**Green Cyn. and Orcutt Creek Watershed Area**		**Lower Santa Maria Watershed Total**	
Land Cover	Acres	Percent	Acres	Percent	Acres	Percent
Open Water	5	0%	84	0.2%	89	0.1%
Developed, Open Space	364	4%	5434	10%	5799	9%
Developed, Low Intensity	436	4%	4901	9%	5337	8%
Developed, Medium Intensity	471	5%	1781	3%	2252	4%
Developed, High Intensity	5	0%	104	0.2%	109	0.2%
Barrens Land	26	0%	18	0.03%	43	0.1%
Deciduous Forrest	0	0%	0	0%	0	0.0%
Evergreen Forrest	5	0%	987	2%	992	2%
Mixed Forrest	0	0%	883	2%	883	1%
Shrub/ Scrub	79	1%	7809	15%	7889	12%
Grassland/ Herbaceous	13	0%	12318	23%	12331	19%
Pasture Hay	1075	11%	4124	8%	5199	8%
Cultivated Crops	7110	73%	15214	28%	22324	35%
Woody Wetlands	74	1%	57	0.1%	131	0.2%
Emergent Herbaceous Wetlands	81	1%	82	0.2%	163	0.3%
Total Acreage	9745	100%	53795	100%	63540	100%

4.5. Source Analysis Summary

Several surface waterbodies in the Santa Maria watershed are impaired for organophosphate pesticides. Staff determined, based on pesticide use analysis and watershed land use analysis that the sources of these impairments were applications to irrigated agricultural crops.

Several waterbodies are also impaired for pyrethroids pesticides. Staff determined based on pesticide use analysis and watershed land use analysis that the sources of these impairments are both irrigated agricultural crops and urban applications.

Critical legacy organochlorine pesticide impairments are pesticide concentrations in fish tissue that exceed safe consumption levels in the lower watershed. Legacy pesticides have not been applied for many years and there is no detailed historic use reporting data. Based on TMDL monitoring, staff determined DDTs are wide spread in channel sediments throughout the watershed in areas with both urban and irrigated agricultural land uses. A 1984 CDFA study on the sources of DDT in the environement found that DDT was widely used for agriculture and for mosquito control. It was also widely used in the urban setting. DDT and its derivatives are bound to sediments in the environements and staff determined disturbed agricultural and urban soils and channels sediment s are source of pollution.

Other legacy organochlorine pesticides were detected in fish tissue but the extent of contamination in the watershed is unknown. Additional monitoring is need to better characterize the presence of these pesticides. Monitoring in Oso Flaco Lake is needed to understand the extent of legacy pesticides stored in the lake sediments.

Table 4-28 Pollutants and sources

Pollutants	**Sources**			**Notes on Applications and Sources**
	Irrigated Ag.	**Urban Stormwater**	**Other**	
Organophosphate Pesticides				
Chlorpyrifos	**X**			Granular applications to broccoli and other cole crops
Diazinon	**X**			Lettuce and broccoli crops
Malathion	**X**			Broccoli, celery, lettuce and strawberry crops
Pyrethroid Pesticides				
Bifenthrin	**X**	**X**		Strawberry crops, structural and consumer applications.

Pollutants	Sources			Notes on Applications and Sources
	Irrigated Ag.	Urban Stormwater	Other	
Cyfluthrin		X		Primarily urban sources
Cypermethrin	X	X		Primarily urban sources with some contribution from a variety of vegetable crops.
Esfenvalerate	X			Primarily irrigated agricultural crop: broccoli, cauliflower and lettuce crops
L-Cyhalothrin	X	X		Primarily urban uses with possible contribution from lettuce crops
Permethrin	X	X		Primarily urban uses with possible contribution from lettuce crops
Organochlorine Pesticides				
DDTs	X	X	X	Disturbed soils: crop land urban sediment, drainage channels and basins
Dieldrin				Unknown
Toxaphene				Unknown
Chlordane				Unknown

5. LOADING CAPACITY, TMDLS AND ALLOCATIONS

5.1. Loading Capacities and TMDLs

The pesticide and toxicity loading capacities (TMDLs) are the amount of pesticides that can be received in surface waters without exceeding the Basin Plan's pesticide and toxicity water quality objectives. TMDLs are calculated as the sum of waste load allocations and load allocation along with a margin of safety.

Waste load allocation is the TMDL allocated to point source dischargers in the watershed and load allocation is the TMDL allocated nonpoint sources of pollution. According to the Code of Federal Regulations, Title 40, §130.2[i], TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure." The pesticide and toxicity TMDLs are equal to numeric targets.

TMDLs for chlorpyrifos, diazinon and malathion are expressed in terms of concentrations and addititve targets, pyrethroids TMDLs are expressed as additive sediment targets, toxicity TMDLs are equal to the toxicity numeric targets, and the organochlorine TMDLs are expressed as both sediment and fish tissue concentration-based targets.

Organophosphate Pesticide TMDLs

TMDLs for chlorpyrifos, diazinon, and malathion are established as water column concentrations refer to Table 5-1.

Table 5-1 Water column concentration-based TMDLs for organophosphate pesticides

Waterbodies assigned TMDLs[1]	TMDL					
	Chlorpyrifos		Diazinon		Malathion	
	CMC[3] (ppb)	CCC[4] (ppb)	CMC (ppb)	CCC (ppb)	CMC (ppb)	CCC (ppb)
Blosser Channel	0.025	0.015	0.16	0.10	0.17[2]	0.028[2]
Bradley Canyon Creek	0.025	0.015	0.16	0.10	0.17[2]	0.028[2]
Bradley Channel	0.025	0.015	0.16	0.10	0.17[2]	0.028[2]
Green Valley Creek	0.025	0.015	0.16	0.10	0.17[2]	0.028[2]
Main Street Canal	0.025	0.015	0.16	0.10	0.17[2]	0.028[2]
Orcutt Creek	0.025	0.015	0.16	0.10	0.17[2]	0.028[2]
Oso Flaco Creek	0.025[2]	0.015[2]	0.16[2]	0.10[2]	0.17	0.028
Santa Maria River	0.025	0.015	0.16	0.10	0.17[2]	0.028[2]
Little Oso Flaco Creek	0.025	0.015	0.16	0.10	0.17	0.028

[1] All reaches of all surface waters in the Santa Maria River watershed, including those listed below.
[2] Waterbody is currently achieving the TMDL
[3] CMC – Criterion Maximum Concentration (Acute: 1- hour average). Not to be exceeded more than once in a three year period
[4] CCC - Criterion Continuous Concentration (Chronic: 4-day (96-hour) average). Not to be exceeded more than once in a three year period

Additive Toxicity TMDL for Organophosphate Pesticides

The additive toxicity TMDL for organophosphate pesticides is based on the additive toxicity targets for organophophate pesticides described in Section 3.1.

$$\frac{C\ (diazinon)}{NT(diazinon)} + \frac{C\ (chlopyrifos)}{NT\ (chlorpyrifos)} = S;\ where\ S\ \leq 1$$

Where:

C = the concentration of a pesticide measured in the receiving water.

NT = the numeric target for each pesticide present.

S = the sum; a sum exceeding one (1.0) indicates that beneficial uses may be adversely affected.

The additive toxicity numeric target formula shall be applied when both diazinon and chlorpyrifos are present in the water column and it applies to all surface waters in the Santa Maria River watershed.

Additive Toxicity TMDL for Pyrethroid Pesticides

The additive toxicity TMDL for pyrethroids pesticides is based on the additive toxicity targets for pyrethroid pesticides described in Section 3.2.

$$\frac{C\ (Pyrethroid\ 1)}{NT(Pyrethroid\ 1)} + \frac{C\ (Pyrethroid\ 2)}{NT\ (Pyrethoird\ 2)} = S;\ where\ S\ \leq 1$$

Where:

C = the concentration of a pesticide measured in sediment.

NT = the numeric LC50 for each pesticide present (Table 3-3).

S = the sum; a sum exceeding one (1.0) indicates that beneficial uses may be adversely affected.

The additive toxicity numeric shall be applied to all surface waters in the Santa Maria River watershed.

Aquatic Toxicity TMDLs

The TMDLs for water column and sediment toxicity is equal to the aquatic toxicity numeric target, which based on standard toxicity tests to aquatic test organisms (see description in the above Aquatic Toxicty Numeric Target section). The TMDL is based on the Basin Plan general objective for toxicity.

Table 5-2 Water Column and Sediment Toxicity TMDLs*

Parameter	Test	Biological Endpoint Assessed	Test Method #
Water Column Toxicity	Water Flea – *Ceriodaphnia (6-8 day chronic)*	Survival and reproduction	EPA-821-R-02-0.13 using alpha of 0.20
Sediment Toxicity	*Hyalella azteca* (10-day chronic)	Survival	EPA 100.1 using alpha of 0.25

* Applies to all surface waters in the Santa Maria River watershed.

Organochlorine Pesticide TMDLs

The organochlorine pesticides TMDLs are equal to the sediment and fish tissue targets (Table 5-3, Table 5-4, and Table 5-4). To account for short-term variations, concentrations should be averaged over a three year period.

