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Calleguas Creek Watershed OC Pesticides and PCBs TMDL Technical Report

Submitted to Los Angeles Regional Quality Control Board

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on behalf of the Calleguas Creek Watershed Management Plan

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1 INTRODUCTION

The Calleguas Creek Watershed OC Pesticides and PCBs Total Maximum Daily Load (TMDL) document presents the required elements for addressing impairments to Calleguas Creek and its tributaries caused by organochlorine pesticides and PCBs in water, sediment, and fish tissue. This report describes the analyses completed to determine causes of these impairments, the appropriate loadings for various sources, and measures to remove these impairments. Organochlorine pesticides and PCBs are referred to collectively and interchangeably in this TMDL as “OC pesticides and PCBs” or simply “OCs” (since all of these chemicals are organochlorine compounds).

Eleven of fourteen reaches in the Calleguas Creek Watershed (CCW), in southern Ventura County, are identified on the 2002 Clean Water Act Section 303(d) list of water-quality limited segments as impaired due to elevated levels of OC pesticides and PCBs (OCs) in water, sediment and/or fish tissue (Figure 1). The 303(d) listings, which were approved by the State Water Resources Control Board in February 2003, require the development of TMDLs to establish the maximum amount of pollutants a water body can receive without exceeding water quality standards. The CCW reaches identified as impaired on the 2002 303(d) list are presented below in Table 1. TMDLs for listed OCs are presented herein in one document because as a class of compounds they possess similar physical and chemical properties that influence their persistence, fate and transport in the environment.

The Clean Water Act requires TMDLs to be developed to restore impaired water bodies, and the Porter-Cologne Water Quality Act requires that an Implementation Plan be developed to achieve water quality objectives. This document fulfills these statutory requirements and serves as the basis for amending the Water Quality Control Plan for the Los Angeles Region (Basin Plan) to achieve water quality standards in Calleguas Creek for OC pesticides and PCBs in water, sediment, and fish tissue. This TMDL addresses the requirements prescribed by Section 303(d) of the Clean Water Act (40 CFR 130.2 and 130.7) and USEPA guidance (USEPA, 1991).

This TMDL is based on analysis provided by Larry Walker Associates under contract to the Calleguas Creek Watershed Management Plan Steering Committee (Steering Committee) with support from the California Regional Water Quality Control Board, Los Angeles Region (Regional Board or LARWQCB), and the United States Environmental Protection Agency, Region 9 (USEPA).

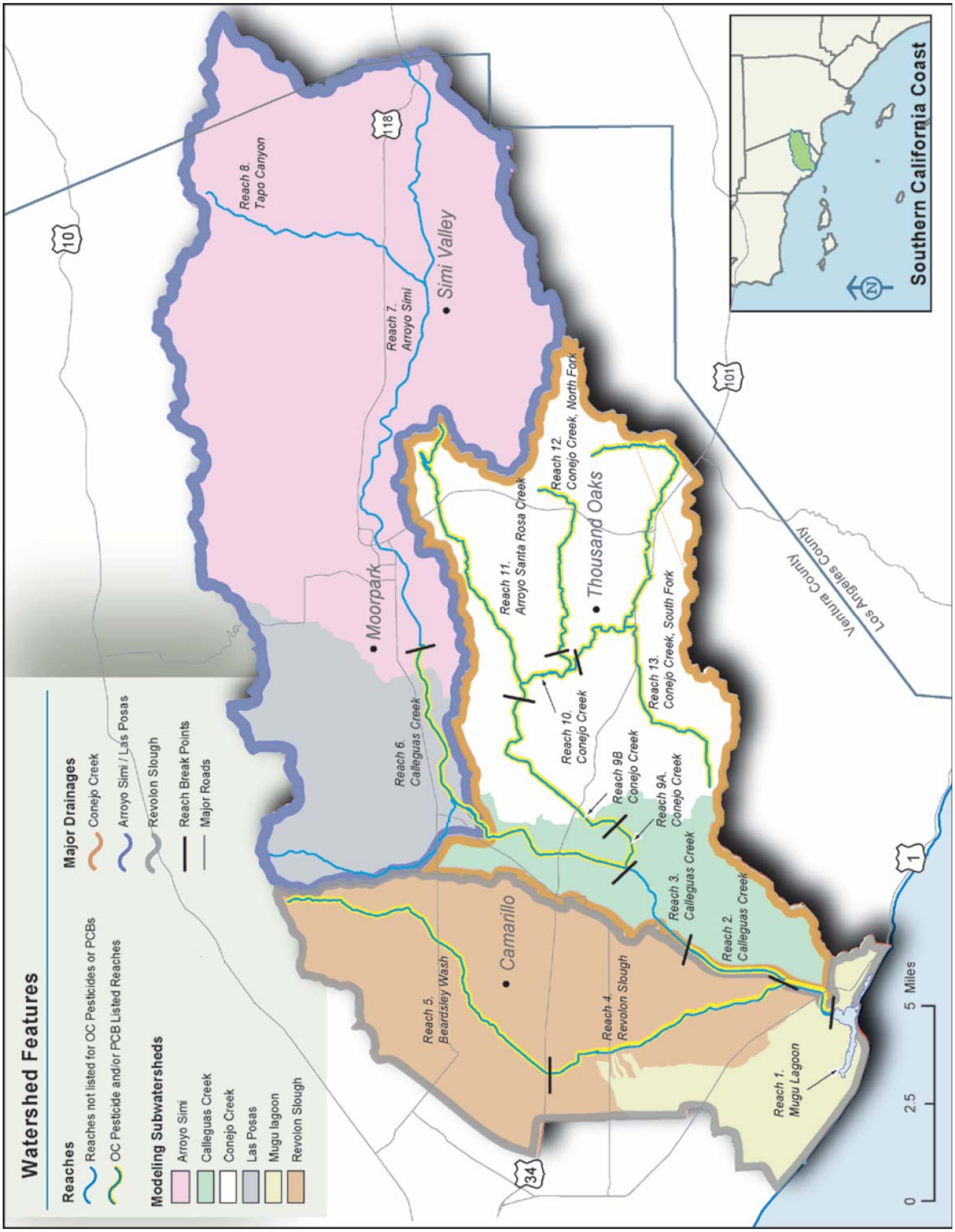


Figure 1. Map of Calleguas Creek Watershed, showing 303d listed reaches for OC pesticides and PCBs.

Table 1. 2002 303(d) Listings for OC Pesticides and PCBs in the CCW. [1]

Reach	Chem-A [2]	Chlordane	DDT	Dacthal	Dieldrin	HCH [3]	Endosulfan	PCBs	Toxaphene
1 – Mugu Lagoon		T	S,T			T		T	
2 – Calleguas Creek, Lower	T	T	S,T,W			T		T	S,T
4 – Revolon Slough	T	S,T	S,T		T	S,T		T	S,T
5 – Beardsley Channel	T	S,T	S,T	S	T	S,T		T	S,T
6 – Arroyo Las Posas			S						
9A – Conejo Creek	T	T	T		T	T	T	T	S,T
9B – Conejo Creek Mainstem	T		T			T			S,T
10 – Conejo Creek, Hill Canyon	T		T			T			S,T
11 – Arroyo Santa Rosa	T		T			T			S,T
12 – Conejo Creek, North Fork		T	T						
13 – Conejo Creek, South Fork	T		T			T			S,T

[1] S = sediment listing; T = tissue listing; W = water column listing.
[2]Chem A Pesticides: aldrin, chlordane, dieldrin, endosulfan, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexane (HCH, including lindane), and toxaphene.
[3] HCH = Hexachlorocyclohexane, including lindane.

1.1 Regulatory Background

Section 303(d) of the Clean Water Act (CWA) requires that "Each State shall identify those waters within its boundaries for which the effluent limitations are not stringent enough to implement any water quality standard applicable to such waters." The CWA also requires states to establish a priority ranking for waters on the 303(d) list of impaired waters and establish TMDLs for such waters.

The elements of a TMDL are described in 40 CFR 130.2 and 130.7 and Section 303(d) of the CWA, as well as in USEPA guidance (USEPA, 1991). A TMDL is defined as the "sum of the individual waste load allocations for point sources and load allocations for non-point sources and natural background" (40 CFR 130.2) such that the capacity of the water body to assimilate pollutant loadings (the loading capacity) is not exceeded. TMDLs are also required to account for seasonal variations, and include a margin of safety to address uncertainty in the analysis.

States must develop water quality management plans to implement the TMDL (40 CFR 130.6). The USEPA has oversight authority for the 303(d) program and is required to review and either approve or disapprove the TMDLs submitted by states. If the USEPA disapproves a TMDL submitted by a state, USEPA is required to establish a TMDL for that water body. The Regional Board identified over 700 water body-pollutant combinations in the Los Angeles Region where TMDLs are required (LARWQCB, 2003). A schedule for development of TMDLs in the Los Angeles Region was established in a consent decree (Heal the Bay Inc., et al. v. Browner C 98-4825 SBA) approved on March 22, 1999. The consent decree combined water body pollutant combinations in the Los Angeles Region into 92 TMDL analytical units. In accordance with the consent decree, this document summarizes the analyses performed and presents the TMDL for addressing analytical unit 7, which contains PCBs listings, and the organochlorine listings presented in analytical unit 5. The remaining analytical unit 5 listings for sediment toxicity are addressed through the CCW Toxicity TMDL. According to the consent decree, TMDLs addressing analytical units 2, 5, and 7 must be approved or established by USEPA by March 2006.

In addition to the federal and state regulations described above, the Regional Board enacted Resolution No. 97-10, *Support for Watershed Management in the Calleguas Creek Watershed* on April 7, 1997*.* Resolution 97-10 recognized watershed management as an innovative, cost-effective strategy for the protection of water quality. Resolution 97-10 also recognized that the Calleguas Creek Municipal Water District and the POTWs in the Calleguas Creek watershed had worked cooperatively with the Regional Board to develop an integrated watershed-wide monitoring program. The Calleguas Watershed Management Plan has been active since 1996 in the development of a watershed management plan for the Calleguas Creek watershed and has proactively worked with the Regional Board and the USEPA to develop TMDLs in the watershed.

1.2 Calleguas Creek TMDL Stakeholder Participation Process

The Calleguas Creek Watershed Management Plan has been active since 1996. In 2001, the group began discussions with the Regional Board and USEPA to provide assistance in the development of the TMDLs for the watershed. In December 2002, the group developed TMDL work plans for most constituents on the 2002 303(d) list. The OC Pesticides and PCBs TMDL Work Plan, developed with input from the LARWQCB and USEPA, forms the basis of all of the work conducted to develop this TMDL. USEPA Region IX approved the OC Pesticides and PCBs TMDL Work Plan in October 2003.

The purpose of the watershed group assisting with the development of the TMDLs was to incorporate local expertise and reach a broad group of stakeholders to develop implementation plans to resolve the water quality problems within the watershed. Stakeholders include representatives of cities, counties, water districts, sanitation districts, private property owners, agricultural organizations, and environmental groups with interests in the watershed.

A high level of stakeholder involvement has occurred throughout the TMDL development process. There have been no interventions from outside groups, and much of the work has been performed, or paid for, by members of local government agencies with partial USEPA grant funding.

1.3 Elements of a TMDL

The CCW OC Pesticides and PCBs TMDL contains the following elements:

- Section 2: Problem Statement – Explanation of environmental setting, beneficial uses, and the basis for listings addressed through this TMDL .
- Section 3: Current Conditions – Summarizes current conditions in water, sediment, and fish tissue.
- Section 4: Numeric Targets – Presents appropriate numeric targets that will result in the attainment of water quality objectives as well as the basis for selection of targets.
- Section 5: Source Analysis – Presents an inventory of the sources of the pollutants of concern.
- Section 6: Linkage Analysis – Analysis developed to describe the relationship between the input of the pollutants of concern and the subsequent environmental response with regard to listings.
- Section 7: TMDL and Allocations – Identifies the TMDL allocations for point sources (waste load allocations) and non-point sources (load allocations) that will result in the attainment of water quality objectives.
- Section 8: Implementation Plan – describes the strategy for implementing the TMDL and achieving water quality objectives, as well as a brief overview of the strategy for monitoring the effects of implementation actions.

2 PROBLEM STATEMENT

The Problem Statement Section provides the context and background for this TMDL. The environmental setting provides an overview of the hydrology, climate, and anthropogenic influences in the CCW. In addition, this section includes an overview of water quality standards for the watershed and reviews water, sediment, and fish tissue data used to develop the 1996, 1998, and 2002 303(d) listings.

2.1 Environmental Setting

Calleguas Creek and its tributaries are located in southeast Ventura County and a small portion of western Los Angeles County. Calleguas Creek drains an area of approximately 343 square miles from the Santa Susana Pass in the east to Mugu Lagoon in the southwest. The main surface water system drains from the mountains in the northeast part of the watershed toward the southwest where it flows through the Oxnard Plain before emptying into the Pacific Ocean through Mugu Lagoon. The watershed, which is elongated along an east-west axis, is about thirty miles long and fourteen miles wide. The Santa Susana Mountains, South Mountain, and Oak Ridge form the northern boundary of the watershed; the southern boundary is formed by the Simi Hills and Santa Monica Mountains.

Land uses in the Calleguas Creek watershed include agriculture, high and low density residential, commercial, industrial, open space, and a Naval Air Base located around Mugu Lagoon. The watershed includes the cities of Simi Valley, Moorpark, Thousand Oaks, and Camarillo. Most of the agriculture is located in the middle and lower watershed with the major urban areas (Thousand Oaks and Simi Valley) located in the upper watershed. The current land use in the watershed is approximately 26% agriculture, 24% urban, and 50% open space. Patches of high quality riparian habitat are present along the length of Calleguas Creek and its tributaries.

The watershed is generally characterized by three major subwatersheds: Revolon Slough in the west, Conejo Creek in the south, and Arroyo Simi/Las Posas in the north. Additionally, the lower watershed is also drained by several minor agricultural drains in the Oxnard plain. The following sections describe the major subwatersheds in more detail. Figure 1 depicts the CCW with reach names and designations used in this TMDL, the three major subwatersheds, and six smaller subwatersheds which are defined for analysis and modeling in this TMDL (Mugu, Revolon, Calleguas, Conejo, Arroyo Las Posas, and Arroyo Simi).

Arroyo Simi / Las Posas

The northern portion of the watershed is drained by the Arroyo Las Posas and the Arroyo Simi, which is tributary to the Arroyo Las Posas. The northern part of the watershed system originates in the Simi Valley and surrounding foothills. The surface flow comes from the headwaters of the Arroyo Simi at Santa Susanna pass (upper parts of Reach 7) and Tapo Canyon (Reach 8). Arroyo Simi and Arroyo Las Posas flow through the cities of Simi Valley and Moorpark and join with Calleguas Creek near Camarillo. Upstream of Simi Valley, the creek is unlined and passes through open space and recreational areas. Through the city of Simi Valley, the Arroyo Simi flows through concrete lined or rip-rapped channels. Between Simi Valley and Moorpark, a distance of approximately 7 miles, the creek is unlined and without rip-rap. From the edge of Moorpark to Hitch Boulevard, the creek is once again rip-rapped on the sides with a soft bottom throughout most of the channel, but in some areas, such as under bridges, the bottom is covered with concrete and rip rap. The Arroyo Simi flows into the Arroyo Las Posas at Hitch Blvd. Downstream of Hitch Boulevard, Arroyo Las Posas passes through agricultural fields and orchards in a primarily natural channel. Although the Arroyo Las Posas channel joins with Calleguas Creek near Camarillo, surface flow is typically not present in this portion of the channel due to evaporation and groundwater recharge upstream of Seminary Road.

Two POTWs discharge in this subwatershed. The Simi Valley Water Quality Control Plant (WQCP) discharges to the Arroyo Simi on the western edge of the City of Simi Valley. The Moorpark Wastewater Treatment Plant (WTP) discharges primarily to percolation ponds near the Arroyo Las Posas downstream of Hitch Boulevard. Direct discharges to the Arroyo Las Posas from the Moorpark WTP only occur during extremely wet periods.

Conejo Creek

Conejo Creek and its tributaries (Arroyo Conejo and Arroyo Santa Rosa) drain the southern portion of the watershed. Flow in the southern portion of the watershed originates in the City of Thousand Oaks and flows through the City of Camarillo before joining Calleguas Creek upstream of the California State University Channel Islands. This area supports significant residential and agricultural land uses. The following sections describe Conejo Creek and its tributaries.

Arroyo Conejo

The Arroyo Conejo runs through Thousand Oaks and has three branches, the main fork, the north fork, and the south fork. The main fork of the Arroyo Conejo runs underground for most of its length. The portions that are above ground are concrete lined until the creek enters Hill Canyon on the western side of the city and converges with the south fork. The south fork runs through the southern and western portions of Thousand Oaks. For most of its length, the south fork flows underground or through concrete lined channels. The Hill Canyon Wastewater Treatment Plant (WTP) discharges to the north fork of the Arroyo Conejo on the western edge of the City of Thousand Oaks. The north fork runs through Thousand Oaks upstream of the Hill Canyon WTP. The channel is concrete lined for the portion that runs through the city, but becomes unlined when it nears the treatment plant. The main fork and the south fork join together about a mile upstream of the treatment plant. The joined flow (usually called the south fork at this point) and the north fork converge approximately 0.4 miles downstream of the Hill Canyon WTP. The Arroyo Conejo then flows in a natural channel through a primarily open space area until it merges with the Arroyo Santa Rosa to form Conejo Creek at the base of the canyon.

Arroyo Santa Rosa

Arroyo Santa Rosa runs on the northern edge of the City of Thousand Oaks and through agricultural land in the Santa Rosa Valley. Arroyo Santa Rosa is a natural channel for most of its length with portions of riprap and concrete lining along the sides and bottom of the channel in the vicinity of homes (such as near Las Posas Road). Prior to 1999, a wastewater treatment plant (Olsen Rd.) discharged to Arroyo Santa Rosa and maintained a constant surface flow in the reach. Since 1999, the POTW has not discharged and much of the channel is dry during non-storm events.

Conejo Creek

Arroyo Conejo and Arroyo Santa Rosa converge at the base of Hill Canyon to form Conejo Creek. Conejo Creek flows downstream approximately 7.5 miles, through the City of Camarillo, to its confluence with Calleguas Creek. Just downstream of the city, the Camarillo Sanitary District Water Reclamation Plant (CSDWRP) discharges to Conejo Creek. Because the Arroyo Las Posas does not generally provide surface flow to Calleguas Creek during dry periods, Conejo Creek provides the majority of the flow in

Calleguas Creek. For most of the length of the Conejo and Calleguas Creeks, the sides of the channel are rip rapped and the bottom is unlined.

Revolon Slough

Revolon Slough drains the agricultural land in the western portion of the watershed (Oxnard Plain). The slough does not pass through any urban areas, but does receive drainage from tributaries that drain urban areas. Revolon Slough starts as Beardsley Wash in the hills north of Camarillo. The wash is a rip rapped channel for most of its length and combines with Revolon Slough at Central Avenue in Camarillo. The slough is concrete lined just upstream of Central Avenue and remains lined for approximately 4 miles to Wood Road. From there, the slough is soft bottomed with rip-rapped sides. The lower mile to mile and a half of the slough to above Las Posas Road appears to be tidally influenced by inflows from Mugu Lagoon. Revolon Slough flows into Mugu Lagoon in a channel that runs parallel to Calleguas Creek. The flows from Revolon Slough and Calleguas Creek only converge in the lagoon. In addition to Revolon Slough, a number of agricultural drains (Oxnard Drain, Mugu Drain, and Duck Pond Drain) serve as conveyances for agricultural and industrial drainage water to the Calleguas Creek estuary and Mugu Lagoon.

Mugu Lagoon

Mugu Lagoon, an estuary at the mouth of Calleguas Creek, supports a diverse wildlife population including migratory birds and endangered species. This area is affected by military land uses of the Point Mugu Naval Air Weapons Station and substantial agricultural activities in the Oxnard Plain. The lagoon consists of approximately 287 acres of open water, 128 acres of tidal flats, 40 acres of tidal creeks, 944 acres of tidal marsh and 77 acres of salt pan (California Resources Agency, 1997). It is comprised of a central basin into which flows from Revolon Slough and Calleguas Creek enter and two arms (eastern and western) that receive some drainage from agricultural and industrial drains. In addition, multiple drainage ditches drain into the lagoon. Two of these ditches, Oxnard drainage ditches 2 and 3, discharge urban and agricultural runoff originating beyond the Station's boundaries into the central and western portion of the lagoon. The remaining ditches discharge urban and industrial runoff originating on the Station.

The salinity in the lagoon is generally between 31 and 33 parts per thousand (ppt) (Granade, 2001). The central basin of the lagoon has a maximum tidal range of approximately -1.1 to 7 feet (as compared to mean sea level) with smaller ranges in the two arms. The western arm of the lagoon receives less tidal volume because of a bridge culvert that restricts the flows in that area. The velocity of water traveling through the mouth of the lagoon is approximately 5-6 knots, which is a high velocity for a lagoon (Grigorian, 2001). The mouth of the lagoon never closes, apparently as a result of a large canyon present at the mouth of Calleguas Creek. The canyon prevents ocean sand from building up to a high enough level to close the mouth and likely accounts for the high velocities in the lagoon (Grigorian, 2001).

Climate and Hydrology

The climate in the watershed is typical of the southern California coastal region. Summers are relatively warm and dry and winters are mild and wet. Eighty-five percent of the rainfall occurs between November and March with most of the precipitation occurring during just a few major storms. Annual rainfall in Ventura County averages 15 inches and varies from 13 inches on the Oxnard Plain to a maximum of 20 inches in the higher elevations (USDA, 1995). Storm events concentrated in the wet-weather months produce runoff usually ranging in duration from one-half day to several days. Discharge during runoff from storm events is commonly 10 to 100 times greater than at other times. Storm events and the resulting high stream flows are highly seasonal, grouped heavily in the months of November through February, with an occasional major storm as early as September and as late as April. Rainfall is rare in other months, and major storm flows historically have not been observed outside the wet-weather season.

Surface Waters

The main surface water system drains from the mountains toward the southwest, where it flows through the Oxnard Plain before emptying to the Pacific Ocean through Mugu Lagoon. Dry weather surface water flow in the Calleguas Creek watershed is primarily composed of groundwater, municipal wastewater, urban non-storm water discharges, and agricultural runoff. In the upper reaches of the watershed, upstream of any wastewater discharges, groundwater discharge from shallow surface aquifers provides a constant base flow. Additionally, urban non-stormwater runoff and groundwater extraction for construction dewatering or remediation of contaminated aquifers contribute to the base flow. Stream flow in the upper portion of the watershed is minimal, except during and immediately after rainfall. Flow in Calleguas Creek is described as storm peaking and is typical of smaller watersheds in coastal southern California.

In the Arroyo Simi/Las Posas Subwatershed, additional flow is contributed by groundwater pumped for dewatering and discharged under permit to the Arroyo Simi upstream of Madera Road. The Simi Valley WQCP discharges downstream of the City of Simi Valley and provides much of the flow in the Arroyo Simi during dry weather. During most of the year, at the point where the channel reaches Seminary Road, the surface water flow has been lost to groundwater percolation and evaporation. During and immediately following significant rains, surface flows in the Arroyo Las Posas discharge to Calleguas Creek. In the Conejo Creek Subwatershed, the Hill Canyon WTP provides the majority of the surface water flow. Additionally, the Camarillo WTP provides some flow in the lower portion of Conejo Creek. Revolon Slough receives all of its flow from agricultural discharges, groundwater seepage, and some urban non-stormwater flow.

Groundwater

Groundwater features of the watershed are dominated by the Fox Canyon Aquifer System, which is linked to the neighboring Santa Clara River Watershed. The Fox Canyon Aquifer System is a series of deep, confined aquifers. These aquifers today receive little or no recharge from the watershed. The water quality in these aquifers is very high. However, because there is little recharge to these aquifers they suffer from overdraft. Major groundwater basins within the watershed include the Simi Basin, East Las Posas, West Las Posas, South Las Posas, Pleasant Valley, and Arroyo Santa Rosa Basins. Significant aquifers within the watershed include the Epworth Gravels, the Fox Canyon aquifer, and the Grimes Canyon aquifer in order from shallowest to deepest. In addition, the top 350 feet of sediments within the Pleasant Valley Basin are often referred to as the "Upper Zone", and are thought by some to be equivalent to the Hueneme aquifer zone that is a more well-defined and recognized layer to the west of the Pleasant Valley Basin.

Shallower, unconfined aquifers are located in the valleys of the watershed. In the upper sub-watersheds of Simi Valley and Conejo Valley, groundwater collects in the lower areas and overflows into the down-gradient valleys. The Tierra Rejada, Santa Rosa and South Las Posas valley basins are larger than the upper valley basins and are the most significant unconfined basins on the watershed. Areas of perched and unconfined groundwater are also present along the base of the Santa Monica Mountains, and overlying areas of the southeastern Oxnard Plain in the Pleasant Valley.

Water rights have not been adjudicated in many of these basins, and groundwater production is not comprehensively controlled or maintained. However, groundwater extractions are regulated in the Oxnard

Plain, Pleasant Valley Basin and the Las Posas Basin by the Fox Canyon Groundwater Management Agency. In some basins, groundwater is being over-drafted and as a result Pleasant Valley has experienced subsidence. In other basins, such as the South Las Posas Basin, groundwater storage has increased significantly in the last several decades.

The chemical properties of groundwater may influence the fate and transport of pesticides and affect toxicity of constituents to aquatic organisms. Data for many of these parameters were analyzed in groundwater samples, and the summary statistics for the results are presented in Table 2. For Calleguas Creek groundwater, temperature and Eh (redox) data were not readily available. The groundwater of the Calleguas Creek watershed is slightly alkaline, with pH typically ranging from 7.3 to 8.0, and alkalinity from 140 to 270 mg/L. Hardness also influences solubility; the analyzed Calleguas Creek groundwater samples exhibited an average hardness of 431 mg/L as $CaCO_3$. The average bicarbonate concentration was 151 mg/L. Finally, the presence of cations, often measured as electrical conductivity, can affect the sorption characteristics of infiltrating loads. As seen in Table 2, Calleguas Creek groundwater is highly heterogeneous with respect to electrical conductivity, typically ranging from 465 to 1,521 µS/cm. Consideration of these chemical properties is important when assessing the impacts of the recharge of surface waters on groundwater supplies.

Table 2. Groundwater Chemical Characteristics.

Water Quality Parameter	n	Mean	Std. Dev.	Maximum	90th Percentile	10th Percentile	Minimum
pH	372	7.6	0.3	10.1	8.0	7.3	7.0
Alkalinity (mg/L)	220	199	54	420	270	140	70
Hardness (mg/L, CaCO3)	76	431	136	700	585	235	132
Bicarbonate (mg/L)	79	151	99	449	233	8	7
Electrical Conductivity (µS/cm)	370	805	428	2,470	1,520	465	321

Anthropogenic Alterations

Historically, the Oxnard Plain served as the flood plain for Calleguas Creek. Starting in the 1850's, agriculture began to be practiced extensively in the watershed. By 1889, a straight channel from the area near the present day location of Highway 101 to the Conejo Creek confluence had been created for Calleguas Creek. In the 1920's, levees were built to channelize flow directly into Mugu Lagoon (USDA, NRCS, 1995). Increased agricultural and urban land uses in the watershed resulted in continued channelization of the creek to the current channel system. Historically, Calleguas Creek was an ephemeral creek flowing only during the wet season. The cities of Simi Valley, Moorpark, Camarillo, and Thousand Oaks experienced rapid residential and commercial development beginning in the 1960s. In the early 70's, State Water Project supplies began being delivered to the watershed. In 1957, the Camarillo Water Reclamation Plant came online, followed by the Hill Canyon WTP in Thousand Oaks in 1961. Increasing volumes of discharges from these POTWs eventually caused the Conejo/Calleguas system to become a perennial stream by 1972 (SWRCB, 1997). When the Simi Valley Water Quality Control Facility began discharging in the early 1970's, the Arroyo Simi/Arroyo Las Posas became a perennial stream that gradually flowed further downstream and currently reaches Seminary Road in Camarillo. However, surface flows from the Arroyo Simi/Arroyo Las Posas do not connect with surface flows in the Conejo Creek/Calleguas system, except during and immediately following storm events.

Sedimentation

Agricultural development and urbanization have brought about significant changes in the watershed such as increased runoff and freshwater flows, accelerated erosion and sedimentation and transport of agricultural chemicals and urban pollutants. Previous to the channelization of lower Calleguas Creek, sediment was deposited largely in a vast estuarine network that meandered across the Oxnard Plain. Numerous drop structures, channel bed stabilizers, dams, and debris basins have since been constructed to compensate for the loss of flood plain. Extensive urban development, farmland conversion, and the resulting redevelopment of orchards onto steeper slopes have changed the hydrology of the area and led to accelerated erosion rates. Accelerated erosion rates have contributed to flooding and sedimentation of the Oxnard Plain and Mugu Lagoon (USDA, NRCS, 1995).

Flow Diversion Project

The Conejo Creek Diversion project in the Calleguas Creek watershed diverts the majority of flow in Conejo Creek to agricultural uses in the Pleasant Valley area. The diversion project is located approximately 7 miles downstream from the Hill Canyon Wastewater Treatment Plant (WTP). The water rights application allows the diversion of an amount equal to Hill Canyon's effluent minus 4 cfs for in-stream uses and channel losses. An additional amount of water equal to the flow contributed by use of imported water in the region (estimated at 4 cfs) may be diverted when at least 6 cfs of water will remain in the stream downstream of the diversion point (SWRCB, 1997). Natural flows due to precipitation will not be diverted. As a result of this project, flows in the lower reach of Conejo Creek have been reduced to less than half of the previous creek flows. Projects similar to the Conejo Creek Diversion project may be developed as part of the overall Watershed Management Plan for Calleguas Creek to address water resource, water quality, or flooding/erosion concerns. As such, TMDLs must be developed in a manner that considers the impacts of changing flows in the watershed and does not result in restrictions on the necessary use of the water for other purposes.

Reach Designations

Table 3 summarizes the reach descriptions of Calleguas Creek used in this TMDL and the correlation between these reaches with the 303(d) and consent decree listed reaches. These reach designations provide greater detail than the designations in the current Basin Plan, and are developed for purposes of this TMDL. The reach revisions may provide an appropriate analytical tool for future analyses in the watershed. At this time, though, the reach revisions are not regulatory and do not alter water quality objectives for the reaches in the existing Basin Plan.

Table 3. Description of CCW Reaches Based on 2002 303(d) List..

Reach Names for OC Pesticides and PCBs TMDL	Reach Names as Listed in 303(d) List and Consent Decree	Geographic Description	Notes: Hydrology, land uses, etc.
1 Mugu Lagoon	Mugu Lagoon	Lagoon fed by Calleguas Creek	Estuarine; brackish, contiguous with Pacific Ocean
2 Calleguas Creek South	Calleguas Creek Reach 1 and Reach 2 (Estuary to Potrero Rd.)	Downstream (south) of Potrero Rd	Tidal influence; concrete lined; tile drains; Oxnard Plain
3 Calleguas Creek North	Calleguas Creek Reach 3 (Potrero to Somis Rd.)	Potrero Rd. upstream to confluence Conejo Creek	Concrete lined ; no tidal influence; Agriculture tile drains; Pleasant Valley Basin. Camrosa WRP discharges to percolation ponds.
4 Revolon Slough	Revolon Slough Main Branch	Revolon Slough from confluence with Calleguas Creek to Central Ave	Concrete lined ; tile drains; Oxnard Plain; tidal influence
5 Beardsley Channel	Beardsley Channel	Revolon Slough upstream of Central Ave.	Concrete lined ; tile drains; Oxnard Plain
6 Arroyo Las Posas	Arroyo Las Posas Reach 1 and Reach 2 (Lewis Somis Rd. to Moorpark Fwy (23))	Confluence with Calleguas Creek to Hitch Road	Ventura Co. POTW discharge at Moorpark to percolation ponds; discharges enter shallow aquifer; dry at Calleguas confluence
7 Arroyo Simi	Arroyo Simi Reach 1 and Reach 2 (Moorpark Fwy (23) to Headwaters)	End of Arroyo Las Posas (Hitch Rd) to headwaters in Simi Valley.	Simi Valley WQCP discharge; discharges from shallow aquifers; pumped GW; GW discharges from shallow aquifers.
8 Tapo Canyon	Tapo Canyon Reach 1 and Reach 2	Confluence w/ Arroyo Simi up Tapo Cyn to headwaters	Origin near gravel mine, used by nursery, ends in residences.
9A Conejo Creek	Conejo Creek Reach 1 (Confl with Calleguas Creek to Santa Rosa Rd.)	Extends from the confluence with Arroyo Santa Rosa downstream to the Camrosa Diversion	Camarillo WTP discharge; Pleasant Valley Groundwater Basin contains both confined and unconfined perched aquifers. Groundwater and surface water used for agriculture.
9B Conejo Creek	Conejo Creek Reach 1 and Reach2 (Confl with Calleguas Creek to Tho. Oaks city limit)	Extends from Camrosa Diversion to confluence with Calleguas Creek.	Pleasant Valley Groundwater Basin contains both confined and unconfined perched aquifers. Camarillo WTP discharges to percolation ponds near downstream end.
10 Hill Canyon reach of Conejo Creek	Conejo Creek Reach 2 and Reach 3 (Santa Rosa Rd. to Lynn Rd.)	Confluence w/ Arroyo Santa Rosa to confluence w/ N. Fork; and N. Fork to just above Hill Canyon WTP	Hill Canyon WTP; stream receives N. Fork Conejo Creek surface water.
11 Arroyo Santa Rosa	Arroyo Santa Rosa	Confluence w/ Conejo Creek to headwaters	Olsen Rd. WRP; dry before Calleguas Ck confluence except during storm flow.
12 North Fork Conejo Creek	Conejo Creek Reach 3 (Tho. Oaks city limit to Lynn Rd.)	Confluence w/Conejo Creek to headwaters	
13 Arroyo Conejo (S.Fork Conejo Cr)	Conejo Creek Reach 4 (Above Lynn Rd.)	Confluence w/ N. Fork to headwaters —two channels	City of Thousand Oaks; pumped/treated GW

2.2 Water Quality Standards

Federal law requires the states to adopt water quality standards, which are defined as the designated beneficial uses of a water segment and the water quality criteria necessary to support those uses (33 U.S.C. §1313). California implements the federal water quality standard requirements by providing for the reasonable protection of designated beneficial uses through the adoption of water quality objectives (CA Water Code §13241). Water quality objectives may be numeric values or narrative statements. For inland surface waters in the Los Angeles Region, beneficial uses and numeric/narrative objectives are identified in the Basin Plan and additional numeric objectives for toxic pollutants are contained in the California Toxics Rule as adopted by the U.S. EPA (40 CFR 131.38). In addition, federal regulation requires states to adopt a statewide antidegradation policy that protects high quality waters and the level of water quality necessary to maintain and protect existing uses.

2.3 Beneficial Uses

The Basin Plan identifies 21 existing, potential and intermittent beneficial uses for water bodies in the Calleguas Creek Watershed (Table 4). The federally-defined beneficial uses (and the Los Angeles Region Basin Plan equivalents) listed as impaired due to elevated levels of OC pesticides and PCBs in the CCW include: aquatic life (WARM, COLD, EST, WET, MAR, WILD, BIOL, RARE, MIGR, SPWN), fish consumption (COMM), shellfish harvesting (SHELL), and primary and secondary contact recreation (REC-1, REC-2). The designated beneficial uses identified as impaired due to elevated levels of OC pesticides and PCBs in the CCW are briefly described below.

Habitat-Related Uses (WARM, COLD, EST, WET, MAR, WILD, BIOL, RARE, MIGR, SPWN)

Several habitat-related beneficial uses are designated for the CCW. These uses include warm and cold freshwater habitats; estuarine, wetland and marine habitats; wildlife habitat; biological habitats (including Areas of Special Biological Significance); habitats that support rare, threatened, or endangered species; habitats that support migration of aquatic organisms; and habitats that support spawning, reproduction, and/or early development of fish.

Human Consumption of Aquatic Organisms (COMM; SHELL)

Uses of water for commercial or recreational collection of fish, shellfish, or other organisms including, but not limited to, uses involving organisms intended for human consumption or bait purposes.

Recreational Uses (REC-1, REC-2)

Water Contact Recreation (REC-1) and Non-Contact Water Recreation (REC-2) are defined as uses of water for recreational activities involving body contact and proximity to water. Some of these activities include swimming and fishing, and where the ingestion of water is reasonably possible.

Table 4. Beneficial Uses Associated With Impaired Reaches in the Calleguas Creek Watershed.

Water body	Reach[1]	Hydro Unit	**Aquatic Life** Beneficial Uses Potentially Impaired by OC Pesticides and PCBs										**Other** Potentially Impaired Beneficial Uses						**Remaining** Beneficial Uses				
			WARM	COLD	EST	WET	MAR	WILD	BIOL	RARE	MIGR	SPWN	MUN	GWR	REC1	REC2	COMM	SHELL	FRSH	NAV	IND	PROC	AGR
Mugu Lagoon	1	403.11			E	E	E	E	E	E	E	E			P	E	E	E		E			
Calleguas Crk Estuary	2	403.11			E	E		E		E	E	E			P	E	E			P			
Calleguas Creek	2, 3	403.11	E	E		E		E		E			P*	E	E	E			E				E
Revolon Slough	4	403.11	E			E		E					P*	E	E	E					P		E
Beardsley Wash	5	403.61	E					E					P*		E	E			E				
Arroyo Las Posas	6	403.12	E	P				E					P*	E	E	E					P	P	P
Arroyo Las Posas	6	403.62	E	P				E					P*	E	E	E			E		P	P	P
Conejo Creek	3, 9A	403.12	E					E					P*	E	E	E					E	E	E
Conejo Creek	9B	403.63	I					E				E	P*	I	I	I			I				
Arroyo Conejo	9A/B,10	403.64	I					E		E			P*	I	I	I			I				
Arroyo Conejo	13	403.68	I					E					P*	I	I	I			I				
Arroyo Santa Rosa	11	403.63	I					E					P*	I	I	I			I				
Arroyo Santa Rosa	11	403.65	I					E					P*	I	I	I			I				
Arroyo Conejo, N.Fork	12	403.64	E					E				E	P*	E	E	E							E

[1] Reach numerical designations based on 2002 303(d) List. P = Potential beneficial use E = Existing beneficial use I = Intermittent beneficial use
* Conditional designations that were designated under SB 88-63 and RB 89-03. Conditional designations are currently not recognized under federal law and are not water quality standards subject to enforcement at this time (see letter from Alexis Strauss [USEPA] to Celeste Cantu [State Board], dated 2/15/02.)

2.4 Water Quality Objectives

Basin Plan Objectives

The Basin Plan contains the following narrative and numeric water quality objectives applicable to the listed chlorinated compounds and their related effects:

Regional Objectives for Inland Surface Waters

- Bioaccumulation – Toxic pollutants shall not be present at levels that will bioaccumulate in aquatic life to levels which are harmful to aquatic life or human health.

- Pesticides: No individual pesticide or combination of pesticides shall be present in concentrations that adversely affect beneficial uses. There shall be no increase in pesticide concentrations found in bottom sediments or aquatic life.

- Polychlorinated Biphenyls (PCBs) - The purposeful discharge of PCBs to waters of the Region, or at locations where the waste can subsequently reach waters of the Region, is prohibited. Pass-through or uncontrollable discharges to waters of the Region, or at locations where the waste can subsequently reach water of the Region, are limited to 70 pg/L (30 day average) for protection of human health and 14 ng/L and 30 ng/L (daily average) to protect aquatic life in inland fresh waters and estuarine waters respectively.

- Toxicity - All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, animal or aquatic life. Effluent limits for specific toxicants can be established by the Regional Board to control toxicity identified under Toxicity Identification Evaluations (TIEs). There are no Basin Plan Objectives specific to sediment toxicity. However, the narrative ambient water toxicity objectives may be used to address sediment toxicity for the purposes of identifying targets for sediment toxicity.

Regional Narrative Objective for Wetlands

- Habitat - Existing habitats and associated populations of wetlands fauna and flora shall be maintained by: protecting food supplies for fish and wildlife.

California Toxics Rule (CTR) Water Quality Criteria

CTR numeric criteria for priority toxic pollutants are promulgated for the protection of aquatic life and human health. The aquatic life criteria indicate one-hour average (acute) and four-day average (chronic) concentrations of these chemicals to which aquatic life can be exposed without harmful effect. The human health criteria are 30 day average concentrations for consumption of organisms and water or consumption of organisms only.

2.5 Antidegradation

The state's Antidegradation Policy is contained in State Board Resolution 68-16, Statement of Policy with Respect to Maintaining High Quality Water in California. The Antidegradation Policy maintains that water quality in surface and ground waters of the state must be maintained unless it is demonstrated that a change will be consistent with the maximum benefit of the people of the state, not unreasonably affect present and anticipated beneficial use of such water, and not result in water quality less than that prescribed in water quality plans and policies. In addition to meeting state Antidegradation Policy, any actions that may result in a reduction of water quality of a water of the United States are subject to the federal Antidegradation Policy provisions contained in 40 CFR 131.12, which allows for the reduction in water quality as long as existing beneficial uses are maintained and that the lowering of water quality is necessary to accommodate economic and social development in the area.

The proposed TMDL is consistent with state and federal antidegradation policies since it does not result in a reduction of water quality.

2.6 Basis For Listings

This section presents the basis for development of the 303(d) listings for OC pesticides and PCBs in the CCW. Regional Board staff conducted water quality assessments in 1996, 1998 and 2002, with the majority of OC pesticides & PCB listings first appearing on the 1996 303(d) list. The only water column listing, for DDT in Reach 2, was based on data from the Calleguas Creek Characterization Study (LWA, 1999). The data used for fish tissue listings included databases from three SWRCB monitoring programs: the Bay Protection Toxic Cleanup Program (BPTCP, 1994-1000), the State Mussel Watch Program (SMWP, 1977-2000), and the Toxic Substances Monitoring Program (TSMP, 1978-2000). Data used for sediment listings included the BPTCP, SMWP, and the Los Angeles Regional Board databases (1952-1998).

The majority of sediment quality data found in the RWQCB database is listed in units of μg/L and could not be directly compared with sediment quality objectives, which are in units of μg/Kg (dry weight). Sediment quality data from the RWQCB database were therefore not included in this discussion.

Beneficial uses were listed as impaired based on exceedances of the following sediment and tissue guidelines listed below in Table 5 (from Table 3-3 of the Regional Board's 2002 305(b) report). The values used by the Regional Board were presented using ug/Kg. Thus, they are presented in Table 5 as ug/Kg, even though values presented in other sections of this TMDL use ug/g (the number of significant digits was preserved whenever numeric targets were converted to ug/g in later sections of this document). A discussion of each guideline follows.

Table 5. Assessment Guidelines for Sediment Chemistry and Fish Tissue Bioaccumulation Data

Constituent	Sediment ERM (μg/Kg dry weight)	Sediment PEL (μg/Kg dry weight)	Tissue MTRL (Inland) (ug/Kg)	Tissue MTRL (bay/estuary) (ug/Kg)	NAS Whole Fish Guidelines (ug/Kg)
Aldrin			0.05	0.33	100 [2]
Chlordane (total)	6	4.79	8.0	8.3	100 [2]
p,p'-DDD	20	7.81	44.5	44.5	
p,p'-DDE	27	374	32.0	32.0	
p,p'-DDT	7	4.77	32.0	32.0	
DDT (total)	46.1	51.7			1000
Dieldrin	8	4.3	0.65	0.7	100 [2]
Endosulfan I			29700	64800	
Endosulfan II			29700	64800	
Endosulfan sulfate			29700	64800	
Endosulfan (total)					100 [2]
Endrin	45		3020	3020	100 [2]
Alpha-BHC (HCH)			0.5	1.7	
beta-BHC (HCH)			1.8	6.0	
gamma-BHC (HCH)		0.99	2.5	8.2	
Hexachlorocyclohexane (HCH, total)					100 [2]
Heptachlor			2.4	2.3	100 [2]
Heptachlor Epoxide			1.1	1.2	100 [2]
PCBs (total)	180	189	5.3	5.3	500
Toxaphene			9.6	9.8	100 [2]

[1] ERM = Effects Range-Median; PEL = Probable Effects Level; MTRL = Maximum Tissue Residue Level; NAS = National Academy of Sciences
[2] Individually or in combination. Chemicals in this group are referred to collectively as Chem A.

Sediment Guideline - Effects Range Median (ERM)

Sediment Effects Range-Median (ERM) values are numerical sediment quality guidelines developed by the National Oceanographic & Atmospheric Administration (NOAA) as informal (non-regulatory) guidelines to estimate the possible toxicological significance of chemical concentrations in sediments (Long et al., 1998). They were derived using a database compiled from saltwater studies. Data from each study were arranged in order of ascending concentrations. Study endpoints in which adverse effects were reported were identified. From the ascending data tables, the 50^{th} percentile (median) of the effects database was identified for each substance. The 50^{th} percentiles were named the "Effects Range-Median" (ERM) values, representative of concentrations above which effects frequently occur. The ERMs were not intended for use in predicting effects in wildlife or humans through bioaccumulation pathways. Because the ERM values were derived from saltwater chemistry and toxicity data, they apply to marine and estuarine waters only; they do not apply to freshwater systems. The ERMs listed in the 2002 Regional Board 305(b) report (and Table 5, above) are applicable to marine sediments.

Sediment Guideline - Probable Effects Level (PEL)

Sediment Probable Effects Levels (PELs) are marine sediment quality assessment guidelines (SQAGs) that were developed by the Florida Department of Environmental Protection for evaluating sediment quality conditions in Florida coastal systems (MacDonald, 1994). A weight of evidence approach developed by NOAA was modified and used to develop the guidelines. This approach involved the collection, evaluation and analysis of sediment chemistry and toxicity data from a wide variety of sources in North America (including data from the NOAA National Status and Trends Program database). The data were used to establish relationships between concentrations of sediment-associated contaminants and their potential for adverse biological effects. The PEL defines the lower limit of the range of contaminant concentrations that are "usually or always" associated with adverse biological effects. PELs do not consider the potential for bioaccumulation in tissues of aquatic organisms or the potential for adverse effects on human and non-human (wildlife) consumers of these aquatic organisms. The SQAGs are applicable to marine and estuarine waters only; they are not applicable to freshwater systems.

Fish Tissue Guideline - Maximum Tissue Residue Levels (MTRLs)

The California State Water Resources Control Board (SWRCB) developed Maximum Tissue Residue Levels (MTRLs) by multiplying the human health water quality criteria in the CTR (for inland MTRLs) and the California Ocean Plan (2000, for bay/estuary MTRLs) by the bioconcentration factor (BCF) for each substance. BCFs were taken from the USEPA 1980 Ambient Water Quality Criteria Documents for each substance (USEPA, 1980). According to the 1994-1995 Toxic Substances Monitoring Program Data Report (SWRCB), "The water quality criteria represent concentrations in water that protect against consumption of fish, shellfish and water (freshwater only) that contain substances at levels which could result in significant human health problems. MTRLs are used as alert levels or guidelines indicating water bodies with potential human health concerns and are an assessment tool and not compliance or enforcement criteria. MTRLs are compared only to fillet or edible tissue samples and should not be compared to whole body or liver samples."

Whole Fish Guideline - National Academy of Sciences (NAS)

National Academy of Sciences (NAS) Guidelines are recommended maximum concentrations of toxic substances in freshwater fish tissue (NAS 1973). They were established not only to protect the organisms containing the toxic compounds, but also to protect the species that consume these contaminated organisms. NAS guidelines are compared to data from whole fish samples only.

2.7 303(d) Listing Data

Summaries of the data used to develop 303(d) listings in the CCW are shown in the tables below. Table 6 contains water column data, Table 7 contains sediment data, and Table 8 through Table 10 contain fish tissue data.

Table 6. Calleguas Creek Watershed: Data Summary for Water Column Listings [1]

Reach	Constituent	Year Listed	Impaired Use Listed	n	Range	Median [2]	% Exceedances
2	4,4'-DDT	2002	Aquatic Life	4	<0.0005 – 0.0055	0.0023	50

[1] All results are listed in units of μg/L.
[2] For median values calculated as the average of a non-detected and detected result, the detection limit for the non-detected result was used in the calculation.

Table 7. Calleguas Creek Watershed: Data Summary for Sediment Listings [1]

Reach	Constituent	Year Listed	Impaired Use Listed	n	Range	Median [2]	% Exceedances
1	DDT	1996	Aquatic Life	9	30.5 - 293	187.9	89 [7]
2	DDT	1996	Aquatic Life	4	187.9 – 575.9	248.4	100 [7]
2	Toxaphene	1996	Aquatic Life	4	30.2 – 1900	157.1	N/A
4	Chlordane	1996	Aquatic Life	4	20.3 – 40.9	31.7	100
4	DDT	1996	Aquatic Life	4	525 – 1648	728.5	100 [7]
4	Endosulfan	1996	Aquatic Life	4	<5 – 32.6	9.0	N/A
4	Toxaphene	1996	Aquatic Life	4	258 - 510	365	N/A
5	Chlordane [3]	1996	Aquatic Life	0	--------	--------	--------
5	Dacthal [3]	1996	Aquatic Life	0	--------	--------	--------
5	DDT [3]	1996	Aquatic Life	0	--------	--------	--------
5	Endosulfan [3]	1996	Aquatic Life	0	--------	--------	--------
5	Toxaphene [3]	1996	Aquatic Life	0	--------	--------	--------
6	DDT [4]	1996	Aquatic Life	1	24.0	24.0	0 [7]
9A	Toxaphene [5]	1996	Aquatic Life	0	--------	--------	N/A
9B	Toxaphene [5]	1996	Aquatic Life	0	--------	--------	N/A
10	Toxaphene	1996	Aquatic Life	0	--------	--------	N/A
11	Toxaphene [6]	2002	Not Indicated	0	--------	--------	N/A
13	Toxaphene	1996	Aquatic Life	0	--------	--------	N/A

[1] All results are listed in units of μg/Kg dry weight.
[2] For median values calculated as the average of a non-detected and detected result, the detection limit for the non-detected result was used in the calculation.
[3] Although results for 4 samples collected at Central Avenue exist in the Regional Board database, units were listed as μg/L and could not be directly compared to sediment quality guidelines.
[4] The single data point cited in the 1996 305(b) report as supporting this listing was collected in 2002 Reach 2 (verified by GIS coordinates) but applied to 2002 Reach 6.
[5] There exists one toxaphene data point for both Reaches 9A and 9B in the Regional Board database, but units were listed as μg/L and could not be directly compared to sediment quality guidelines.
[6] Reach 11 (Arroyo Santa Rosa) did not appear on either the 1996 or 1998 303(d) lists. The Reach 11 toxaphene listing was added to the 2002 303(d) list without an accompanying fact sheet explaining the rationale for the listing.
N/A = No applicable sediment quality guidelines exist for this constituent.
[7] All forms of DDT (DDD, DDE, DDT, and Total DDT) were considered in determining the % exceedance values, according to appropriate targets for each form.

Table 8. Calleguas Creek Watershed: Data Summary for Tissue Listings, Reaches 1-4 [1]

Reach	Constituent	Year Listed	Impaired Use Listed [2]	n	Range	Median [3]	% Exceedances
1	Chlordane	1996	[2]	21	<5 – 40.6	3.5	43
1	DDT	1996	[2]	25	8.7 – 594	96.0	76
1	Endosulfan	1996	[2]	18	<5 – 132	18.6	17
1	PCBs	1996	[2]	25	<50 – 120	17.0	72
2	Chem A [4]	1996	[2]	0 [5]	--------	--------	--------
2	Chlordane	1996	[2]	5	23.9 – 40.6	30.7	100
2	DDT	1996	[2]	5	224 – 495	338	100
2	Endosulfan [6]	1996	[2]	5	<5 – 132	51.4	20
2	Toxaphene	1996	[2]	5	147 – 468	277.2	100
2	PCBs	1996	[2]	5	9.0 – 83.7	22.5	100
3 [7]	Chem A [4]	N/L	---	6	815 – 5541	2400	100
3 [7]	Chlordane	N/L	---	17	<5 – 117.7	33.2	53
3 [7]	DDT	N/L	---	17	208 – 4948	1500	100
3 [7]	PCBs	N/L	---	17	<50 – 346	<50	45
3 [7]	Toxaphene	N/L	---	17	<100 – 5400	640	88
4	Chem A [4]	1996	[2]	4	3389 – 12328	4265	100
4	Chlordane	1996	[2]	14	30.3 – 303,9	128.5	100
4	DDT	1996	[2]	14	107.9 – 9885	2900	100
4	Dieldrin	1996	[2]	14	4.4 – 120	18.5	79
4	Endosulfan	1996	[2]	14	<85 – 2355	127.5	33
4	Toxaphene	1996	[2]	14	<50 – 12,000	3056	93
4	PCBs	1996	[2]	14	<5 – 6100	47.2	36

[1] All results are listed in units of μg/Kg wet weight.
[2] Aquatic Life; COMM (commercial or sport fishing involving human consumption of fish); REC-1 (water contact recreation, which may involve fishing); REC-2 (non-contact recreation).
[3] For median values calculated as the average of a non-detected and detected result, the detection limit for the non-detected result was used in the calculation.
[4] TSMP combination of Chem-A pesticides, including aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexane (including lindane), endosulfan, and toxaphene. The NAS guideline for Chem A is applicable to whole fish samples only.
[5] Supporting data for this listing were missing from the TSMP database. Although TSMP data were cited for this listing, there are no TSMP monitoring stations between the estuary and Potrero Road.
[6] The 1996 303(d) List Staff Report listed dry weight results (880 ppb) for this constituent. This table contains wet weight results.
[7] Although this TSMP monitoring location was originally identified to be in "Reach 1/2" in the 1996 305(b) report, the GIS coordinates place this station in 2002 Reach 3 at Lewis Road.
N/L = Not listed.

Table 9. Calleguas Creek Watershed: Data Summary for Tissue Listings, Reaches 5-10 [1]

Reach	Constituent	Year Listed	Impaired Use Listed [2]	n	Range	Median [3]	% Exceedances
5	Chem A [4]	1996	[2]	0 [5]	--------	--------	--------
5	Chlordane	1996	[2]	0 [5]	--------	--------	--------
5	DDT	1996	[2]	0 [5]	--------	--------	--------
5	Dieldrin	1996	[2]	0 [5]	--------	--------	--------
5	Endosulfan	1996	[2]	0 [5]	--------	--------	--------
5	Toxaphene	1996	[2]	0 [5]	--------	--------	--------
5	PCBs	1996	[2]	0 [5]	--------	--------	--------
9A	Chem A [4]	1996	[2]	5	883 – 2322	1800	100
9A	Chlordane [6]	2002	[2]	5	39.7 – 94.9	50.0	0
9A	DDT	1996	[2]	5	1002 – 2422	1391	100
9A	Dieldrin [6]	2002	[2]	5	16.5 – 39	20.0	0
9A	Endosulfan	1996	[2]	5	<85 – 210	<10	20
9A	Hexachlorocyclohexane [6]	2002	[2]	5	2.6 – 7.9	4.0	0
9A	Toxaphene	1996	[2]	5	819 – 2200	1700	100
9A	PCBs [6]	2002	[2]	5	20.3 – 356	51	0
9B	Chem A [4]	1996	[2]	0 [7]	--------	--------	--------
9B	DDT	1996	[2]	0 [7]	--------	--------	--------
9B	Endosulfan	1996	[2]	0 [7]	--------	--------	--------
9B	Toxaphene	1996	[2]	0 [7]	--------	--------	--------
10	Chem A [4] [8]	1996	[2]	4	3.4 – 80.5	12.8	0
10	DDT	1996	[2]	4	7.4 – 59	15.1	25
10	Endosulfan [8]	1996	[2]	3	<2 – <85	<2	0
10	Toxaphene [8]	1996	[2]	4	<20 – <100	<60	0

[1] All results are listed in units of μg/Kg wet weight.
[2] Aquatic Life; COMM (commercial or sport fishing involving human consumption of fish); REC-1 (water contact recreation, which may involve fishing); REC-2 (non-contact recreation).
[3] For median values calculated as the average of a non-detected and detected result, the detection limit for the non-detected result was used in the calculation.
[4] TSMP combination of Chem-A pesticides, including aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexane (including lindane), endosulfan, and toxaphene. The NAS guideline for Chem A is applicable to whole fish samples only.

[5] No TSMP tissue samples were collected in Reach 5. When the 1996-designated Revolon Slough/Beardsley Wash reach was split into two reaches in 1998 303(d) list, Reach 4 (Revolon) listings were likely applied to Reach 5 (Beardsley).
[6] This constituent was listed by comparing data from whole fish samples to MTRLs.
[7] Data from Reach 9A (Conejo Creek at Pancho/Howard Rd) were used for this listing. There were no TSMP tissue samples collected in Reach 9B.
[8] This constituent was listed based on data collected in 1996 Conejo Reach 1 (2002 Reach 9A), which was originally applied to all 4 1996 Conejo Creek Reaches.

Table 10. Calleguas Creek Watershed: Data Summary for Tissue Listings, Reaches 11-13 [1]

Reach	Constituent	Year Listed	Impaired Use Listed [2]	n	Range	Median [3]	% Exceedances
11	Chem A [4] [5]	2002	not indicated	0	--------	--------	--------
11	Chlordane [5]	2002	not indicated	0	--------	--------	--------
11	DDT [5]	2002	not indicated	0	--------	--------	--------
11	Dieldrin [5]	2002	not indicated	0	--------	--------	--------
12	Chlordane	1996	[2]	2	<2 – 42.1	22.1	0
12	DDT	1996	[2]	2	<2 – 63.4	32.7	0
13	Chem A [6] [7]	1996	[2]	3	<18 – 18	<18	0
13	DDT [7]	1996	[2]	3	<5 – 32	9.2	0
13	Endosulfan [7]	2002	[2]	3	<85	<85	0
13	Toxaphene [7]	1996	[2]	3	<100	<100	0

[1] All results are listed in units of µg/Kg wet weight.
[2] Aquatic Life; COMM (commercial or sport fishing involving human consumption of fish); REC-1 (water contact recreation, which may involve fishing); REC-2 (non-contact recreation).
[3] For median values calculated as the average of a non-detected and detected result, the detection limit for the non-detected result was used in the calculation.
[4] TSMP combination of Chem-A pesticides, including aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexane (including lindane), endosulfan, and toxaphene. The NAS guideline for Chem A is applicable to whole fish samples only.

[5] Reach 11 (Arroyo Santa Rosa) did not appear on either the 1996 or 1998 303(d) lists. The Reach 11 tissue listings were added to the 2002 303(d) list without an accompanying fact sheet explaining the rationale for the listing.
[6] All samples are fish fillets; the NAS guideline therefore does not apply.
[7] Data from Reach 9A (Conejo Creek at Pancho/Howard Rd) were likely used for this listing.

3 CURRENT CONDITIONS

This section summarizes available information and monitoring data for describing the presence of OC pesticides and PCBs in the Calleguas Creek Watershed. Several constituents included on the 2002 303(d) list for the CCW are currently exceeding target levels rarely or not at all (referred to as category-2 constituents). A detailed discussion of current conditions is presented for the remaining constituents (referred to as category-1 constituents) using recent water, sediment, and fish tissue data.

3.1 Regulatory Status

OC pesticides and PCBs are often called historic or legacy pollutants, since concentrations of these chemicals persist in the environment despite enactment of regulations to restrict and/or end their use. All but two of the OCs listed for the CCW (dacthal and endosulfan) have been banned from use and manufacture in the United States, as shown in Table 11. The unique properties that contribute to the effectiveness of these chemicals as pesticides and industrial products have also contributed to their tendency to persist in soils and sediment, concentrate in biota, and magnify in the food chain.

Table 11. Use History of OC Pesticides and PCBs in the United States (shading indicates time period of legalized use).

CONSTITUENT	1925 - 1929	1930 - 1934	1935 - 1939	1940 - 1944	1945 - 1949	1950 – 1954	1955 - 1959	1960 - 1964	1965 - 1969	1970 - 1974	1975 - 1975	1980 - 1984	1985 - 1989	1990 - 1994	1995 - 1999	2000 - 2004
Chlordane					1948								1988			
Dacthal							1958									
DDT			1939								1972					
Dieldrin/Aldrin					1948								1987			
Endosulfan						1954										
Endrin						1951								1991		
Heptachlor						1952							1988			
HCH/Lindane					1945											2002
PCBs	1929										1979					
Toxaphene					1945									1990		
Dicofol [1]							1957									

[1] Dicofol is not included on the 303(d) list for the CCW, but does contain trace amounts of DDT.

3.2 Sources of Monitoring Data

Since the mid-1990's various studies have been conducted to assess water, sediment, and fish tissue quality in the CCW. Portions of the data collected through these studies were incorporated into the 1996, 1998, and 2002 LARWQCB Water Quality Assessments to identify exceedances of water quality objectives. The portion of the available data that formed the basis of the listings was presented in the Problem Statement section. This section presents additional relevant environmental monitoring data that may not have been included in the Water Quality Assessments; which includes water column, sediment, and tissue chemistry data. Sources and associated types of data used for completion of the OC Pesticides and PCBs TMDL are shown in Table 12.

TMDL Work Plan Data

Development of this TMDL included monitoring of OC pesticides and PCBs in water, sediment, and fish tissue during 2003-2004 (TMDL Work Plan monitoring). The purpose of TMDL Work Plan monitoring is to augment previously existing data for the CCW, which contained a high proportion of non-detected values and very few sampling events occurring concurrently across mediums (water, sediment, fish tissue). TMDL Work Plan data accounts 42% of all water, sediment, and tissue records in the CCW database and 52% of data collected since 1996, when the original 303(d) listings were issued. Analysis of TMDL Work Plan samples used methods with lower detection limits than much of the previously existing data and included several events with concurrent water, fish tissue, and sediment monitoring. Thus, these data significantly improve understanding of current conditions relating to OCs in the CCW and also improve the capability for data analysis and modeling.

Table 12. Summary of Data Sources Used for the OC Pesticides and PCBs TMDL.

Data Source	Begin Date	End Date	OC Pesticides	PCBs	Fish Tissue	Flow
Bay Protection Toxic Cleanup Program – BPTCP	10/92	2/97	S	S	X	
Calleguas Creek Characterization Study – CCCS (LWA, 2000)	7/98	6/99	W, S	W, S		X
Camarillo WWTP NPDES Monitoring (City of Camarillo)	9/85	12/01	W	W		X
Camrosa WWRF NPDES Monitoring	1/86	12/02	W	W		X
Hill Canyon WWTF (City of Thousand Oaks)	1/90	8/03	W	W		X
Moorpark WWTP (City of Moorpark)	2/95	12/02	W	W		X
Olsen Road WRP (City of Thousand Oaks)	1/87	8/02	W	W		X
Simi Valley WQCP	12/93	1/03	W	W		X
State Mussel Watch Program – SMWP	7/77	2/94	S	S		X
City of Thousand Oaks	5/74	8/01				X
Toxic Substance Monitoring Program – TSMP	4/85	8/00	S	S	X	
TMDL Work Plan Monitoring (LWA, 2004)	8/03	8/04	W, S	W, S	X	X
United States Navy (personal communication, S.Granade)	1/94	6/02	W,S	W,S	X	
University of California Davis Study (Anderson *et al.*, 2002)	3/95	6/99	W			
University of California Los Angeles Study (Abrol *et al.*, 2003)	1/98	12/01	W			
Ventura County Watershed Protection District, VCWPD	10/68	9/03	W	W		X

W – Water Column Data, S – Sediment Data

3.3 Summary of Monitoring Data

The data summary tables presented below consider all water, tissue, and sediment data collected from receiving waters in the CCW which are included in the CCW Database (LWA, 2004a). In one instance, water samples collected during a storm event were split and analyzed as filtrate and filtered solids. The measured values of the filtrate and filtered solids were combined as a total value before statistical analysis was conducted. This was done so the stormwater data would be comparable to the remaining data which had been analyzed as whole samples. Only sediment samples collected from the streambed surface are considered in the summary tables (in the case of multi-depth samples, lower depth values were removed to maintain consistency with the majority of sediment data). During analysis of samples from two sediment sampling events, samples were split into two grain size fractions and analyzed separately. The measured values of the two grain size fractions were combined based on the percent grain size in each fraction before statistical analysis was conducted using the data. This was done so these sediment data would be comparable to the remaining data which had been analyzed as whole samples.

A large proportion of the data used to develop the summary statistics for this TMDL are non-detected values. Using these data requires methods for dealing with the inherent uncertainty in characterizing the true range of conditions. The method used in this TMDL to consider non-detected data is typically known as regression on order statistics (ROS). ROS utilizes detected and non-detected data to estimate the distribution of actual concentrations (Helsel, 1988, 1990). The ROS method develops probability-plotting positions for each data point (censored and uncensored) based on the ordering of the data. A least-squares regression line is fitted by regressing log-transformed values to the uncensored probability plotting positions. The censored data points (non-detects) are assigned values based on their probability plotting positions and the regression line equation (Helsel, 1990 and Shumway et al, 2002). Summary statistics are then calculated based on the uncensored data points and the filled-in censored values. Criteria for sufficient data to use the ROS method are: 1) at least 20% and preferably 50% detected data and 2) at least three unique detected values. Instances of insufficient detected data are marked in the summary statistics tables. Use of the ROS method, when statistical criteria are met, more appropriately estimates actual values than the commonly employed practice of assuming one half the detection limit for non-detect values.

In order to calculate percent exceedances for the data summary tables presented in this section, data are compared with a range of criteria and guideline concentration values. Water column data are compared with CTR aquatic life criteria (lower of chronic or acute criteria used when available, human health criteria used if no chronic or acute criteria exist). Tissue concentrations for filet/muscle samples are compared with CTR-based criteria (TTRLs, described in the Numeric Targets section) and whole organism samples are compared with National Academy of Science targets. Sediment data are compared with Threshold Effects Level targets (TELs) from the NOAA Screening Quick Reference Tables (Buchman, 1999).

Numeric targets used in the 303(d) listing process (see Problem Statement section, Basis for Listings) differ from those used in this section. The targets used in this section are lower on average, in order to ensure that estimates of “percent exceedance” are conservative (i.e., any bias would suggest higher than actual percent exceedance, rather than lower). In the Numeric Targets section, the range of potential targets are narrowed down to the most appropriate for each medium and those final targets are used throughout the rest of the TMDL development process, including calculation of final allocations.

Receiving Water Data (Water, Sediment, Aquatic Biota)

Summarized in
Table 13 through Table 15 are the water column, streambed sediment, and aquatic biota data, respectively, for the entire watershed considering all years of available data. These results provide the following information.

- 4,4’-DDE, total DDT (sum of DDD, DDE, and DDT), and dacthal were the only OCs detected in greater than 20% of receiving water samples (only 4,4’-DDE exceeded criteria in greater than 10% of freshwater and marine samples).

- 4,4'-DDE, 4,4'-DDT, 4,4'-DDD, total DDT, total chlordane, dacthal, total PCBs, and toxaphene were detected in greater than 20% of freshwater or marine sediment samples.
- 4,4'-DDE, 4,4'-DDT, 4,4'-DDD, total DDT, chlordane, and toxaphene were detected in greater than 20% of aquatic biota samples; and all of these exceeded applicable criteria in greater than 20% of aquatic biota samples (dieldrin was detected and exceeded criteria in 16% of filet/muscle samples).

Based on the data presented in this section, only 4,4'-DDE (hereafter referred to simply as DDE), dacthal, and total DDT have been detected consistently enough to allow for robust statistical analysis. Among these three constituents, only DDE consistently exceeded applicable targets in water, sediment, and tissue (targets for total DDT only exist for water toxicity, and that criterion is exceeded due mainly to the presence of DDE).

Selection of DDE as a Representative Constituent

Since no other constituent is consistently detected and found to routinely exceed applicable targets, and because OCs possess many similar physical and chemical properties that influence their fate and transport in the environment (see Linkage Analysis section), DDE is chosen as a representative constituent for most of the analyses and modeling used to develop this TMDL.

Table 13. Summary statistics for OCs in all water column samples, 1986-2004.

Constituent	Freshwater				Marine			
	n	% Detect	Target (ug/L)	% Exceed	n	% Detect	Target (ug/L)	% Exceed
4,4'-DDD	435	10%	0.00084 [2]	10%	138	8%	0.00084 [2]	8%
4,4'-DDE	449	23%	0.00059 [2]	23%	138	20%	0.00059 [2]	20%
4,4'-DDT	448	12%	0.00059 [2]	12%	138	7%	0.00059 [2]	7%
DDT, Total (Summed DDD, DDE, DDT)	450	25%	NA		120	23%	NA	
Aldrin	432	0%	0.00014 [2]	0%	20	0%	0.00014 [2]	0%
BHC-alpha (HCH)	416	1%	0.013 [2]	0%	19	0%	0.013 [2]	0%
BHC-beta (HCH)	420	1%	0.046 [2]	0%	137	1%	0.046 [2]	0%
BHC-delta (HCH)	413	3%	NA		137	1%	NA	
BHC-gamma (HCH, Lindane)	422	6%	0.063 [2]	0%	138	8%	0.063 [2]	2%
HCH, Total (summed alpha,beta,delta,gamma)	426	9%	NA		120	11%	NA	
Chlordane	167	0%	0.00059 [2]		0	--	0.00059 [2]	--
Chlordane (technical)	32	0%	NA		0	--	NA	--
Chlordane,Total (summed alpha,gamma)	249	5%	0.00059 [2]	5%	119	4%	0.00059 [2]	4%
DCPA (Dacthal)	136	46%	3500 [3]	0%	13	92%	NA	
Dieldrin	437	0%	0.00014 [2]	0%	138	1%	0.00014 [2]	1%
Endosulfan I	436	0%	0.056 [1]	0%	138	0%	0.0087 [1]	0%
Endosulfan II	424	0%	0.056 [1]	0%	138	1%	0.0087 [1]	0%
Endosulfan sulfate	424	3%	240	0%	138	4%	240 [2]	0%
Endrin	437	0%	0.036 [1]	0%	138	1%	0.0023 [1]	1%
Heptachlor	434	0%	0.00021 [2]	0%	138	2%	0.00021 [2]	2%
Heptachlor epoxide	432	1%	0.00011 [2]	1%	137	1%	0.00011 [2]	1%
PCBs,Total (Summed Aroclors)	384	1%	0.00017 [2]	1%	119	1%	0.00017 [2]	1%
Toxaphene	418	0%	0.00075 [2]	0%	20	0%	0.00075 [2]	0%

[1] Lower of acute or chronic CTR criteria.
[2] CTR human health criteria.
[3] Drinking water standard of 3500 ug/L adopted by states of Florida and Arizona is the only potentially applicable target. It is used here only as a reference point, and is likely overprotective.

Table 14. Summary statistics for OCs in all sediment samples, 1989-2004.

Constituent	Freshwater [1]				Marine [2]			
	n	% Detect	Target (ug/g)	% Exceed	n	% Detect	Target (ug/g)	% Exceed
4,4'-DDD	82	33%	0.00354	26%	137	63%	0.00122	61%
4,4'-DDE	82	56%	0.00142	54%	137	86%	0.00207	83%
4,4'-DDT	82	34%	NA		137	45%	0.00119	34%
DDT, Total (Summed DDD, DDE, DDT)	82	56%	0.0069	39%	138	86%	0.0039	80%
Aldrin	80	0%	NA		15	0%	NA	
BHC-alpha (HCH)	80	0%	NA		22	5%	NA	
BHC-beta (HCH)	62	0%	NA		122	2%	NA	
BHC-delta (HCH)	82	2%	NA		130	0%	NA	
BHC-gamma (HCH, Lindane)	82	6%	0.00094	4%	137	1%	0.00032	1%
HCH, Total (summed alpha,beta,delta,gamma)	82	6%	NA		137	4%	NA	
Chlordane	18	0%	0.0045	0%	0	--	0.00226	--
Chlordane (technical)	0	--	NA	--	0	--	NA	--
Chlordane,Total (summed alpha, gamma)	64	22%	0.0045	16%	137	23%	0.00226	18%
DCPA (Dacthal)	44	27%	NA		19	63%	NA	
Dieldrin	82	9%	0.00285	4%	137	12%	0.00072	10%
Endosulfan I	74	12%	NA		130	5%	NA	
Endosulfan II	74	8%	NA		137	9%	NA	
Endosulfan sulfate	54	0%	NA		121	5%	NA	
Endrin	82	1%	0.00267	0%	137	1%	NA	
Heptachlor	66	0%	NA		129	3%	NA	
Heptachlor epoxide	54	0%	0.0006	0%	120	0%	NA	
PCBs,Total (Summed Congeners)	44	11%	0.0341	11%	15	73%	0.0216	67%
Toxaphene	80	11%	NA		15	33%	NA	

[1] Freshwater sediment quality guidelines contained in NOAA Screening Quick Reference Tables (Buchman, 1999); TEL = Threshold Effects Level
[2] Marine Sediment quality guidelines contained in NOAA Screening Quick Reference Tables (Buchman, 1999); TEL = Threshold Effects Level

Table 15. Summary statistics for OCs in all aquatic biota samples, 1977-2004.

Constituent	Filet / Muscle [1]				Whole Organism [2]			
	n	% Detect	Target (ug/g,dry)	% Exceed	n	% Detect	Target (ug/g,dry)	% Exceed
4,4'-DDD	69	52%	0.045	28%	93	90%	NA	
4,4'-DDE	69	90%	0.032	65%	93	100%	NA	
4,4'-DDT	69	35%	0.032	28%	93	72%	NA	
DDT, Total (Summed DDD, DDE, DDT)	69	90%	NA		109	100%	1.0	23%
Aldrin	69	0%	0.00005	0%	49	0%	0.1	0%
BHC-alpha (HCH)	69	0%	0.002	0%	63	10%	NA	
BHC-beta (HCH)	69	0%	0.006	0%	49	0%	NA	
BHC-delta (HCH)	69	0%	NA		49	0%	NA	
BHC-gamma (HCH, Lindane)	69	12%	0.008	0%	62	31%	0.1	2%
HCH, Total (summed alpha,beta,delta,gamma)	69	12%	NA		63	35%	NA	
Chlordane	0	--	0.0083	--	0	--	NA	--
Chlordane (technical)	0	--	0.0083	--	0	--	NA	--
Chlordane,Total (summed alpha, gamma)	69	33%	0.0083	22%	67	66%	0.1	3%
DCPA (Dacthal)	69	35%	NA		65	80%	NA	
Dieldrin	69	16%	0.0007	16%	63	57%	0.1	2%
Endosulfan I	66	20%	64.8	0%	63	22%	NA	
Endosulfan II	53	4%	64.8	0%	57	21%	NA	
Endosulfan sulfate	53	6%	64.8	0%	57	26%	NA	
Endrin	69	3%	3.22	0%	63	17%	0.1	0%
Heptachlor	69	0%	0.0024	0%	63	3%	0.1	0%
Heptachlor epoxide	69	0%	0.0012	0%	63	16%	0.1	0%
PCBs,Total (Summed Congeners)	32	9%	0.0053	9%	40	53%	0.5	0%
Toxaphene	69	26%	0.0098	26%	65	57%	0.1	46%

[1] TTRLs are used (explained in the numeric targets section).
[2] National Academy of Science guidelines are used.

3.4 Definition of Category-1 and Category-2 Constituents

A total of nine constituents or combinations of constituents are included on the 2002 303(d) list for the Calleguas Creek Watershed. Available data suggest that some of these constituents are frequently exceeding criteria or guideline concentration levels, while others are exceeding infrequently or not at all. For the purposes of this TMDL, those constituents frequently exceeding are referred to as category-1 constituents, and those which rarely or never exceed are referred to as category-2. Methodology recently released by the State Water Resource Control Board for describing allowable numbers of exceedances according to sample size (SWRCB, 2004c) was used to define CCW 303(d) listed constituents as either category-1 or category-2. Data from the CCW Database for each constituent were compared against the allowed number of exceedances in the guidance tables of the SWRCB document. Constituents having more than the allowed number of exceedances in any medium (water, fish tissue, or sediment) are defined as category-1. Constituents having fewer than the allowed number of exceedances in all mediums (water, fish tissue, and sediment) are defined as category-2. Constituents in the group listing Chem-A are considered individually. Category-1 and category-2 constituents are summarized in Table 16.

Table 16. Exceedance status of 303d listed constituents in the CCW.