Table 5-3 Sediment concentration-based TMDLS for DDT and derivatives

Waterbodiess	TMDL

Assigned TMDLs[1]	DDD, 4,4-(p,p-DDD) o.c.[2]	DDE, 4,4-(p,p-DDE) o.c.	DDT, 4,4-(p,p-DDT) o.c.	Total DDT o.c.
	ug/kg	ug/kg	ug/kg	ug/kg
Green Valley Creek	9.1	5.5	6.5	10
Little Oso Flaco Creek	9.1	5.5	6.5	10
Orcutt Creek	9.1	5.5	6.5	10
Oso Flaco Creek	9.1	5.5	6.5	10
Oso Flaco Lake	9.1	5.5	6.5	10
Santa Maria River	9.1	5.5	6.5	10

[1] All reaches of all surface waters in the Santa Maria River watershed, including those listed.
[2] **o.c.** is organic carbon corrected concentrations

Table 5-4 Sediment concentration-based TMDLS for additional organochlorine pesticides

Waterbodiess Assigned TMDLs[1]	TMDL			
	Chlordane o.c.[2]	Dieldrin o.c.	Endrin o.c.	Toxaphene o.c.
	ug/kg	ug/kg	ug/kg	ug/kg
Oso Flaco Lake	1.7	0.14	--	--
Santa Maria River	1.7	0.14	550	20
Orcutt Creek	1.7[3]	0.14	550[3]	20[3]

[1] All reaches of all surface waters in the Santa Maria River watershed, including those listed.
[2] **o.c.** is organic carbon corrected concentrations
[3] Waterbody is currently achieving the TMDL

Table 5-5 Fish Tissue TMDL for Organochlorine Pesticides

Waterbodiess Assigned TMDLs	Fish Tissue TMDL			
	Chlordane	DDTs	Dieldrin	Toxaphene
	ng/g* (ppb)	ng/g* (ppb)	ng/g* (ppb)	ng/g* (ppb)
Oso Flaco Lake	5.6	21	--	--
Oso Flaco Creek	5.6	21		
Santa Maria River	5.6	21	**0.46**	**6.1**
Orcutt Creek	5.6	21	**0.46**	**6.1**

*ng/g: i.e. nanograms of pollutant per grams of fish tissue (e.g. a fillet)

5.2. Linkage Analysis

The goal of the linkage analysis is to establish a link between pollutant loads and desired water quality. This, in turn, ensures that the loading capacity specified in the TMDLs will result in attaining the desired water quality.

For the organophosphate pesticide TMDLs, this link is established because the load allocations are equal to the numeric targets, which are the same as the TMDLs. Therefore, reductions in chlorpyrifos, diazinon and/or malathion loading to the extent allocated will result in achieving the water quality standards.

Surface waters are impaired for organochlorine pesticides due to the presence of these pesticides in the tissue of fish. The desirable concentrations in fish tissue are linked to levels of in sediment. This is due to a correlation between the concentrations in sediment and fish tissue (Callegus Creek, 2006) (CRWQCBCVR, 2010). Organisms can accumulate pesticides from water and/or sediment as well as consumption of organisms from lower trophic levels in the food-web (WHO, 1998). Since organonchlorine pesticides have extremely high affinity to bind to sediments, the transport of sediment is the primary pathway of pesticide from land use to polluted receiving waterbody. Therefore, a reduction of organonchlorine pesticide loading into surface waters necessitates minimizing sediment loading from areas where sediment is contaminated with organonchlorine pesticides. As discussed in the source analysis, organonchlorine pesticide contamination is present across a spectrum of land use categories, including the agricultural and urban land uses. Therefore, sediment loading must be minimized to the maximum extent practical to achieve the TMDLs, and therefore desired water quality. An adaptive management approach must be taken to derive the allowable sediment loading that achieves the organonchlorine pesticide TMDLs; staff will monitor TMDL concentration targets during the implementation phase.

For the pryrethroid pesticide TMDLs, the link is established with load allocations equal to the numeric targets, which are equal TMDLs. Therefore, reductions in pyrethroid loading to the extent allocated will result in achieving the desired water quality. If, during the TMDL implementation phase staff proposes updated TMDLs for pyrethroids, the loading allocations will also be modified to reflect the change.

5.3. Allocations

The TMDLs are allocated to point source and non-point sources in the Santa Maria watershed. Point source TMDLs are waste load allocations and non-point sources TMDLs are load allocations. The waste load allocations in the Santa Maria valley are assigned to municipal stormwater programs. Both the City of Santa Maria and the County of Santa Barbara have municipal stormwater permits in the watershed. The City of Guadalupe does not but will likely in the near future and is therefore assigned a waste load allocation.

Load allocations in the Santa Maria valley are assigned to irrigated agriculture and agencies that maintain and manage drainage and flood control systems. The agencies were assigned a load allocation for organochlorine pesticides which were detected in the channels during the TMDL monitoring and channels and basins were historically treated with pesticides for vector control. Irrigated agricultural operations have waste load allocations for organophophate pesticides, pyrethroids, and toxicity, since these pesticides classes are currently applied on farms and were found to be sources of aquatic toxicity. Organochlorine pesticides were historically applied to irrigated agricultural crops and were detected in channels adjacent to farms.

Municipal stormwater programs have TMDLs for pyrethroids, toxicity and organochlorine pesticides. They do not have a waste load allocation for organophophate pesticides, since non-agricultural use of chlorpyrifos and diazinon was banned. Pyrethroids are commonly applied in urban areas, are commonly detected in stormwater, and are associated with sediment toxicity. Organochlorine pesticides historically used for residential pest control and were detected in drainages with stormwater discharge.

Table 5-6 Waste Load Allocations and Load Allocations

Waste Load Allocations		
Responsible Party	**Source**	**Allocation**
City of Santa Maria - NPDES No. CAS000004	Urban Stormwater	3, 4 & 5
County of Santa Barbara - NPDES No. CAS000004	Urban Stormwater	3, 4 & 5
City of Guadalupe	Urban Stormwater	3, 4 & 5
Load Allocations		
Responsible Party	**Source**	**Allocation**
Owners/operators of irrigated agricultural lands in the Santa Maria Watershed	Discharges from irrigated lands	1, 2, 3, 4 & 5
San Luis Obispo County Public Works	Roadside drainages	5
Santa Barbara County Public Works	Roadside drainage	5
Santa Barbara County Flood Control District	Flood Control Channels and drainages	5

Allocation-1: Organophophate Pesticide TMDLs* - (refer to Table 5-1)

Allocation-2 :Additive Toxicity TMDL for Organophosphate Pesticides*

Allocation-3: Additive Toxicity TMDL for Pyrethroid Pesticides*

Allocation-4: Aquatic Toxicity TMDLs* - (refer to Table 5-2)

Allocation-5: Organochlorine Pesticide TMDLs* - (refer to Tables 5-2, 5-3, 5-4)

*The TMDLs are decribed in Section 5.1

5.4. Margin of Safety

The TMDL requires a margin of safety component that accounts for the uncertainty about the relationship between the pollutant loads and the quality of the receiving water (CWA 303(d)(1)(C)). The margin of safety is incorporated in these TMDLs implicitly though conservative assumptions. The desired water quality is achieved through allocations and targets equal to desired water quality; hence an implicit conservative approach. If, during the TMDL implementation phase staff develops numeric targets and TMDLs that better reflect the desired water quality, the allocations will be set equal to these modified targets and TMDLs.

5.5. Critical Conditions

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

5.6. Seasonal Variation

The TMDLs and allocations are expressed in terms of concentration equal to the desired water quality conditions (targets), which are applicable to all seasons and flow-regimes. Therefore, TMDLs and allocations developed on the basis of seasonal variation are not appropriate in this case. Additionally a review of monitoring data for the TMDL found exceedances of water quality objectives for chlorpyrifos and diazinon occurred during both wet and dry seasons.

There were insufficient monitoring data for pyrethroids for staff to conclude seasonality of impairment in the project area. However, in an urban pesticide monitoring study conducted by DPR in northern California, DPR found that rainstorms drive more pesticides into urban surface waters and that, generally, more pesticides are detected in first flush rain storms than during later irrigation season dryflow or a late spring rainstorms. Also more pesticides were detected in spring rainstorms than during dryflow (Ensiminger, 2011). This anecdotal evidence suggests that implementation efforts, particularly for sediment-bound pesticides, should include focus primarily on wet weather loading. During the dry season there is a risk of pyrethroid pollution and toxicity from low flow dry season runoff and therefore pyrethroids are a concern yearround.

Organochlorine pesticides are persistent for many years and therefore impacts and impairments do not vary seasonally.

5.7. Load Duration Curves

Based on USEPA guidance, staff has provided daily load expressions to supplement the concentration-based expression of the TMDLs and allocations (see APPENDIX D – Flow Duration Curves, Load Duration Curves, and Percent Load Reductions).

The daily load expressions contained in Appendix B are not the TMDLs. However daily load expressions can facilitate the development of management actions to achieve the allocations and TMDL. For example, the load duration curves may show that exceedance of the numeric targets during a particular flow regime is excessive, or no exceedance at all. This information could be useful to determine implementation strategies. To this end, staff will continue to update the load duration curves when data become available, and when appropriate.

USEPA (2007) recommends that TMDLs include a daily time increment in conjunction with other temporal or concentration-based expressions; the load-duration curves achieve this recommendation.

6. IMPLEMENTATION AND MONITORING

6.1. Introduction

Due to the types of water quality problems and nature of the sources, the TMDL implementation is divided into two implementation plans, one for currently applied pesticides and one for legacy organochlorine pesticides. Organochlorine pesticides are persistent for many decades in the environment and available monitoring data indicates DDTs in particular are ubiquitous in the watershed requiring farmland and drainage channel mitigation measures. Organochlorine pesticides bioaccumulate in the food chain and are also present in wildlife tissue consumed by humans. Currently applied pesticides are generally less persistent in the environment; therefore, water quality problems should respond to changes in management practices implemented through existing regulatory programs.

Sources of currently applied pesticide can also directly be traced to specific applications. Uses of currently applied pesticides are regulated by DPR, which has a responsibility to assure use of pesticides in a manner that does not harm the environment. Municipalities do not have direct regulatory authority over the use of pesticides. DPR has no authority over persistent organochlorine pesticides that were applied many decades ago. In addition the Water Board has regulatory programs that address pesticide pollution from agricultural and urban runoff.

Current Water Board regulatory programs can be used to address discharge of organochlorine pesticide polluted sediment but additional regulatory programs need to be developed to address pollution in surface waters.

6.2. Implementation Plan for Currently Applied Pesticides

The TMDL implementation plan for currently applied pesticides utilizes an interagency approach between DPR and the Water Boards to address pesticide impairments in the Santa Maria Watershed. The approach is described in the California Pesticide Management Plan for Water Quality (California Pesticide

Plan), which is an implementation plan of the Management Agency Agreement (MAA) between DPR and the Water Boards, signed in 1997. The Water Boards and DPR have responsibilities to protect water quality from the potential adverse effects of pesticides and the MAA was established to provide a unified cooperative program to protect water quality related to the use of pesticides.

The California Pesticide Plan describes how DPR and the County Agricultural Commissioners (Commissioners) will work in cooperation with the Water Boards. The Pesticide Plan is an effort to make State programs addressing pesticides and water quality more understandable, consistent and efficient. The two agencies have complementary regulatory authorities and programs, with DPR regulating pesticide use and the Water Boards regulating discharge to surface waters. The MAA and the Pesticide Plan are accepted by the State Water Board as measures consistent with the State's Nonpoint Source Management Plan.

<u>Four-Stage Approach to TMDL Implementation</u>

The TMDL implementation plan utilizes a four-stage response program identified in the California Pesticide Plan to minimize the potential movement of pesticides to waters of the state. The four-stage approach is outlined below:

Stages 1: Education and outreach efforts to communicate pollution prevention strategies.

Stage 2: Self-regulating or cooperative efforts to identify and implement the most appropriate site-specific reduced-risk practices.

Stage 3: Mandatory compliance is achieved through restricted use permit requirements, implementation of regulations, or other DPR regulatory authority, as required in the Food and Agriculture Code.

Stage 4: Compliance is achieved through State and Regional Water Boards' Water Quality Control Plans or other appropriate regulatory measures consistent with applicable authorities.

Stages 1 through 4 are listed in sequence that should generally apply but they may be implemented as necessary. The Pesticide Plan states that: *If adequate protection cannot be achieved by Stage 2, DPR and the Commissioners implement Stage 3.*

<u>Response Process</u>

A companion state document is the *Process for Responding to the Presence of Pesticides in Surface Water* (Response Process), which describes how the DPR and the Water Boards will respond to the presence of pesticides in surface water.

The Response Process is also incorporated into the TMDL implementation plan. The components of the Response Plan implemented in response to violations of water quality objectives are outlined below:

A. Determination of Violations
   1. Water Board determines violation of water quality objectives, the Water Board's executive officer will transmit to DPR the determination when the objective is exceeded for reasons related to currently registered pesticides*. The TMDL technical report supports the determination of violation of water quality objectives from currently registered pesticides. The Executive Officer should transmit the TMDL findings to the Director of DPR to initiate response to violation of water quality objectives*.

B. Response to Violations
   1. If DPR and the Water Board can collaboratively identify the pesticide(s) or use practice responsible for the violation of the water quality objective, they will implement a program in accordance to the response process. *DPR and the Water Board will implement the Four-Stage Approach outlined in the Pesticide Plan.* When possible, programs will support regulatory incentives as a means for attaining acceptable compliance with water quality objectives. *For the TMDL, implementations of regulatory incentives are considered Stage 1 and 2 activities of the Pesticide Plan, education and outreach and self-regulating activities.*
      a. DPR and the Water Board staff will jointly evaluate regulatory options for addressing the violation of water quality objectives, including the practicality of the regulatory option, enforceability, and likelihood of success. *For the TMDL these are considered Stage 3 and 4 activities of the Pesticide Plan*
         i. Consideration of DPR regulatory authorities.
         ii. Consideration of Water Board regulatory authorities.
         iii. A summary of water quality violation, staff evaluations and recommendations will be forwarded to the Director (DPR) and the Executive Officer (Water Board) for a decision.
         iv. The Director and the Executive Officer will prepare a joint response regarding the actions that each will take.
         v. The Director and the Executive Officer will coordinate execution of the joint implementation.
   2. If DPR and the Water Board cannot determine the pesticide or use practice that is responsible for the violation of the water quality

objective, DPR and the Water Board determine what additional information is needed, how and when it will be developed and who is responsible for gathering it. *Once the responsible use is determined DPR and the Water Board will implement the Four-Stage Approach as outlined in above item 1.* (Note: this step was included for stakeholders to understand the MAA process but this step will not be implemented in the Santa Maria watershed since the sources of currently applied pesticides have been identified in the TMDL). When making their determination, they will:

a. Recommend additional assessment and research to identify pesticides or use practices that will support regulatory and non-regulatory (Stages 1-4) response from the DPR and the Water Board.
b. Consider funding opportunities that may address data gaps and research needs.
c. Consider the use of DPR's reevaluation process as a means to attain water quality objectives.
d. Consider Water Board authorities as a means to obtain additional information.
e. Consider promotion of self-determined management practices as a mean to attain water quality objectives

3. DPR and the Water Board will jointly evaluate the effectiveness of measures in achieving compliance with water quality objectives. Water quality monitoring will help demonstrate effectiveness.

Pesticide Registration Reevaluations by DPR

DPR has the responsibility to evaluate the environmentally safe use of pesticides and can order a reevaluation of a use of registered pesticide by the pesticide registrant. The organophosphate pesticides chlorpyrifos and diazinon as well as pyrethroids are being reevaluated for registered uses common on central coast due to the presence of these pesticides in surface waters. Reevaluations can involve water quality monitoring and monitoring data assessment, the identification of problematic uses, identification of mitigation measures, education and outreach and the assessment of management practice effectiveness.

Implementation for Irrigated Agricultural Operations

The primary irrigated agricultural land implementation mechanism under direct Water Board regulatory authority is the Conditional Waiver of Discharge Requirements for Discharges from Irrigated Lands (Ag. Order), which is managed under the Water Board's Agricultural Regulatory Program (Ag. Program). Irrigated agricultural operations must sign a Notice of Intent to comply with the Ag. Order and submit it directly to the Water Board. The Ag. Order is a waiver of waste discharge requirements but irrigated agricultural operations must comply with the conditions of the Ag. Order and applicable TMDL requirements, including these implementation plan requirements. The TMDL implementation for irrigated agricultural operations follows the four-stage approach described in the California Pesticide Plan.

Stage 1: Education and Outreach

It is recommended that dischargers farming in watersheds with pesticide impairments be required to annually complete 1 hours of Water Board approved pesticide water quality education. This requirement could be developed incoordination between the Water Board and the County Agricultural Commissioners.

Stage 2 : Self-regulating cooperative efforts (Development of Pesticide Load Allocation Attainment and Monitoring Plan)

A requirement of the Ag Order is that all irrigated agricultural dischargers must develop and implement a farm water quality management plan (Farm Plan) that includes a pesticide planning and management section. The Farm Plan describes management practices and their effectiveness in protecting water quality. Staff recommends that Dischargers applying pesticides and farming ranches in the Santa Maria watershed include the following additional planning and management information to protect water quality from pesticide run-off to surface waters:

- Watershed description and map.
    - Include site location, drainage patterns, major water bodies, etc.
- Farm/ranch, field boundaries crop type and acreage.
- Roads and driveways.
- Buildings and structures;
    - Include pesticide storage locations and mixing areas
- Hydrologic features;
    - Locations of wells and/or other water supply.
    - All onsite and adjacent waterbodies (streams, creeks, lakes, drainage ditches, ponds, reservoirs, etc.).
    - Site topography, such as slopes and surface drainage patterns.