Constituents included on 303(d) list, 2002	Constituents evaluated during TMDL work plan monitoring	Category-1 Constituents [1]	Category-2 Constituents [1]
Chlordane	Chlordane [3]	Chlordane	--
DDT (DDE, DDD)	DDT (DDE, DDD)	DDT (DDE, DDD)	--
Dacthal	Dacthal	--	Dacthal [2]
Dieldrin	Dieldrin [3]	Dieldrin	--
HCH (incl. Lindane)	HCH (incl. Lindane) [3]	--	HCH (incl. Lindane)
Endosulfan	Endosulfan [3]	--	Endosulfan
PCBs	PCBs	PCBs	--
Toxaphene	Toxaphene [3]	Toxaphene	--
Chem-A [3]	Aldrin [3]	--	Aldrin
	Endrin [3]	--	Endrin
	Heptachlor [3]	--	Heptachlor
	Heptachlor Epoxide [3]	--	Heptachlor Epoxide

[1] Category-1 vs. Category-2 status defined according to SWRCB guidance document (SWRCB, 2004c)

[2] No approved toxicity or human health criteria exist for dacthal in water, sediment, or fish tissue. However, dacthal concentrations in the CCW are well below the drinking water standard of 3500ug/L adopted in the states of Arizona and Florida (see Numeric Targets Section)

[3] Chem-A includes the following constituents, which are considered individually: aldrin, chlordane, dieldrin, endosulfan, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexane (HCH, including lindane), and toxaphene

In-depth analysis conducted for category-1 constituents is presented in the Current Conditions, Source Analysis and Linkage Analysis sections; and final allocations are calculated according to methods described in the TMDL Allocations section. A brief summary of detections and exceedances in all years of available receiving water data for category-2 constituents is presented below, in Table 17. Since available data suggest that category-2 constituents are not causing impairment of beneficial uses, and because in-depth analysis of those constituents is not possible due to their low frequency of detection, they are generally excluded from analysis and modeling in the remainder of the TMDL. Final allocations for category-2 constituents are set equal to numeric targets for listed reaches, as explained in the TMDL Allocations section.

Table 17. Percent detected and exceedance of Category-2 constituents in water, sediment, and tissue. [1]

Constituent	Water Column				Sediment				Tissue			
	Freshwater		Marine		Freshwater		Marine		Filet/Muscle		Whole Org	
	% Det	% Exc	% Det	% Exc	% Det	% Exc	% Det	% Exc	% Det	% Exc	% Det	% Exc
Aldrin	0	0	0	0	0		0		0	0	0	0
BHC-alpha (HCH)	1	0	0	0	0		5		0	0	10	
BHC-beta (HCH)	1	0	1	0	0		2		0	0	0	
BHC-delta (HCH)	3		1		2		0		0	0	0	
BHC-gamma (HCH, Lindane)	6	0	8	2	6	4	1	1	12	0	31	2
DCPA (Dacthal)	46	0	92		27		63		35		80	
Endosulfan I	0	0	0	0	12		5		20	0	22	
Endosulfan II	0	0	1	0	8		9		4	0	21	
Endosulfan sulfate	3	0	4	0	0		5		6	0	26	
Endrin	0	0	1	1	1	0	1		3	0	17	0
Heptachlor	0	0	2	2	0		3		0	0	3	0
Heptachlor epoxide	1	1	1	1	0		0		0	0	16	0

[1] Yellow shaded cells indicate instances where no applicable criteria or guidelines exist.

3.5 Status of Category-1 Constituents

In this section, time series plots and tables of current conditions are presented for water column, sediment, and tissue data for each category-1 constituent. The time series plots aggregate data from the entire watershed, and the current conditions tables present data individually by reach. All years of available data are used for the time series plots in order to best convey long term trends, while the current conditions tables for each constituent consider only more recent data from 1996-2004. This time frame is selected for the current conditions tables because most of the 303(d) listings for the CCW are originally from the 1996 listing cycle and also because detection limits improved significantly in the years following 1996. When only these more recent years are considered, the data set contains a very low proportion of detected values. Thus, final percent reductions presented later in the TMDL and Allocations section draw upon all years of data in order to have sufficient detected data for robust statistical analysis.

As previously mentioned, use of the ROS method for developing summary statistics requires certain prerequisite data conditions (i.e., minimum number of samples and percent detected). When "na" appears in the data tables presented below, it indicates a value not calculated by the ROS method due to considerations of statistical validity. In order to prevent calculations from being biased by non-detected data with high detection limits, non-detected samples were removed when detection limits were higher than concentrations considered characteristic of the reach (based on the range of detected values, according to best professional judgment). Table 18 presents the range of detection limits that were considered uncharacteristic. Very few records were removed as a result of this procedure.

Table 18. Removal of non-detect data records with abnormally high detection limits.

Medium	Constituent	Data Removed, if DL > this value:	Units
Water	4,4'-DDE	10	ug/L
	4,4'-DDT	10	
Sediment	BHC-gamma	0.02	ug/g
	Dieldrin	0.33	
Tissue	None	--	--

DDT (DDE, DDD)

As stated earlier, DDE is the constituent most detected at levels exceeding criteria in all mediums and is designated as the representative constituent for much of the analysis and modeling in this TMDL. Figure 2 shows the detected values for DDE across all years of available data for water, sediment, and fish tissue. Data for DDT and DDD parallel those for DDE in water, sediment, and fish tissue; although at slightly lower concentrations on average.

During 1995-1996, DDE concentrations recorded in water samples ranged from 28-302 ug/L. This is noticeably high relative to concentrations during 1997-2004, which ranged from 0.001-0.8 ug/L (Figure 2). The elevated concentrations detected during 1995-96 are not understood, although original records were checked to confirm the anomalous data were not the result of errors in CCW database data entry. Possible explanations for these elevated data include, but are not limited to:

- illegal use of DDT during that time period;
- construction activity in 1995-1996 on land where heavy DDT use occurred previously;
- erroneous lab results or mistakes in original data entry;
- large storm events causing flux of high DDT concentration sediment from unknown source;

Of these potential explanations, illegal use of DDT or construction activity seem most plausible, since the elevated levels occurred only in a single subwatershed (Revolon Slough) and because concentrations declined suddenly after 1996. Erroneous lab results seem unlikely, since the elevated levels are found in almost a dozen separate sampling events which occurred during that time period. The possibility these data resulted from large storm events is not supported by corresponding spikes in sediment or fish tissue data.

The possibility that elevated data from 1995-1996 are representative of average concentrations during the 1980s and early 1990s was also considered. Given that pre-1995 sampling recorded no detected values of DDE, and the fact that pre-1995 detection levels were sufficiently low to record concentrations comparable to those from 1995-1996 (Figure 3); there is no evidence to support the possibility that the 1995-1996 data are representative of concentrations from earlier years.

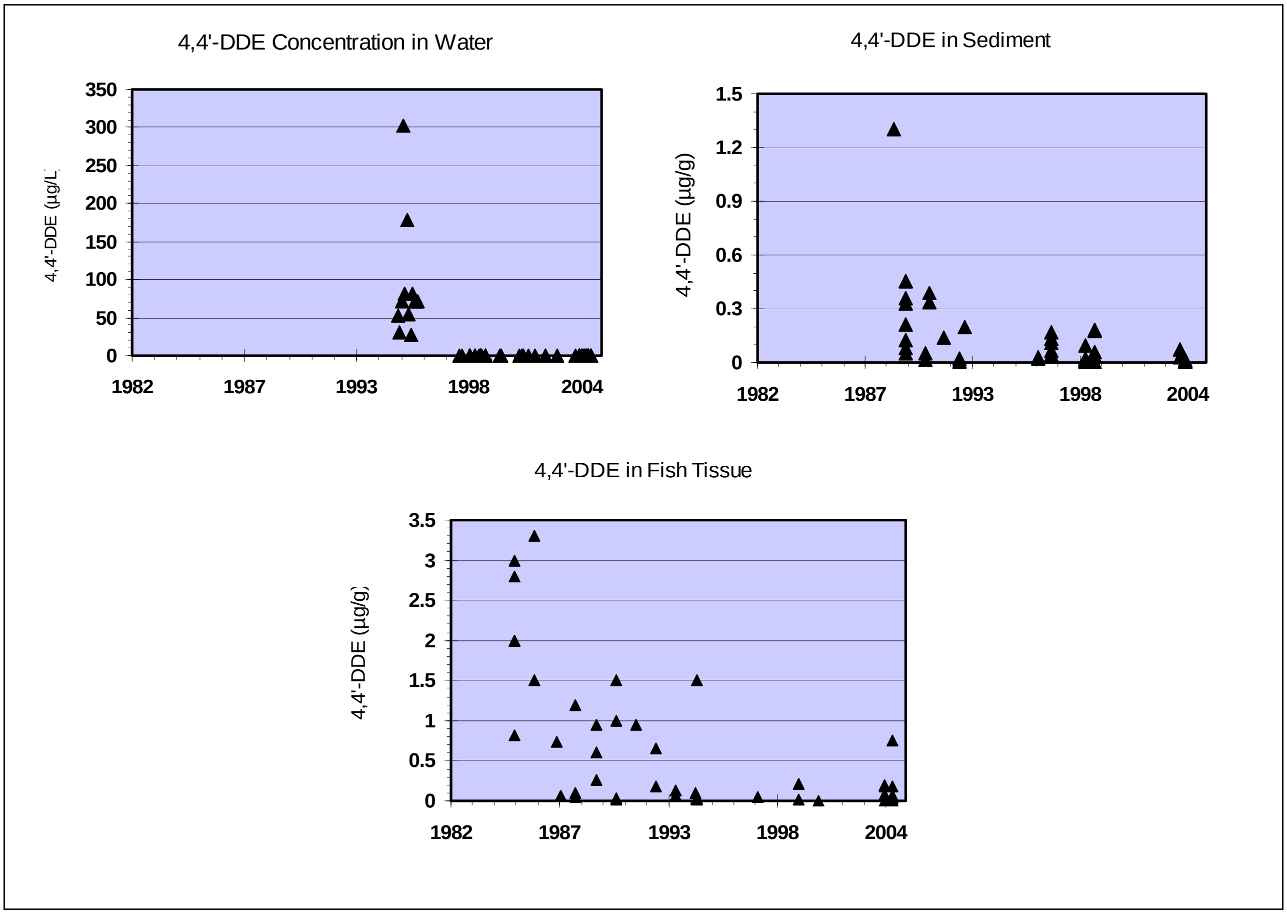


Figure 2. Detected values for DDE in water, sediment, and fish tissue samples for all years of available data. Note elevated levels of DDE in water during 1995-1996.

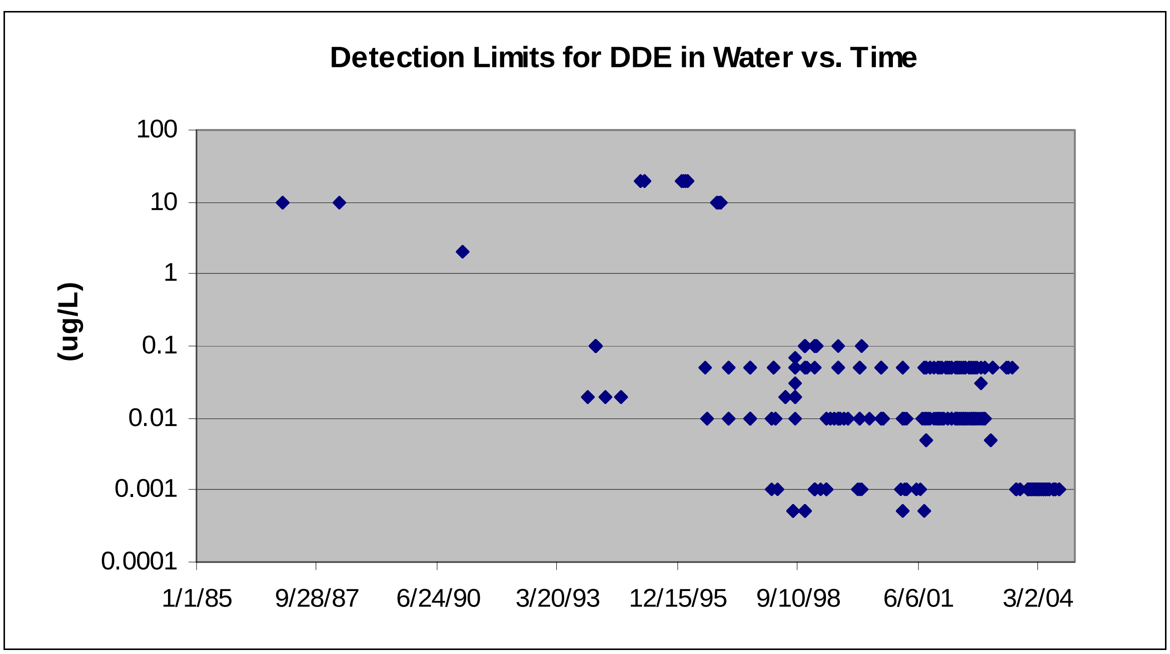


Figure 3. Detection limits reported for all DDE data in the CCW Database, plotted versus time.

The data for DDD, DDE, and DDT in water samples from 1996-2004 (Table 19) indicate the highest percent of detections in the Mugu, Revolon, and Calleguas Subwatersheds (reaches 1, 2, 3, 4, and 5). Detections in sediment samples occur throughout the watershed, but concentrations are much lower in samples from the Conejo subwatershed (reaches 9b, 10,11,12) -- as shown in Table 20. A noticeably higher percentage of exceedances is apparent in tissue samples for DDE than for DDD or DDT (Table 21, Table 22). Samples from the Conejo subwatershed (reaches 9b, 10,11,12) have very few detections or exceedances compared to samples from the rest of the watershed.

Table 19. DDD, DDE, and DDT current conditions in water by reach using data from 1996-2004.

Reach	Form	n	# Detect	# Exceed	% Detect	% Exceed	Mean ug/L	SD	Median ug/L	Max Detect ug/L
1	4,4'-DDD	64	6	6	9.4%	9.4%	na	na	na	0.030
	4,4'-DDE	64	21	21	32.8%	32.8%	0.010	0.008	0.008	0.050
	4,4'-DDT	64	7	7	10.9%	10.9%	na	na	na	0.020
2	4,4'-DDD	21	4	4	19.0%	19.0%	na	na	na	0.220
	4,4'-DDE	21	6	6	28.6%	28.6%	0.043	0.188	0.000	0.863
	4,4'-DDT	21	2	2	9.5%	9.5%	na	na	na	0.003
3	4,4'-DDD	68	5	5	7.4%	7.4%	na	na	na	0.015
	4,4'-DDE	67	21	21	31.3%	31.3%	0.019	0.055	0.005	0.430
	4,4'-DDT	68	15	15	22.1%	22.1%	0.021	0.133	0.001	1.10
4	4,4'-DDD	37	15	15	40.5%	40.5%	0.031	0.096	0.002	0.564
	4,4'-DDE	37	28	28	75.7%	75.7%	0.130	0.294	0.020	1.56
	4,4'-DDT	37	18	18	48.6%	48.6%	0.057	0.155	0.006	0.901
5	4,4'-DDD	14	6	6	42.9%	42.9%	0.016	0.048	0.001	0.183
	4,4'-DDE	14	10	10	71.4%	71.4%	0.093	0.279	0.014	1.06
	4,4'-DDT	14	3	3	21.4%	21.4%	0.043	0.151	0.000	0.567
6	4,4'-DDD	18	0	0	0.0%	0.0%	--	--	--	--
	4,4'-DDE	18	5	5	27.8%	27.8%	0.004	0.007	0.001	0.024
	4,4'-DDT	18	2	2	11.1%	11.1%	na	na	na	0.025
7	4,4'-DDD	97	2	2	2.1%	2.1%	na	na	na	0.159
	4,4'-DDE	83	7	7	8.4%	8.4%	na	na	na	0.267
	4,4'-DDT	83	2	2	2.4%	2.4%	na	na	na	0.176
8	4,4'-DDD	11	0	0	0.0%	0.0%	--	--	--	--
	4,4'-DDE	11	0	0	0.0%	0.0%	--	--	--	--
	4,4'-DDT	11	0	0	0.0%	0.0%	--	--	--	--
9A	4,4'-DDD	20	1	1	5.0%	5.0%	na	na	na	0.092
	4,4'-DDE	20	11	11	55.0%	55.0%	0.020	0.068	0.002	0.309
	4,4'-DDT	20	1	1	5.0%	5.0%	na	na	na	0.317
9B	4,4'-DDD	32	0	0	0.0%	0.0%	--	--	--	--
	4,4'-DDE	32	4	4	12.5%	12.5%	na	na	na	0.007
	4,4'-DDT	32	0	0	0.0%	0.0%	--	--	--	--
10	4,4'-DDD	42	1	1	2.4%	2.4%	na	na	na	0.002
	4,4'-DDE	41	1	1	2.4%	2.4%	na	na	na	0.070
	4,4'-DDT	42	0	0	0.0%	0.0%	--	--	--	--
11	4,4'-DDD	18	1	1	5.6%	5.6%	na	na	na	0.001
	4,4'-DDE	18	3	3	16.7%	16.7%	na	na	na	0.139
	4,4'-DDT	16	1	1	6.3%	6.3%	na	na	na	0.006
12	4,4'-DDD	32	0	0	0.0%	0.0%	--	--	--	--
	4,4'-DDE	39	1	1	2.6%	2.6%	na	na	na	0.130
	4,4'-DDT	39	1	1	2.6%	2.6%	na	na	na	0.010
13	4,4'-DDD	18	0	0	0.0%	0.0%	--	--	--	--
	4,4'-DDE	25	2	2	8.0%	8.0%	na	na	na	0.001
	4,4'-DDT	25	0	0	0.0%	0.0%	--	--	--	--

"na" indicates value not calculated by the ROS method due to considerations of statistical validity.

Table 20. DDD, DDE, and DDT current conditions in sediment by reach using data from 1996-2004. [1]

Reach	Form	n	# Detect	# Exceed	% Detect	% Exceed	Mean ug/g	SD	Median ug/g	Max Detect ug/g
1	4,4'-DDD	37	27	13	73.0%	35.1%	0.010	0.013	0.005	0.064
	4,4'-DDE	37	35	1	94.6%	2.7%	0.061	0.080	0.028	0.440
	4,4'-DDT	37	24	15	64.9%	40.5%	0.012	0.020	0.004	0.086
2	4,4'-DDD	7	2	0	28.6%	0.0%	na	na	na	0.004
	4,4'-DDE	7	6	0	85.7%	0.0%	0.017	0.022	0.006	0.062
	4,4'-DDT	7	0	[2]	0.0%	[2]	--	--	--	--
3	4,4'-DDD	6	1	0	16.7%	0.0%	na	na	na	0.004
	4,4'-DDE	6	4	2	66.7%	33.3%	0.011	0.015	0.004	0.039
	4,4'-DDT	6	1	[2]	16.7%	[2]	na	na	na	0.016
4	4,4'-DDD	7	5	2	71.4%	28.6%	0.005	0.004	0.004	0.010
	4,4'-DDE	7	6	6	85.7%	85.7%	0.054	0.064	0.029	0.184
	4,4'-DDT	7	5	[2]	71.4%	[2]	0.031	0.072	0.004	0.193
5	4,4'-DDD	3	3	1	100.0%	33.3%	0.048	0.078	0.009	0.138
	4,4'-DDE	3	3	3	100.0%	100.0%	0.190	0.243	0.083	0.467
	4,4'-DDT	3	3	[2]	100.0%	[2]	0.219	0.375	0.017	0.653
6	4,4'-DDD	6	2	0	33.3%	0.0%	na	na	na	0.005
	4,4'-DDE	6	3	2	50.0%	33.3%	0.010	0.014	0.002	0.033
	4,4'-DDT	6	2	[2]	33.3%	[2]	na	na	na	0.020
7	4,4'-DDD	9	2	2	22.2%	22.2%	na	na	na	0.015
	4,4'-DDE	9	7	4	77.8%	44.4%	0.025	0.042	0.004	0.118
	4,4'-DDT	9	2	[2]	22.2%	[2]	na	na	na	0.025
8	4,4'-DDD	3	0	0	0.0%	0.0%	--	--	--	--
	4,4'-DDE	3	0	0	0.0%	0.0%	--	--	--	--
	4,4'-DDT	3	0	[2]	0.0%	[2]	--	--	--	--
9A	4,4'-DDD	6	3	1	50.0%	16.7%	0.003	0.004	0.001	0.010
	4,4'-DDE	6	5	4	83.3%	66.7%	0.056	0.068	0.020	0.179
	4,4'-DDT	6	2	[2]	33.3%	[2]	na	na	na	0.030
9B	4,4'-DDD	3	1	0	33.3%	0.0%	na	na	na	0.005
	4,4'-DDE	3	3	1	100.0%	33.3%	0.016	0.021	0.008	0.040
	4,4'-DDT	3	1	[2]	33.3%	[2]	na	na	na	0.002
10	4,4'-DDD	6	0	0	0.0%	0.0%	--	--	--	--
	4,4'-DDE	6	3	0	50.0%	0.0%	0.001	0.001	0.001	0.004
	4,4'-DDT	6	1	[2]	16.7%	[2]	na	na	na	0.002
12	4,4'-DDD	3	0	0	0.0%	0.0%	--	--	--	--
	4,4'-DDE	3	1	0	33.3%	0.0%	na	na	na	0.130
	4,4'-DDT	3	1	[2]	33.3%	[2]	na	na	na	0.010
13	4,4'-DDD	3	0	0	0.0%	0.0%	--	--	--	--
	4,4'-DDE	3	0	0	0.0%	0.0%	--	--	--	--
	4,4'-DDT	3	0	[2]	0.0%	[2]	--	--	--	--

[1] No samples have been collected from Reach 11.
[2] No sediment guidelines exist for DDT in freshwater.
"na" indicates value not calculated by the ROS method due to considerations of statistical validity.

Table 21. DDD, DDE, and DDT current conditions in fish tissue (filet/muscle) samples by reach, 1996-2004. [1]

Reach [1]	Form	n	# Detect	# Exceed	% Detect	% Exceed	Mean	SD	Median	Max
							ug/g		ug/g	ug/g
1	4,4'-DDD	1	0	0	0.0%	0.0%	--	--	--	--
	4,4'-DDE	1	1	1	100.0%	100.0%	na	na	na	0.043
	4,4'-DDT	1	0	0	0.0%	0.0%	--	--	--	--
3	4,4'-DDD	7	6	0	85.7%	0.0%	0.009	0.006	0.008	0.019
	4,4'-DDE	7	7	7	100.0%	100.0%	0.143	0.060	0.130	0.208
	4,4'-DDT	7	2	1	28.6%	14.3%	na	na	na	0.042
4	4,4'-DDD	2	2	1	100.0%	50.0%	na	na	na	0.071
	4,4'-DDE	2	2	2	100.0%	100.0%	na	na	na	0.757
	4,4'-DDT	2	1	1	50.0%	50.0%	na	na	na	0.048
7	4,4'-DDD	2	0	0	0.0%	0.0%	--	--	--	--
	4,4'-DDE	2	2	0	100.0%	0.0%	na	na	na	0.004
	4,4'-DDT	2	0	0	0.0%	0.0%	--	--	--	--
9A	4,4'-DDD	5	4	0	80.0%	0.0%	0.006	0.005	0.004	0.015
	4,4'-DDE	5	5	5	100.0%	100.0%	0.171	0.173	0.122	0.466
	4,4'-DDT	5	2	0	40.0%	0.0%	na	na	na	0.010
9B	4,4'-DDD	5	3	0	60.0%	0.0%	0.005	0.007	0.002	0.018
	4,4'-DDE	5	5	3	100.0%	60.0%	0.074	0.067	0.056	0.189
	4,4'-DDT	5	0	0	0.0%	0.0%	--	--	--	--
10	4,4'-DDD	8	0	0	0.0%	0.0%	--	--	--	--
	4,4'-DDE	8	6	0	75.0%	0.0%	0.007	0.005	0.005	0.019
	4,4'-DDT	8	0	0	0.0%	0.0%	--	--	--	--
12	4,4'-DDD	1	0	0	0.0%	0.0%	--	--	--	--
	4,4'-DDE	1	0	0	0.0%	0.0%	--	--	--	--
	4,4'-DDT	1	0	0	0.0%	0.0%	--	--	--	--
13	4,4'-DDD	6	0	0	0.0%	0.0%	--	--	--	--
	4,4'-DDE	6	3	0	50.0%	0.0%	0.003	0.001	0.003	0.005
	4,4'-DDT	6	0	0	0.0%	0.0%	--	--	--	--

[1] No samples were collected in reaches 2, 5, 6, 8, 11.
"na" indicates value not calculated by the ROS method due to considerations of statistical validity.

Table 22. DDD, DDE, and DDT current conditions in whole aquatic organism samples by reach, 1996-2004. [1]

Reach	Form	n	# Detect	# Exceed [2]	% Detect	% Exceed [2]	Mean ug/g	SD	Median ug/g	Max Detect ug/g
1	4,4'-DDD	24	24		100.0%		0.044	0.115	0.013	0.574
	4,4'-DDE	24	24		100.0%		0.207	0.156	0.156	0.495
	4,4'-DDT	24	24		100.0%		0.005	0.004	0.003	0.012
2	4,4'-DDD	2	2		100.0%		na	na	na	0.052
	4,4'-DDE	2	2		100.0%		na	na	na	0.433
	4,4'-DDT	2	0		0.0%		--	--	--	--
3	4,4'-DDD	7	7		100.0%		0.114	0.130	0.053	0.300
	4,4'-DDE	7	7		100.0%		1.89	1.54	1.29	4.10
	4,4'-DDT	7	5		71.4%		0.042	0.038	0.027	0.100
4	4,4'-DDD	3	3		100.0%		0.205	0.212	0.145	0.450
	4,4'-DDE	3	3		100.0%		2.31	2.23	1.59	4.80
	4,4'-DDT	3	3		100.0%		0.079	0.105	0.040	0.200
5	4,4'-DDD	3	2		66.7%		na	na	na	0.016
	4,4'-DDE	3	3		100.0%		0.045	0.008	0.045	0.052
	4,4'-DDT	3	0		0.0%		--	--	--	--
6	4,4'-DDD	2	2		100.0%		na	na	na	0.019
	4,4'-DDE	2	2		100.0%		na	na	na	0.339
	4,4'-DDT	2	0		0.0%		--	--	--	--
7	4,4'-DDD	8	4		50.0%		0.004	0.005	0.002	0.012
	4,4'-DDE	8	8		100.0%		0.036	0.015	0.034	0.067
	4,4'-DDT	8	0		0.0%		--	--	--	--
9A	4,4'-DDD	2	2		100.0%		na	na	na	0.035
	4,4'-DDE	2	2		100.0%		na	na	na	0.932
	4,4'-DDT	2	2		100.0%		na	na	na	0.100
9B	4,4'-DDD	3	3		100.0%		0.018	0.005	0.017	0.023
	4,4'-DDE	3	3		100.0%		0.317	0.063	0.313	0.369
	4,4'-DDT	3	0		0.0%		--	--	--	--
12	4,4'-DDD	4	2		50.0%		na	na	na	0.018
	4,4'-DDE	4	4		100.0%		0.050	0.009	0.050	0.061
	4,4'-DDT	4	0		0.0%		--	--	--	--

[1] No samples were collected in reaches 8, 10, 11, 13.
[2] Appropriate numeric targets do not exist (NAS are not adopted criteria, OEHHA are for frequent consumers of sport fish).
"na" indicates value not calculated by the ROS method due to considerations of statistical validity.

Chlordane

For the purpose of this TMDL, and in accordance with standard convention, chlordane is considered as the sum of alpha-chlordane and gamma-chlordane, displayed in Figure 4 below as "summed" chlordane. Like most of the organochlorine compounds, chlordane is more frequently detected in sediment and fish tissue than in water. Chlordane detections in water during the 1996-2004 time period occur in the Mugu, Revolon, Calleguas, and Simi subwatersheds -- reaches 1, 3, 4, 5, 7 (Table 23). Sixteen sediment samples from Mugu contained detectable levels of chlordane; while only four other detections occurred in the rest of the watershed. A high proportion of tissue samples during 1996-2004 recorded detections of chlordane, although the total number of samples was not large (Table 25 and Table 26).

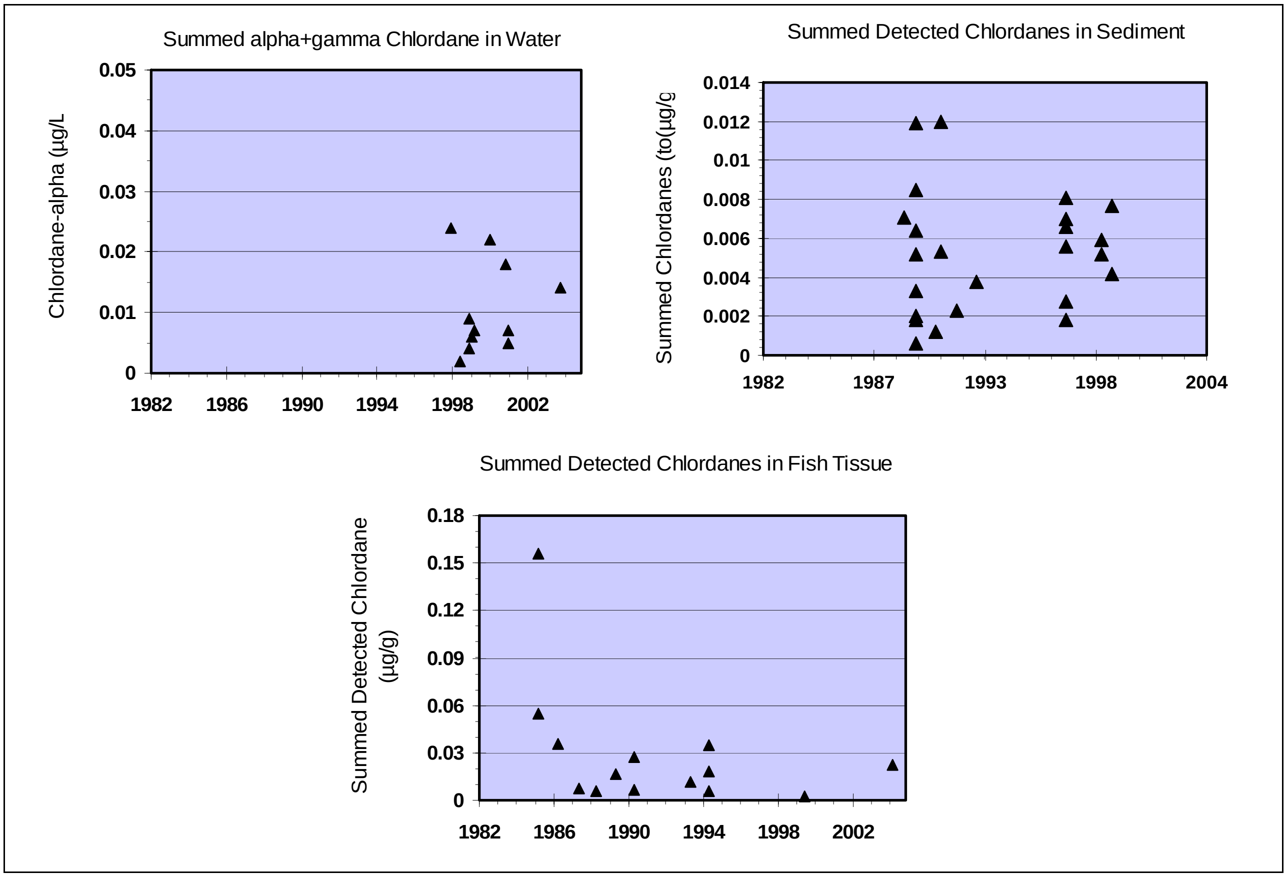


Figure 4 - Detected values for Chlordane in water, sediment, and fish tissue samples for all years of available data

Table 23. Chlordane current conditions in water samples by reach, 1996-2004.

Reach	n	# Detect	# Exceed	% Detect	% Exceed	Mean ug/L	SD	Median ug/L	Max Detect ug/L
1	118	6	6	5.1%	5.1%	0.015	0.017	0.008	0.040
2	22	0	0	0.0%	0.0%	--	--	--	--
3	42	2	2	4.8%	4.8%	na	na	na	0.007
4	39	9	9	23.1%	23.1%	0.085	0.225	0.010	0.684
5	14	1	1	7.1%	7.1%	na	na	na	0.014
6	18	0	0	0.0%	0.0%	--	--	--	--
7	42	1	1	2.4%	2.4%	na	na	na	0.294
8	11	0	0	0.0%	0.0%	--	--	--	--
9A	20	0	0	0.0%	0.0%	--	--	--	--
9B	19	0	0	0.0%	0.0%	--	--	--	--
10	23	0	0	0.0%	0.0%	--	--	--	--
11	5	0	0	0.0%	0.0%	--	--	--	--
12	11	0	0	0.0%	0.0%	--	--	--	--
13	18	0	0	0.0%	0.0%	--	--	--	--

"na" indicates value not calculated by the ROS method due to considerations of statistical validity.

Table 24. Chlordane current conditions in sediment samples by reach, 1996-2004. [1]

Reach	n	# Detect	# Exceed	% Detect	% Exceed	Mean	SD	Median	Max Detect
						ug/g		ug/g	ug/g
1	43	16	2	37.2%	4.7%	0.004	0.005	0.003	0.020
2	7	0	0	0.0%	0.0%	--	--	--	--
3	6	0	0	0.0%	0.0%	--	--	--	--
4	7	2	0	28.6%	0.0%	na	na	na	0.008
5	3	0	1	0.0%	33.3%	--	--	--	--
6	6	0	0	0.0%	0.0%	--	--	--	--
7	7	0	0	0.0%	0.0%	--	--	--	--
8	3	0	0	0.0%	0.0%	--	--	--	--
9A	6	1	0	16.7%	0.0%	na	na	na	0.004
9B	3	0	0	0.0%	0.0%	--	--	--	--
10	6	1	0	16.7%	0.0%	na	na	na	0.006
12	3	0	0	0.0%	0.0%	--	--	--	--
13	3	0	0	0.0%	0.0%	--	--	--	--

[1] No samples were collected from Reach 11.
"na" indicates value not calculated by the ROS method due to considerations of statistical validity.

Table 25. Chlordane current conditions in fish tissue (filet/muscle) samples by reach, 1996-2004. [1]

Reach [1]	n	# Detect	# Exceed	% Detect	% Exceed	Mean	SD	Median	Max
						ug/g		ug/g	ug/g
1	1	0	0	0.0%	0.0%	--	--	--	--
3	7	1	0	14.3%	0.0%	na	na	na	0.002
4	2	1	1	50.0%	50.0%	na	na	na	0.022
7	2	0	0	0.0%	0.0%	--	--	--	--
9A	5	1	0	20.0%	0.0%	na	na	na	0.005
9B	5	1	0	20.0%	0.0%	na	na	na	0.001
10	8	0	0	0.0%	0.0%	--	--	--	--
12	1	0	0	0.0%	0.0%	--	--	--	--
13	6	0	0	0.0%	0.0%	--	--	--	--

[1] No samples were collected in reaches 2, 5, 6, 8, 11.
"na" indicates value not calculated by the ROS method due to considerations of statistical validity.

Table 26. Chlordane current conditions in whole aquatic organism samples by reach, 1996-2004. [1]

Reach	n	# Detect	# Exceed [2]	% Detect	% Exceed [2]	Mean ug/g	SD	Median ug/g	Max Detect ug/g
2	2	1		50.0%		na	na	na	0.009
3	7	4		57.1%		0.027	0.020	0.021	0.047
4	3	2		66.7%		na	na	na	0.092
5	3	0		0.0%		--	--	--	--
6	2	0		0.0%		--	--	--	--
7	8	1		12.5%		na	na	na	0.003
9A	2	2		100.0%		na	na	na	0.008
9B	3	1		33.3%		na	na	na	0.002
12	4	1		25.0%		na	na	na	0.010

[1] No samples were collected in reaches 1, 8, 10, 11, 13.
[2] Appropriate numeric targets do not exist (NAS are not adopted, OEHHA are for frequent consumers of sport fish).
"na" indicates value not calculated by the ROS method due to considerations of statistical validity.

Dieldrin

Dieldrin has been detected only once in water across all years of available data, yet many detections occur in both sediment and fish tissue samples (Figure 5). In recent data from 1996-2004, only one detection of dieldrin in water is present, from Mugu Lagoon. Six out of seven recent detections in sediment also occurred in samples from Mugu Lagoon (Table 28). Only two detections of dieldrin occur in recent filet/muscle tissue samples (Table 29), one each in the Calleguas and Conejo Subwatersheds. A total of eight detections occurred in whole organism samples during 1996-2004 (Table 30).

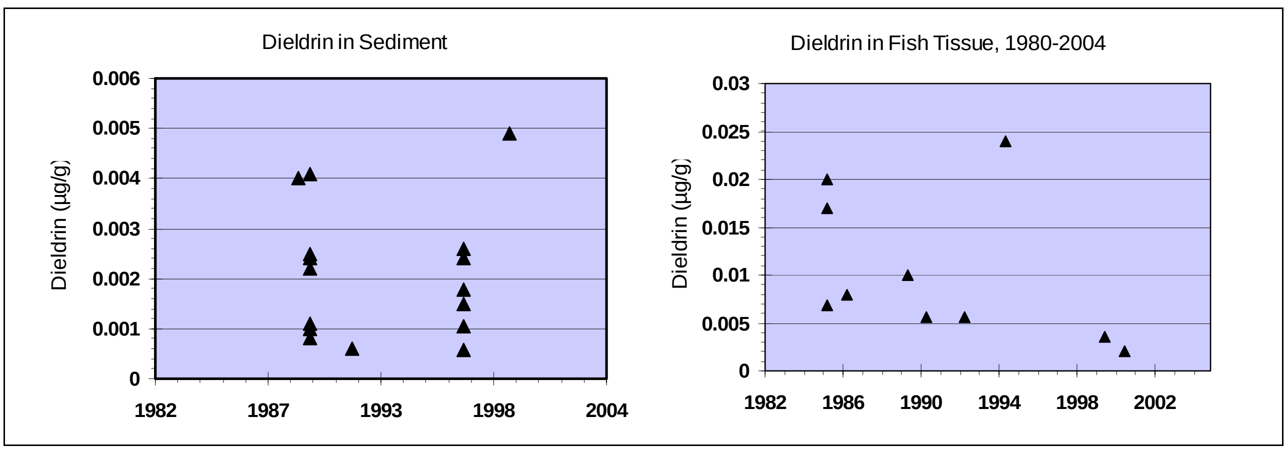


Figure 5. Detected values for Dieldrin in sediment and fish tissue samples for all years of available data. Dieldrin was not detected in any water samples.