        - Field row direction and head ditches.
        - Irrigation type.
        - Tile drain locations, drainage patterns, sumps and outlets.
        - All offsite discharge locations.
    - General soil map and type.
    - Water quality goals for the site (including numeric targets for this TMDL).
    - Pesticide run-off risk analysis (refer to Pesticidewise website and/or UCANR Publication 8161 Pesticide Choice: Best Management Practice (BMP) for Protecting Surface Water in Agriculture). Include:
        - List all pesticides applied on the site and the potential to discharge from site.
        - Assess the overall runoff risk of each pesticide. Note the solubility, adsorption rate and persistence.
        - Location of field applications.
    - Management Practices
        - Select management practices based on pesticide properties, site conditions and water quality goals.
    - List all onsite management practices. Plan for assessing the effectiveness of management practices.
        - Include mechanisms for implementing alternate management practices following assessment of effectiveness.
    - Monitoring
        - Irrigation Return Flow Monitoring
            - Document offsite discharges:
                - Keep a current log of offsite discharges. Log date, time, estimate of flow and duration of flow.
                - Seasonally photo-document discharge.
        - Stromwater Monitoring
            - Seasonally photo-document stormwater discharge.
    - Training
        - Conduct water quality training of key staff

Stage 3: Mandatory compliance with DPR regulations
Pesticides must be applied as described on the label requirements.

The Water Board and DPR are jointly responding to the presence of pesticides in surface waters in the Santa Maria Watershed as per the MAA, Pesticide Plan and the Response Process. Violations of water quality objectives are documented in the TMDL and the TMDL technical report will be transmitted to DPR and the Santa Barbara and San Luis Obispo County Agricultural Commissioners (Commissioners). The TMDL also identifies the pesticides and use practices responsible for many of the violations. DPR will coordinate with the Water Board regarding regulatory incentives and actions.

Pesticides must be applied as described on the label requirements. DPR and the Commissioners are responsible for assuring that pesticides are applied according to label restrictions. The label conditions are the responsibility of USEPA but are enforced by DPR and the Commissioners. Recent label conditions placed on diazinon and pyrethroids agricultural use products should improve water quality.

REQUIRE A PERMIT FROM THE COUNTY AGRICULTURAL COMMISSIONER'S OFFICE TO APPLY CHLORPYRIFOS ON COLE CROPS

According to the Food and Agricultural Code (FAC), the Commissioners have the authority to require permits for the use of pesticides that are not restricted permits when they determine that the use of a pesticide will present an undue hazard when used under local conditions. The TMDL demonstrates evidence that water quality problems from the use of chlorpyrifos meet the conditions in the FAC for a county use permit. The Water Board has notified DPR and the Commissioners about surface water quality problems from the use Chlorpyrifos to cole crops and the Water Board should coordinate with DPR and the county Commissioners to potentially develop a County Agricultural Commissioner permit requirement to use chlorpyrifos.

BUFFER ZONES FOR PYRETHROID APPLICATION

In 2008, USEPA required pesticide registrants to update spray drift language for pyrethroid agricultural use products (EPA 2008). The primary mitigation measure is the requirement of buffer zones between applications and down gradient aquatic habitat. The label update states that growers must do the following:

Vegetative Buffer Strip

Construct and maintain a minimum 10-foot-wide vegetative filter strip of grass or other permanent vegetation between the field edge and down gradient aquatic habitat (such as but not limited to, lakes; reservoirs; permanent stream; marshes or natural ponds; estuaries; and commercial fish farm ponds).

Only apply products containing (name of pyrethroid) onto fields where a maintained vegetative buffer strip of at least 10 feet exists between the field and down gradient aquatic habitat.

Buffer Zone for Ground Application (groundboom, overhead chemigation, of airblast) *Do not apply within 25 feet of aquatic habitats (such as but not limited to, lakes, reservoirs, rivers, streams, marshes, ponds, estuaries, and commercial fish ponds.*

The language also contains revised conditions for aerial application buffers and other spray drift requirements. The Water Board should ensure that aquatic habitats described in the basin plan are clearly understood by parties implementing the label restrictions.

Aquatic Habitat Descriptions from the Basin Plan

DPR and the Commissioners enforce pyrethoid label requirements for buffer zones to protect aquatic habitats as designated and assigned in the Basin Plan.

The beneficial uses with aquatic habitat protection in the Santa Maria Watershed are Warm Fresh Water Habitat (WARM) and Cold Fresh Water Habitat (COLD). The following surface water bodies in the Santa Maria Watershed are in proximity of agricultural operations and are specifically designated with aquatic habitat beneficial uses protection in Table 2-1 of the Basin Plan; therefore, growers operating adjacent to the following waterbodies or their tributaries must protect aquatic habitat from pyrethroids:

- Oso Flaco Lake (WARM)
- Oso Flaco Creek (WARM)
- Santa Maria River (COLD)(WARM)
- Sisquoc River, downstream (COLD)(WARM)
- Cuyama River, upstream Twitchell Reservoir (WARM)
- Cuyama River, upstream Twitchell Reservoir (COLD)(WARM)
- Orcutt Creek (COLD)

In addition, the Basin Plan states that surface water bodies within the Region that do not have a beneficial use designated for them in Table 2-1 of the Basin Plan are assigned aquatic life protection. Examples of additional surface waters protected as aquatic habitat in the Santa Maria Watershed include:

- Main Street Canal
- Green Canyon Channel
- Bradley Channel
- Bradley Canyon
- Tributary public roadside drainages and channels (e.g. Oso Flaco Road, Division Road, Main Street, etc.)

DIAZINON LABEL CHANGES

In 2004 USEPA issued an Interim Reregistration eligibility Decision (IRED) for Diazinon that required mitigation measures to, in part, increase protection of the environment (EPA 2004). By 2006, USEPA completed assessment of the diazinon IRED and it was finalized as the Reregistration Eligibility Decision. Some of the label changes include reductions in the number of applications on lettuce to one pre-plant soil and one foliar application per crop.

Stage 4: Mandatory Compliance with Water Board Regulatory Measures and Monitoring

Irrigated farming operations on the central coast enrolled in the Ag Order are required to comply with the specific conditions of the order and the monitoring and reporting requirements. Additionally, the order states that dischargers must comply with the requirements of applicable TMDLs. The Ag Order contains the following requirement:

> *This Order regulates discharges of waste from irrigated lands by requiring individuals subject to this Order to comply with the terms and conditions set forth herein to ensure that such discharges do not cause or contribute to the exceedance of any Regional, State, or Federal numeric or narrative water quality standard (hereafter referred to as exceedance of water quality standards) in waters of the State and of the United States.* (finding 9 Page4)
>
> *Dischargers must comply with applicable Total Maximum Daily Loads (TMDLs), including any plan of implementation for the TMDL, commencing with the effective date or other date for compliance stated in the TMDL.*

ORGANOPHOSPHATE PESTICIDES

Chlorpyrifos and Diazinon Monitoring

Implementation of agricultural dischargers enrolled in the Ag Order are separated into monitoring one of three tier levels based in part on whether chorpyrifos or diazinon are applied or not on a site and whether there is discharge from sites with chlopyrifos or diazinon applications.

- Tier 1 - dischargers do not apply chlorpyrifos or diazinon
- Tier 2 - dischargers apply chlorpyrifos or diazinon
- Tier 3 - dischargers apply chlorpyrifos or diazinon and discharge to impaired surface waters

All operations enrolled in the Ag Order are required to participate in either cooperative watershed monitoring or monitor individually. Starting October 1, 2013, Tier 3 dischargers are required to individually monitor discharge irrigation and storm water run-off from sites that with chlorpyrifos or diazinon applications that discharge to impaired surface waters. In 2014 they are required to report the results of the monitoring.

Chlorpyrifos and diazinon degradates are a potential source of toxicity and when the Ag Order is renewed the pesticide degradate toxicity should be considered as a potential source of toxicity and staff should consider monitoring degradates in the monitoring and reporting program.

Malathion Monitoring

The Ag Order does not have tiered monitoring requirements for agricultural dischargers applying malathion, therefore the TMDL outlines additional monitoring recommendations for surface waters impaired by malathion. In the Santa Maria watershed, Oso Flaco Creek was identified as impaired for malathion, and the following monitoring is recommended to address impairments.

- Operations farming the Oso Flaco watershed should include one wetseason and one dry season monitoring event of malthion to correspond with existing cooperative watershed toxicity monitoring as described below under Agricultural Watershed Surface Water Monitoring Requirements.

In addition to monitoring for malathion, operations should monitor for the malathion degradate, maloxon. In recent studies, maloxon is characterized as possing a serious ecological risk (OPP, 2007). Maloxon should be monitored along with malathion.