Table 27. Dieldrin current conditions in water column by reach, 1996-2004.

Reach	n	# Detect	# Exceed	% Detect	% Exceed	Mean	SD	Median	Max Detect
						ug/L		ug/L	ug/L
1	64	1	1	1.6%	1.6%	na	na	na	0.002
2	21	0	0	0.0%	0.0%	--	--	--	--
3	68	0	0	0.0%	0.0%	--	--	--	--
4	37	0	0	0.0%	0.0%	--	--	--	--
5	14	0	0	0.0%	0.0%	--	--	--	--
6	18	0	0	0.0%	0.0%	--	--	--	--
7	97	0	0	0.0%	0.0%	--	--	--	--
8	11	0	0	0.0%	0.0%	--	--	--	--
9A	20	0	0	0.0%	0.0%	--	--	--	--
9B	32	0	0	0.0%	0.0%	--	--	--	--
10	42	0	0	0.0%	0.0%	--	--	--	--
11	18	0	0	0.0%	0.0%	--	--	--	--
12	39	0	0	0.0%	0.0%	--	--	--	--
13	24	0	0	0.0%	0.0%	--	--	--	--

“na” indicates value not calculated by the ROS method due to considerations of statistical validity.

Table 28. Dieldrin current conditions in sediment samples by reach, 1996-2004. [1]

Reach	n	# Detect	# Exceed	% Detect	% Exceed	Mean	SD	Median	Max Detect
						ug/g		ug/g	ug/g
1	37	6	0	16.2%	0.0%	na	na	na	0.003
2	7	0	0	0.0%	0.0%	--	--	--	--
3	6	0	0	0.0%	0.0%	--	--	--	--
4	7	1	0	14.3%	0.0%	na	na	na	0.005
5	3	0	0	0.0%	0.0%	--	--	--	--
6	6	0	0	0.0%	0.0%	--	--	--	--
7	9	0	0	0.0%	0.0%	--	--	--	--
8	3	0	0	0.0%	0.0%	--	--	--	--
9A	6	0	0	0.0%	0.0%	--	--	--	--
9B	3	0	0	0.0%	0.0%	--	--	--	--
10	6	0	0	0.0%	0.0%	--	--	--	--
12	3	0	0	0.0%	0.0%	--	--	--	--
13	3	0	0	0.0%	0.0%	--	--	--	--

[1] No samples have been collected from Reach 11.
“na” indicates value not calculated by the ROS method due to considerations of statistical validity.

Table 29. Dieldrin current conditions in fish tissue (filet/muscle) samples by reach, 1996-2004.

Reach [1]	n	# Detect	# Exceed	% Detect	% Exceed	Mean ug/g	SD	Median ug/g	Max ug/g
1	1	0	0	0.0%	0.0%	--	--	--	--
3	7	1	1	14.3%	14.3%	na	na	na	0.004
4	2	0	0	0.0%	0.0%	--	--	--	--
7	2	0	0	0.0%	0.0%	--	--	--	--
9A	5	0	0	0.0%	0.0%	--	--	--	--
9B	5	0	0	0.0%	0.0%	--	--	--	--
10	8	1	1	12.5%	12.5%	na	na	na	0.002
12	1	0	0	0.0%	0.0%	--	--	--	--
13	6	0	0	0.0%	0.0%	--	--	--	--

[1] No samples were collected in reaches 2, 5, 6, 8, 11.
"na" indicates value not calculated by the ROS method due to considerations of statistical validity.

Table 30. Dieldrin current conditions in whole aquatic organism samples by reach, 1996-2004. [1]

Reach	n	# Detect	# Exceed [2]	% Detect	% Exceed [2]	Mean ug/g	SD	Median ug/g	Max Detect ug/g
2	2	0		0.0%		--	--	--	--
3	7	3		42.9%		0.007	0.006	0.005	0.016
4	3	1		33.3%		na	na	na	0.063
5	3	0		0.0%		--	--	--	--
6	2	0		0.0%		--	--	--	--
7	8	1		12.5%		na	na	na	0.004
9A	2	2		100.0%		na	na	na	0.017
9B	3	0		0.0%		--	--	--	--
12	4	1		25.0%		na	na	na	0.010

[1] No samples were collected in reaches 1, 8, 10, 11, 13.
[2] Appropriate numeric targets do not exist (NAS are not adopted criteria, OEHHA are for frequent consumers of sport fish).
"na" indicates value not calculated by the ROS method due to considerations of statistical validity.

PCBs

PCBs have been detected consistently in water, sediment, and tissue samples across all years of data (Figure 6). PCB concentrations are typically quantified as either the sum of Aroclors or the sum of PCB congeners. Aroclors are various PCB mixtures identified by a four-digit numbering code in which the first two digits indicate the molecular type of the mixture and the last two digits indicate the approximate chlorine content by weight percent (ATSDR, 2000). Congeners are single, unique, specifically-defined forms of PCB which are named according to the total number of chlorine substituents and the position of each chlorine (website, www.epa.gov/toxteam/pcbid/defs.htm). Total Aroclor concentrations are used to evaluate water data and total PCB congener concentrations are used to evaluate sediment and fish data, in accordance with numeric targets for each medium. During 1996-2004, PCBs have been generally been detected in a low percentage of all samples (Table 31 - Table 34). However, 88% of 203 sediment samples from Mugu Lagoon contained detectable levels of PCBs.

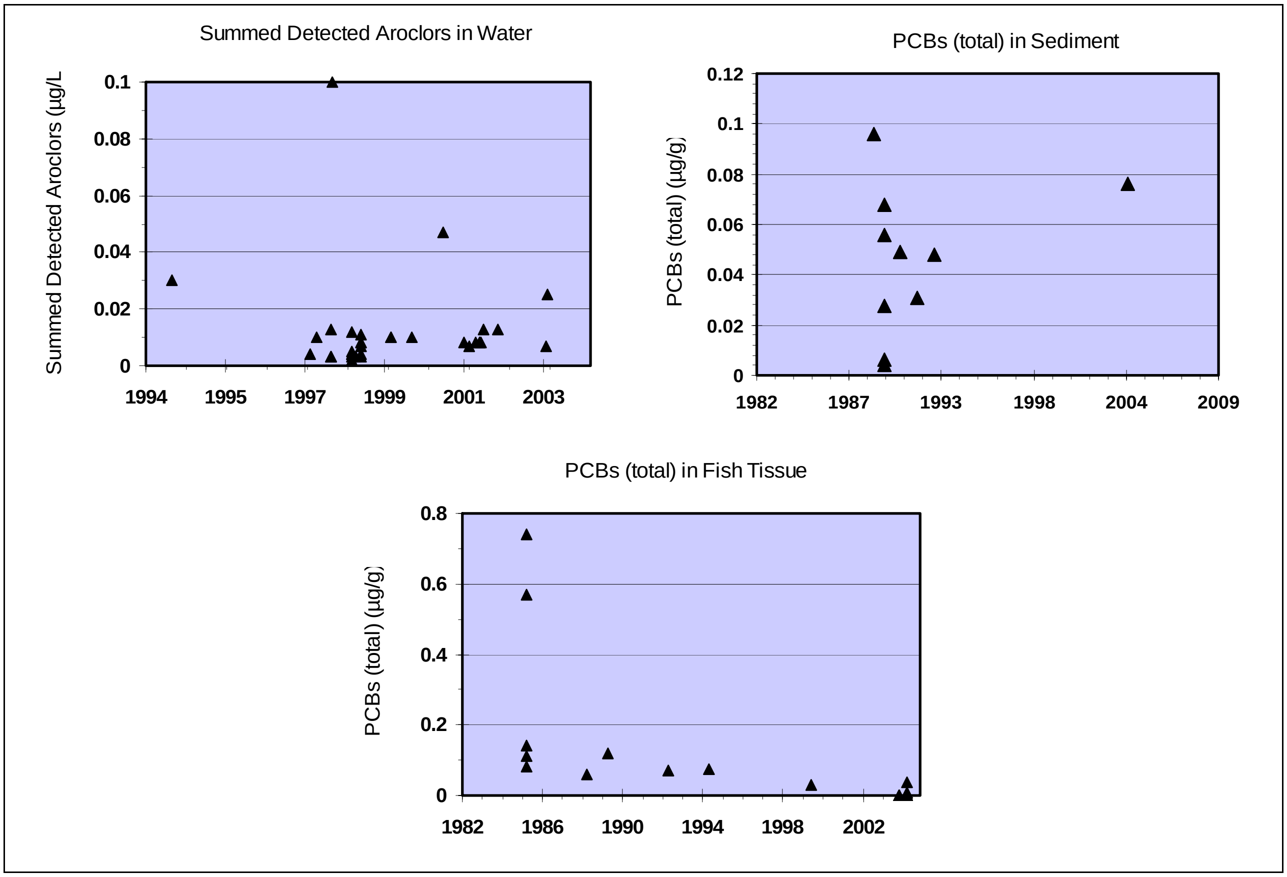


Figure 6 - Detected values for PCBs in water, sediment, and fish tissue samples for all years of available data.

Table 31. Summed detected Aroclors, current conditions in water by reach, 1996-2004.

Reach	n	# Detect	# Exceed	% Detect	% Exceed	Mean ug/L	SD	Median ug/L	Max Detect ug/L
1	287	1	1	0.3%	0.3%	na	na	na	0.064
2	27	0	0	0.0%	0.0%	--	--	--	--
3	62	0	0	0.0%	0.0%	--	--	--	--
4	41	1	1	2.4%	2.4%	na	na	na	2.980
5	13	1	1	7.7%	7.7%	na	na	na	0.036
6	41	0	0	0.0%	0.0%	--	--	--	--
7	348	1	1	0.3%	0.3%	na	na	na	1.671
8	10	0	0	0.0%	0.0%	--	--	--	--
9A	19	0	0	0.0%	0.0%	--	--	--	--
9B	31	0	0	0.0%	0.0%	--	--	--	--
10	162	1	1	0.6%	0.6%	na	na	na	0.025
11	18	0	0	0.0%	0.0%	--	--	--	--
12	30	0	0	0.0%	0.0%	--	--	--	--
13	17	0	0	0.0%	0.0%	--	--	--	--

“na” indicates value not calculated by the ROS method due to considerations of statistical validity.

Table 32. PCBs (total) current conditions in sediment samples by reach, 1996-2004. [1]

Reach	n	# Detect	# Exceed	% Detect	% Exceed	Mean ug/g	SD	Median ug/g	Max Detect ug/g
1	203	180	0	88.7%	0.0%	0.001	0.001	0.001	0.007
2	4	0	0	0.0%	0.0%	--	--	--	--
3	4	0	0	0.0%	0.0%	--	--	--	--
4	4	0	0	0.0%	0.0%	--	--	--	--
5	3	0	0	0.0%	0.0%	--	--	--	--
6	4	0	0	0.0%	0.0%	--	--	--	--
7	4	0	0	0.0%	0.0%	--	--	--	--
8	3	0	0	0.0%	0.0%	--	--	--	--
9A	4	0	0	0.0%	0.0%	--	--	--	--
9B	3	0	0	0.0%	0.0%	--	--	--	--
10	4	0	0	0.0%	0.0%	--	--	--	--
12	3	0	0	0.0%	0.0%	--	--	--	--
13	3	0	0	0.0%	0.0%	--	--	--	--

[1] No samples have been collected from Reach 11.
"na" indicates value not calculated by the ROS method due to considerations of statistical validity.

Table 33. PCBs(total) in fish tissue (filet/muscle) by reach, 1996-2004

Reach	n	# Detect	# Exceed	% Detect	% Exceed	Mean ug/g	SD	Median ug/g	Max ug/g
1	1	0	0	0.0%	0.0%	--	--	--	--
3	6	1	1	16.7%	16.7%	na	na	na	0.035
4	2	0	0	0.0%	0.0%	--	--	--	--
7	2	0	0	0.0%	0.0%	--	--	--	--
9A	5	2	2	40.0%	40.0%	na	na	na	0.023
9B	5	0	0	0.0%	0.0%	--	--	--	--
10	6	0	0	0.0%	0.0%	--	--	--	--
12	1	0	0	0.0%	0.0%	--	--	--	--
13	6	0	0	0.0%	0.0%	--	--	--	--

[1] No samples were collected in reaches 2, 5, 6, 8, 11.
"na" indicates value not calculated by the ROS method due to considerations of statistical validity.

Table 34. PCBs(total) in whole aquatic organism samples by reach, 1996-2004. [1]

Reach	n	# Detect	# Exceed [2]	% Detect	% Exceed [2]	Mean ug/g	SD	Median ug/g	Max Detect ug/g
1	1	0		0.0%		--	--	--	--
2	2	2		100.0%		na	na	na	0.047
3	4	3		75.0%		0.060	0.039	0.053	0.105
4	2	1		50.0%		na	na	na	0.019
5	3	0		0.0%		--	--	--	--
6	2	0		0.0%		--	--	--	--
7	5	0		0.0%		--	--	--	--
9A	1	0		0.0%		--	--	--	--
9B	3	0		0.0%		--	--	--	--
12	3	0		0.0%		--	--	--	--

[1] No samples were collected in reaches 8, 10, 11, 13.
[2] Appropriate numeric targets do not exist (NAS are not adopted criteria, OEHHA are for frequent consumers of sport fish).
"na" indicates value not calculated by the ROS method due to considerations of statistical validity.

Toxaphene

There have been no detections of toxaphene in any water samples collected within the CCW across all years of available data, but many detections have occurred in sediment and fish tissue samples (Figure 7). Toxaphene was not detected in any water or sediment samples during 1996-2004 (Table 35 and Table 36). Only one detection of toxaphene has occurred in recent filet/muscle tissue samples, in reach 3 (Table 37). A total of eight detections occur in recent data for whole organism tissue (Table 38), several of which are from upper reaches in the watershed.

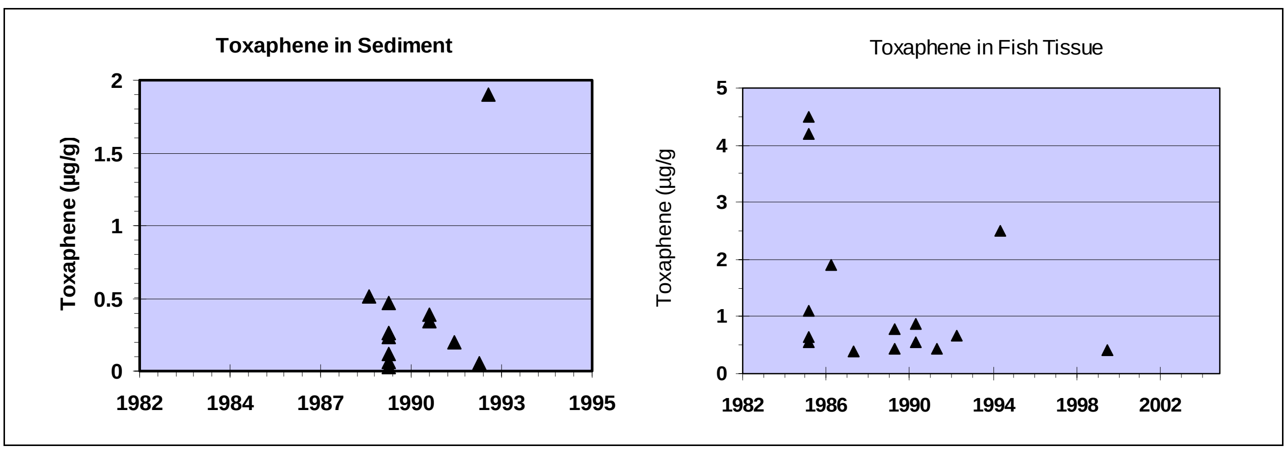


Figure 7. Detected values for Toxaphene in sediment and fish tissue samples for all years of available data. Toxaphene was not detected in any water samples.

Table 35 - Toxaphene current conditions in water column by reach, 1996-2004

Reach	n	# Detect	# Exceed	% Detect	% Exceed	Mean	SD	Median	Max Detect
						ug/L		ug/L	ug/L
1	3	0	0	0.0%	0.0%	--	--	--	--
2	16	0	0	0.0%	0.0%	--	--	--	--
3	67	0	0	0.0%	0.0%	--	--	--	--
4	33	0	0	0.0%	0.0%	--	--	--	--
5	13	0	0	0.0%	0.0%	--	--	--	--
6	13	0	0	0.0%	0.0%	--	--	--	--
7	94	0	0	0.0%	0.0%	--	--	--	--
8	11	0	0	0.0%	0.0%	--	--	--	--
9A	19	0	0	0.0%	0.0%	--	--	--	--
9B	30	0	0	0.0%	0.0%	--	--	--	--
10	41	0	0	0.0%	0.0%	--	--	--	--
11	18	0	0	0.0%	0.0%	--	--	--	--
12	39	0	0	0.0%	0.0%	--	--	--	--
13	23	0	0	0.00%	0.00%	--	--	--	--

“na” indicates value not calculated by the ROS method due to considerations of statistical validity.

Table 36. Toxaphene current conditions in sediment samples by reach, 1996-2004. [1]

Reach	n	# Detect	# Exceed [2]	% Detect	% Exceed [2]	Mean	SD	Median	Max Detect
						ug/g		ug/g	ug/g
2	6	0		0.0%		--	--	--	--
3	6	0		0.0%		--	--	--	--
4	6	0		0.0%		--	--	--	--
5	3	0		0.0%		--	--	--	--
6	6	0		0.0%		--	--	--	--
7	9	0		0.0%		--	--	--	--
8	3	0		0.0%		--	--	--	--
9A	6	0		0.0%		--	--	--	--
9B	3	0		0.0%		--	--	--	--
10	6	0		0.0%		--	--	--	--
12	3	0		0.0%		--	--	--	--
13	3	0		0.0%		--	--	--	--

[1] No samples have been collected from Reaches 1 or 11.
[2] No sediment guidelines exist for toxaphene.
“na” indicates value not calculated by the ROS method due to considerations of statistical validity.

Table 37. Toxaphene current conditions in fish tissue (filet/muscle) samples by reach, 1996-2004.

Reach [1]	n	# Detect	# Exceed	% Detect	% Exceed	Mean	SD	Median	Max
						ug/g		ug/g	ug/g
1	1	0	0	0.0%	0.0%	--	--	--	--
3	7	1	1	14.3%	14.3%	na	na	na	0.424
4	2	0	0	0.0%	0.0%	--	--	--	--
7	2	0	0	0.0%	0.0%	--	--	--	--
9A	5	0	0	0.0%	0.0%	--	--	--	--
9B	5	0	0	0.0%	0.0%	--	--	--	--
10	8	0	0	0.0%	0.0%	--	--	--	--
12	1	0	0	0.0%	0.0%	--	--	--	--
13	6	0	0	0.0%	0.0%	--	--	--	--

[1] No samples were collected in reaches 2, 5, 6, 8, 11.
"na" indicates value not calculated by the ROS method due to considerations of statistical validity.

Table 38. Toxaphene current conditions in whole aquatic organism samples by reach, 1996-2004. [1]

Reach	n	# Detect	# Exceed [2]	% Detect	% Exceed [2]	Mean	SD	Median	Max Detect
						ug/g		ug/g	ug/g
2	2	0		0.0%		--	--	--	--
3	7	3		42.9%		1.671	2.426	0.383	5.400
4	3	1		33.3%		na	na	na	12.000
5	3	0		0.0%		--	--	--	--
6	2	0		0.0%		--	--	--	--
7	8	1		12.5%		na	na	na	0.033
9A	2	2		100.0%		na	na	na	0.874
9B	3	0		0.0%		--	--	--	--
12	4	1		25.0%		na	na	na	0.027

[1] No samples were collected in reaches 1, 8, 10, 11, 13.
[2] Appropriate numeric targets do not exist (NAS are not adopted criteria, OEHHA are for frequent consumers of sport fish).
"na" indicates value not calculated by the ROS method due to considerations of statistical validity.

3.6 Conclusions

Receiving water data for water, sediment, and tissue include a large proportion of non-detected values for most of the OC pesticides and PCBs included on the 2002 303(d) list for the CCW. In general, a higher proportion of detected samples occurs in fish tissue and sediment samples than in water samples. DDE is designated as an appropriate representative constituent for data analysis and modeling throughout this TMDL, since it is the only constituent consistently detected in exceedance of targets in water, sediment, and fish tissue samples; and for additional reasons detailed in the Linkage Analysis section.

Several constituents in the watershed appear to no longer be exceeding target levels, and are referred to hereafter as "category-2 constituents". Only constituents currently exceeding targets, referred to as "category-1 constituents", are discussed in depth in the Source Analysis and Linkage Analysis Sections. However, waste load and load allocations are assigned in the TMDL and Allocations Section for all listed constituents.

A downward trend is observed over time for many category-1 constituent concentrations, which is especially apparent in fish tissue concentrations. When data from 1996-2004 are examined, even the category-1 constituents are currently being detected only rarely in many locations throughout the watershed. Since all category-1 constituents have been banned from legal use for more than ten years, such a pattern may reflect the natural attenuation of residual sources in the watershed. These degradation trends are further examined later in the Linkage Analysis Section. The highest concentrations for category-1 constituents tend to occur in the Revolon Slough, Mugu Lagoon, and Calleguas Creek Subwatersheds.

4 NUMERIC TARGETS

Numeric targets identify specific goals for the OC Pesticides and PCBs TMDL which equate to attainment of water quality standards and provide the basis for data analysis and final TMDL allocations. Multiple numeric targets are often considered when there is uncertainty that a single numeric target is sufficient to ensure protection of designated beneficial uses. The 2002 303(d) list for the Calleguas Creek Watershed contains listings for OC pesticides and PCBs (OCs) in the water column, fish tissue, and sediment. In order to address these listings, water criteria and fish tissue and sediment guidelines are selected as numeric targets (Table 39).

Inclusion of the water, fish tissue, and sediment targets mentioned above adequately protects benthic and aquatic organisms, wildlife, and human health from potentially harmful effects associated with OC pesticides and PCBs. A complete description of each set of numeric targets follows.

Table 39. Numeric targets for water, fish tissue, and sediment.

Constituent	Water Quality Targets [1] (ug/L)		Fish Tissue Targets [2] (ug/Kg)	Sediment Targets [3] (ug/dry Kg)	
	Freshwater	Marine		Freshwater, TEL	Marine, ERL
Aldrin	3.0 [4]	1.3 [4]	0.050	NA	NA
Chlordane	0.0043	0.0040	8.3	4.5	0.5
Dacthal	3500 [5]	NA [5]	NA [5]	NA	NA
DDD	NA	NA	45	3.5	2.0
DDE	NA	NA	32	1.4	2.2
DDT	0.001	0.001	32	NA	1.0
Dieldrin	0.056	0.0019	0.65	2.9	0.02
Endosulfan I	0.056	0.0087	65,000	NA	NA
Endosulfan II	0.056	0.0087	65,000	NA	NA
Endrin	0.036	0.0023	3200	2.7	NA
HCH (alpha-BHC)	NA	NA	1.7	NA	NA
HCH (beta-BHC)	NA	NA	6.0	NA	NA
HCH (delta-BHC)	NA	NA	NA	NA	NA
HCH (gamma-BHC)	0.95 [4]	0.16 [4]	8.2	0.94	NA
Heptachlor	0.0038	0.0036	2.4	NA	NA
Heptachlor Epoxide	0.0038	0.0036	1.2	0.6	NA
PCBs	0.014 [6]	0.030 [6]	5.3 [7]	34 [7]	23 [7]
Toxaphene	0.00020	0.00020	9.8	NA	NA

[1] CTR water quality criteria for protection of aquatic life. Chronic criteria (Criteria Continuous Concentration, or CCC) are applied, where they exist. In the absence of chronic standards, acute criteria (Criteria Maximum Concentration, or CMC) are applied.

[2] Threshold Tissue Residue Levels (TTRLs), derived from CTR human health criteria for consumption of organisms only.

[3] Sediment quality guidelines contained in NOAA Screening Quick Reference Tables (Buchman, 1999); TEL = Threshold Effects Level

[4] No chronic criteria exist; acute criteria are used.

[5] No chronic or acute criteria exist, drinking water standard of 3500 ug/L adopted by Florida and Arizona is applied for freshwater.

[6] PCBs in water are measured as sum of seven Aroclors.

[7] PCBs in fish tissue and sediment are measured as sum of all congeners.

"NA" indicates that no applicable target exists for the constituent.

4.1 Water Column Targets

California Toxics Rule (CTR) aquatic life criteria for water are selected as numeric targets for protection of freshwater and marine life from aquatic toxicity. Chronic criteria (Criteria Continuous Concentration, or CCC) are applied when available. In the absence of chronic criteria, acute criteria (Criteria Maximum Concentration, or CMC) are applied. When neither chronic nor acute criteria are defined by the CTR for a given constituent, no numeric target is presented (since no other appropriate water criteria exist for protection of aquatic life from toxicity). As described in 40 CFR 131, compliance with these CTR criteria is required for all CCW reaches.

<u>Alternative Considered</u>

CTR water quality criteria for protection of human health from consumption of contaminated fish or other aquatic organisms were considered. Generating water concentration values resulting in fish tissue levels safe for human consumption involves significant uncertainties. Because of these uncertainties and since many of the CTR human health criteria numbers are below current detection limits for OCs in water, fish tissue targets derived from the CTR human health criteria are used instead (see below).

4.2 Fish Tissue Targets

Fish tissue targets selected for this TMDL are derived from CTR human health criteria, which are adopted criteria for water designed to protect humans from consumption of contaminated fish or other aquatic organisms. The derived fish tissue targets are referred to in this document as Threshold Tissue Residue Levels (TTRLs). Use of fish tissue targets is appropriate to account for uncertainties in the relationship between pollutant loadings and beneficial use effects (EPA, Newport Bay TMDL, 2002) and most directly addresses potential human health impacts from consumption of contaminated fish or other aquatic organisms. Since the TTRL numeric targets are generally higher than current detection limits (unlike many of the water column criteria for protection of human health), compliance monitoring is feasible with current technology. Use of fish tissue targets also allows the TMDL analysis to more completely use site-specific data where limited water column data are available, consistent with the provisions of 40 CFR 130.7(c)(1)(i). Thus, use of TTRLs provides an effective method for accurately quantifying achievement of the water quality objectives/standards.

<u>Derivation of the Threshold Tissue Residue Levels (TTRLs)</u>

The TTRLs shown in the far right column of Table 40 are derived from CTR human health criteria for "consumption of organisms only." CTR human health criteria were developed by determining OC pesticide and PCB concentrations in edible fish tissue that would pose a health risk to humans consuming 6.5 grams per day of fish. These fish tissue concentrations were then converted to water column concentrations using a bioconcentration factor (BCF), which is the ratio of the chemical concentration in fish to the chemical concentration in water. TTRLs are calculated by eliminating the BCF from the human health criteria equation, thereby reverting back to the original fish tissue concentration upon which the CTR human health criteria are based.

Table 40. Derivation of Threshold Tissue Residue Levels (TTRLs)

Constituent	CTR Human Health Water Criteria (μg/L) [1]	BCF (L/Kg) [2]	TTRL, Edible Tissue Concentration (μg/Kg wet weight)
Aldrin [3]	0.00014	[4]	0.05
Chlordane [3]	0.00059	14100	8.3
4,4'-DDT	0.00059	53600	32
4,4'-DDE	0.00059	53600	32
4,4'-DDD	0.00084	53600	45
Dieldrin [3]	0.00014	4670	0.65
Endosulfan I [3]	240	270	65,000
Endosulfan II [3]	240	270	65,000
Endosulfan sulfate [3]	240	270	65,000
Endrin [3]	0.81	3970	3200
Heptachlor [3]	0.00021	11200	2.4
Heptachlor Epoxide [3]	0.00011	11200	1.2
alpha-BHC (HCH) [3]	0.013	130	1.7
beta-BHC (HCH [3]	0.046	130	6
gamma-BHC (HCH) [3]	0.063	130	8.2
PCBs (total)	0.00017	31200	5.3 [5]
Toxaphene [3]	0.00075	13100	9.8

[1] USEPA. 2000. Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California; Rule. May 18, 2000. The human health criteria listed are "For the Consumption of Organisms Only".

[2] Obtained from the USEPA 1980 Ambient Water Quality Criteria Documents for each constituent.

[3] Included in the list of "Chem A" pesticides.

[4] The numeric target for aldrin was derived from a combination of aldrin and dieldrin risk factors and BCFs as recommended in "Ambient Water Quality Criteria for Aldrin/Dieldrin" (USEPA 1980, 1990).

[5] Applies to the sum of all congener or isomer or homolog or Aroclor analyses.

4.3 Sediment Targets

Sediment quality guidelines endorsed by the National Oceanic and Atmospheric Administration (NOAA) and contained in NOAAs Screening Quick Reference Tables (SQuiRTs) (Buchman, 1999) are selected as numeric targets for sediment. NOAA included the following caveat in the introductory comments to the SQuiRTs: "These tables are intended for preliminary screening purposes only; they do not represent NOAA policy and do not constitute criteria or clean-up levels. NOAA does not endorse their use for any other purposes." Multiple sediment screening values are included in the SQuiRTs "to help portray the entire spectrum of concentrations which have been associated with various probabilities of adverse biological effects." The specific numeric values selected from the SQuiRTs tables as numeric targets are the Threshold Effects Level (TEL) values for freshwater sediment and the Effects Range Low (ERL) values for marine sediment. TELs are calculated using the geometric mean of the 15th percentile concentration of the data set and the median of the no-effect data set; they represent the concentration below which adverse effects are expected to occur only rarely. ERLs are calculated as the lower 10th percentile concentration of the available sediment toxicity data which has been screened for only those samples which were identified as toxic by original investigators; they represent the value at which toxicity may begin to be observed in sensitive species. Thus, use of TELs and ERLs represents a conservative (i.e., more protective choice). Since these sediment guidelines are not adopted sediment quality criteria, they are used as numeric targets only for reaches with sediment listings (the exact methodology for use of the sediment guidelines is explained in the TMDL Allocations section).

The CCW Toxicity TMDL did not identify any OC pesticides or PCBs as causing toxicity in water or sediment. Any unidentified toxicity which may result from OCs is addressed in this TMDL by selection of numeric targets which are protective of toxicity in water and sediment.

4.4 Protection of Wildlife Habitat and Endangered Species

While most of the original basis for listing of OCs was for protection of human health (i.e., tissue listings), this TMDL must also protect the beneficial uses of wildlife habitat (WILD) and preservation of rare and endangered species (RARE) to be federally approvable. The working assumption is that numeric targets, load and waste load allocations, and the resulting implementation actions that are derived to protect human health are also protective of wildlife. As a backstop, it is also appropriate to define additional numeric targets specific to species of concern, where sufficient risk assessment information is available.

Table 41 Summarizes common names, scientific names, diet, effects of concern, and proposed targets for Federally Endangered Species that live in the CCW in and around Mugu Lagoon (see Appendix I for more complete list of CCW species). In general, for avian species, the most appropriate indicator is the concentration of organochlorines in eggs, because the effect of concern is impairment of reproductive success. For harbor seals, the effect of concern is suppression of the immune system, and the appropriate indicator is the OC concentration of blubber.

A literature review was conducted to gather no-effect levels and critical levels for OC contaminants in wildlife. The available data support definition of targets that are no-effect levels for DDE and total PCBs in bird eggs, and PCBs and DDT in harbor seal blubber. Critical levels have been established for Dieldrin in bird eggs and Toxaphene in bird tissue. It is important to note that these critical levels correspond to known effect levels. Numeric targets would necessarily be lower than the critical levels.

Other species, such as raccoons, coyote, weasels, and raptors, that forage in the Calleguas Creek watershed should also be protected by attainment of human health targets; since aquatic organisms represent only a portion of their diet. If more protective targets are established for these organisms through consultation with wildlife resource agencies, those targets will be established in the TMDL through the reevaluation process.

The linkage from risk assessment targets to OC concentrations in food items, sediments and water is not well understood in this watershed. Reducing OC loads to attain human health based targets will result in progress toward attainment of wildlife targets. In the implementation phase of the TMDL, additional wildlife targets will be defined and established through reevaluation if needed as risk assessment information becomes available.

Table 41. Proposed targets for protection of Federally listed wildlife species.

Federally Endangered Species					
Common Name	California Brown pelican	western snowy plover	California least tern	Light-footed clapper rail	harbor seals
Scientific name	*Pelecanus occidentalis*	*Charadrius alexandrinus nivosus*	*Sterna antillarum browni*	*Rallus longirostris levipes*	*Phoca vitulina*
Diet	Piscivore	Insectivore	Piscivore	Benthic omnivore	Piscivore
Effect of concern	Reproductive Impairment				Immune system impairment
p,p'-DDE target	1 µg/g in eggs [1]				
DDT (total) Target					0.3 µg/g or mg/kg lipid (blubber) [2]
Dieldrin target	< 1 µg/g in eggs [3]				
PCBs (total) target	0.5 µg/g in eggs [4]				5 mg/kg lipid (blubber) [2]
Toxaphene target	< 40 µg/g in bird tissue [3]				

[1] Hothem and Powell (2000); no-effect level for DDE in Forster's Tern eggs from Texas.
[2] Barron et al (20003); no-effect level for total DDTs in harbor seals from Germany, Denmark, and the United Kingdom.
[3] From Braune et al (1999); critical levels in peregrine falcon eggs and critical levels in bird tissue.
[4] Muir et al (1999); no-effect level for deformities for total PCBs in White Leghorn Chicken eggs.

Water quality criteria designed to protect wildlife from adverse impacts resulting from consumption of food and/or water from the Great Lakes ecosystem are shown in Table 42 for DDT and PCBs (criteria are not defined for any other OCs). These criteria take into consideration the reproductive success and survival of a species. Relevant CTR aquatic life criteria are also shown in Table 42 for comparison. Since CTR criteria are lower than the Great Lakes wildlife criteria, numeric targets selected for this TMDL should protect wildlife. Monitoring, special studies, and adaptive management described in the Implementation Plan will further assure necessary protections for wildlife. Data of DDE concentrations in Least Tern and Clapper Rail chicks and eggs from the Point Mugu Naval Base which are included in Appendix II may prove useful for future efforts to gauge effectiveness of wildlife protection.

Table 42. Comparison of Tier I Great Lakes Wildlife Criteria and CTR Aquatic Life Criteria.

Constituent	Great Lakes Wildlife Criteria		CTR Aquatic Life Criteria (ug/L)	
	(mg/L)	(ug/L)	Freshwater	Marine
DDT & Metabolites	0.000011	0.011	NA	NA
DDD	NA	NA	NA	NA
DDE	NA	NA	NA	NA
DDT	NA	NA	0.001	0.001
PCBs (total)	0.000074	0.074	0.014	0.03

4.5 Alternatives Considered

Whole organism tissue targets were considered, but filet/muscle tissue targets are selected since no appropriate standards exist for whole organism concentrations (NAS standards are not adopted criteria, OEHHA targets are for frequent consumers of sport fish) and because filet/muscle tissue targets are most relevant for protection of human health from consumption.

The State Water Resources Control Board is currently developing sediment quality guidelines, which will be incorporated into the CCW OCs TMDL, if appropriate.

5 SOURCE ANALYSIS

Initial steps in the development of a TMDL include assessing sources and then linking the loads from those sources to concentrations in environmental compartments. A generalized conceptual model of the linkage between sources, pathways, and reservoirs of OC pesticides and PCBs is presented in Figure 8. Most sources to surface waters in the CCW are related to historical uses of OCs. Agricultural runoff is likely responsible for the majority of OC pesticides introduced into the watershed over time. Past use of PCBs as coolants and lubricants in transformers, capacitors, and other electrical equipment is suspected as the primary source of PCB residues. Available evidence suggests that POTWs, groundwater, atmospheric deposition, and imported water are not responsible for major contributions to current loading of OCs in the watershed. This section focuses on the category-1 constituents defined in the Current Conditions section.

As mentioned previously, DDE is chosen as a representative constituent for analyses used to develop this TMDL. This is appropriate since DDE is the only constituent to consistently exceed applicable targets in water, sediment, and tissue samples (see Current Conditions); and also because OC Pesticides and PCBs possess similar physical and chemical properties that influence their fate and transport in the environment (see Linkage Analysis).

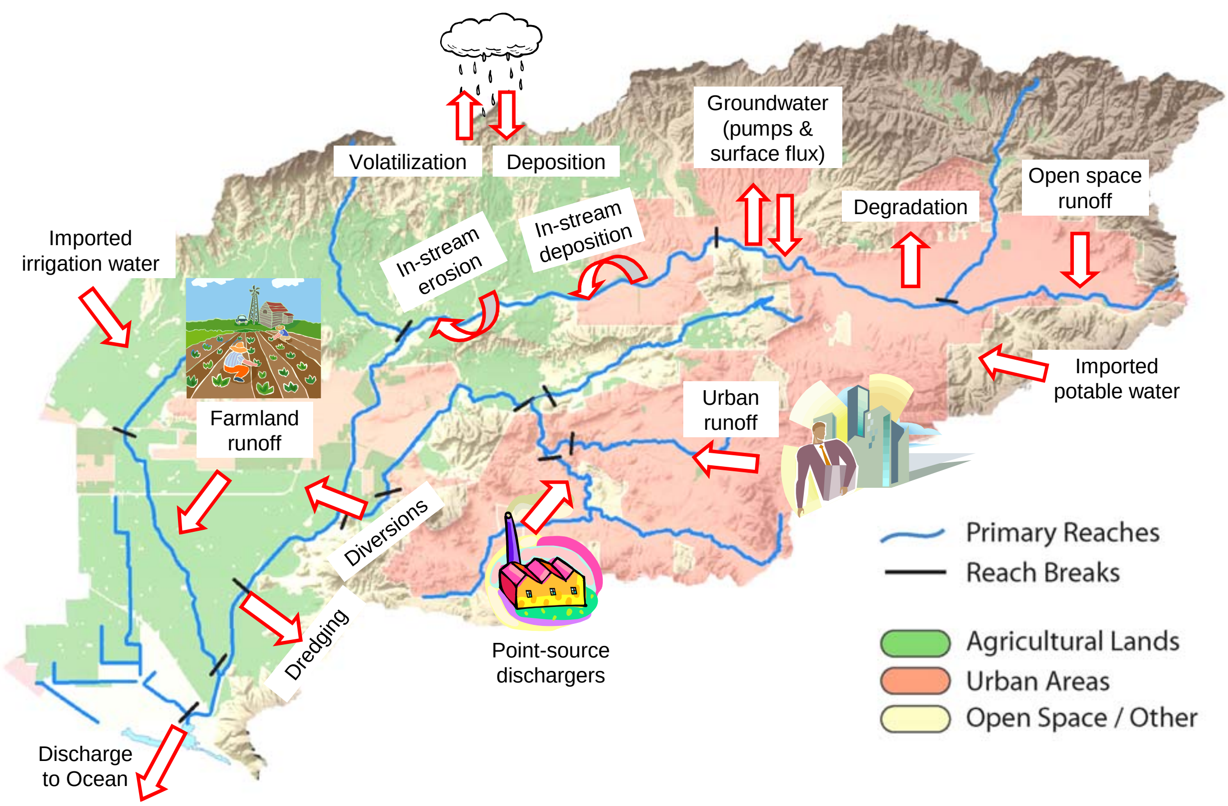


Figure 8. Generalized conceptual model of sources and pathways of OCs in the Calleguas Creek Watershed.

5.1 Data Resources and Analysis

Land-Use Runoff and Discharge Data

Runoff data characterized by land use (land-use runoff data) and data from point source discharges (discharge data) are available from several sources, shown in Table 43. This information is used to gain understanding about the relative contributions of OCs from agricultural, urban, groundwater discharge, and POTW sources. Debris basins, atmospheric deposition, and imported water are discussed separately since land-use runoff data cannot directly address those two issues.

Table 43. Summary of Land-Use Runoff and Discharge Data Sources

Data Source	Begin Date	End Date	Urban Land Use Sites	Agricultural Land Use Sites	Groundwater Discharge	POTW
205(j) Non Point Source Study	11/98	5/99	X	X		
Ventura County WPD	2/92	2/04	X	X		
Calleguas Creek Characterization Study(LWA, 1999)	8/98	5/99	X	X	X	X
Camrosa WRF	12/95	12/02				X
Camarillo WRP	8/98	12/01				X
Hill Canyon WWTP	2/94	11/02				X
Moorpark WWTP	9/97	2/02				X
Olsen Road WRP	8/93	5/99				X
Simi Valley WQCP	12/93	10/02				X
TMDL Work Plan Monitoring (LWA, 2004a)	8/03	8/04	X			

All available land-use runoff and discharge data for the major point and non-point source categories are summarized in Table 44, which includes: agricultural runoff, urban runoff (commercial/industrial and residential), runoff from native land (undeveloped open space), pumped groundwater, and POTW effluent. Every OC summarized was detected most often in agricultural runoff.

Pumped groundwater discharged from the Simi Valley dewatering wells was sampled on four occasions, of which one sample contained detectable concentrations of DDE, lindane, and PCBs. A NPDES permit allows the discharge of pumped groundwater from these dewatering wells to the storm drain system, for the purpose of lowering the local water table. Since these four samples may not accurately represent groundwater discharges from the Simi Valley dewatering wells, a special study is included in the Implementation Plan to determine potential contributions from these groundwater discharges. Note that these groundwater discharges are unlike natural exfiltration, and are not likely representative of any exfiltration which may occur in other parts of the watershed.

Runoff from native land has not been monitored explicitly; however, one monitoring site drains a lightly developed portion of Tapo Canyon considered representative of native land. Samples from this site have been analyzed for concentrations of OCs on five occasions, all of which were non-detected. Thus, there is no indication that native land in the watershed is a contributing source of OCs to water bodies.

Table 44. Summary of land-use runoff and discharge data indicating the percentages of samples that were measured at concentrations exceeding the analytical detection limits for each constituent.

Constituent	n Total	n Det.	Agricultural Runoff (% detect)	Urban Runoff [1] (% detect)	Native Land [2] (% detect)	Effluent Discharge (% detect)	Pumped Groundwater (% detect)
4,4'-DDD	299	83	71	4	0	4	0
4,4'-DDE	299	108	82	16	0	7	25 [4]
4,4'-DDT	298	89	81	3	0	0	0
Aldrin	300	31	29	0	0	0	0
Chlordane, Summed Detected [3]	148	55	55	0	0	4	0
Dacthal	6	0	0	NA	NA	NA	NA
Dieldrin	301	20	19	0	0	0	0
Endosulfan I	287	41	38	0	NA	0	0
Endosulfan II	287	53	50	0	NA	0	0
Endosulfan sulfate	299	60	46	0	0	11	0
Endrin	299	30	27	0	0	1	0
HCH (BHC-alpha)	302	28	26	0	0	0	0
HCH (BHC-beta)	302	53	49	0	0	1	0
HCH (BHC-delta)	299	37	35	0	0	0	0
HCH (BHC-gamma, Lindane)	301	68	44	4	0	17	25 [4]
Heptachlor	301	21	20	0	0	0	0
Heptachlor epoxide	299	38	36	0	0	0	0
PCBs, Summed Detected Aroclors	227	3	3	0	0	1	25 [4]
Toxaphene	230	0	0	0	0	0	0

[1] Represented by industrial, residential, and commercial runoff sites.

[2] Represented by Site 8.

[3] Measured as summed detections of alpha-chlordane + gamma-chlordane.

[4] 25% = one detection out of four samples taken from pumped groundwater discharged by the Simi Valley dewatering wells.

N/A = constituent has not been analyzed in samples from this source

Debris Basin Samples

In February of 2004, sediment collected from seven debris basins within the CCW was analyzed for OC pesticides and PCBs (Table 45). Sediments were sieved into <63um and 63um – 2mm fractions. Five of the seven sampled debris basin sediments contained detectable DDT's, three contained detectable levels of chlordane, and one contained detectable PCB's. Dieldrin, lindane, and toxaphene were not detected in any samples. None of the category-2 constituents were detected in any samples. The 11D_DB3-05 debris basin had the greatest number of detections and highest concentrations and was also the only debris basin in which flow was present. All the other basins were dry, with very coarse sediments.

Table 45. Concentration of OCs Detected in Sediment Collected from Debris Basins on February 21st, 2004 (ng/dry g).

Sample Site [1] [2]	Numeric Target	5D_DB3-13	5D_DB3-13	6D_DB3-15	6D_DB3-15	7D_DB3-09	7D_DB3-09	11D_DB3-05	11D_DB3-05
Fraction		63µm-2mm	<63µm	63µm-2mm	<63µm	63µm-2mm	<63µm	63µm-2mm	<63µm
4,4'-DDD	3.54	2.3	1.3	1.2	ND	ND	ND	**10.5**	2.7
4,4'-DDE	1.42	16.8	11.7	10	4.2	1.7	1.3	**37.9**	5.1
4,4'-DDT	NA	6.3	4.6	9.7	ND	ND	ND	**37.8**	4
DDT, total detected	6.98	27.3	17.6	25	4.2	1.7	1.3	**93.7**	12.7
Chlordane-alpha	NA	**3**	1.8	ND	ND	ND	1.1	ND	ND
Chlordane-gamma	NA	**2.2**	1.3	ND	ND	ND	ND	ND	ND
Chlordane, total detected	4.5	**5.2**	3.1	--	--	--	1.1	--	--
Dieldrin	2.85	ND	ND	ND	ND	ND	ND	ND	ND
Total Detected PCBs	34.1	0	0	0	0	0	0	**30.3**	0
Toxaphene	NA	ND	ND	ND	ND	ND	ND	ND	ND

[1] The prefix of each debris basin sample name represents the reach to which the debris basin discharges (i.e., 5D_DB3-13 = reach 5).

[2] Sample sites 6D_DB3-01 and 7D_DB3-17 are not shown, since no OCs were detected in samples from either debris basin.

Bolded values indicate sample sites with the highest concentration for each constituent.

Note that fourteen of the samples shown above contained concentrations that exceed the TEL numeric target for sediment. These contaminated sediments could find their way into receiving waters of the CCW via several possible scenarios, including: mobilization of the sediments due to wind or water currents, use of sediment from the debris basins for fill dirt or landscaping, or accidental spills during transport for proper disposal. Thus, a need exists to evaluate current methods for disposing of these sediments.

Atmospheric Deposition

Residues from past use of OC pesticides and PCBs are volatilized, transported, and redeposited from both local and distant sources. Present day applications of OC pesticides are responsible for some aerial deposition by means of drift from applications as well as volatilization, transport, and redepostion. Continued use in other countries of OC pesticides banned in the United States represents another active source to the atmosphere. OC pesticides and PCBs are deposited from the atmosphere during precipitation events (wet deposition) as well as from pesticide drift and settling from the atmosphere due to gravity (dry deposition).

No known studies estimate the rates of atmospheric deposition for OCs in the CCW. However, a study by Park et al. in 2001 estimated atmospheric deposition rates for PCBs and various OC pesticides to Galveston Bay, Texas (Table 46). This study yielded results that were comparable to other similar studies conducted in North America and elsewhere, including a study in the Great Lakes region (Chan et al, 1994).

Table 46. Atmospheric Deposition Rates for PCBs and OC Pesticides to Galveston Bay, Texas (Park et al., 2001)

Constituent	Wet Deposition		Dry Deposition	Total Deposition
	Dissolved	Particulate	Particulate	Dry + Wet
	µg/m²/yr	µg/m²/yr	µg/m²/yr	µg/m²/yr
tPCBs [1]	0.99	0.54	4.86	6.40
tHCHs [2]	1.54	0.09	0.10	1.73
tChlordanes [3]	0.12	0.40	0.23	0.75
tCyclodienes [4]	0.06	0.19	0.54	0.79
tDDTs [5]	0.29	1.22	0.43	1.94

[1] tPCBs (total PCBs, including di-, tri-, tetra-, penta-, hexa-, hepta-, octa-, nona-, deca-chlorinated congeners).
[2] tHCHs (total Hexachlorocyclohexanes, including alpha, beta, gamma, delta isomers).
[3] tChlordanes (chlordane-related compounds, including heptachlor, heptachlor epoxide, oxychlordane, alpha-chlordane, gamma-chlordane, cis-nonachlor, trans-nonachlor)
[4] tCyclodienes (total Cyclodiene pesticides, including aldrin, dieldrin, endrin).
[5] tDDTs (total DDT, including 2,4'-DDD, 4,4'-DDD, 2,4'-DDE, 4,4'-DDE, 2,4'-DDT, 4,4'-DDT).

Wet and dry deposition rates for DDT, DDE, DDE, alpha-chlordane, and gamma-chlordane were estimated for the CCW using concentrations from the Galveston and Great Lakes studies in conjunction with local data for rainfall, theoretical deposition velocity, and watershed area. Although various differences in climatic and land use conditions generate some uncertainty about the appropriateness of comparing these three areas, no other studies are know to have been completed in more comparable geographic regions. The approach is presented below.

Wet Deposition Loading (lbs/yr) calculated as:

$$C * V_{rain} * A$$

Where:

C = pesticide concentration in rain (dissolved plus particulate)[1]

V_{rain} = average annual rainfall (15 in/yr)[2]

A = Watershed Area (344 square miles)

[1] Data from Galveston and Great Lakes used to approximate concentrations in CCW

[2] Source: Ventura Countywide Stormwater Monitoring Program, 2002/03 Monitoring Report (July 2003).

Dry Deposition Loading (lbs/yr) calculated as:

$$C * V_{dep} * A$$

Where:

C = atmospheric particulate concentration [1]

V_{dep} = theoretical deposition velocity[2]

A = Watershed Area (344 square miles)

[1] Data from Galveston and Great Lakes used to approximate concentrations in CCW

[2] Vd = 0.175 cm/sec (Joshua Tree NP, CASTNet), the same value used to estimate atmospheric deposition of salts to the CCW in the Dec. 30, 2003 LWA Technical Memo.

In order to better estimate actual dry deposition in the CCW, atmospheric particulate concentrations presented in the Galveston and Great Lakes studies were normalized according to PM10 data from Galveston, Great Lakes, and Ventura County (PM10 data measures the amount of airborne particulate matter 2.5-10 micrometers in size). The method is shown below in Equation 1.

Equation 1. $\text{Dry Deposition in CCW} = [\,C_{\text{galveston, great lakes}} * PM10_{\text{ventura}} / PM10_{\text{galveston, great lakes}}\,] * V_{dep} * A_{ccw}$

The results are shown in Table 47. Notice that these estimates are reported in total pounds of deposition per year across all land and water areas of the CCW. This method over predicts the actual contribution of OCs to water resulting from aerial deposition since only a portion of all OCs deposited on land actually reach water (due to degradation which occurs before the OCs are released from terrestrial soils by erosion). The extent of this over prediction is dependant on sorption, in addition to degradation.

Table 47. Atmospheric deposition rates for DDT and chlordane compounds upon total land and water surface area in the CCW using estimates from two studies, normalized according to Ventura County PM10 data.

Constituent	Lb/yr Based on Galveston Study			Lb/yr Based on Great Lakes Study		
	Wet	Dry [1]	*Total*	Wet	Dry [1]	*Total*
4,4'-DDD	0.03	0.12	*0.15*	0.016	0.077	*0.093*
4,4'-DDE	0.013	0.076	*0.089*	0.04	0.28	*0.32*
4,4'-DDT	0.14	0.21	*0.35*	0.1	0.17	*0.27*
alpha-Chlordane	0.024	0.03	*0.054*	0.048	0.14	*0.19*
gamma-Chlordane	0.017	0.061	*0.078*	0.11	0.11	*0.22*

[1] CCW dry deposition load estimates "normalized" to Ventura Countywide 2004 Average PM10 data, as explained above. Annual arithmetic mean PM10 values used in calculations: Galveston, 22 ug/m3; Great Lakes, 28.1 ug/m3; Ventura County, 31 ug/m3 (source of PM10 data: http://www.epa.gov/air/data/).

It is somewhat misleading to consider aerial deposition upon land surfaces as a discrete source of OCs, since inputs from land-use runoff are considered for all land areas and aerial deposition is implicitly captured in those measurements. An alternate method commonly used for estimating the contribution of pollutant from atmospheric deposition is to consider only direct deposition to water. Since the surface area of all water bodies in the CCW is less than 2% of the total area, only a minute amount of the pounds per year shown above are considered as loading to water using this method.

Imported water

Imported water used in the CCW is eventually received by POTWs or used for landscaping, washing cars, and other purposes that result in runoff into storm drains or infiltration of groundwater. Drinking water and irrigation water are imported to the watershed from the State Water Project and the Freeman Diversion, respectively. The State Water Project pumps water from the San Francisco Bay Delta which originates in northern and central California, including the Central Valley. The Central Valley is cultivated extensively and OC pesticides have been used there. The concentration of OCs in the imported water is unknown, but may be estimated for some constituents using monitoring data from stations at the mouths of the Sacramento and San Joaquin Rivers, the major tributaries to the Delta. Samples collected in 1994 analyzed for toxaphene were all non-detected, 80% of endrin samples were non-detected, and total concentrations for the remaining OCs ranged from 0.000022 ug/L for heptachlor to 0.00047 ug/L for DDT (San Francisco Estuary, www.sfei.org).

Since imported water eventually finds its way into POTW effluent, urban runoff, or groundwater; this potential source is implicitly considered when land-use runoff and discharge data are examined for urban runoff, POTWs, and groundwater. Also, it is important to note that imported water undergoes treatment prior to use in homes and on lawns which removes many hydrophobic particle-associated contaminants.

Once treated, the imported water likely contains lower concentrations of contaminants than the highest values measured in the delta because many of the particles are removed during transport in the canal system and because many contaminants are transformed by chlorine or ozone during disinfection.

Pesticide Use Data

Pesticide Use Report (PUR) data from the California Department of Pesticide Regulation (DPR) provide detailed information about pesticide application rates according to crop types for each county in the state. Prior to 1990, limited use reporting requirements existed. In 1990, California began requiring full use reporting for all agricultural pesticide use and commercial pest control applications. As outlined by DPR (DPR, 2002), the following pesticide uses are considered "reported uses" requiring applicators to submit detailed use reports to the County Agricultural Commissioner:

- For the production of any agricultural commodity, except livestock.
- For the treatment of post harvest agricultural commodities.
- For landscape maintenance in parks, golf courses, and cemeteries.
- For roadside and railroad rights-of-way.
- For poultry and fish production.
- Any application of a restricted material.
- Any application of a pesticide with the potential to pollute ground water.
- Any application by a licensed pest control operator.

Exclusions from reporting requirements include industrial, institutional, and residential landscape and garden pesticide uses. These uses are collectively referred to as "unreported uses". PUR data contain extensive information about the quantities and types of pesticides used in each county, as well as information about the acreage and types of crops treated. These data are collected by county agriculture commissioners in most counties and then passed along to DPR for QA/QC and database management. Analysis of PUR data in this document examines the years 1998-2003 as a relevant timeframe for potential active sources and residual sources of OC pesticides and PCBs.

Pesticide Sales Data

Pesticide registrants, pest control dealers and pesticide brokers must report to DPR the total dollar value and total pounds or gallons of each product they sell for use in California. The active ingredient in any pesticide product is the chemical or chemicals that kill or otherwise controls target pests. Sales reporting includes only the active ingredient(s) in pesticide products and does not include their inert ingredients. When there are three or fewer registrants reporting sales of a pesticide product containing the same active ingredient, such reports are considered trade secrets and are not disclosed by DPR. Cumulative sales totals are provided for all active ingredients, disclosed and undisclosed. Included in this amount are insecticides, miticides, fumigants, nematicides, rodenticides, desiccants, defoliants, growth regulators, herbicides, bactericides, antimicrobials, algicides, and fungicides. The total pounds of active ingredients sold fluctuate from year to year, attributable to a variety of factors such as: changing weather conditions, changes in planted acreage, crop planting, pest infestations, marketing techniques, company takeovers, and sales promotions. Registration of new products may initially result in an increase of pounds of product sold. Cancellation or suspension of products may subsequently affect the sale of other products. Also, duplications in reporting may be responsible for a margin of fluctuation (if a registered product with complete use directions is sold to another registrant, who then re-labels it, both would report the sale). Pesticide sales information from DPR is only available for the years after 1991.

5.2 Land Use

There are about 344 square miles in the Calleguas Creek Watershed, approximately 51% of which is utilized by some form of human activity (DWR, 2000). About one fourth of the land is urban or urban landscape and about one fourth is used for agriculture (Figure 9). The non-utilized land is comprised almost completely of native vegetation (96%), but also includes some water areas and barren or idle lands (the terms 'native land' and 'non-utilized land' are used interchangeably in this document to describe undeveloped open space). The category 'urban landscape' includes cemeteries, golf courses, and other urban lawn areas. Agricultural lands primarily yield truck crops and citrus; with lemons, avocados, strawberries, green beans, celery, and onions being the most common crops. The term "truck crop" describes vegetables grown in furrows that go straight to market when harvested (e.g. green beans, peppers, celery, tomatoes), and the term "field crop" indicates crops such as cotton, flax, hops, and sugar beets that do not necessarily go straight to market. A detailed list of all land use types existing in the watershed by subcategory and acreage is found in Appendix III. In recent decades the CCW has experienced dramatic growth in urban residential and commercial development, but historically a much larger percentage of land was used for farming (Figure 10 - Figure 12).

Note: the figures presented in this section are best viewed in color.

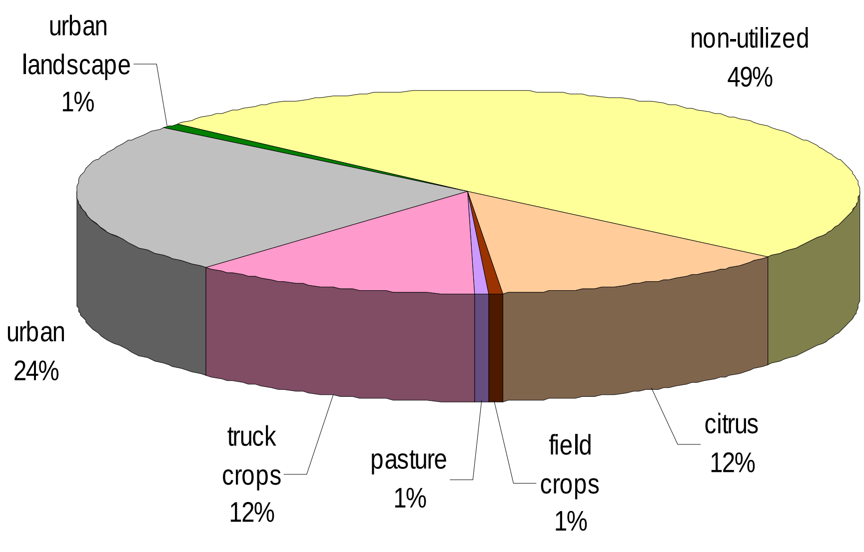


Figure 9. Land Use in CCW (DWR, 2000)

Urban Land Use

About two thirds of the urban land within the watershed is residential, situated mostly in the central to upper portions of the watershed (Table 48, Figure 13). Less than 3% of all land in the watershed is dedicated to industrial and commercial purposes combined. Since 1932, the cities of Thousand Oaks, Simi Valley, and Camarillo have grown from being isolated small towns to their current extent (Figure 10 - Figure 12).

Table 48. Breakdown of Urban Land Use in CCW (SCAG, 2000)

Urban Land Uses	Acres *	% of Urban Land Use	% of Watershed Area [1]
Residential	28,898	68%	13%
Transportation & Utilities	5,003	12%	2%
Public Facilities & Institutions	4,063	10%	2%
Industrial	2,403	6%	1%
Commercial	2,399	6%	1%

[1] The SCAG land use classification system is not identical to that of California Department of Water Resources (DWR), which is used for all other land use analysis in this document. Thus, total acreage for "urban" in this table is not the same as total urban acres shown in Appendix III. The SCAG data is presented here because it breaks urban land into subcategories (DWR does not).

Agricultural Land Use

Current agricultural land uses vary spatially according to such factors as coastal proximity, altitude, slope, and soil type. Figure 14 shows specific crop types grown in the area, according to subcategory. Citrus crops such as lemons, oranges, and avocados commonly occur in flat or gently sloping foothill areas that are slightly inland, with avocado orchards tending to exist somewhat upslope of lemon groves and oranges usually growing a bit further inland than lemons. Floodplain areas are currently predominated by a wide range of truck crops such as strawberries, peppers, green beans, celery, onions, garlic, lettuce, melons, and squash; as well as turf farms and various types of nurseries. The uppermost portions of the watershed are not cultivated extensively.

Agricultural activities in the watershed are somewhat challenging to characterize at a fine scale due to several factors. Although some changes in crop composition occur over many years (such as conversion of field crops to truck crops and the disappearance of walnut groves, both during the period 1932-1969), there are also constant changes in crop selection from year to year as farmers adjust to fluctuating market prices or strive to preserve soil by rotating their crops/fields. Additionally, many fields are used to grow successive crops during a single calendar year. This multi-cropping technique is most common in the lower parts of the watershed, adjacent to Revolon Slough and Lower Calleguas Creek (Figure 15). Fields that are multi-cropped do not always follow a time interval that begins and ends within the course of a calendar year. For example, it is common to grow three crops of strawberries in a two year period with some other crop such as barley following the first two strawberry harvests. Growers of turf often plant celery, cabbage or cauliflower in rotation with turf crops to reduce the negative effects upon soil that occur when turf is harvested (S. McIntyre, pers. comm., 2004). The twenty most common multi-crop combinations in the watershed are shown below, in Table 49. Agricultural activity within the Oxnard Plain is spatially heterogeneous with highly variable multi-cropping activity.

Table 49. Top twenty multi-cropping combinations in the Calleguas Creek Watershed by acreage, “double” and “triple” indicate the number of crops grown per year on a given piece of land (DWR, 2000).

crop types	acres	crop types	acres
Double - strawberries, strawberries	4,005	Double - beans(green), celery	199
Triple - beans(green), celery, beans(green)	474	Double - misc-truck, misc-truck	198
Double - celery, peppers	338	Triple - misc-truck, misc-truck, misc-truck	166
Triple - beans(green), celery, peppers	275	Triple - onions-garlic, celery, beans(green)	160
Double - beans(green), beans(green)	269	Triple - peppers, peppers,iD00 celery	154
Double - peppers, peppers	251	Double - peppers, celery	154
Double - peppers, beans(green)	246	Triple - beans(green), broccoli, beans(green)	148
Double - celery, beans(green)	229	Double - barley, barley	137
Triple - misc-truck, misc-truck, misc-truck	226	Double - celery, onions-garlic	134
Double - celery, celery	217	Double - onions-garlic, celery	130

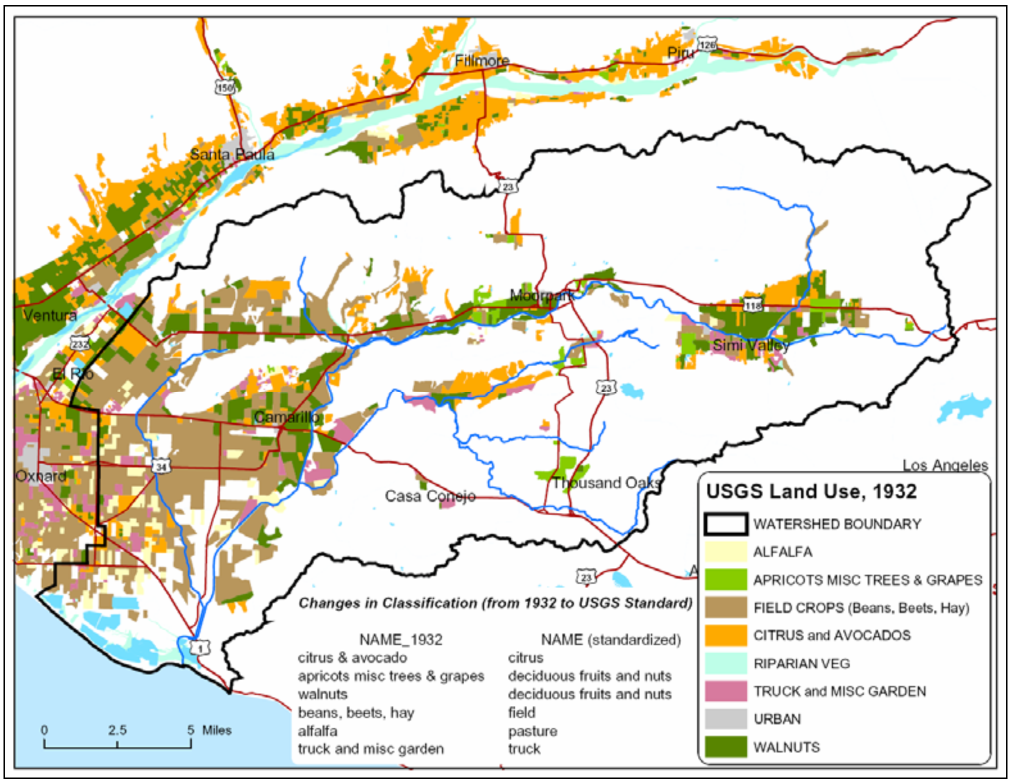


Figure 10. Land Use in the Calleguas Creek Watershed, 1932 (USGS, 2004).

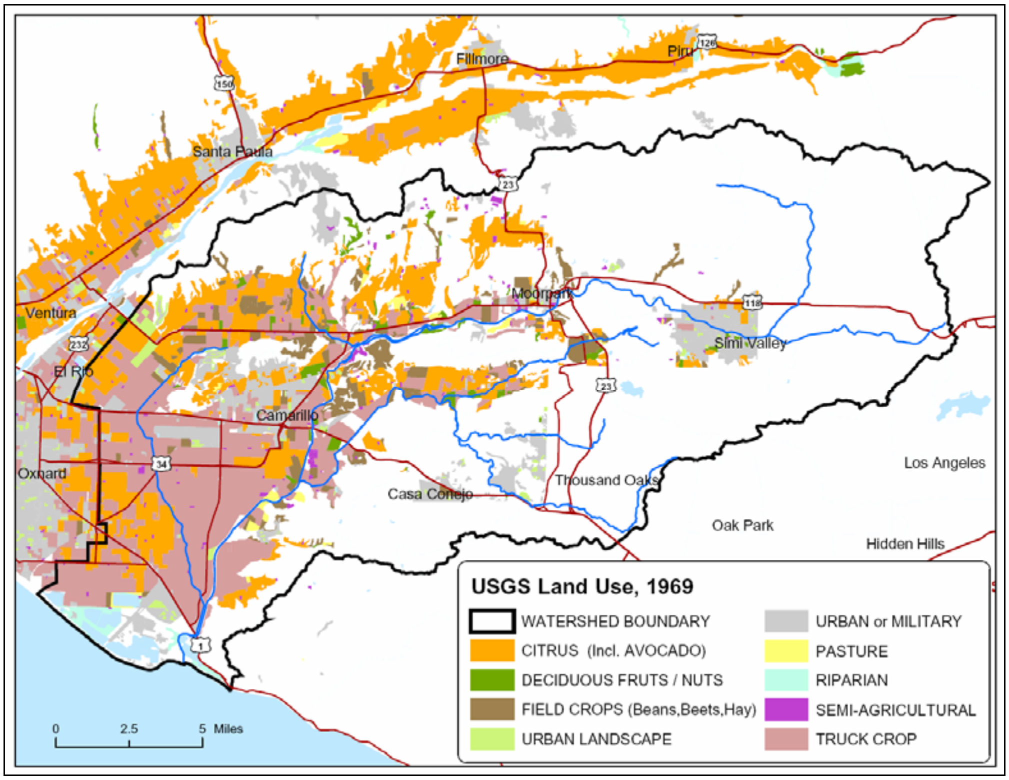


Figure 11. Land Use in the Calleguas Creek Watershed, 1969 (USGS, 2004).

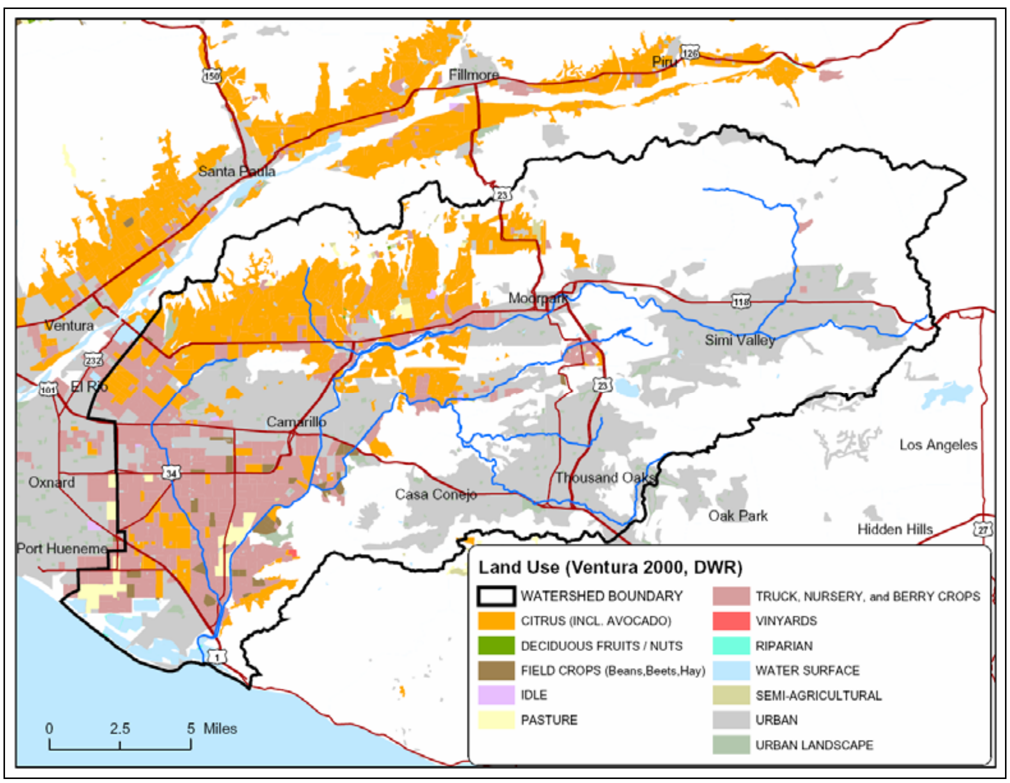


Figure 12. Land Use in the Calleguas Creek Watershed, 2000 (DWR, 2000).

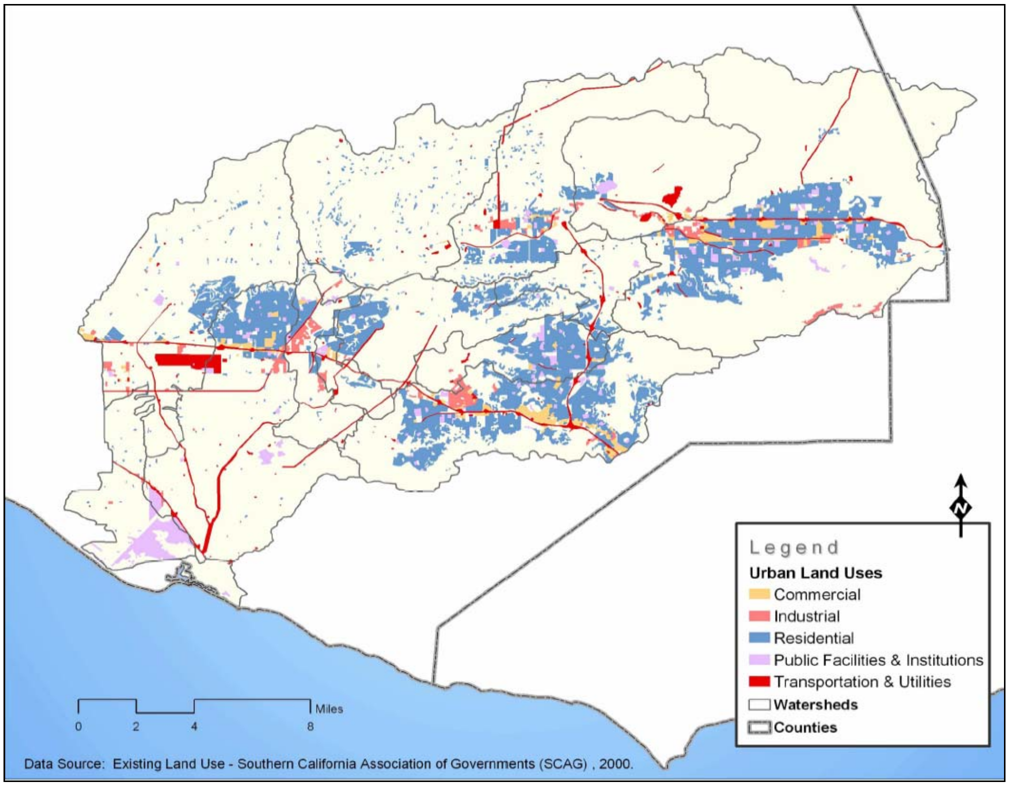


Figure 13. Urban Land Uses in the Calleguas Creek Watershed (SCAG 2000).

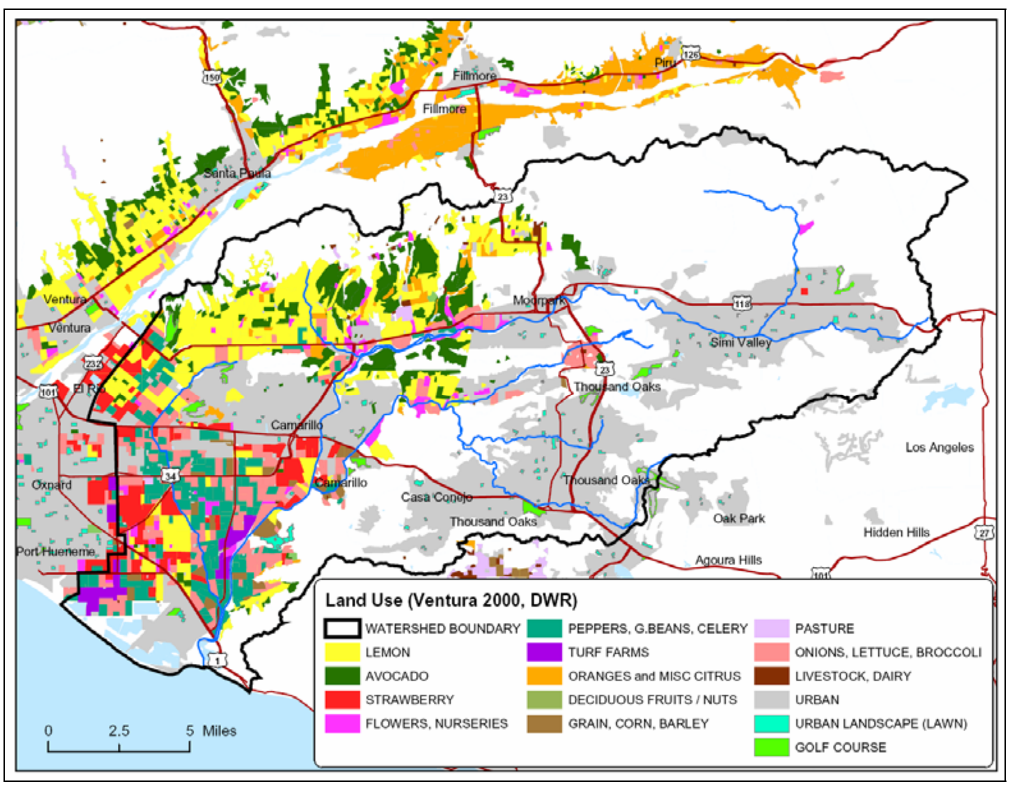


Figure 14. Land Use in the Calleguas Creek Watershed by Specific Crop, 2000 (DWR, 2000).