PYRETHROID PESTICIDES

The Ag.Order does not have tiered monitoring requirements for agricultural dischargers applying pyrethroids, therefore dischargers in the watershed applying pyrethroid pesticides should include the following in their pesticide management plan:

- Map of site and down gradient aquatic habitat
- Location of onsite vegetative buffers
- Description and location of other sediment controls

Pyrethroid Monitoring

Surface waters impaired for pyrethroids and sediment toxicity should be monitored for pyrethroids in sediment and water column in concurrance with required existing Ag Order toxicity monitoring. The analysis of toxicity monitoring data is described In Section 3.3 AquaticToxicity Numeric Targets. The collection of pyrethroid monitoring samples is complicated by the loss of pyrethroids onto storage container surfaces and sample collection devices and staff recommends collection methods developed by Hladik et al., (2009), as described in the table below.

Table 6-1 Sediment toxicity and pyrethroid monitoring methods

Water Quality Parameters	Tests	Method Detection Limit	Reporting Limit
Invertebrate Toxicity Survival and Reproduction			
Sediment Toxicity, *Hyalella azteca*	10-day	Results reported as survival, growth, or reproduction rates as % of control (0 to > 100%). Minimum reportable results = 0	
Pyrethroid Pesticides Sediment (Units ng/g, ppb)			
Allethrin	To be determined[2]	0.5	2
Bifenthrin	To be determined[2]	0.5	2
Cyfluthrin	To be determined[2]	0.5	2
Cypermethrin	To be determined[2]	0.5	2
Danitol	To be determined[2]	0.5	2
Deltamethrin	To be determined[2]	0.5	2
Esfenvalerate	To be determined[2]	0.5	2
Fenvalerate	To be determined[2]	0.5	2
Fluvianate	To be determined[2]	0.5	2
Lambda-Cyhalothrin	To be determined[2]	0.5	2
Permethrin	To be determined[2]	5	25
Prallethrin	To be determined[2]	0.5	2
Other Parameters			
Total Organic Carbon Analysis	EPA 9060Am	0.01% (DW)	0.02% (DW)

[2] A monitoring method shall be submitted to CCAMP for approval, DW = dry weight

EROSION AND SEDIMENT CONTROL

Sediment moving off of irrigated lands, urban run-off and in drainage channels is a source of legacy organochlorine pesticides and currently available pesticides such as chlorpyrifos and synthetic pyrethroids. Sediment loading should be monitored and analyzed as part of the Ag Order MRP and urban stormwater programs. Sediment controls should be incorporated in implementation plans to reduce pesticide loading into surface waters.

AGRICULTURAL WATERSHED SURFACE WATER MONITORINIG REQUIREMENTS

The Ag Order requires dischargers to either individually or collectively monitor receiving water quality in the Santa Maria Watershed. The following are some of the toxicity and pesticide water quality monitoring required under the Ag Order:

- *Water column toxicity samples: two monthly "dry season" and two monthly "wet season" sampling events only, concurrent with sampling for conventional constituents.*
- *Sediment toxicity samples: one monthly event during spring only, concurrent with sampling for conventional constituents.*
- *Toxicity-related constituents in water (e.g. pesticides, metals, phenol) concurrent with toxicity sampling for one year only (4 events, during the second year of the Waiver cycle only).*
- *Toxicity-related constituents in sediment (e.g. pesticides, sulfide) concurrent with toxicity sampling in sediment for one year only (1 event, during the third year of the Waiver cycle).*

The TMDL recommends additional monitoring when water quality improves to have enough samples to delist improved surface waters. The following are additional monitoring requirements that should be incorporated in the Watershed Pesticide Plan:

- When watershed monitoring indicates improvements in water quality for period of one or two years. Dischargers should submit a monitoring plan for delisting the surface water. The delisting plan shall be submitted to the TMDL program. Staff will assist dischargers in developing delisting MRP with increased monitoring frequency.
- The Oso Flaco watershed is listed as impaired for water column toxicity, it was also impaired for the pesticide malathion in the surface water, based on a minimal number of detections. Irrigated agricultural operations in the Oso Flaco watershed should conduct additional watershed monitoring to identify the sources of unknown toxicity and to investigate malathion impairments.

Implementation for Municipalities

The TMDL implementation plan utilizes the Four –Stage Approach from the California Pesticide Plan to address pesticide pollution in urban storm water. The four stages of the California Pesticide Plan include education and outreach, self-regulation, regulatory response from the DPR, and regulation from the Water

Board. The primary urban pesticide problems identified in the TMDL are the contamination of surface waters from pyrethroid insecticides, which enter surface waters in storm water run-off.

One implementation goal in the urban environments is to apply pesticides in a manner that minimizes the movement of the pesticide from a site and into storm water systems and receiving waters. These practices are referred to as reduced-risk application practices in the California Pesticide Plan.

The implementation of reduced-risk practices will require regulation, extensive education and outreach, and self-directed implementation to mitigate the effects of pyrethroids in surface waters. This approach is necessary since insecticides are applied by both commercial applicators, who are hired to apply pesticides, and homeowners who are able to directly purchase and apply pesticides. Commercial applicators are professionals licensed by DPR and regulated at the county level by the Commissioners. Commercial applicators must comply with label and other use restrictions and report use to the Commissioners. Homeowner use is not reported or closely regulated making the implementation of management practices or use restrictions challenging. Ultimately, given the broad urban landscape, it is the responsibility of pesticide applicators to use pesticides in a manner that is protective of the environment. The regulation of use is under the authority of DPR and DPR implemented use restrictions and controls at the state level are the primary means of implementation.

Stage 1: Education and Outreach

Education and outreach is a key component in implementing reduced risk practices. The operators of Municipal Separate Storm Sewer Systems (MS4s) should coordinate with the Commissioners on a program to educate homeowners and professional applicators on practices to protect water quality from pesticide run-off.

There are several education and training recommendations in the California Pesticide Plan designed to increase the awareness of pest control business and managers and homeowners to prevent pesticide water quality problems. Some of the recommendations include:

- Develop pamphlets that summarize water quality issues and pyrethroid specific reduced risk practices for distribution by the Commissioners when they issue permits, register licenses and conduct training.
- Develop reduce risk practice fact sheets for the general public that discusses pesticide use and water quality protection.

- Work with MS4 staff on the implementation of IPM and use of reduced runoff pesticide application.
- The City should support efforts by statewide organizations such as California Stormwater Quality Association (CASQA) to have DPR and EPA develop and implement use restrictions on pesticides such pyrethroids, that are detected and cause toxicity in stormwater runoff.

In addition, through the reevaluation process DPR should encourage registrants to provide education materials and workshops in the watershed to educated homeowners and professional applicators.

Stage 2: Self-Regulation

Commercial pesticide applicators should participate in self-directed programs that encourage reduced-risk pesticide applications, reduced pesticide use and integrated pest management (IPM). One such program is the Green Gardener Program for Santa Barbara County. The program encourages pollution prevention landscape maintenance practices and offers training and certification. Additional programs should be developed for structural pest control applicators and homeowners.

Stage 3: Regulatory Approach Using DPR's Authority (Urban Surface Water Protection Regulations)

DPR has recently approved urban pesticide surface water protection regulations that place restrictions on non-agricultural commercial/professional applications of pyrethroids. The regulations apply to for hire urban applicators such as gardeners, structural applicators, and pest control business. Some of the measures in the regulations include:

- Limiting applications methods in landscapes and on impervious surfaces to spot treatments, crack and crevice treatments and pin stream treatments of one-inch wide or less. Landscape perimeter band and broadcast treatments are permitted in areas in close proximity to buildings but away from impervious surfaces.
- Prohibiting landscape and impervious surface applications within 25 of downgradient aquatic habitat and within 10 feet of a downgradient storm drains.
- Prohibiting applications to surfaces with landscape and impervious surfaces with standing water as well as prohibiting direct applications to landscape and municipal storm drain systems.

It is anticipated that the regulations should significantly reduce pesticide contaminated runoff from homes and businesses in urban areas, since the regulations are targeted at the largest group of pyrethroids applicators (CDPR, 2012).

The effectiveness of the regulations was evalutated as a Phd. Thesis project (Jorgenson, 2011), which concluded based on a watershed model in the Sacramento area that the regulations would result in an approximately 50% reduction in the mass of pyrethroids applied to pervious surfaces and and 80% reduction pyrethroids mass applied to impervious surfaces. The model also predictied an over 80% reduction in toxicity (exposure to toxicity units) in surface waters.

The County Agricultural Commissioner engages DPR's regulatory authority at the local level for commercial agricultural and non-agricultural use of pesticides. The Commissioner should have an active role in implementing urban regulations and work with the MS4s in reporting on the implementation of regulations.

Stage 4: Regulatory Approach Using Water Board Authority

The Water Board regulates municipal storm water run-off from communities with MS4s in the Santa Maria Watershed under the National Pollution Discharge Elimination System (NPDES) municipal storm water permit program. The MS4s shall have pesticide storm water plans incorporated into their storm water permit requirements.

Entities such as the City of Santa Maria and the County of Santa Barbara that manage stormwater systems do not have the authority to regulate the use of pesticides applied within their jurisdiction. Pesticide use is regulated by DPR, but they do have a legal responsibility for discharges of pesticide from their stormwater system. The legal responsibility of the City for pesticide discharges in the stormwater system is described in the following excerpt of the Federal Register. Fed Reg vol 64, No 235, p. 68765-66.

"*The operator of a small MS4 that does not prohibit and/or control discharges into its system essentially accepts ''title'' for those discharges. At a minimum, by providing free and open access to the MS4s that convey discharges to the waters of the United States, the municipal storm sewer system enables water quality impairment by third parties. Section 122.34 requires the operator of a regulated small MS4 to control a third. party only to the extent that the MS4 collection system receives pollutants from that third party and discharges it to the waters of the United States. The operators of regulated small MS4s cannot passively receive and discharge pollutants from third parties.*"

The Central Coast Water Board will require municipal separate storm sewer systems (MS4) entities to develop, submit, and implement a Wasteload

Allocation Attainment Program (WAAP). WAAP development, submittal and implementation will be required in the Phase II municipal stormwater permit. The WAAP will be required to include descriptions of the actions that will be taken by the MS4 entity to attain the TMDL waste load allocations.

Urban stormwater pesticide problems are not unique to the MS4s in the Santa Maria watershed, but are problems faced by MS4s throughtout the state. Staff recognizes that the primary means of achieving the water quality goals in the TMDL will rely on the effectiveness of statewide pesticide programs and regulations by DPR to control pesticides. The MS4s should use statewide programs and regulations as the primary means of the TMDL implementation and compliance and describe in the WAAP how the MS4s plan to support and engage in the statewide efforts. Staff recommends that the MS4s use mitigation measures developed in the DPR surface water regulations as stormwater Best Management Practices (BMPs) in the WAAP.

A draft Wasteload Allocation Attainment Programs should include:

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 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.

MS4 Monitoring Recommendations

MS4 entities with operations and storm water conveyance systems in the TMDL project areas will be 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.

The MS4s should develop and submit creative and meaningful monitoring programs. Monitoring strategies may be able to 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 facilitate accurate assessment of how well the best management practices control pollution sources may be acceptable, with the intent of successful practices then being implemented in other or larger parts of the MS4 jurisdiction.

The City of Santa Maria has direct storm water discharge to Main Street Canal and Bradley Channel which are impaired for sediment toxicity and pyrethroid pesticides. Therefore, they should monitor these water bodies every two years for sediment toxicity and concentrations of pyrethroids. The monitoring parameters and required limits are described in Table 6-2. The toxicity monitoring methods are described in Section 3.3 AquaticToxicity Numeric Targets.

The Lower Santa Maria River is impaired for sediment toxicity and pyrethroid pesticides. The unincorporated areas of Santa Barbara County, specifically Orcutt potentially contribute pesticide loads but are not considered significant enough given the extent of agricultural run-off to the river to warrant monitoring by the county.

Table 6-2 Municipal stormwater monitoring parameters

Water Quality Parameters	Tests	Method Detection Limit	Reporting Limit
Invertebrate Toxicity Survival and Reproduction			
Sediment Toxicity, *Hyalella azteca*	10-day	Results reported as survival, growth, or reproduction rates as % of control (0 to > 100%). Minimum reportable results = 0	
Pyrethroid Pesticides Sediment (Units ng/g, ppb)			
Allethrin	To be determined[2]	0.5	2
Bifenthrin	To be determined[2]	0.5	2
Cyfluthrin	To be determined[2]	0.5	2
Cypermethrin	To be determined[2]	0.5	2
Danitol	To be determined[2]	0.5	2
Deltamethrin	To be determined[2]	0.5	2
Esfenvalerate	To be determined[2]	0.5	2
Fenvalerate	To be determined[2]	0.5	2
Fluvianate	To be determined[2]	0.5	2
Lambda-Cyhalothrin	To be determined[2]	0.5	2
Permethrin	To be determined[2]	5	25
Prallethrin	To be determined[2]	0.5	2
Other Parameters			
Total Organic Carbon Analysis	EPA 9060Am	0.01% (DW)	0.02% (DW)

[2] A monitoring method shall be submitted to CCAMP for approval, DW = dry weight

Bradley Channel and Main Street Canal have a mix of urban and agricultural run-off, to determine the urban contribution and to evaluate the effectiveness of the city's program; the City of Santa Maria shall monitor an urban subwatershed for toxicity and pyrethroid pesticides.

In addition to direct monitoring of Main Street Canal and Bradley Channel, the MS4s should monitor urban tributary subwatersheds that are representative indicators of urban pesticide runoff for sediment toxicity and pyrethroid pesticides. Due to the mix of urban and agricultural run-off, the city should monitor urban only outfalls to determine the urban contribution to the impairments and to evaluate the effectiveness of their implementation programs. The city should develop a plan for urban watershed monitoring and submit it to the Water Board for approval as part of the Waste Load Allocation Plan. The MS4s may monitor indicator watersheds within the MS4s jurisdiction boundaries or participate in statewide monitoring and reporting programs.

The collection of pyrethroid monitoring samples is complicated by the loss of pyrethroids onto storage container surfaces and sample collections devices and staff recommends collection methods developed by Hladik et al., (2009).

BMP Tracking and Assessment Report

The assessment of management practice effectiveness is a vital component in assessing progress towards achieving the TMDL.

The Wasteload Allocation Attainment Plan should include an annual assessment of:

- Pesticide use in the watershed
- Pesticide management practices implemented in the watershed
- Pesticide management practice effectiveness.
    - Including effectiveness in improving water quality.

The annual assessments should include a spatial distribution of practices and their effectiveness in relation to water quality monitoring sites. Since the MS4s are utilizing state programs to implement the TMDL the MS4s should provide reporting on the effectiveness of the statewide programs.

6.3. Organochlorine Pesticide Implementation Plan

For the organochlorine pesticide implementation, staff proposes a community-based watershed approach to address organochlorine pesticide water quality problems in the Santa Maria watershed, with the implementation lead by stakeholders (EPA, 2005). Staff proposes a community-based watershed approach due to the complex nature of organochlorine pesticides in the environment, the extended duration of organochlorine pesticide water quality problems, and the broad stakeholder group necessary to address this problem.

Organochlorine pesticides may have been directly applied to the Santa Maria Estuary and Oso Flaco Lake as vector control measures and implementation monitoring should include investigative monitoring of sediments to evaluate the distribution and concentrations in the sediments. A similar study was conducted of Pinto Lake near Watsonville California that evaluated sediment concentrations of organochlorine pesticides and chronological data of the sediment (Plater et al., 2006).

Organochlorine pesticide problems will not be quickly resolved quickly, and programs will need long-term stake holder involvement in scientific investigation, planning, management and implementation. While a community-based watershed approach is recommended to address organochlorine problems, the primary regulatory responsibility for the organochlorine pesticide implementation plan is with the landowners in the watershed with sites that are the sources of organochlorine pesticides. A landowner stakeholder group should be developed to support implementation of the TMDL. The proposed implementation framework is similar to the framework developed for the organochlorine pesticide TMDL in Ventura County in which the landowners pay fees for enrollment in a TMDL implementation program managed by Ventura County Farm Bureau.

EPA supports the implementation of community-based watershed approach to address water quality problems in coastal watersheds because it's:

- focus on the watershed,
- use of science to inform decision-making,
- emphasis on collaborative problem solving, and
- involvement of the public.

The implementation plan should include an adaptive management process with the following components:

- a system for monitoring organochlorine water quality problems
- water quality monitoring
- modification of the management plan as necessary

Implementation Plan Components

Stakeholder Group

Staff recommends that stakeholders in the Santa Maria Watershed form a watershed planning group to implement a plan to address organochlorine pesticide water quality problems. Suggested participants and interests in the watershed include:

- **City of Santa Maria:** Manages urban storm water
- **The Grower-Shipper Association of Santa Barbara and San Luis Obispo Counties:** Represents the interest of growers in the watershed
- **Cachuma Resource Conservation District:** Manages programs to assist landowners, farmers and ranchers in the Santa Maria Watershed.
- **San Luis Coastal Resource Conservation District:** Manages Oso Flaco Lake conservation projects for State Parks.
- **Santa Barbara County Farm Bureau:** Represents agricultural interests in Santa Barbara County.
- **San Luis Obispo County Farm Bureau:** Represents agricultural interests in the Oso Flaco watershed.
- **Santa Barbara County Flood Control District:** Manages the flood control system in the Santa Barbara County portion of the Santa Maria watershed.
- **San Luis Obispo County Public Works:** Manages flood control and roadside drainages in the Oso Flaco Watershed.
- **Santa Barbara County Parks:** Manages the Rancho Guadalupe Dunes coastal county park, which includes the Santa Maria Estuary.
- **California State Parks:** Manages the Oceano Dunes State Vehicular Recreation Area and the adjacent coast dune habitat which includes Oso Flaco Lake. State Parks has initiated watershed studies to protect the lake habitat.