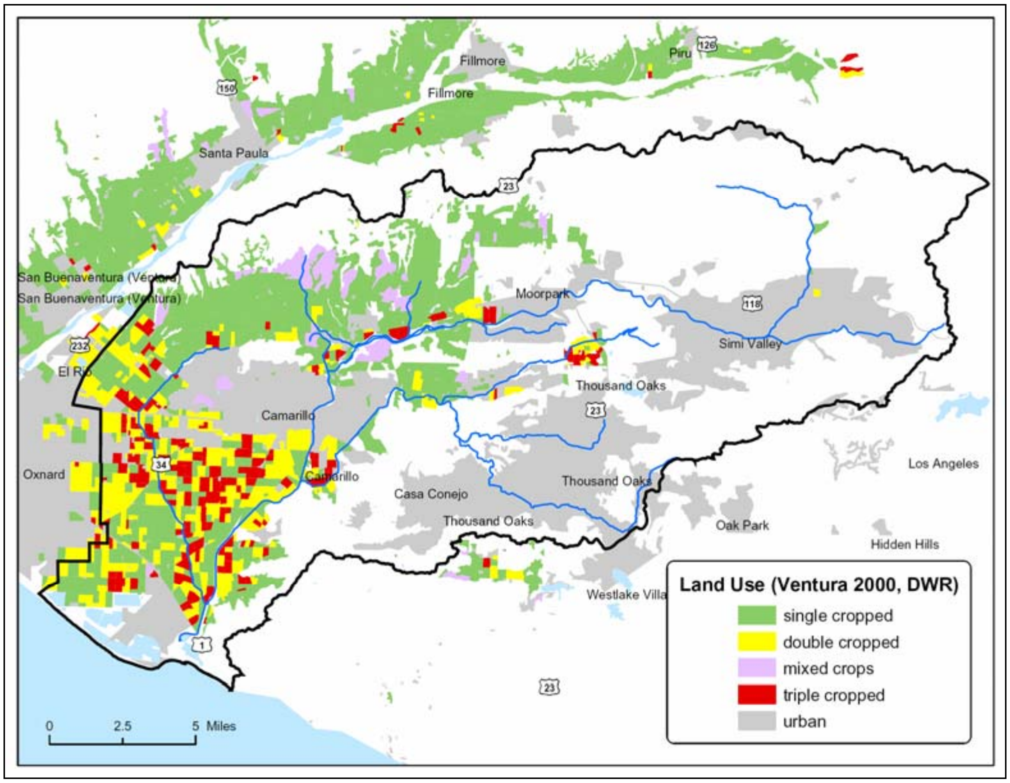


Figure 15. Multi-cropping Activity in the Calleguas Creek Watershed, 2000 (DWR, 2000).

5.3 Historical Assessment of Category-1 Constituents

This section presents information about the history of use for each category-1 constituent based upon a review of the literature, consultation with agricultural and pesticide experts, and all other available information. Given the highly persistent nature of OC Pesticides and PCBs, such information is essential for assessing the sources of these chemicals. Historical uses are described according to local spatial scales whenever possible, although such detailed information is not available in many cases.

DDT

DDT was first used as a pesticide in 1939. It was widely used to control insects in agriculture and insects that carry diseases such as malaria. During World War II (1939-1945), it was extensively employed for the control of malaria, typhus, and other insect-transmitted diseases. At its peak in 1962, DDT was used on 334 agricultural commodities. It was also used in the home as a mothproofing agent and to control lice. In 1972, 67–90% of the total US consumption of DDT was on cotton; the remainder was primarily used on peanuts and soybeans. The uses of DDT in California ranged from control of agricultural pests to control of cockroaches in residences and mosquito abatement in neighborhoods. Table 50 shows statewide reported DDT usage in California for the years 1970-1980. All uses of DDT have been banned in the USA since 1972, except for control of emergency public health problems (ATSDR, 2000a).

Table 50. 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
1973[b]	NUR[b,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

Given that DDT was banned in 1972, and that PUR data are not available before 1974; PUR data of actual DDT use are not examined. The information presented in Table 50 was probably gathered using hard copy records which are either non-existent or incomplete for Ventura County (Lichtenberger, pers. comm., 2004).

One of the largest DDT manufacturing sites in the world, the Montrose Chemical Company DDT plant, was located in the Los Angeles area about seven miles from the coast, in the City of Torrance. Waste from the facility contaminated numerous off-site locations and the coastal areas in the vicinity of Palos Verdes. There is no evidence to suggest the Calleguas Creek Watershed was contaminated by waste from the Montrose facility.

In August of 1984, the California State Assembly directed the California Department of Food and Agriculture (CDFA) to investigate possible sources of DDT and/or its breakdown products (DDTr) in the environment and to report findings to the Legislature within one year. This resolution was introduced in response to studies showing that, although its use was banned in 1972, DDTr was still being found over a decade later in California water, fish, shellfish, and produce samples. Additionally, the chemical composition of the DDTr being found indicated that it might be from recent use. CDFA investigated three possible sources of contamination by DDT and/or its breakdown products: illegal use of DDT, use of other pesticides that might be contaminated with DDTr, and long-lived residues from previous legal applications of DDT. Based on analysis of historical and empirical evidence, CDFA concluded that residues from legal applications of DDT, before its use was banned, appear to be the source of this contamination (Mischke et al, 1985). Specific findings of the study are quoted 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 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."

Agricultural Use

Although cotton, peanuts, and soybeans accounted for most of nationwide DDT use, there is no indication that any of these three crops have been grown in the CCW in significant amounts (according to Ventura County Crop Reports and USGS land use layers for the years 1932, 1950, 1969, and 2000). DDT is known to have been used extensively on walnut groves in the CCW, which constituted a sizable proportion of agricultural lands in the watershed before 1669. A 10/10% mixture of DDT/toxaphene was commonly used on walnuts, where it was usually applied three times per year during the "leaf period" (McIntyre, pers. comm., 2004). Acreage dedicated to walnut groves decreased from 1932 to the present (Figure 10 - Figure 12) because growers in the CCW could not produce them as cost effectively as growers in the Sacramento Valley. Beets, lima beans, and tomatoes also are known to have been treated with DDT for a number of years before it was banned in 1972. Sugar beet farming was greatly reduced in the watershed when a local sugar beet factory closed down in about 1948. At that time, many farmers started growing lima beans instead of sugar beets (McIntyre, pers. comm., 2004). It is almost certain that DDT has been applied in the CCW for other agricultural purposes besides walnuts, beets, lima beans, and tomatoes; but no information specific to CCW regarding these other uses has been found. Figure 16 shows likely historical DDT application areas; based upon USGS land use layers, Ventura County crop reports, and information related above (the degree of uncertainty associated with Figure 16 is very high). Areas of darkest red represent most recent applications and/or high cumulative applications of DDT based upon historical presence of the following land use types, in order of emphasis: 1) walnut 2) field crops 3) truck crops, urban, urban landscape, and citrus. It is important to note that this map represents nothing more than a best guess based upon available information.

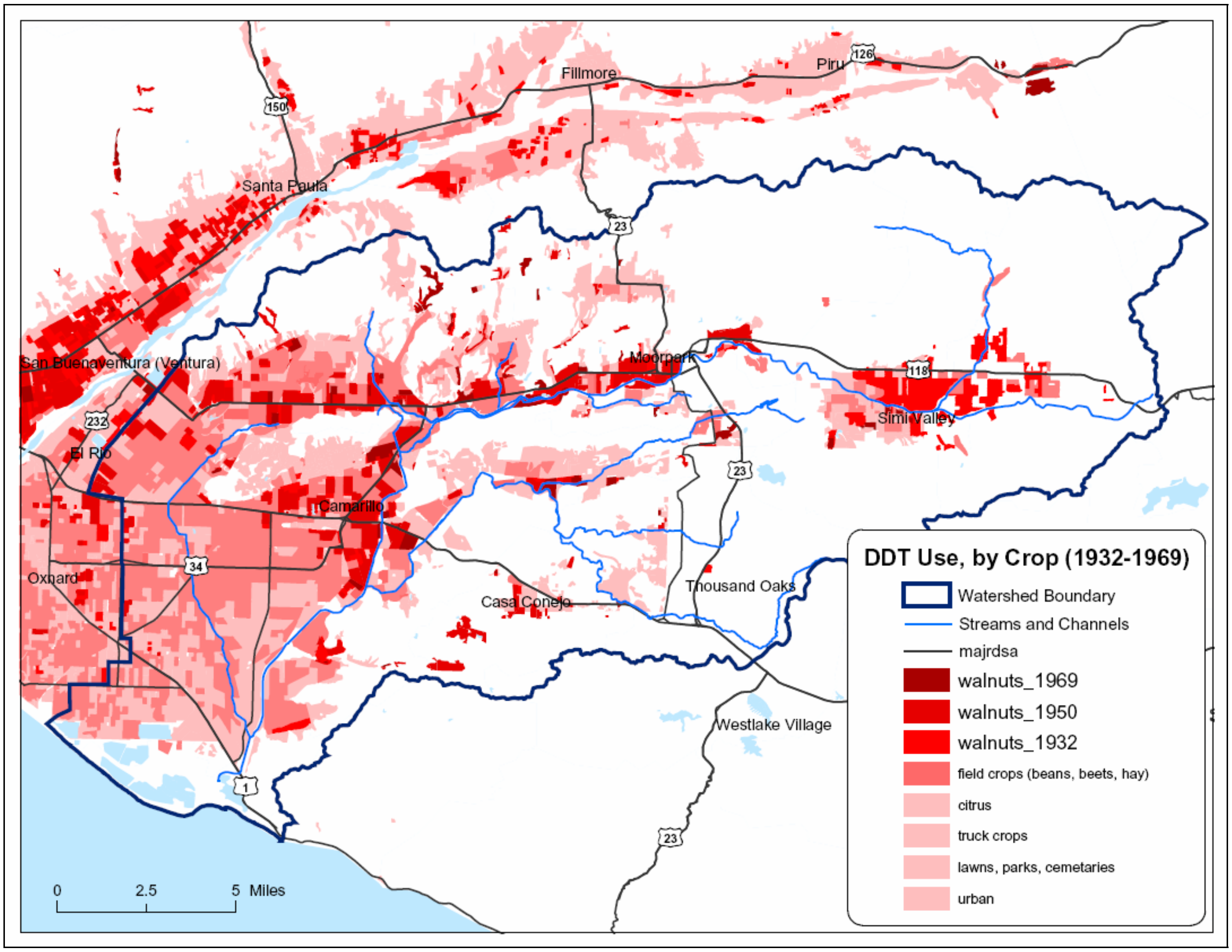


Figure 16. Predicted areas of relatively high DDT use during the time period 1932-1969 (USGS land use layers, Ventura County crop reports, interview with Sam McIntyre).

Urban Use

In many areas throughout the United States and globally, the primary non-agricultural use of DDT was for mosquito control. DDT is not known to have been used extensively for this purpose in the CCW, although it is known that Malathion was sprayed for mosquito control for many years (McIntyre, pers. comm., 2004). Ventura County Mosquito Abatement and Vector Control does not have records of any DDT use for mosquito control by that agency (Smith, pers. comm., 2004). However, a previous mosquito abatement program existed sometime before 1979 and there was a lapse period between the end of that program and startup of the current program. For many years before it was banned, DDT was commonly used by private residents for a variety of home and garden uses. However, there are no known records of such residential uses of DDT.

POTWs

Imported produce and clothing of agricultural workers from other countries may contribute DDT to influent received by POTWs in the Calleguas Creek Watershed. Due to widespread past use of DDT and the persistence and slow degradation of its breakdown products, low levels of DDE residues are still detected frequently in foods consumed in the US (Snedeker, 2001 and EIP, 1997). POTW influent may also contain

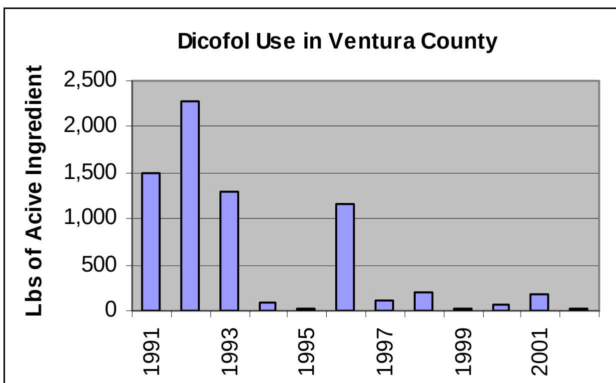
DDT originating from imported water sources as a result of terrestrial residues and atmospheric deposition in the regions from which water is drawn.

Atmospheric Deposition

Although the use of DDT is no longer permitted in the United States, it may be released to the atmosphere in other countries such as Mexico where manufacture and use continue. DDT, DDE, and DDD may also enter the air when local residues volatize from contaminated water and soil in a process referred to as gaseous evasion. Wind erosion of soils and sediments containing sorbed residues can also play a key role. This cycle of volatilization, erosion, and deposition may be repeated many times. As a result, DDT and its breakdown products can be carried long distances in the atmosphere. Although there is some deposition of DDT onto soils in North America via volatilization and atmospheric transport from countries in Central and South America that still use DDT, the magnitude of exposure through this route is considered to be small (Snedeker, 2001). In the atmosphere, about 50% of DDT is adsorbed to particulate matter and 50% exists in the vapor phase (ATSDR, 2002a). Estimated rates of atmospheric deposition for DDT are presented above in Table 46 and Table 47.

DDT in Dicofol

Dicofol is an organochlorine miticide/pesticide currently used for on cotton, apples, citrus, strawberries, beans, peppers, tomatoes, pecans, walnuts, and non-residential lawns/ornamentals. It is created from DDE (one of the breakdown products of DDT), which is reacted with chlorine to form “chlorinated DDE” and then reacted further to produce dicofol. The DDE used to make dicofol contains some DDT as a result of its own manufacturing process. The final dicofol product therefore can contain levels of DDT and “chlorinated DDE” (which can dechlorinate back to DDE in the environment). Thus, dicofol can be a direct source of both DDT and DDE. After 1987, the sum of DDT, DDE, DDD and "chlorinated DDE" allowed in dicofol products was reduced so as not to exceed 0.1% (Mischke et al, 1985). Regardless, dicofol applications are considered a potential source of DDT in the CCW.



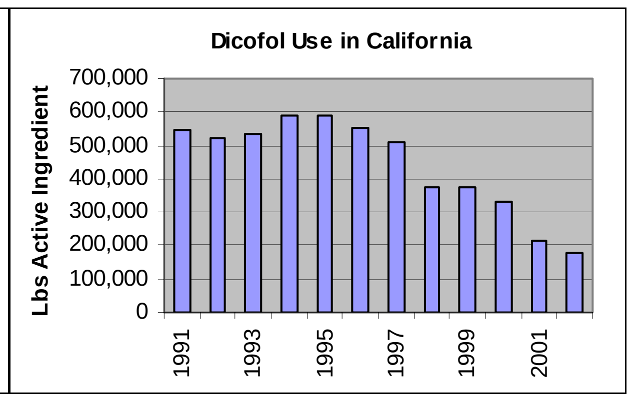


Figure 17. Dicofol use in Ventura County and statewide, 1991-2003 (DPR, 2004).

Dicofol was first registered as a pesticide in the U.S. in 1957. In 1998 manufacturers voluntarily cancelled all residential turf uses. A noticeable decrease has occurred in reported applications of dicofol in Ventura County and statewide during the 1990s (Figure 17). Allowable application levels for citrus crops have been reduced from 8 pounds of active ingredient per acre to 3 pounds per acre, and the application rate for wettable powders on strawberries has been reduced from 2.4 pounds/acre to 2 pounds/acre (EPA, 1998). Currently, 32 dicofol products are registered, including end use and manufacturing use products.

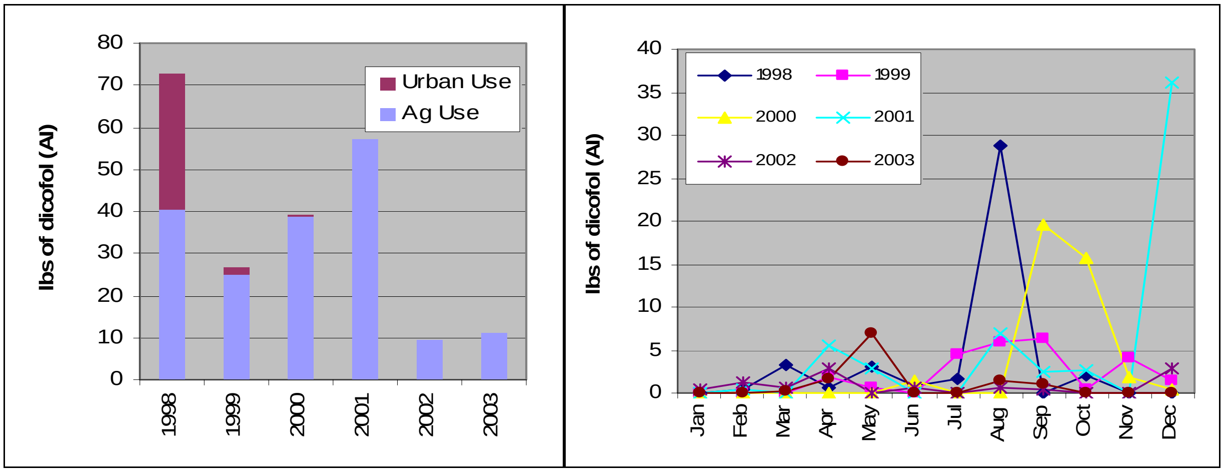


Figure 18. Dicofol use in CCW, 1998-2003 (DPR, 2004).

There were about 150 reported applications of dicofol in the CCW from 1998-2003, totaling about 216 pounds of active ingredient over that time period (Figure 18). Nursery plants and flowers received more than 95% of the agricultural applications. Although lemons, strawberries, and Christmas trees received only one or two applications each, these crops accounted for 70 of the 216 pounds applied from 1998-2002. Most of the urban uses were for landscape maintenance, although a few applications for structural pest control were reported. Two urban applications of dicofol on the same day in 1998 totaling 27 pounds account for the relatively large amount of urban use in that year. One was for structural pest control and the other for landscape maintenance.

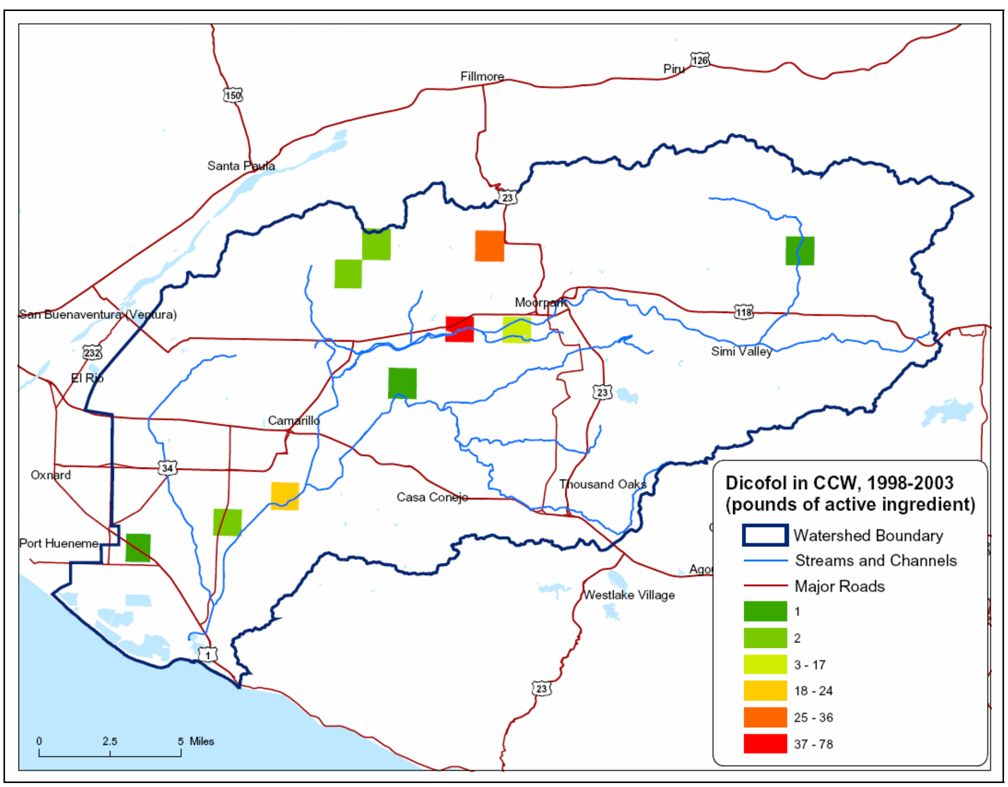


Figure 19. Dicofol use in the Calleguas Creek Watershed from 1998-2003 (DPR, 2004).

The locations and amounts of dicofol reportedly applied are shown in Figure 19. Note that all of the 150 applications occurred within a total of only 10 township/range sections. All uses of dicofol reported from 1998-2003 were applied on the ground (no aerial applications). The 216 pounds of dicofol used in the CCW from 1998-2003 would have contained about 0.2 pounds of DDT, amounting to an average of 16.3 grams of DDT per year.

Chlordane

Chlordane is a pesticide used for crops such as corn and citrus, home lawns and gardens, and termite control. It was first used in 1948. All uses except termite control were banned in 1983, and all uses were banned in 1988. The use pattern of chlordane in the US during the mid 1970s was as follows: 35% by pest control operators, mostly for termite control; 28% on agricultural crops, including corn and citrus; 30% for home lawn and garden use; and 7% on turf and ornamentals. The use of chlordane decreased noticeably in the 1970s when EPA moved to cancel all uses other than subterranean termite control. Between July 1983 and April 1988 the sole use for chlordane was to control subterranean termites. Chlordane does not degrade rapidly in soils and may persist in soil for over 20 years (ATSDR, 1994).

PUR data for the years 1974, 1979, 1984, and 1989 were examined for chlordane use in Ventura County. Use of chlordane was not reported in 1989, which is expected since all uses were banned in 1988. All reported uses of chlordane in 1984 were for the use category “federal agency”. Since many of the uses reported in the 1974, 1979, and 1984 data involved liquid applications, the data for pounds of active ingredient reported in those years may contain errors and are not evaluated (DPR, 2000). The nationwide decrease in chlordane use mentioned above seems to also have occurred in the CCW, since the number of applications dropped from 468 in 1974 to 149 in 1979. Approximately 57% of the applications in 1974 and 1979 combined were agricultural and 43% for urban uses.

The main crops known to use chlordane that have historically existed in the CCW are lemons and oranges. However, the primary treatment for citrus pests over the years has been petroleum oil, which is used as a smothering agent. Turf farms also used chlordane to fight off weevils (McIntyre, pers. comm., 2004). Since the locations of citrus groves are visible in Figure 10 - Figure 12, it is possible to form a rough idea about some agricultural areas in the watershed that have received relatively greater amounts of chlordane. PUR data from 1974 and 1979 indicate that chlordane was applied to the following crops: beans, citrus, tomato, peas, peppers, celery, and cabbage. Most of the applications of chlordane were for beans and citrus in 1974 and for citrus in 1979. In the years of PUR data that were examined, there were no reported uses of chlordane for turf farms.

The amount of chlordane used for urban purposes in the CCW is unknown. During the years examined, PUR data indicate chlordane was used for the following urban uses: city agency, federal agency, other agency, recreational area, school district, state highway, and structural control (termites). All applications in 1984 and most of the applications in 1979 were for the category “federal agency”. The largest number of applications in 1974 were for structural pest control. It is not possible to estimate urban use of chlordane based upon statewide sales data from DPR, because those data were not published until 1991.

Chlordane may be transported long distances and deposited by wet or dry deposition. In air, chlordane exists predominantly in the vapor phase. Vapor-phase chlordane degrades by photolysis and hydroxyl radical reaction. However, the relatively small fraction of particle-bound chlordane appears to be of major importance in atmospheric deposition. The small amount of adsorbed chlordane at ordinary temperatures appears to play an important role in atmospheric deposition. In samples collected in Texas, 98% of the chlordane scavenged rain was particle-bound chlordane, rather than vapor-phase chlordane that partitioned into rain drops. The chlordane concentration in rain was 1,900 times the concentration in air (ATSDR, 1994). Estimated rates of atmospheric deposition for total chlordanes are presented above in Table 46 and Table 47.

Dieldrin / Aldrin

Source analysis for dieldrin and aldrin is discussed here together since aldrin rapidly degrades to dieldrin in the environment (ATSDR, 200b). Dieldrin and aldrin were used extensively from the 1950s until 1970, when the U.S. Department of Agriculture canceled all uses of both pesticides. In 1972, however, EPA approved dieldrin and aldrin for killing termites. Use of the chemicals to control termites continued until 1987, when the manufacturer voluntarily canceled the registration for use in controlling termites (ATSDR, 2002b). Use of dieldrin and aldrin in the USA peaked in 1966. Decreased use after that time is attributed primarily to increased insect resistance, and development of more effective and environmentally safer pesticides (ATSDR, 2002b). Dieldrin and aldrin ranked second after DDT among agricultural chemicals used in the United States in the 1960s. Aldrin use was most concentrated in the midwest, while dieldrin was used more heavily in the south and on the west coast. Dieldrin was recommended for use on approximately 90 crops, principally corn, hay, wheat, rye, barley and oats, and orchards and vegetables. More than 50% of the dieldrin produced in 1964 was used for pest control instead of agriculture. This included soil application for termite control and mothproofing during wool carpet and clothing manufacturing. Pest control uses also included control of harvest and fire ants and for aerial spraying of spruce budworm and gypsy moths (Jorgenson, 2001).

Aldrin is estimated to have a half-life in soil of 1.5-5.2 years, depending on soil composition and other factors. Dieldrin degradation appears to vary according to its concentration in the soil, with half-lives ranging from 2.6 to 12.5 years (Jorgenson, 2001). The resistance of dieldrin and aldrin to soil leaching generally precludes their appearance in groundwater. A general absence of both chemicals from groundwater samples supports this conclusion (ATSDR, 2002b).

Atmospheric data have established that dieldrin travels very long distances from the source where it is applied. Deposition of dieldrin and aldrin can accumulate in remote areas thought to be pristine (Jorgenson, 2001). Estimated rates of atmospheric deposition for three cyclodienes, including dieldrin and aldrin, are presented above in Table 46.

PUR data for dieldrin and aldrin use in Ventura County were examined for the years 1974, 1979, 1984, and 1989. There were 14 applications of dieldrin and 3 applications of aldrin reported in 1974, all of which were for structural control. In 1979 and 1984 combined, there were 4 applications of dieldrin and 1 application of aldrin in the CCW. No use was reported for either chemical in 1989. Across all years examined uses were reported only for structural control and for “federal agency”. Known limitations of PUR data from before 1990 are described in a report available from the Department of Pesticide Regulation (DPR, 2000).

Toxaphene

Toxaphene is an insecticide containing over 670 chemicals that was first used in the 1940s. EPA canceled the registrations of toxaphene for most uses as a pesticide or pesticide ingredient in 1982. Toxaphene was one of the most heavily used insecticides in the United States until that time. It was used primarily in the southern United States to control insect pests on cotton and other crops. Toxaphene was also used to control insect pests on livestock and to kill unwanted fish in lakes (ATSDR, 1996). All registered uses were banned in 1990 and existing stocks were not allowed to be sold or used in the United States. The continued use of toxaphene after 1990 shown in Figure 20 is not understood at this time. It is not known whether the 4.5 pounds of toxaphene applied in Ventura County in 1998 occurred within the CCW, since location information was not included in that record (the use was for structural pest control).

After the 1969 DDT ban, toxaphene became the most heavily used insecticide in the United States. In 1974, an estimated 44 million pounds of toxaphene used on crops in the US was distributed as follows: 85% on cotton, 7% on livestock and poultry, 5% on other field crops, 3% on soybeans, and less than 1% on sorghum (ATSDR, 1996). This national pattern of toxaphene use describes applications on crops typically not grown in the CCW. However, it is known that toxaphene was applied for many years in the CCW before 1990 onto walnut groves and some other crops in a 10/10% dust formulation of toxaphene /DDT (McIntyre, pers. comm., 2004).

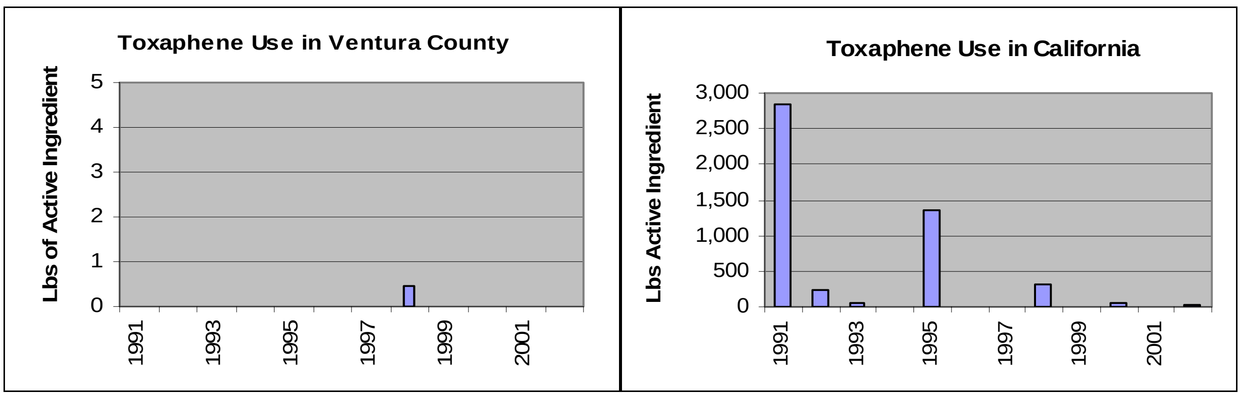


Figure 20. Toxaphene use in Ventura County and statewide, 1991-2003 (DPR, 2004).

The transport and transformation of toxaphene's many components is influenced by individual physical and chemical properties in addition to those of the mixture as a whole. The environmental fate of the mixture rather than of individual components has been studied by most investigators. A major difficulty in estimating past use of toxaphene is that, due to factors such as environmental and metabolic transformation and selective volatilization and atmospheric transport of some congeners, there is a difference in congener composition between the standard technical toxaphene and that found in environmental or biological samples. Therefore, almost all estimates of toxaphene concentration are semi-quantitative.

PUR data for toxaphene use in Ventura County were examined for the years 1974, 1979, 1984, and 1989. Known limitations of PUR data from before 1990 are described in a report available from the Department of Pesticide Regulation (DPR, 2000). There were 1,090 applications of toxaphene during the years examined, a majority of which was used to treat beans and celery (Table 51). No use was reported in 1989.

Table 51. Reported Toxaphene applications in Ventura County by Use Type in 1974, 1979, 1984, 1989 (DPR, 2004).

1974		1979		1984		1989	
bean	419	bean	65	bean	7		
celery	287	celery	51	university of California	1		
tomato	71	turf	17				
ornamental	67	tomato	15				
pepper	13	pepper	10				
lettuce, head	12	cabbage	7				
broccoli	8	flower	4				
flower	8	ornamental	4				
cabbage	6	strawberry	3				
school district	3	broccoli	2				
strawberry	3	lettuce, leaf	2				
		university of California	2				
		corn	1				
		pepper, chili	1				
		shrub	1				
total =	897	total =	185	total =	8	total =	0

PCBs

Commercial production of PCBs in the United States began in 1929. In the beginning, PCBs were used both for nominally closed applications (capacitors, transformers, heat transfer fluids, hydraulic fluids) and in open-end applications (flame retardants, inks, adhesives, paints, pesticide extenders, plasticizers, polyolefin catalyst carriers, surface coatings, wire insulators, metal coatings). Most domestic use of PCBs was restricted to nominally closed applications by 1974, and manufacture of PCBs was stopped in the USA by 1977 because of evidence that they build up in the environment and can cause harmful health effects. Aroclors were no longer used in the production of capacitors and transformers after 1979.

Atmospheric transport is the most important mechanism for long-range dispersion of PCBs. Biphenyls with 0–1 chlorine atom remain in the atmosphere, those with 1–4 chlorines gradually migrate toward polar latitudes in a series of volatilization/deposition cycles, those with 4–8 chlorines remain in mid-latitudes, and those with 8–9 chlorines remain close to the source of contamination (Wania and Mackay, 1996). Rates of atmospheric deposition for PCBs presented in a study by Park et al. in 2001, are presented in Table 46. Park et al state that atmospheric concentrations of PCBs in their study were comparable to the range of concentrations reported for other sampling sites; higher than those from Bermuda and Chesapeake Bay, but lower than those from Chicago and London. A study of dry deposition of PCBs in the Lake Michigan Air Basin conducted from 1993 to 1995 found geometric mean fluxes of total PCBs at four locations ranging from 0.057-0.21 $\mu g/m^2$-day. General atmospheric levels of PCBs were decreasing over time, although higher levels of PCBs were detected in urban sites, as compared to rural locations (Franz et al, 1998).

Although the dominant source of PCBs to surface waters is likely atmospheric deposition (both directly deposited to streams and also transported from land by runoff), desorption of sediment-bound PCBs may contribute significantly to the concentrations detected in water. PCBs in water are transported by diffusion and currents. PCBs are removed from the water column by sorption to suspended solids and sediments, by volatilization from water surfaces, and by accumulation in the tissues of biota. PCBs in soil are unlikely to migrate to groundwater because of strong binding to soil. In water, abiotic transformation processes such as hydrolysis and oxidation do not significantly degrade PCBs. Photolysis appears to be the primary abiotic degradation process in water (ATSDR, 2000). The estimated photolysis half-lives in water for various PCBs range from less than one day up to more than 200 days; dependant upon a number of factors such as water depth, sun exposure, and the degree of chlorination of the various congeners. PCBs, particularly the highly chlorinated congeners, adsorb strongly to sediment and soil where they tend to persist with half-lives on the order of months to years (ATSDR, 2000).

Accidental Spilling of PCBs

A review of the available information on sites contaminated by PCBs suggests accidental releases in the past as a common cause of PCB residues in soil (recent releases are less common since PCBs have been banned for more than twenty years). Such spills may have occurred at storage, shipping, or maintenance facilities within the watershed that handled products containing PCBs. However, no specific sites within the watershed where spills are likely to have occurred have been identified. Neither the PCB Activity Database System (PADS) nor the PCB Transformer Registration Database (both maintained by USEPA) contain records of PCB related activity in the CCW.

5.4 OC Loads in Water by Source

Concentrations of OCs in water are primarily the result of loads from nonpoint sources and discharges from point sources. The analysis in this section considers OC loads into and out of CCW subwatersheds, using DDE as a representative constituent. The numerical model developed for this purpose is characterized as:

- Empirical – Based on the statistics of the available data;
- Static – Simulating conditions as annual averages;
- Stream reach – Simulating conditions in representative stream reaches; and
- Water quality – Focused on the physical and chemical conditions in the modeled stream reaches that determine concentrations and loads of OCs in water.

Load (mass per time, *L*) is calculated as the product of concentration (*C*) and flow rate (*Q*):

$$L = C * Q$$

Flow rates for each land use in each subwatershed are calculated from daily mean values for water years 1990-2003 estimated by the Dynamic Calleguas Creek Modeling System, or DCCMS (LWA, 2004b). DDE concentrations from major sources to water are estimated based on the land-use runoff and discharge data summarized in Table 44.

Loads are calculated in according to two different methods. First, DDE sources from land-use runoff and point source discharges to receiving water are quantified. The sum of those loads presumably represents the total load of DDE to water. Second, actual DDE loads in water from representative reaches are quantified using receiving water data presented in the Current Conditions section. These loads should mirror the loads to water, but could vary depending on the effects of in-stream processes.

DDE Loads in Water Calculated from Land-Use Runoff and Discharge Data

Average DDE concentrations and estimated annual average loads of DDE from major land use categories are shown in Table 52. Agricultural runoff accounts for over 90% of the DDE load among these sources.

The largest load is to the Revolon Slough Subwatershed, followed by Calleguas Creek and Arroyo Las Posas Subwatersheds. Based on these load estimates and land use coverage data, unit loads are 0.54 lb/1000 acre-yr for agricultural runoff and 0.04 lb/1000 acre-yr for urban runoff.

Table 52. Estimated average annual load of DDE from major land use categories into each subwatershed. Load is calculated as flow rate multiplied by concentration and converted to appropriate units.

Subwatershed	Flow Rate (cfs)[1]					
	Urban	Native	Agric	POTWs	GW	Total
Mugu Lagoon	1.3	0.3	4.9	-	-	6.5
Calleguas Creek	5.9	0.9	9.6	4.4	5	25.9
Revolon Slough	3.1	0.7	19.9	-	-	23.6
Arroyo Las Posas	1.7	1.1	12	2	-	16.8
Arroyo Simi	17.8	8.6	3.6	14.2	4.1	48.2
Conejo Creek	15.2	2.9	3.7	16.8	2.2	40.8[2]
Concentration (ug/L)[3]	0.027	-	0.289	0.024	0.003	

Subwatershed	Average Annual DDE Load (lb/yr)					
	Urban	Native	Agric	POTWs	GW	Total
Mugu Lagoon	0.07	-	2.79	-	-	2.9
Calleguas Creek	0.31	-	5.48	0.21	0.03	5.8
Revolon Slough	0.16	-	11.3	-	-	11.5
Arroyo Las Posas	0.09	-	6.84	0.09	-	6.9
Arroyo Simi	0.93	-	2.05	0.67	0.02	3
Conejo Creek	0.8	-	2.09	0.79	0.01	2.9
Total (lb/yr) =	*2.35*	--	*30.55*	*1.76*	*0.06*	*32.9*
Percent of Total	*7.1%*	--	*92.9%*	*5.3%*	*0.2%*	*100.0%*

[1] Flow rates estimated by DCCMS (LWA, 2004b).

[2] Approximately 9,000 acre-ft/yr (~12 cfs) is diverted upstream of Calleguas Creek.

[3] Average concentrations estimated from land-use runoff and discharge data.

DDE Loads in Water from Representative Reaches

Loads leaving each reach can be calculated as a comparison to the source load estimates presented above. The estimated average daily flow rates, average DDE concentrations, and resultant average annual DDE loads and unit loads in the subwatersheds are given in Table 53.

Table 53. Flow rates, DDE concentrations, and estimated DDE loads for representative reaches.

Subwatershed	Representative Reach	Average Daily Flow Rate (cfs)[1]	Average DDE Concentration (ug/L)[2]	DDE Load (lb/yr)	DDE Unit Load (lb/1000 acre-yr)
Mugu Lagoon	1	119	0.038	9.0	0.04
Calleguas Creek	3	90.4	0.019	3.4	0.02
Revolon Slough	4	23.0	0.1	6	0.1
Arroyo Las Posas	6	37.8	0.004	0.3	0.00
Arroyo Simi	7	38.0	0.015	1.1	0.01
Conejo Creek[3]	9B	33.5	0.006	0.4	0.01

[1] Flow rates estimated by DCCMS (LWA, 2004b).

[2] Average concentrations estimated from receiving water data. See accompanying text for how non-detected data were handled. Shaded cells indicate <20% detected data.

[3] The flow rate and loads are adjusted to account for the Conejo Diversion.

These load estimates should be considered approximate because of the limited available data. Calculating an average concentration based predominately on non-detected data provides only an approximation of the actual load. One check on the accuracy of these estimates is to compare the sum of land-use runoff loads to the load in the receiving water. A comparison of these values is shown in Table 54. The calculated loads in runoff exceed the loads in receiving water in every subwatershed except Mugu. One potential explanation for this discrepancy is the fact that runoff samples were collected disproportionately more frequently during storm events, which may affect source water runoff concentrations more than receiving water. Nevertheless, these estimates are on the same order of magnitude and may represent best possible estimates given the limitations of available data.