Lead Organization

A lead organization should be determined to manage the organochlorine TMDL implementation plan. It is important to have an organization designated to coordinate outreach, education watershed analysis, planning, implementation, monitoring, data management and effectiveness evaluation. One of the stakeholder organizations, or a separate newly formed organization, should lead the effort towards a healthy functioning watershed. The organization will report on the compliance of TMDL requirements to the Water Board.

Organochlorine Planning Compliance Timeline and Deliverables

Table 6-3 Recommended Organochlorine Pesticide TMDL Milestones

MILESTONE DELIVERABLE	DATE DUE
Formation of watershed implementation group and governance structure	1-year following TMDL approval. (by OAL).
Development of a watershed management plan	4-year following TMDL approval. (by OAL).
Implementation of the management plan	Upon completion of management plan
Evaluation of monitoring data and implementation effectiveness	7-years after TMDL approval
Adjust management plan	8-Years after TMDL appoval

Monitoring Plan

Landowners should have the regulatory responsibility for organochlorine pesticide water quality problems and for making progress towards achieving TMDL goals. Staff recommends that stakeholders coordinate monitoring with existing ongoing monitoring programs such as CCAMP, the Cooperative Monitoring Program for Irrigated Agriculture and the statewide Stream Pollution Trends (SPoT) monitoring program. SPoT already annually monitors sediment in the Santa Maria estuary for DDT and other pesticides.

Since the ban on the sale organochlorine pesticides in the 1970s, organochlorine pesticides have been intermittently monitored in the Santa Maria Watershed. Recent monitoring confirms the persistence and ubiquitous presence of organochlorine pesticides in the environment, particularly the DDT degradates, DDE and DDD. UC Davis, as part of an estuary study, found high levels of DDTs in sand crabs sampled on the coastal shoreline north and south of the Santa Maria River. The DDT levels were much higher than safe tissue consumption levels. While sand crabs are generally not consumed by humans, they are indicators of ecosystem health and are a lower level food chain organism consumed by fish. DDT is known to biomagnify in the food chain and the concentrations of DDTs in coast fish is a concern and should be monitored. Due to significant health concerns from DDT, it's persistence in the environment and bioaccumulation in the food chain, a long-term monitoring program is needed to provide consistent monitoring of sediment and regular feedback on the safety of fish for human consumption. TMDL implementation and monitoring goals are outlined in Table 6-4.

Table 6-4 Organochlorine Pesticide Implementation and Monitoring Schedule

Location	**Description of Action**	**Timeline**
Watershed	Watershed organochlorine mitigation and monitoring plan	Within 4 years of TMDL adoption
Watershed	Development of a watershed DDT pesticide/sediment mass loading model and mass load allocations	Within 5 years of TMDL adoption
Farm Field	Development of farm site irrigation and erosion control management plans	Annual
Farm Field	Verify implementation of on farm management practices	Annual
Farm Field	Stormwater and irrigation run-off monitoring	Annual
Farm Field, Watershed	Soil monitoring for organochlorine pesticides, random confidential watershed scale monitoring of representative farms.	Every five years
Watershed	Watershed stream and channel organochlorine sediment monitoring	Every five years
Flood Control Channels	Development of a channel management and monitoring plan to control sediment and organochlorine pesticide transport	
Coastal shoreline	Sand crab and fish monitoring north and south of the Santa Maria River mouth and the Oso Flaco Lake outlet	Sand crab every five years and fish samples every two years
Estuary	Fish and sediment monitoring	Every two years
Oso Flaco Lake	Fish and sediment monitoring	Every two years

6.4. Santa Maria Watershed Pesticide Management Plan

All agricultural dischargers discharging pesticides in the Santa Maria Watershed should support and/or participate in the development and implementation of a Santa Maria Watershed Pesticide Management Plan (Watershed Pesticide Plan).

All enrolled dischargers in the Agricultural Order are currently required to conduct surface water quality monitoring and reporting. Dischargers have the option of either participating in a cooperative monitoring program managed by the CMP or individually monitoring. The Watershed Pesticide Plan is designed to augment the Agricultural Order requirements to document that programs are achieving TMDL goals. The Cooperative Monitoring Program (CMP) is a watershed scale program that allows growers to combine resources for lower cost monitoring than as individuals. Details of the CMP are described in the approved monitoring and reporting program (MRP) of the Agricultural Order (see MRP section) and in the CMP-developed sampling plan. The MRP has the following goals (CMP 2011):

1. Assess the status of receiving water quality and associated beneficial uses in impaired water bodies with substantial agricultural land use;
2. Evaluate water quality impacts resulting from agricultural discharges (including but not limited to tile drains);
3. Evaluate status, short term patterns, and long term trends (five to ten years or more) in receiving water quality; and
4. Evaluate storm water quality.

The MRP is intended to characterize the ambient conditions of agricultural watersheds explicit to the TMDL goals. The goals of the TMDL include:

1. Achieving the TMDLs.
2. Improve water quality and delist impaired waters from the 303(d) list.
3. Monitor progress towards achieving the TMDL.
4. Monitor the effectiveness of BMP implementation.
5. Identify specific pesticides or other toxicants causing unknown toxicity.

Therefore, additional monitoring and reporting requirements are recommended to assess progress toward achieving the TMDL.

BMP Tracking and Assessment Report

The assessment of management practice effectiveness is a vital component in assessing progress towards achieving the TMDL.

The Watershed Pesticide Plan should include, at a minimum, an annual watershed assessment of:

- Pesticide use in the watershed
- Irrigation practices in the watershed
- Pesticide management practices implemented in the watershed
- Pesticide management practice effectiveness.
- Erosion and sediment control management practices

The annual assessments should include a spatial distribution of practices and their effectiveness in relation to water quality monitoring sites.

TMDL Progress Assessment Report

The assessment of management practice effectiveness is a vital component in assessing progress towards achieving the TMDL.

The Watershed Pesticide Plan should include an annual assessment of:

- Trend analysis of water quality in terms of pesticides in the water column and sediment. The trend should be compared with TMDL targets.
- Summary of progress towards achieving the TMDLs.

Table 6-5 Recommended TMDL Progress Assessment Reporting Milestones

Report	Date Due to Water Board
Water Quality Monitoring Summary Report	3-years following TMDL approval, and every year thereafter
BMP Tracking and Assessment Report	3-years following TMDL approval and biennially thereafter
TMDL Progress Assessment Report	3-years following TMDL approval and biennially thereafter

Santa Maria Estuary Planning Area

Planning and implementation to protect the Santa Maria Estuary should be directed at the Orcutt Creek sub-watershed since it is the primary source of organochlorine pollution. The Santa Maria River is ephemeral and the middle to upper Santa Maria River has only intermittent hydrologic connectivity with the Santa Maria Estuary; the Orcutt Creek watershed has perennial flow into the estuary. This was documented in an estuary study which analyzed dry season flow into the estuary and determined that over 80% of the flow into the estuary was from Orcutt Creek (SAIC, 2004). The study also evaluated flows from the upper Santa Maria watershed and determined that sediments were held upstream of Bonita School Road crossing of the Santa Maria River.

Given the size of the Orcutt Creek watershed, it is important determine priority areas within the watershed. The Lower Orcutt Creek, Green Canyon and the middle Orcutt sub-watersheds are in close proximity of the estuary and have intensive irrigated crop production with irrigation run-off. Sediments from the Upper Orcutt Creek sub-watershed may have less of an impact on the estuary, since there is deposition in the Betteravia Lakes area. Also while Orcutt Creek has perennial flows in the upper and lower reaches it has subsurface flow in the middle reaches, which would impede sediment transport to the lower watershed.

The Orcutt Creek watershed has mixed land uses. The valley floor is dominated with irrigated crop production. There are urban areas in the upper subwatersheds with rangeland and open space in the foothills. The primary source of contaminated sediments is likely disturbed irrigated agricultural soils along with contaminants already present in streams and channels. For irrigated agricultural lands, standard irrigation and sediment BMPs should reduce sediment movement from farms.

With a combination of contaminated and non-contaminated sediments in the stream system, practices to reduce contaminated sediment loading should decrease total contaminated loading in the estuary. Reductions of loading to the coast should also have bearing on organochlorine pesticides entering the coast food chain. A study of organochlorine pesticides concentrations in sand crabs along the coast found a negative correlation between organochlorine pesticide concentrations in the sand crabs and the distance from the river mouth (Dugan, 2005). The concentrations in tissue decreased in relation to the distance they were sampled along the shore away from the river.