Table 54. Comparison of source runoff and receiving water load estimates for DDE.

Subwatershed	Sum of Source Loads (lb/yr)	Receiving Water Load (lb/yr)
Mugu Lagoon	2.9	9.0
Calleguas Creek	5.8	3.4
Revolon Slough	11.5	6
Arroyo Las Posas	6.9	0.3
Arroyo Simi	3.0	1.1
Conejo Creek	2.9	0.4
Total=	32.9	9.1 [1]

[1] This total is the sum of loads from Calleguas and Revolon Slough, and corroborates the estimate downstream for Mugu Lagoon.

Summary of DDE Load Estimates

These data indicate that agricultural runoff is the primary source of DDE in the watershed, primarily in the Revolon Slough Subwatershed. Urban runoff, including industrial, commercial, and residential land uses, and municipal wastewater effluent do not appear to be significant contributors of DDE in the watershed. This assessment is based on the following findings:

- Representative reaches with the majority of urbanized area and effluent discharges (Reaches 3, 6, 7, and 9B) have lower DDE concentrations on average than reaches without them (Reach 4);
- Agricultural runoff samples had detectable concentrations of DDE in 91% of samples, resulting in an average concentration over 10 times higher than in runoff from other land uses;
- Only 7% of wastewater effluent discharge samples had detectable concentrations of DDE even though analytical detection limits for these samples were generally lower than for other sample sources;
- Of the 93% of non-detected samples in wastewater effluent, most (92%) were measured using detection limits less than 0.2 ug/L.

5.5 Conclusions

Assessing sources of legacy pesticides and PCBs in the CCW is a difficult task. Detailed records of past uses for these chemicals are either scarce or non-existent. Land use mapping and GIS resources offer fewer and less detailed impressions of past conditions than present ones. Issues related to long term fate and transport create additional uncertainties. Despite these known challenges, a significant foundation of understanding has been established by reviewing the literature, analyzing all available data (such as PURs, land use layers, and crop reports) interviewing local experts. Cumulative understanding of OC pesticides and PCB sources resulting from all the above mentioned efforts guide the process of linkage analysis and determination of allocations.

6 LINKAGE ANALYSIS

The linkage analysis connects loads of OC pesticides and PCBs (OCs) to beneficial uses. Protection of beneficial uses from impairment by OCs is fundamentally about reducing OC concentrations in aquatic biota to acceptable levels, which necessitates reductions in water and sediment. The numeric targets for OCs in fish tissue define acceptable levels for protection of human health and wildlife, while numeric targets for water and sediment protect lower trophic level organisms and help trace impairment in biota back to sources.

The linkage analysis starts with the conceptual model for OC fate, transport, and effects. This model, supported by the physical and chemical properties of the OCs, is necessary to understand the central role of sediments as a storage compartment and conveyance mechanism. The conceptual model helps support the basic assumption of this TMDL analysis, which is that actions to reduce OC concentrations in sediments will reduce OC concentrations in fish tissue and in the water column.

As mentioned previously, DDE is used as a representative constituent for most of the analyses presented in this TMDL document. This is appropriate because DDE is the only constituent consistently detected and found to exceed numeric targets in water, sediment, and tissue samples (see Current Conditions section); and also because OC Pesticides and PCBs possess similar physical and chemical properties that influence their fate and transport in the environment (described below).

6.1 Conceptual Model / Fate and Transport

A general conceptual model for OC fate, transport and effects in the CCW is shown in Figure 21. The size of the arrows for each process indicates the relative importance. The dominant source of OCs is nonpoint source runoff from areas with high OC concentrations, resulting primarily from use of these chemicals in the past. Nonpoint source runoff also includes the load from atmospheric deposition, which is a much smaller contribution compared to the legacy load. As discussed in the Source Assessment (Section 5), point source inputs from water reclamation plants are a much smaller fraction of the overall load. The primary removal mechanism of OCs from the watershed is by flushing to the Pacific Ocean via Mugu Lagoon. Gaseous evasion and degradation (discussed below) are removal mechanisms, but act on much slower timescales than hydraulic inputs and outputs.

The OCs of concern in this TMDL all sorb strongly to particles. Thus, the gross movement of OCs through the watershed can be modeled as transport on the particulate phase. Although this simplifying assumption helps model watershed loads, site-specific factors that can enhance solubility (especially in pore waters) do need to be considered with regards to effects on beneficial uses.

The linkage of OCs in water and sediment to beneficial uses is uptake by organisms. Uptake by filter feeders depends on their exposure to suspended particulate OCs. Uptake by benthic detritivores is influenced primarily by OC concentrations in sediments. Dissolved OC concentrations in the interstitial waters of sediments (pore waters) may also be an important factor affecting OC uptake by benthic organisms. Fish can acquire dissolved OCs from the water column passing directly across the gills, as well as from consumption of contaminated organisms. Humans and wildlife are susceptible to consumption of organisms contaminated with OCs.

Sediment OC concentrations are important to all of these bio-uptake pathways. Filter feeders and benthic detritivores are directly affected by the OC concentrations of bottom and suspended sediments. OC concentrations in sediments indirectly affect organisms whose primary route of exposure is to dissolved OCs. Higher OC concentrations in sediments drive the adsorption-desorption equilibrium towards higher dissolved concentrations.

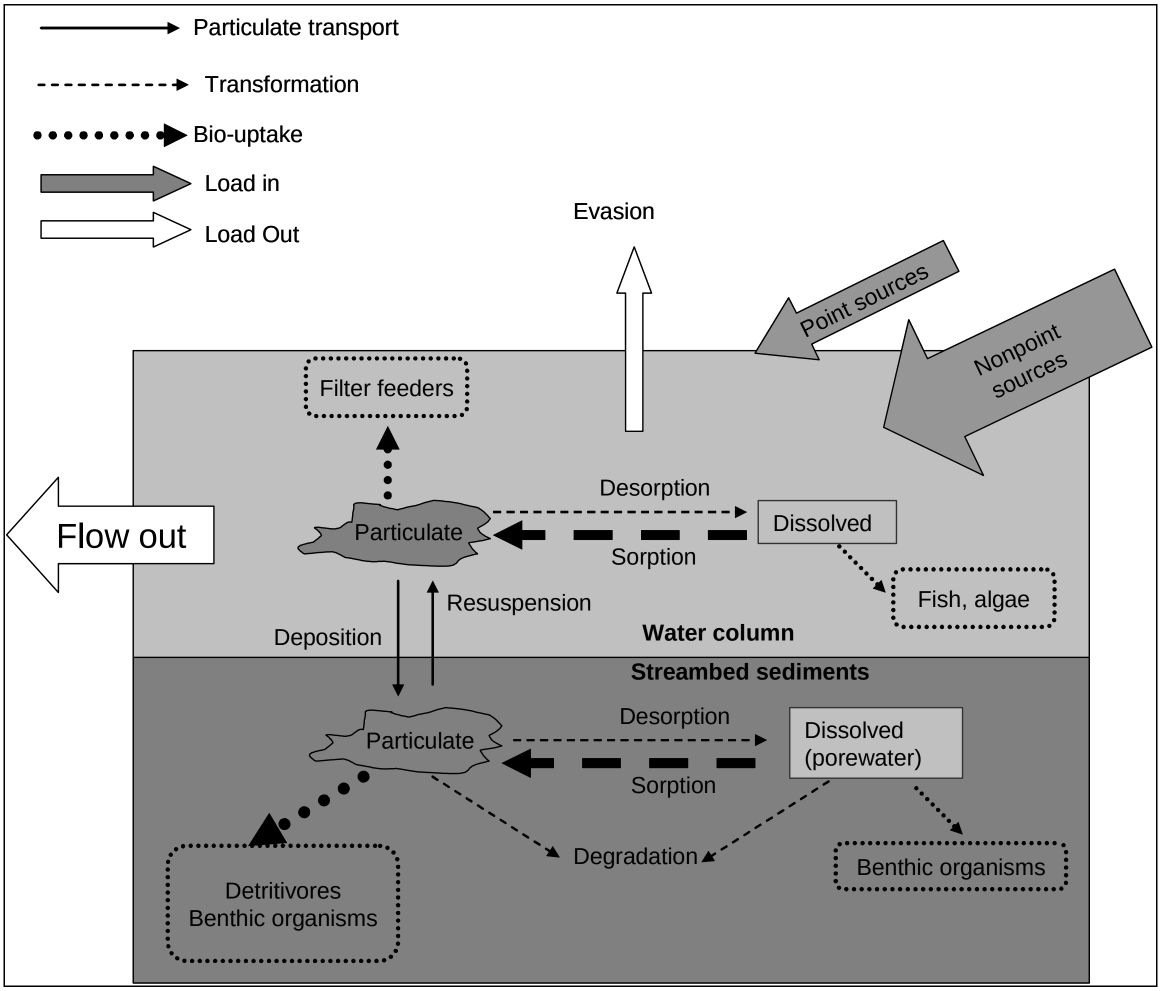


Figure 21. Conceptual model of the key transport and transformation processes of OCs in surface waters of the CCW, and entry points to the food chain.

Chemical Properties and Partitioning of OCs

Relevant chemical properties for the 303(d) listed OCs are shown in Table 55, followed by a description of these physical and chemical characteristics. Due to the hydrophobic nature of OCs they are strongly adsorbed onto silt, sediment particles, and organic matter within a water body. However, the dissolved fraction (operationally defined as the portion of a sample that passes a 1.2-µm filter) is of potential significance since it is sometimes more toxic and bioavailable. The organic carbon fraction of sediments is most commonly correlated with sorption of OCs.

Table 55. Chemical properties of OC pesticides and PCBs.

Constituent	Molecular Weight [1]	Henry's Law Constant [2] (atm-m^3/mole)	Log K_{OW} [2]	Log K_{OC} [2]	Log BCF [2]	Half Life in Soil, Low (days) [1]	Half Life in Soil, High (days) [1]	Water Solubility (mg/L) [2]
Aldrin	NA	1.70E-04	5.52	4.69	3.5	NA [3]	NA [3]	0.017
Chlordane	409.8	4.86E-05	NA	3.09	4.27	350	7,300	0.056
Dacthal	303.9	2.18E-06	4.19	3.81	2.96	15	100	0.5
DDD	321	4.00E-06	6.02	NA	4.9	730	2,190	0.09
DDE	319	2.10E-05	5.69	4.70	4.91	1,000	5,475	0.120
DDT	354.5	8.10E-06	6.36	5.18	4.97	1,460	5,330	0.025
Dieldrin	380.93	1.51E-05	4.55	3.92	3.65	109	4,560	0.195
Endosulfan	406.95	1.12E-05	3.83	3.82	3.02	5	150	0.45-0.51
Endrin	380.92	7.52E-06	4.56	4.06	3.17	60	5,110	0.25
HCH (Lindane)	290.85	1.40E-05	3.61	3.03	3.1	3	1,095	7.3
Heptachlor	NA	1.48E-03	4.27	3.54	3.98	180	1,200	0.18
Heptachlor Epoxide	389.2	9.50E-04	5.4	1.02	4.16	NA	NA	0.2
PCBs	200.7-453	4.0 E-04 [4]	3.9-6.7	NA	NA	730	2,190	0.004-0.91
Toxaphene	414	6.00E-06	4.68	5.32	3.49	9	5,110	0.74

Kow = octanol-water partitioning coefficient, Koc = organic carbon-normalized distribution coefficient, BCF = bioconcentration factor

[1] Sources: ATSDR website (www.atsdr.cdc.gov/toxfaq.html), EXTOXNET website (http://pmep.cce.cornell.edu/profiles/extoxnet/), Journal of Pesticide Reform website (www.pesticide.org) , Mackay et al. (1997)

[2] Source: Syracuse Research Corporation, http://www.syrres.com/esc/chemfate.htm

[3] Aldrin rapidly degrades to dieldrin in the environment (ATSDR, 2002b), thus half life of dieldrin is representative.

[4] Source: Burkhard et al, 1985 (Henry's law constant for PCBs not available from Syracuse Research Corporation website).

NA = information not available.

OCs tend to bind to organic matter because of their hydrophobicity. As a result, they adsorb to silt and sediment particles and adsorb to suspended and dissolved organic matter. The distribution coefficient (K_d) of a compound describes the partitioning of the compound between the solid and liquid phase, assuming equilibrium conditions. The organic carbon-normalized distribution coefficient (K_{OC}) is a related value that accounts for the fact that partitioning to sediments by hydrophobic compounds will increase with increasing amounts of organic carbon on sediments. The relationship between K_d and K_{OC} is as follows, where f_{OC} is the fraction of organic carbon in soil or sediment:

$$K_d \cong f_{OC} * K_{OC}$$

The approximate symbol is used because other sediment textural factors (e.g., surface area to volume ratios) can affect the site-specific distribution coefficient. The K_d can also vary with site-specific factors such as pH, temperature, and the concentration of the adsorbing pollutant. While the K_d is a useful property for ranking the relative affinity of different compounds for particles, equations defining the K_d should not be used too literally in modeling without site-specific information from monitoring.

A compound's potential to bioaccumulate is often measured by the ratio of its concentration in tissue to its concentration in water. This ratio is called the bioconcentration factor (BCF). The octanol: water partition coefficient (K_{ow}) is often used as a surrogate for the BCF with octanol acting as lipids (fat) and water acting as the aquatic environment. Note that the BCFs in Table 55 generally follow their K_{ow} values.

Suitability of DDE as a Representative Constituent

The use of DDE as a representative constituent for the organochlorine compounds included in this TMDL is appropriate for several reasons. As described in the Current Conditions section, it is the only constituent detected frequently enough to allow for robust analysis and modeling at varied spatial and temporal scales. It is also a suitable representative chemical because OC pesticides and PCBs have similar chemical properties, as described above.

The representative relationship is probably least appropriate for dacthal and for PCBs. There is little need for concern in the case of dacthal, since it is a category-2 constituent. In the case of PCBs, which have more widely ranging chemical properties and a significantly different use history, the compliance monitoring and adaptive management components outlined in the Implementation Plan will adequately address any issues that become apparent over time.

One additional benefit of using DDE as a representative constituent is that it is one of the most persistent OCs, which means that implementation measures and timescales set for achieving DDE targets will facilitate achievement of targets for the other OCs.

Gaseous Evasion

Evasion means the escape of OC compounds into the atmosphere. Evasion is generally considered to be significant for compounds that have Henry's Law constants (H values) greater than 10^{-4} atm-m^3/mole, although other factors such as wind speed, atmospheric concentration, and temperature also affect evasion rates. Evasion of most OCs from soil and water bodies is not considered to be a major loss mechanism. Heptachlor, heptachlor epoxide, and dieldrin all have H values above 10^{-4}, so gaseous evasion could be an important removal process for those constituents.

Seasonal variations in DDE Concentration

Water column data for each subwatershed were aggregated into wet and dry season samples and then averaged. Seasonal averages are calculated based on the average of detected values and half of the detection limit for non-detected values. The results indicate that DDE concentrations in receiving water are higher in the wet season than in the dry season for all reaches except Arroyo Las Posas (Table 56). Although the differences in the means are all statistically significant ($p<0.05$), some uncertainty is associated with the analysis of seasonality presented here because wet and dry averages are based on less than 20% detected values in three of the six subwatersheds.

No correlations between DDE and seasonality are found in sediment or tissue data.

Seasonal variation in DDE water column concentrations supports the importance of DDE loading from agricultural areas. The average DDE concentration in the water column increases by an order of magnitude during the wet season in Revolon Slough, but wet-weather increases in DDE concentrations are much more subtle in all other reaches (Table 56). The wet-weather increase in DDE concentrations in Revolon Slough is probably attributable to transport of DDE-laden sediments.

Table 56. Average DDE concentrations (ug/L) in representative TMDL reaches for wet and dry season water column samples.

Season[2]	Subwatershed [1]					
	Mugu	Calleguas	Revolon	Las Posas	Simi	Conejo
Dry	0.022	0.019	0.018	0.073	0.009	0.003
Wet	0.049	0.035	0.266	0.050	0.023	0.008

[1] Yellow shaded cells indicate less than 20% of samples had detectable levels. One-half the detection limit is used in place of non-detected values in these instances.
[2] Wet season is December-April; Dry season is May-November.

Degradation

Degradation of organochlorines can proceed by both biologically mediated and abiotic processes. Abiotic degradation mechanisms include photolysis and hydrolysis. Hydrolysis, the reaction of a water molecule with a molecular bond, is not a very important degradation pathway for most legacy OC pesticides (Mackay et al., 1997). Photolytic degradation can proceed directly when a molecular bond absorbs light, or indirectly, when photolytically produced reactive substances (e.g., superoxide radical, hydroxyl radical) attack molecular bonds. The mechanism and relative importance of photolysis (direct or indirect) depends on many factors, including the OC compound in question, the presence or absence of light-absorbing compounds (chromophores) that can produce reactive intermediates, and the degree of light penetration (in water) due to water depth and turbidity (e.g., Kulovaara et al., 1995).

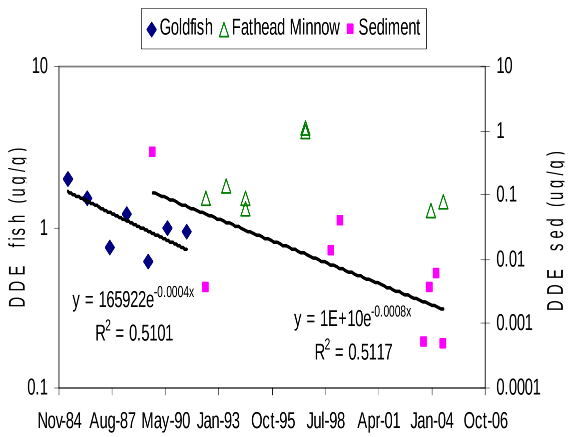
Biologically mediated degradation is generally a more important degradation pathway than hydrolysis or photolysis for OC pesticides, especially DDT and DDE (Aislabel et al, 1997). For DDT and DDE, the distribution of intermediates formed in the biotransformation process is sensitive to redox conditions. Under anaerobic conditions, microbial transformation of DDT occurs primarily by reductive dechlorination to produce DDD (1,1-dichloro-2,2-bis(p-chlorophenyl)ethane). Under aerobic conditions, DDT dechlorination produces primarily DDE and DBP (Perieira et al., 1996).

Degradation to bis(chlorophenyl)acetic acid (DDA) is a potential concern because DDA is a polar (i.e., more water soluble) degradation product (Heberer and Dünnbier, 1999). Environmental assessments often miss DDA because as a polar compound it requires a separate analytical procedure from DDT and non-polar metabolites. No data for DDA are included in the CCW database. Future monitoring efforts may wish to consider including analysis for this breakdown constituent.

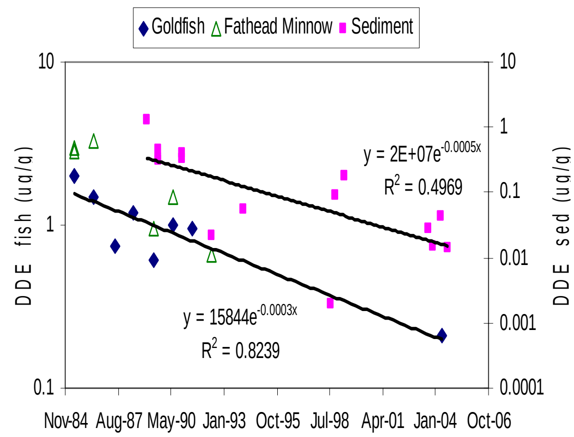
The range in reported degradation rates for OCs in soils are reported as “half life” in Table 55. These values take into account all degradation reactions. Environmental monitoring data tend to indicate that degradation rates reported from controlled laboratory studies are generally faster than what is actually observed under natural conditions (Spencer et al., 1996; Zepp and Cline, 1977).

Attenuation of OCs in the CCW

Banned OC pesticides generally show a loss of concentration over time, due to a sum total effect of all the loss terms (balanced by residual, legacy loads), as illustrated by the conceptual model (Figure 21). The best example of this can be seen in the DDE concentrations of fish and sediment samples reported for Revolon Slough and Calleguas Creek (Figure 22). Streambed sediment samples collected over a relatively long period indicate a decrease in DDE content over the past 15 years. Goldfish were collected most often in earlier samples while fathead minnows have been collected most often in more recent samples. The trend for both fish species is a decrease in DDE content over the last 20 years (although the trend is less apparent in Calleguas Creek for fathead minnow samples).



a)



b)

Figure 22. DDE content in streambed sediments and fish tissue for a) Calleguas Creek and b) Revolon Slough. Trend lines are shown for goldfish data; fathead minnow data are included because they have been collected more recently than goldfish in Calleguas Creek.

The decreases in DDE concentrations of sediments and biota emphasizes that natural attenuation of OCs is occurring already, due to degradation, burial, and flushing to the Ocean. A primary goal of this TMDL is to augment natural attenuation through implementation actions. The conceptual model in Figure 21 shows the action most likely to result in progress towards that goal is reduction of nonpoint source loads of OC pesticides and PCBs.

6.2 Linkage Between OC Loads, Targets, and Beneficial Uses

The conceptual model for OC fate, transformation and uptake supports four basic linkages in this TMDL Analysis, shown in Figure 23. The first linkage, that risk is proportional to pollutant concentrations in fish times consumption rates, is inherent to the target development process in section 4. The remaining three linkages are explained in detail below.

OC Concentrations in Tissue are proportional to OC concentrations in sediments.

The basic premise underlying this linkage is explained in the conceptual model presented above: OCs in sediments are taken up directly by filter feeders and benthic feeders. Organisms taking up dissolved OCs are still affected by OCs in sediment, because of adsorption-desorption equilibria. When the OC concentration of sediments in the CCW approaches zero, the OC concentration in the water column, interstitial waters, and the food chain will also approach zero.

This TMDL analysis makes the simplifying assumption that the relationship between OC concentrations in fish and sediments is linear, with the slope of the line being the overall sediment–organism bioaccumulation factor (BAF) (Figure 24-A). It is possible that a non-linear relationship between sediments and fish tissue exists (Figure 24-B, Figure 24-C). This is an acknowledged uncertainty in the TMDL analysis. However, it is important to note that the uncertainty does not prevent action, because there is reasonable certainty that lower OC concentrations in sediments will lead to lower OC concentrations in the food chain.

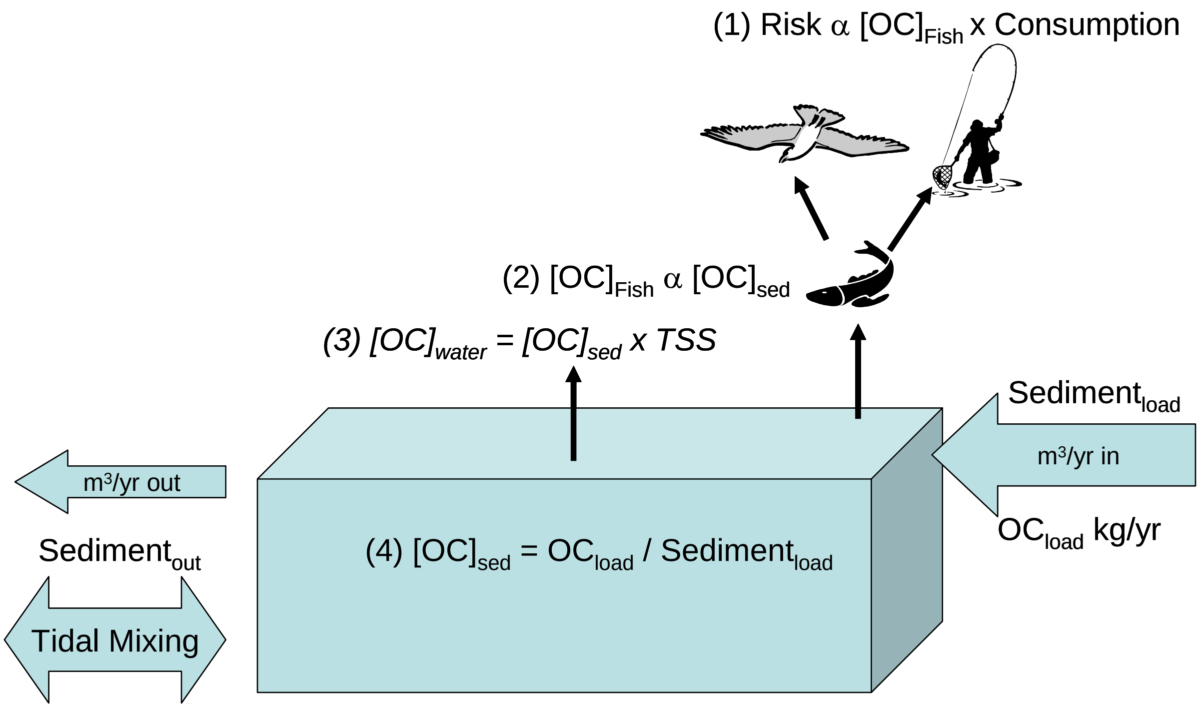


Figure 23. Conceptual illustration of the four basic linkages in this TMDL analysis: (1) Risk is proportional to OC concentration in fish times the fish consumption rate by people and wildlife; (2) OC concentrations in fish are proportional to OC concentrations in sediments; (3) OC concentrations in water are equal to OC concentrations in suspended sediments times the suspended sediment load; and (4) OC concentrations in sediments are equal to OC loads divided by sediment loads.

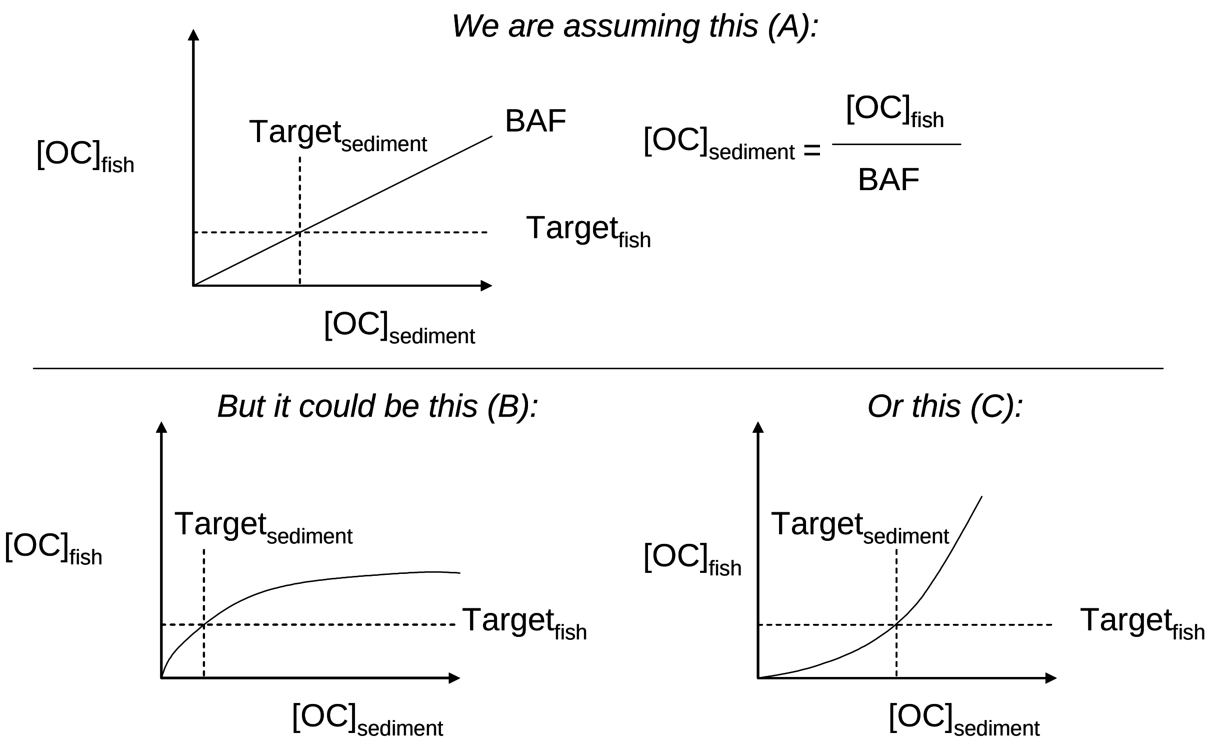


Figure 24: Comparison of the working assumption of direct proportionality between sediments and fish (A) with alternative non-linear models (B) and (C).

To better predict the expected relationship between OC concentration in sediments and OC concentrations in fish tissue, it is important to develop and populate a food web model such as the one shown in Figure 25. An assessment of all organisms present in the food web for the CCW has not been completed, but preliminary monitoring information is available.

DDE concentrations in organisms found in the CCW are shown in Table 57 and Table 58. The average concentrations of DDE do not generally increase with trophic level, as would normally be expected for bioaccumulative substances. This likely reflects an incomplete understanding of the food web. For example, the sharks in Mugu lagoon (TL 4) are not necessarily feeding on an exclusive diet of surfperch (TL3), and both organisms are free to forage outside of Mugu Lagoon. Additionally, many of the highest concentrations might be associated with specific locations where species reside (e.g., herbivores and/or detritivores living in or near agricultural discharges).

In summary, with incomplete information on the food web and OC bioaccumulation processes, proportionality between sediments and fish is assumed. Development of a detailed food web model and population of the model with matched predator-prey-sediment data could verify or refute that assumption. If a non-linear model applies, then the resulting TMDL may be lower or higher than that which is calculated by assuming a linear sediment-organism BAF. If that is discovered to be the case through assessment carried out in TMDL implementation, the TMDL can be adjusted through the TMDL review process.

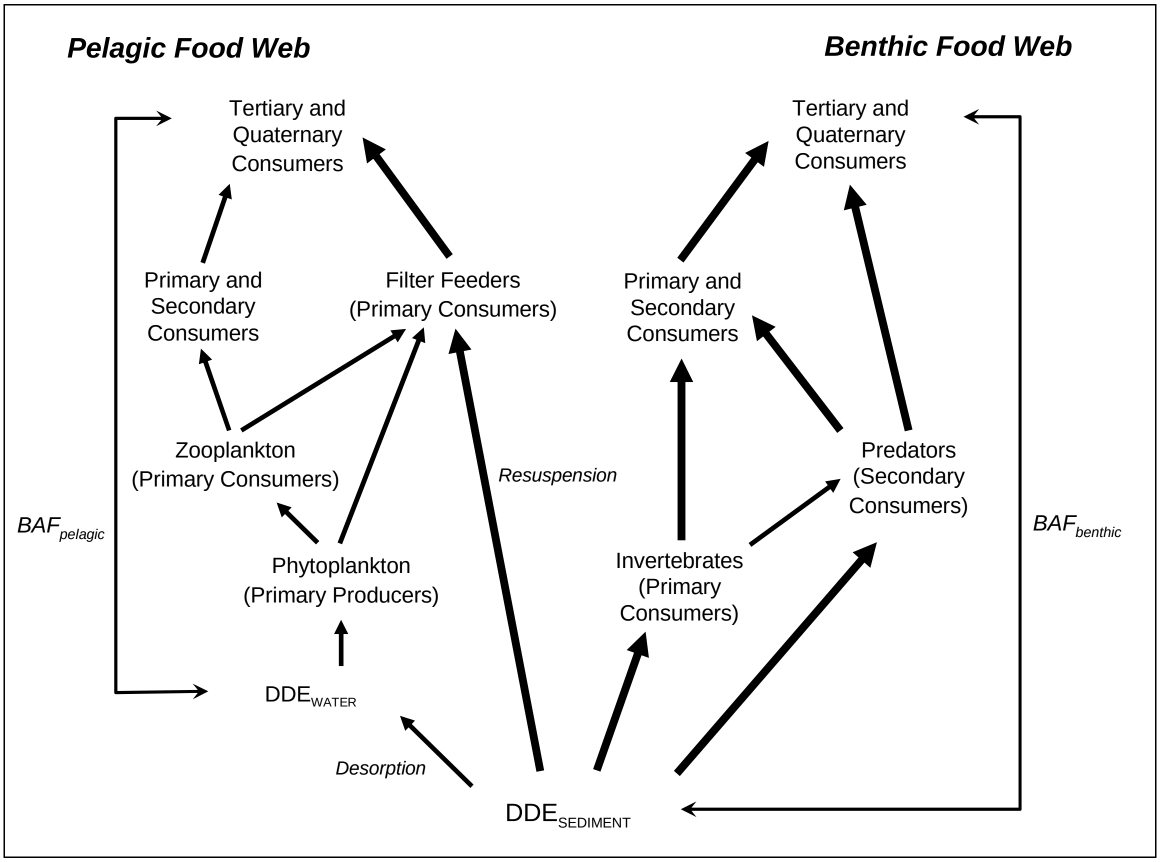


Figure 25. Basic food web model for CCW aquatic organisms, freshwater and marine.

Table 57. Marine organisms found in the CCW database (Reach 1) and average DDE tissue concentrations according to trophic level.

Trophic Level	Trophic Level Description	Organism	Linnean Classification	n	Avg DDE Concentration (ug/g)	
					Filet/Muscle	Whole Org
1	Primary Consumer (Herbivore)	Benthic invertebrate	Class Polychaeta	2	N/A	0.24
		Clam	Class Bivalvia	4		
		Mussel	Class Pelecypoda	3		
		Resident California Mussel	*Mytilus californianus*	6		
		Snails	*Melampus olivasceous*	2		
		Transplanted California Mussel	Class Pelecypoda	10		
2	Secondary Consumer (Primary Carnivore)	Crab	*Pachygrapsus crassipes*	11	0.08	0.41
		Longjaw Mudsucker	*Gillichthys mirabilis*	2		
		Shiner Perch	*Cymatogaster aggregata*	1		
		Shiner Surfperch	*Cymatogaster aggregata*	1		
		Topsmelt	*Atherinops affinis*	1		
3	Tertiary Consumer (Secondary Carnivore)	Crayfish	*Procambarus spp.*	2	N/A	0.35
4	Quaternary Consumer (Tertiary Carnivore)	Gray Smoothhound Shark	*Mustelus californicus*	7	0.11	N/A

Table 58. Freshwater organisms found in the CCW database (Reaches 2-13) and average DDE tissue concentrations according to trophic level.

Trophic Level	Trophic Level Description	Organism	Linnean Classification	n	Avg DDE Concentration (ug/g)	
					Filet/Muscle	Whole Org.
1	Primary Consumer (Herbivore)	African Clawed Frog Tadpoles	*Xenopus laevis*	1	2.57	0.64
		Goldfish	*Carassius auratus*	17		
		Transplanted Fresh Water Clam	*Corbicula spp.*	4		
2	Secondary Consumer (Primary Carnivore)	Arroyo Chub	*Gila orcutti*	15	0.84	1.52
		California Killifish	*Fundulus parvipinnis*	1		
		Carp	Family Cyprinidae	6		
		Fathead Minnow	*Pimephales promelas*	14		
		Mosquitofish	*Gambusia affinis*	7		
3	Tertiary Consumer (Secondary Carnivore)	Black Bullhead	*Ameiurus melas*	13	0.33	N/A
		Brown Bullhead	*Ameiurus nebulosus*	3		
		Bullhead	*Ameiurus spp.*	1		
		Green Sunfish	*Lepomis cyanellus*	7		
		Red Swamp Crayfish	*Procambarus clarkii*	1		

OC Concentrations in Water are a Function of OC Concentrations in Sediment

For particle-associated pollutants, the pollutant concentration in water is the TSS concentration of the water multiplied by the pollutant concentration on the TSS. This simplifying assumption is fundamental to many particle-associated TMDLs, such as the recently adopted TMDL for mercury in San Francisco Bay (SFBRWQCB, 2004). Site-specific data from the CCW show how this fact is central to understanding how reducing OC concentrations in sediments will not only lead to reduced concentrations in fish, but will attain water column targets as well.

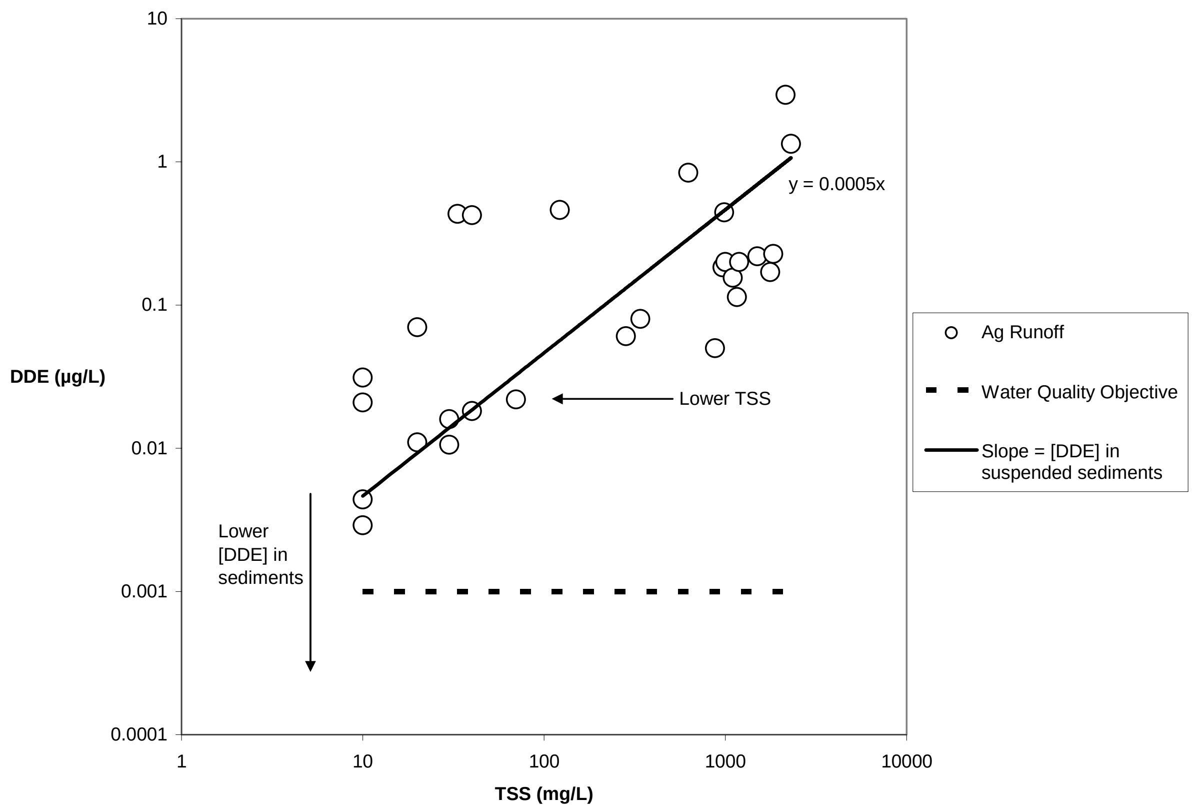


Figure 26. DDE concentrations in water increase with increasing TSS in agricultural drainage of the CCW. Note that the slope of the line gives the DDE concentration of suspended particulate matter (= 0.0005 µg DDE /mg sed or 500 ng/g).