Two plans were developed for the watershed with management practices to protect water quality. One is the *Santa Maria Estuary Enhancement and Management Plan* (estuary plan) (SAIC, 2004) and another is the *Santa Maria River Watershed Non-point Source Pollution Management Plan* (Non-point source plan) (Cachuma RCD, 2000). The non-point source plan provides general management practice recommendations for irrigated crops but does not include specific onsite planning to address erosion. The estuary plan also does not include specific agricultural management practices but does propose a watershed treatment wetland in the lower Orcutt creek watershed near the confluence with the Santa Maria River, which could mitigate the flow of pollutants into the estuary. Additional planning is needed in the watershed to assist growers and land owners with the implementation of sediment control BMPs.
Implementation Summary

Table 6-6 Summary of TMDL implementation and activities

TMDL Implementation	Water Quality Problem	Description and Current Status
DPR - Pesticide Reevaluations	Chlorpyrifos Diazinon Pyrethroids	DPR's reevaluation branch is in the process of investigating with pesticide registrants the sources of water quality problems, mitigation measures and monitoring progress towards addressing problems.
Water Board - Irrigated Agricultural Order	Chlorpyrifos Diazinon Malathion Pyrethroids DDT Aquatic Toxicity	Tiered monitoring and reporting program for use of chlorpyrifos and diazinon. Ongoing farm planning and reporting of management practices and ambient surface water monitoring of TMDL waterbodies.
Water Board and DPR -Management Agency Agreement	Chlorpyrifos	Ongoing commitment by DPR and the Water Board to coordinate on addressing chlorpyrifos pollution.
County Ag. Com. pesticide restricted use permit	Chlorpyrifos Aquatic Toxicity	DPR, Commissioners from Santa Barbara, San Luis Obispo and Monterey Co. are developing a pilot project to a county restricted use permit for using chlorpyfos.
USEPA – Agricultural use pesticide label buffer requirements for pyrethroid applications	Pyrethroids Aquatic Toxicity	In 2008 EPA required registrant to begin adding buffer requirements to agricultural use of pyrethroids to protect aquatic habitats. The extent of buffer implementation is uncertain and should be evalutated. Increased implementation and enforcement of regulations may be need.
USEPA – Diazinon agricultural use pesticide label changes to protect water quality	Diazinon Aquatic Toxicity	For environmental protection EPA reduced the number of crops that diazinon is labeled and reduced the number of applications allowed on crops such as lettuce.
DPR – Statewide urban surface water protection regulation	Pyrethroids Aquatic Toxicity	In 2012 DPR enacted surface water protection regulations for professional nonagricultural use of pyrethroids.
MS4 – Waste Load Allocation Attainment Plan (WAAP)	Pyrethroids Aquatic Toxicity DDT	One year following adoption of the TMDL the MS4s are required to develop WAAPs.
Organochlorine Pesticide Implementation Plan	DDT and other Organochlorine pesticides	Proposed watershed implementation plans that will need new resources for development.
Santa Maria Watershed Pesticide Plan	Chlorpyrifos Diazinon Malathion Pyrethroids Aquatic Toxicity DDT	

6.5. Cost Estimate and Sources of Funding

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[1] 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).

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[2] necessary to reduce pesticide 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 pesticide pollution are already required by compliance with an existing regulatory program [Agricultural Order No. R3-2012-0011, including any pending and future renewals of the Order]. Compliance with these implementation measures are

[1] 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"*
[2] Porter-Cologne Water Quality Control Act §13360.(a)

required *with or without* the TMDL and are therefore not attributable to TMDL implementation As outlined in in this report, 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. 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. 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

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 6-7 presents the cost estimates to implement the Agricultural Order throughout the entire Central Coast Region.

Table 6-7 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 costs associated with implementing this TMDL, by using the information in Table 6-7.

Table 6-8 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 6-7). Based on the information presented in Table 6-8, the costs associated with TMDL implementation for five years are approximately 4.5 million dollars. 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 6-8. Cost estimates based on standard compliance with Agricultural Order in TMDL Project Area.

Management Practice Category	Acres[A]	Correction[B] Factor	Acres Practice Applied to:	Cost per Acre	Total Cost
Sediment/Erosion Control and Stormwater Management	52854	5%	2,643	$992	$2,621,558
Pesticide Management	52854	50%	26,427	$72	$1,902,744
Total Cost					$4,524,302

[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 used for the Agricultural Order.

Cost Estimates for MS4 Entities

Anticipating 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 assessment workplans to address organochlorine pesticides and/or pyrethroid pesticides 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, and will undoubtedly aid in the TMDL implementation. 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) 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.

Table 6-9. 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 6-10. 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

Some of 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, which could potentially mitigate pesticide loading, strategies are estimated to range as shown in Table 6-11.:

Table 6-11. 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

Funding Sources

Grants

There are several grant funding programs available to stakeholders that currently fund projects in the Santa Maria watershed for non-point source pollution control including Clean Water Act 319(h) grant program and state proposition 84 grants. To facilitate watershed funding, staff recommends that stakeholders participate in the areas IRWM planning process. Additionally, adoption of the TMDL should improve the opportunity for stakeholders to obtain grant funds.

Existing Organizations

Existing organizations working in the watershed could provide direct funds and staff time towards implementing the TMDL as part of ongoing efforts to protect water quality.

Irrigated Agricultural Land Owner Contribution to TMDL Implementation
Irrigated agricultural lands are identified as a source of organochlorine pesticide pollution in the TMDL. Land owners are responsible for TMDLs and should directly support the implementation of the TMDL by paying fees based on the acreage in the watershed. In Ventura County, the Farm Bureau manages a TMDL implementation and monitoring program that is supported by land owners. The model used in Ventura County could be developed in the Santa Maria watershed.

6.6. Timeline and Milestones

The target date to achieve the pesticide TMDLs for the organophosphates (chlorpyrifos, diazinon) is October 2016. This estimate is based on apparent decreased use, implementation of management practices to mitigate loadings, and existing regulatory efforts to lessen loading. These pesticides have only agricultural uses and The Ag Order requires extensive Tier 3 monitoring and reporting by operations that apply either chlorpyrifos or diazinon and discharge either irrigation runoff or stormwater to impaired surface waters.

The target date to achieve the TMDL for malathion is ten years after approval of the TMDL by the Office of Administrative Law. This estimate is based on the increase in current usage and current limited regulatory oversight. Malathion impairments are localized in the Oso Flaco watershed but malathion may be an emerging water quality problem as malathion use increases due to recent restrictions on chlorpyrifos and diazinon.

The target date to achieve the TMDLs for pyrethroids is 15 years after approval of the TMDL by the Office of Administrative Law. This estimate is based on the widespread availability of pyrethroids, including consumer usage and current limited regulatory oversight. Pyrethroids are applied to agricultural crops and for structural pest control by licensed applicators. Commercial uses of pyrethroids are regulated to protect water quality but home and garden applications by consumers are not and are difficult to control. Milestones for achieving the pyrethroid TMDL are outline in Table 6-9.

Table 6-12 Milestones for achieving pyrethroid additive toxicity TMDL

Year After Approval	Additive TMDL
5 Years	< 1.5 TU
10 years	< 1.0 TU
12 Years	.75 TU
15 Years	.25

TU = Toxicity Unit

The target date to achieve the TMDLs for organochlorine pesticides (DDT, DDD, DDE, chlordane, eldrin, toxaphene, and dieldrin) is 30 years after approval of the TMDL by the Office of Administrative Law. Organochlorine pesticides are extremely persistent in the environment. Use of DDT was discontinued over 30 years ago but DDT and its breakdown products are still detected in the watershed and food chain. Fortunately, more recent monitoring data indicates that DDT derivatives are present in the watershed, which indicates that the technical pesticide is breaking down since it was last applied. The estimate for achieving the organochlorine TMDL is based on pesticide persistence and mobility in the environment, widespread usage and deterction in the watershed and bioaccumulation in the food web.

6.7. Determination of Compliance with Wasteload Allocations

In this TMDL the City of Santa Maria, the County of Santa Barbara and the City of Guadalupe are assigned are allocated waste load allocations for pyrethroids pesticides, organochlorine pesticides additive pesticides and toxicity.

Waste load allocations will be achieved through a combination of implementation of management practices and strategies to reduce pesticide loading and water quality monitoring.

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

A. Attaining the waste load allocations in the receiving water.
B. Demonstrating compliance by measuring pesticide concentrations and toxicity in stormwater outfalls.
C. 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.
D. Any other effluent limitations and conditions that are consistent with the assumptions and requirements of the waste load allocations.

6.8. Determination of Compliance with Load Allocations

Demonstration of compliance with the load allocations is consistent with compliance with the Agricultural Order. Load allocations will be achieved through a combination of implementation of management practices and strategies to reduce pesticide loading, and water quality monitoring. Flexibility to allow owners and 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 surface water impairments.

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

A. Attaining the load allocations in receiving waters.
B. Implementing management practices that are capable of achieving load allocations identified in this TMDL.
C. Owners and operators of irrigated lands may provide 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 or operator to the Executive Officer that the owner or operator is not causing waste to be discharged to impaired waterbodies resulting or contributing to violations of the load allocations.

7. PUBLIC PARTICIPATION

Program staff held several stakeholder meetings during the development of the TMDL. The following is a summary of TMDL meetings and information items

- February 23, 2010 – Initial watershed TMDL meeting.
- January 25, 201l – Meeting to outline approach to developing the TMDL. Presented pesticides water quality problems, impairments and sample numeric targets.
- June 14, 2012 – Status update on TMDL development.
- November 7, 2012 – CEQA scoping meeting.

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