The fact that DDE concentrations in the water column increase with increasing TSS leads to two possible strategies to attain water column targets. Reducing the TSS would lower water column DDE concentrations, but it isn't feasible to keep TSS low enough (considerably less than 10 mg/L). Rather, if the concentration of DDE in suspended particulates were reduced below the current level of 500 ppb (ng/g), then the entire line would shift downwards, making attainment of the water quality objective for DDE (0.001 µg/L) feasible at ambient TSS levels.

OC Concentrations in Sediment are a Function of OC Loading and Sediment Transport

Pollutant concentration in sediments is the master variable for attainment of beneficial uses in this TMDL analysis. OC loads are related to OC concentrations in sediment via a simple, one-box mixing model. In reality, multi-box sediment transport dynamic models are more accurate representations, but the one-box approach is often sufficient to identify the most logical next steps in TMDL implementation.

The sediments in any reach of the CCW, or in Mugu Lagoon, can be considered to be a well-mixed reservoir of a defined mass. Sediments enter from upstream, deposit, are mixed by winds, currents, tides, and organisms, and re-suspended. OC pollutants enter on sediments or, if in the dissolved phase, are scavenged onto sediments. Sediments leave the box representing a reach by either current flow or tidal action.

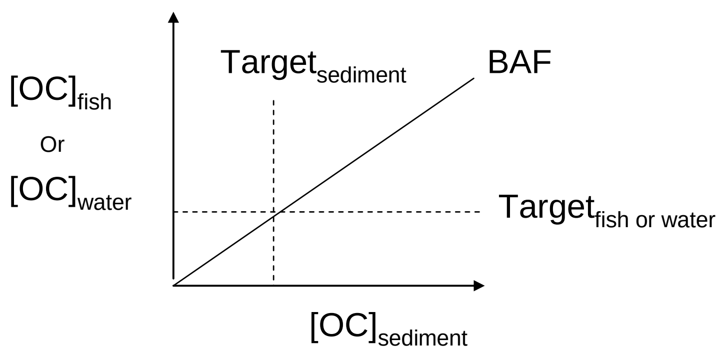
The long-term average concentration of OC pollutants in any given reach will simply be the long-term annual average OC load, divided by the long-term annual average sediment load. This becomes a reasonable basis for calculation of a Total Maximum Pollutant Load needed to attain a target concentration of an OC in sediment. The key information needed is the sediment load, which is not well known for this watershed. Therefore, an early task in the implementation plan is an assessment of sediment transport dynamics.

The importance of this concept is that it leads directly to the implementation actions needed to augment the effects of natural attenuation. The fastest way to attain the target concentrations of OCs in sediments, and therefore attain beneficial uses, is to address the largest controllable OC loads. In general, this will mean assessing OC concentrations in different land use types, and implementing BMPs to reduce soil erosion, and siltation from areas with the highest OC concentrations in sediments.

Although the basic mechanisms that transport terrestrial soils are understood (i.e., erosion from agricultural and urban soils contaminated with OCs) more specific information about the concentrations and quantities of sediment transported by runoff and erosion are not currently available, although development of such information is included in the Implementation Plan.

7 TMDL AND ALLOCATIONS

The goals of this TMDL are to reduce OC pesticide and PCB concentrations in fish tissue to levels safe for human consumption and to assure sediment and water column concentrations are protective of aquatic life. Category-2 constituents identified in the Current Conditions Section are assigned allocations equal to numeric targets for fish tissue and water, although current data suggests they are not exceeding these allocations. The TMDL for category-1 constituents is calculated as a reduction in sediment concentration, which is based upon fish tissue and water concentrations (and consideration of sediment guidelines, for reaches with sediment listings). In order to translate required reductions in fish tissue and water column concentrations into sediment concentration reductions, it is assumed that BAFs for fish tissue to sediment and water to sediment are linear, and that a given percent reduction in fish tissue or water concentration results in an equal percent reduction in sediment concentration (Figure 27). The basis for this assumption is presented in the Linkage Analysis. The validity of this assumption will be evaluated as part of the Implementation Plan and adjusted if necessary to ensure compliance with numeric targets and achievement of beneficial uses.



$$BAF = \frac{[OC]_{fish\ or\ water}}{[OC]_{sediment}}$$

$$\frac{\%\ Reduction_{fish\ or\ water}}{\%\ Reduction_{sediment}} = 1$$

Figure 27. BAF assumptions for translation of fish tissue and water concentration reductions to sediment reductions.

In order to ensure that both fish tissue and water criteria levels are attained, percent reductions in sediment concentration are set equal to the more stringent of the required fish tissue or water column reduction, as shown in Equation 2 and Equation 3.

Equation 2. When $PR_{fish} > PR_{water}$, $PR_{fish} = PR_{sed}$ --> TMDL *

Equation 3. When $PR_{water} > PR_{fish}$, $PR_{water} = PR_{sed}$ --> TMDL *

Where:

PR_{sed} = percent reduction in sediment concentration (ug/g)
PR_{fish} = percent reduction in fish tissue concentration (ug/g)
PR_{water} = percent reduction in water column concentration (ug/L)

* for reaches with sediment listings, lower of PR_{sed} or sediment guideline is applied as final TMDL concentration

Although allocations are expressed in terms of sediment concentration, TMDL progress will be measured according to achievement of all numeric targets in addition to compliance with waste load allocations and load allocations. Thus, any margin of error associated with the implicit use of BAFs and assumption of equal percent reduction across media (from fish tissue and water to sediment) might affect the validity of PR_{sed} in the short term but will not affect achievement of numeric targets in the long run.

TMDLs are comprised of a waste load allocation (WLA), a load allocation (LA), a background load (BL), and a margin of safety (MOS), as shown in Equation 4.

Equation 4 $TMDL = PR_{sed} = WLA + LA + BL + MOS$

WLAs are assigned to point source contributors of pollutants and LAs are assigned for non-point source contributions. Since OCs are not naturally occurring, the background load is set to zero. A significant implicit margin of safety is included, which is fully explained later in this section.

The allocation approach for each constituent depends upon whether or not any sediment listings exist for that constituent, the status of the constituent (category 1 versus category 2), and whether or not sediment guidelines exist for the constituent. Specific factors leading to the allocation approach for all listed constituents are shown in Figure 28.

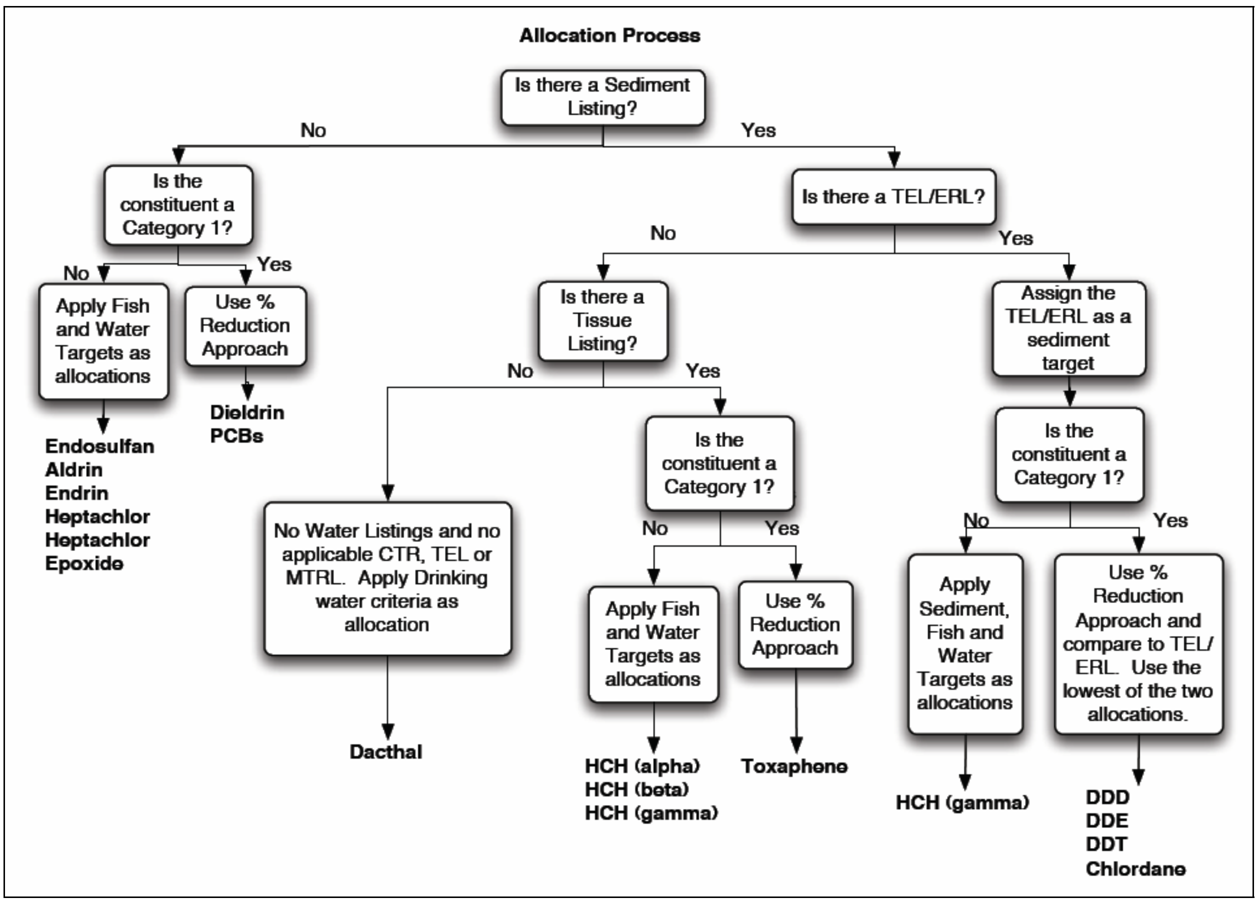


Figure 28. Approach used to develop allocations for each constituent.

The CCW Toxicity TMDL did not identify any OCs as causing toxicity in water or sediment. Any unidentified toxicity which may result from OCs is addressed in the OCs TMDL by selection of numeric targets which are protective of toxicity in water and sediment.

Alternatives Considered

WLAs and LAs expressed as loads in sediment, rather than as sediment concentrations, were considered. Deemed to be an inferior approach due to a lack of sufficient knowledge of sediment transport processes in the watershed (capability does not exist for quantifying transport of both fine and course sediment), and also because reducing total loading of sediment-borne OCs would not necessarily result in decreased concentrations of OCs in sediment.

Use of sediment guidelines, exclusively. The sediment guidelines are not adopted, not clearly protective of human health or aquatic toxicity, and no guidelines exist for many constituents.

7.1 Critical Conditions

The Clean Water Act stipulates a TMDL must take into account critical conditions and seasonal variation. OC concentrations in water, as represented by DDE in the Linkage Analysis section, are correlated with TSS and possibly correlated with flow and seasonality (wet vs. dry season). However, no correlations with flow or seasonality were found to exist in sediment or tissue data. Given that allocations for this TMDL are expressed in terms of OC concentrations in sediment, a critical condition is not identified based upon flow or seasonality.

Since the potential effects of OCs are related to bioaccumulation in the food chain over long periods of time, short term variations in concentration are not likely to cause significant impacts upon beneficial uses. Thus, average concentrations on an annual timescale are hereby defined as the critical condition.

Numeric targets selected for this TMDL are based on conservative (i.e., highly protective) values of water quality objectives, and the methodology for determining allowable concentrations employs several conservative assumptions. In combination, these factors ensure final WLAs and LAs will result in attainment of water quality objectives under all conditions of flow and loading.

7.2 Existing and Allowable Concentrations

Whenever sufficient data exist, percent reductions for category-1 constituents are calculated for fish tissue and water column concentrations by comparing data for existing conditions with the numeric targets. The percent reduction for sediment concentrations is set equal to the greater percent reduction required to meet either the fish tissue or water column target (Equation 2 and Equation 3). That percentage is used to calculate the allowable sediment concentration at the discharge point of each subwatershed, referred to as the "discharge goal." Potential downstream impacts are then considered. When the discharge goal for a given subwatershed is higher than its downstream neighbor, the final allowable concentration of the upstream subwatershed is set equal to the discharge goal of the downstream neighbor (in order to ensure protection of downstream subwatersheds from upstream inputs). This concentration is the final allowable concentration for all constituents without 303(d) listings for sediment. In the case of constituents with listings for sediment, the allowable concentration determined by percent reduction and downstream effects is compared with the sediment guideline numeric target; and the lower of the two is selected as the final allowable concentration.

Existing concentrations, percent reductions, and allowable concentrations for category-1 constituents are shown in Table 59 through Table 65. Existing concentrations are based on mean values for each constituent by subwatershed, using available receiving water data from all years. Non-detect results are quantified as half the detection limit. Italicized values shown in green shaded cells are estimated from mostly non-detected samples. Cells marked with "IDD" indicate an insufficient number of detected data to merit calculation of mean concentration. The marker "NL" is used to denote cells for which no listing exists. The column "Allowable Concentration" reflects the final allowable concentration, after consideration of all relevant factors described above.

Table 59. Existing concentrations and percent reductions required in water, fish tissue, and sediment for Chlordane.

Subwatershed	Water (ug/L)		Fish (ug/g)		Sediment (ug/g)					
	Mean	% Red.	Mean	% Red.	Mean	% Red.	Discharge Goal	Downstream Consideration	Sediment Target	Allowable Concentration
Mugu Lagoon	IDD	0%	IDD	0%	*0.0023*	0%	0.0023	--	NL	0.0023
Calleguas Creek	IDD	0%	*0.0045*	0%	*0.0006*	0%	0.0006	0.0023	NL	0.0006
Revolon Slough	*0.0078*	48%	*0.0331*	75%	*0.0054*	75%	0.0014	0.0023	0.0045	0.0014
Arroyo Las Posas	IDD NL	0%	IDD NL	0%	IDD NL	0%	IDD NL	0.0006	NL	0.0006
Arroyo Simi	IDD NL	0%	IDD NL	0%	IDD NL	0%	IDD NL	0.0006	NL	0.0006
Conejo Creek	IDD	0%	*0.0022*	0%	IDD	0%	IDD	0.0006	NL	0.0006

Table 60. Existing concentrations and percent reductions required in water, fish tissue, and sediment for 4,4'-DDD.

Subwatershed	Water (ug/L)		Fish (ug/g)		Sediment (ug/g)					
	Mean	% Red.	Mean	% Red.	Mean	% Red.	Discharge Goal	Downstream Consideration	Sediment Target	Allowable Concentration
Mugu Lagoon	0.0806	0%	*0.0063*	0%	0.0178	0%	0.0178	--	0.002	0.002
Calleguas Creek	0.0615	0%	0.0414	0%	0.0091	0%	0.0091	0.002	0.0035	0.002
Revolon Slough	*0.0254*	0%	0.1818	75%	0.0501	75%	0.0124	0.002	0.0035	0.002
Arroyo Las Posas	IDD NL	0%	IDD NL	0%	0.0068	0%	0.0068	0.002	0.0035	0.002
Arroyo Simi	IDD NL	0%	IDD NL	0%	*0.0021*	0%	0.0021	0.002	0.0035	0.002
Conejo Creek	IDD	0%	*0.0025*	0%	IDD	0%	IDD	0.002	0.0035	0.002

Table 61. Existing concentrations and percent reductions required in water, fish tissue, and sediment for 4,4'-DDE.

Subwatershed	Water (ug/L)		Fish (ug/g)		Sediment (ug/g)					
	Mean	% Red.	Mean	% Red.	Mean	% Red.	Discharge Goal	Downstream Consideration	Sediment Target	Allowable Concentration
Mugu Lagoon	*0.0382*	0%	0.1043	69%	0.0575	69%	0.0176	--	0.0022	0.0022
Calleguas Creek	0.0235	0%	0.6444	95%	0.0604	95%	0.0030	0.0022	0.0014	0.0014
Revolon Slough	0.1165	0%	1.6368	98%	0.2314	98%	0.0045	0.0022	0.0014	0.0014
Arroyo Las Posas	0.0038	0%	*0.0040*	0%	0.0396	0%	0.0396	0.0014	0.0014	0.0014
Arroyo Simi	*0.0138*	0%	IDD	0%	0.0142	0%	0.0142	0.0014	0.0014	0.0014
Conejo Creek	*0.0093*	0%	0.0229	0%	0.0026	0%	0.0026	0.0014	0.0014	0.0014

[1] no aquatic life criteria exist for DDE.

Table 62. Existing concentrations and percent reductions required in water, fish tissue, and sediment for 4,4'-DDT.

Subwatershed	Water (ug/L)		Fish (ug/g)		Sediment (ug/g)					
	Mean	% Red.	Mean	% Red.	Mean	% Red.	Discharge Goal	Downstream Consideration	Sediment Target	Allowable Concentration
Mugu Lagoon	*0.0377*	97%	IDD	0%	0.0096	97%	0.0003	--	0.0010	0.0003
Calleguas Creek	*0.0250*	96%	0.0326	2%	0.0142	96%	0.0006	0.0003	NA	0.0003
Revolon Slough	0.0516	98%	0.1933	83%	0.0791	98%	0.0015	0.0003	NA	0.0003
Arroyo Las Posas	*0.0577*	98%	IDD	0%	0.0254	98%	0.0004	0.0003	NA	0.0003
Arroyo Simi	IDD NL	0%	IDD NL	0%	*0.0032*	0%	0.0032	0.0003	NA	0.0003
Conejo Creek	IDD	0%	IDD	0%	*0.0081*	0%	0.0081	0.0003	NA	0.0003

Table 63. Existing concentrations and percent reductions required in water, fish tissue, and sediment for Dieldrin.

Subwatershed	Water (ug/L)		Fish (ug/g)		Sediment (ug/g)					
	Mean	% Red.	Mean	% Red.	Mean	% Red.	Discharge Goal	Downstream Consideration	Sediment Target	Allowable Concentration
Mugu Lagoon	IDD NL	0%	IDD NL	0%	*0.0043*	0%	0.0043	--	NL	0.0043
Calleguas Creek	IDD	0%	*0.0027*	76%	*0.0009*	76%	0.0002	0.0043	NL	0.0002
Revolon Slough	IDD	0%	0.0089	93%	0.0015	93%	0.0001	0.0043	NL	0.0001
Arroyo Las Posas	IDD NL	0%	IDD NL	0%	IDD NL	0%	IDD NL	0.0002	NL	0.0002
Arroyo Simi	IDD NL	0%	IDD NL	0%	IDD NL	0%	IDD NL	0.0002	NL	0.0002
Conejo Creek	IDD NL	0%	IDD NL	0%	IDD NL	0%	IDD NL	0.0002	NL	0.0002

Table 64. Existing concentrations and percent reductions required in water, fish tissue, and sediment for PCBs.

Subwatershed	Water (ug/L)		Fish (ug/g)		Sediment (ug/g)					
	Mean	% Red.	Mean	% Red.	Mean	% Red.	Discharge Goal	Downstream Consideration	Sediment Target	Allowable Concentration
Mugu Lagoon	IDD	0%	IDD	0%	*0.1752*	0%	0.1752	--	NL	0.1752
Calleguas Creek	IDD	0%	*0.0062*	14%	*0.1379*	14%	0.1183	0.1752	NL	0.1183
Revolon Slough	IDD	0%	IDD	0%	*0.1252*	0%	0.1252	0.1752	NL	0.1252
Arroyo Las Posas	IDD NL	0%	IDD NL	0%	IDD NL	0%	IDD NL	0.1183	NL	0.1183
Arroyo Simi	IDD	0%	IDD	0%	IDD	0%	IDD	0.1183	NL	0.1183
Conejo Creek	IDD NL	0%	IDD NL	0%	IDD NL	0%	IDD NL	0.1183	NL	0.1183

Table 65. Existing concentrations and percent reductions required in water, fish tissue, and sediment for Toxaphene.

Subwatershed	Water (ug/L)		Fish (ug/g)		Sediment (ug/g)					
	Mean	% Red.	Mean	% Red.	Mean	% Red.	Discharge Goal	Downstream Consideration	Sediment Target	Allowable Concentration
Mugu Lagoon	IDD NL	0%	IDD NL	0%	0.3552	0%	0.3552	--	NA	0.3552
Calleguas Creek	IDD	0%	0.3906	97%	*0.0235*	97%	0.0006	0.3552	NA	0.0006
Revolon Slough	IDD	0%	1.6647	99%	0.1637	99%	0.0010	0.3552	NA	0.0010
Arroyo Las Posas	IDD NL	0%	IDD NL	0%	IDD NL	0%	IDD NL	0.0006	NA	0.0006
Arroyo Simi	IDD	0%	IDD	0%	IDD	0%	IDD	0.0006	NA	0.0006
Conejo Creek	IDD	0%	IDD	0%	IDD	0%	IDD	0.0006	NA	0.0006

"NA" indicates that no sediment targets exist for toxaphene.

7.3 Waste Load Allocations and Load Allocations

Waste load allocations (WLAs) are assigned to point source discharges, including urban runoff from stormwater co-permittees and wastewater treatment plants (POTWs). Load allocations (LAs) are allocated to nonpoint source discharges, in this case agricultural discharges. Urban runoff, POTWs, and agricultural discharges are collectively referred to as discharges. Compliance with WLAs and LAs will be determined at the base of each subwatershed because water, fish tissue, and sediment data collected there represent cumulative inputs from the drainage area. The source analysis and linkage analysis have demonstrated the contributions of OC pesticides and PCBs to receiving waters from each of these discharges are potentially significant, depending on specifics related to each constituent.

Phased WLAs and LAs for category-1 constituents are set to allow time for reductions in OC concentrations attributable to implementation efforts and natural attenuation to occur before incorporating final WLAs and LAs into permits (the terms "phased" and "interim" are both used refer to non-final WLAs and LAs; the term "phased" is used by USEPA and "interim" by RWQCB). Phased WLAs and LAs are based on the 95th percentile value of in-stream sediment data whenever a sufficient number of detected values exist. The use of 95th percentile values to develop phased limits is consistent with current NPDES permitting methodology. When a sufficient number of detected values are not available for calculation of the 95th percentile, the highest detected value is used as the phased WLA or LA. If no detected values exist in the relevant data set, the phased limit is set according to the Minimum Level issued by SWRCB in the Statewide Implementation Plan (SIP).

WLAs and LAs are not applied for subwatershed-constituent combinations which meet all of the following conditions: the constituent is not listed for any reaches in the subwatershed, a sufficient number of data exist to determine exceedances are occurring rarely or not at all (according to the same methodology used for defining category-2 constituents in the Current Conditions section), and no potential for downstream impacts exists.

Waste Load Allocations for Urban Runoff

WLAs for category-1 constituents in urban runoff (i.e., stormwater co-permittees) are set equal to the allowable concentration for in-stream sediment, with compliance determined at the base of each subwatershed, as shown in Table 66. Should an exceedance occur at the base of a subwatershed, future source-specific sediment monitoring will attempt to identify causes of the exceedance. As explained previously, WLAs for category-2 constituents are assigned as water and fish tissue numeric targets, shown in Table 67.

Table 66. Phased/Interim and Final Sediment WLAs for MS4 Permittees for Category-1 Constituents.

Constituent	Allocation Type	Mugu Lagoon (µg/g)	Calleguas Creek (µg/g)	Revolon Slough (µg/g)	Arroyo Las Posas (µg/g)	Arroyo Simi (µg/g)	Conejo Creek (µg/g)
Chlordane	Phased/Interim Annual Allocation	0.025	0.017	0.048	0.0033 [NL]	0.0033 [1, NL]	0.0034
	Final Annual Average Allocation [2]	0.0033	0.0033	0.0009	0.0033 [NL]	0.0033 [NL]	0.0033
4,4-DDD	Phased/Interim Annual Allocation	0.069	0.066	0.40	0.29	0.014 [NL]	0.0053
	Final Annual Average Allocation [2]	0.0012 [3]	0.0012 [3]	0.0012 [3]	0.0012 [3]	0.0012 [3, NL]	0.0012 [3]
4,4-DDE	Phased/Interim Annual Allocation	0.30	0.47	1.6	0.95	0.17 [NL]	0.02
	Final Annual Average Allocation [2]	0.0021 [3]	0.0014 [3]	0.0014 [3]	0.0014 [3]	0.0014 [3, NL]	0.0014 [3]
4,4-DDT	Phased/Interim Annual Allocation	0.039	0.11	0.69	0.67	0.025 [NL]	0.002
	Final Annual Average Allocation [2]	0.0003	0.0003	0.0003	0.0003	0.0003 [NL]	0.0003
Dieldrin	Phased/Interim Annual Allocation	0.019 [NL]	0.003	0.0057	0.0011 [NL]	0.0011 [1, NL]	0.003 [1]
	Final Annual Average Allocation [2]	0.0043 [NL]	0.0002	0.0001	0.0002 [NL]	0.0002 [NL]	0.0002
PCBs	Phased/Interim Annual Allocation	0.18	3.8	7.6	25.7 [NL]	25.7 [1, NL]	3.8 [1]
	Final Annual Average Allocation [2]	0.18	0.12	0.13	0.12 [NL]	0.12 [NL]	0.12 [NL]
Toxaphene	Phased/Interim Annual Allocation	22.9 [NL]	0.26	0.79	0.23 [NL]	0.23 [1, NL]	0.26 [1]
	Final Annual Average Allocation [2]	0.36 [NL]	0.0006	0.001	0.0006 [NL]	0.0006 [NL]	0.0006

1. Phased/Interim WLAs are set equal to the Minimum Level as defined in the SIP because there are no detected values in the dataset.
2. Final allocations set equal to the sediment concentrations determined through calculating the percent reductions required to achieve fish tissue and water column targets as described in the allocation section unless otherwise noted.
3. Final allocations are set equal to the TEL or ERL, as described in Figure 28.
"NL" Subwatershed-constituent combination with no 303(d) listing. Allocations assigned based on downstream impacts.

Table 67. Final Water and Fish Tissue WLAs for MS4 Permittees for Category-2 Constituents.

Constituent	Allocation Type	Mugu Lagoon	Calleguas Creek	Revolon Slough	Arroyo Las Posas	Arroyo Simi	Conejo Creek
Aldrin	Final Monthly Average Water Allocation (µg/L) [1]	1.3 [3]	3 [3]	3 [3]	3 [3]	3 [3]	3 [3]
	Final Annual Average Tissue Allocation (µg/kg) [2]	0.05	0.05	0.05	0.05	0.05	0.05
Dacthal	Final Monthly Average Water Allocation (µg/L) [1]	NA	NA	3500 [4]	NA	NA	NA
	Final Annual Average Tissue Allocation (µg/kg) [2]	NA	NA	NA	NA	NA	NA
Endosulfan	Final Monthly Average Water Allocation (µg/L) [1]	NA	NA	NA	NA	NA	0.056
	Final Annual Average Tissue Allocation (µg/kg) [2]	NA	NA	NA	NA	NA	64800
Endrin	Final Monthly Average Water Allocation (µg/L) [1]	0.0023	0.036	0.036	0.036	0.036	0.036
	Final Annual Average Tissue Allocation (µg/kg) [2]	3220	3220	3220	3220	3220	3220
HCH (gamma-BHC)	Final Monthly Average Water Allocation (µg/L) [1]	0.16	0.95	0.95	0.95	0.95	0.95
	Final Annual Average Tissue Allocation (µg/kg) [2]	8.2	8.2	8.2	8.2	8.2	8.2
Heptachlor	Final Monthly Average Water Allocation (µg/L) [1]	0.0036	0.0038	0.0038	0.0038	0.0038	0.0038
	Final Annual Average Tissue Allocation (µg/kg) [2]	2.4	2.4	2.4	2.4	2.4	2.4
Heptachlor Epoxide	Final Monthly Average Water Allocation (µg/L) [1]	0.0036	0.0038	0.0038	0.0038	0.0038	0.0038
	Final Annual Average Tissue Allocation (µg/kg) [2]	1.2	1.2	1.2	1.2	1.2	1.2

1. CTR chronic toxicity criteria for the protection of aquatic life are used, unless otherwise noted. Available data indicates that Category-2 constituents are not currently exceeding acute or chronic targets.
2. Tissue Threshold Residue Levels (TTRLs), derived from CTR human health criteria.
3. No chronic criteria exist. Acute criteria are used.
4. No chronic or acute criteria exist. Drinking water standard of 3500 µg/L adopted by Florida and Arizona is applied. No marine or fish tissue standards exist.
“NA” Allocations are not necessary because the constituent is Category-2, not listed for the reach to which the POTW discharges, and does not have any downstream listings or exceedances.

Waste Load Allocations for POTWs

WLAs are assigned in water for POTWs, since they discharge negligible amounts of sediment. US EPA, LARWQCB, and POTW representatives in the CCW reached consensus regarding use of this approach after considering a range of alternatives. Phased WLAs for POTWs are based on either maximum detected values or Minimum Levels from the SIP, since an insufficient number of detected values are available for calculation of 95th percentiles. Final WLAs are generated using the methodology for calculating effluent limits which is presented in section 1.4 of the SIP. The resulting WLAs are shown in Table 68.

Table 68. Phased/Interim and Final WLAs for POTWs.

Constituent	Allocation Type	Hill Canyon WWTP	Simi Valley WQCP	Moorpark WTP	Camarillo WRP	Camrosa WRP
Category 1		(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
Chlordane	Phased/Interim WLAs [1]	2.4 [2]	0.1	0.1	0.1	0.1
	Final Daily WLAs [3]	0.0012	0.0012	0.0012	0.0012	0.0012
	Final Monthly WLAs [3]	0.00059	0.00059	0.00059	0.00059	0.00059
4,4-DDD	Phased/Interim WLAs [1]	0.02 [2]	0.05	0.05	0.006	0.05
	Final Daily WLAs [3]	0.0017	0.0017	0.0017	0.0017	0.0017
	Final Monthly WLAs [3]	0.00084	0.00084	0.00084	0.00084	0.00084
4,4-DDE	Phased/Interim WLAs [1]	0.26[2]	0.005[2]	0.001[2]	0.188[2]	0.05
	Final Daily WLAs [3]	0.0012	0.0012	0.0012	0.0012	0.0012
	Final Monthly WLAs [3]	0.00059	0.00059	0.00059	0.00059	0.00059
4,4-DDT	Phased/Interim WLAs [1]	0.01	0.01	0.01	0.01	0.01
	Final Daily WLAs [3]	0.0012	0.0012	0.0012	0.0012	0.0012
	Final Monthly WLAs [3]	0.00059	0.00059	0.00059	0.00059	0.00059
Dieldrin	Phased/Interim WLAs [1]	0.01	0.01	0.01	0.01	0.01
	Final Daily WLAs [3]	0.00028	0.00028	0.00028	0.00028	0.00028
	Final Monthly WLAs [3]	0.00014	0.00014	0.00014	0.00014	0.00014
PCBs	Phased/Interim WLAs [1]	0.5	0.5	0.5	0.031[2]	0.5
	Final Daily WLAs [3]	0.00034	0.00034	0.00034	0.00034	0.00034
	Final Monthly WLAs [3]	0.00017	0.00017	0.00017	0.00017	0.00017
Toxaphene	Phased/Interim WLAs [1]	0.5	0.5	0.5	0.5	0.5
	Final Daily WLAs [3]	0.00033	0.00033	0.00033	0.00033	0.00033
	Final Monthly WLAs [3]	0.00016	0.00016	0.00016	0.00016	0.00016
Category 2		(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
Aldrin	Final Daily WLAs [3]	0.00028	0.00028	0.00028	0.00028	0.00028
	Final Monthly WLAs [3]	0.00014	0.00014	0.00014	0.00014	0.00014
Dacthal	Final Daily WLAs [3]	NA	NA	NA	NA	NA
	Final Monthly WLAs [3]	NA	NA	NA	NA	NA
Endosulfan	Final Daily WLAs [3]	0.092	NA	NA	NA	NA
	Final Monthly WLAs [3]	0.046	NA	NA	NA	NA
Endrin	Final Daily WLAs [3]	0.059	0.059	0.059	0.059	0.059
	Final Monthly WLAs [3]	0.029	0.029	0.029	0.029	0.029
HCH (gamma-BHC)	Final Daily WLAs [3]	0.13	0.13	0.13	0.13	0.13
	Final Monthly WLAs [3]	0.063	0.063	0.063	0.063	0.063
Heptachlor	Final Daily WLAs [3]	0.00042	0.00042	0.00042	0.00042	0.00042
	Final Monthly WLAs [3]	0.00021	0.00021	0.00021	0.00021	0.00021
Heptachlor Epoxide	Final Daily WLAs [2]	0.00022	0.00022	0.00022	0.00022	0.00022
	Final Monthly WLAs [2]	0.00011	0.00011	0.00011	0.00011	0.00011

1. Except where noted, Phased/Interim WLAs are set equal to Minimum Level defined in the SIP because there are no detected values in dataset.
2. Phased/Interim WLAs are set equal to the maximum value detected in discharge data.
3. Final WLAs are calculated using procedures outlined in the SIP using the CTR aquatic life and human health for organisms only criteria.

"NA" Allocations are not necessary because the constituent is Category-2, not listed for the reach to which the POTW discharges, and does not have any downstream listings or exceedances.

Load Allocations for Agricultural Runoff

LAs for category-1 constituents in agricultural runoff are set equal to the allowable concentration for in-stream sediment at the base of each subwatershed (Table 69). Should an exceedance occur at the base of a subwatershed, future source-specific sediment monitoring will attempt to identify causes of the exceedance. LAs for category-2 constituents are assigned as water and fish tissue numeric targets for each constituent (Table 70).

Table 69. Phased/Interim and Final Sediment LAs for Agriculture for Category-1 Constituents.

Constituent	Allocation Type	Mugu Lagoon (µg/g)	Calleguas Creek (µg/g)	Revolon Slough (µg/g)	Arroyo Las Posas (µg/g)	Arroyo Simi (µg/g)	Conejo Creek (µg/g)
Chlordane	Phased/Interim Annual Allocation	0.025	0.017	0.048	0.0033 [NL]	0.0033 [1, NL]	0.0034
	Final Annual Average Allocation [2]	0.0033	0.0033	0.0009	0.0033 [NL]	0.0033 [NL]	0.0033
4,4-DDD	Phased/Interim Annual Allocation	0.069	0.066	0.40	0.29	0.014 [NL]	0.0053
	Final Annual Average Allocation [2]	0.0012 [3]	0.0012[3]	0.0012[3]	0.0012[3]	0.0012 [3, NL]	0.0012[3]
4,4-DDE	Phased/Interim Annual Allocation	0.30	0.47	1.6	0.95	0.17 [NL]	0.02
	Final Annual Average Allocation [2]	0.0021[3]	0.0014[3]	0.0014[3]	0.0014 [3]	0.0014 [3, NL]	0.0014 [3]
4,4-DDT	Phased/Interim Annual Allocation	0.039	0.11	0.69	0.67	0.025 [NL]	0.002
	Final Annual Average Allocation [2]	0.0003	0.0003	0.0003	0.0003	0.0003 [NL]	0.0003
Dieldrin	Phased/Interim Annual Allocation	0.019 [NL]	0.003	0.0057	0.0011 [NL]	0.0011 [1, NL]	0.003 [1]
	Final Annual Average Allocation [2]	0.0043 [NL]	0.0002	0.0001	0.0002 [NL]	0.0002 [NL]	0.0002
PCBs	Phased/Interim Annual Allocation	0.18	3.8	7.6	25.7 [NL]	25.7 [1, NL]	3.8 [1]
	Final Annual Average Allocation [2]	0.18	0.12	0.13	0.12 [NL]	0.12 [NL]	0.12 [NL]
Toxaphene	Phased/Interim Annual Allocation	22.9 [NL]	0.26	0.79	0.23 [NL]	0.23 [1, NL]	0.26 [1]
	Final Annual Average Allocation [2]	0.36 [NL]	0.0006	0.001	0.0006 [NL]	0.0006 [NL]	0.0006

1. Phased/Interim WLAs are set equal to the Minimum Level as defined in the SIP because there are no detected values in the dataset.
2. Final allocations set equal to the sediment concentrations determined through calculating the percent reductions required to achieve fish tissue and water column targets as described in the allocation section unless otherwise noted.
3. Final allocations are set equal to the TEL or ERL as described in the allocation section.
"NL" Subwatershed-constituent combination with no 303(d) listing. Allocations assigned based on downstream impacts.

Table 70. Final Water and Fish Tissue LAs for Agriculture for Category-2 Constituents.

Constituent	Allocation Type	Mugu Lagoon	Calleguas Creek	Revolon Slough	Arroyo Las Posas	Arroyo Simi	Conejo Creek
Aldrin	Final Monthly Average Water Allocation (µg/L) [1]	1.3 [3]	3 [3]	3[3]	3[3]	3[3]	3[3]
	Final Annual Average Tissue Allocation (µg/kg) [2]	0.05	0.05	0.05	0.05	0.05	0.05
Dacthal	Final Monthly Average Water Allocation (µg/L)	NA	NA	3500[4]	NA	NA	NA
	Final Annual Average Tissue Allocation (µg/kg)	NA	NA	NA	NA	NA	NA
Endosulfan	Final Monthly Average Water Allocation (µg/L)	NA	NA	NA	NA	NA	0.056
	Final Annual Average Tissue Allocation (µg/kg)	NA	NA	NA	NA	NA	64800
Endrin	Final Monthly Average Water Allocation (µg/L)	0.0023	0.036	0.036	0.036	0.036	0.036
	Final Annual Average Tissue Allocation (µg/kg)	3220	3220	3220	3220	3220	3220
HCH (gamma-BHC)	Final Monthly Average Water Allocation (µg/L)	0.16	0.95	0.95	0.95	0.95	0.95
	Final Annual Average Tissue Allocation (µg/kg)	8.2	8.2	8.2	8.2	8.2	8.2
Heptachlor	Final Monthly Average Water Allocation (µg/L)	0.0036	0.0038	0.0038	0.0038	0.0038	0.0038
	Final Annual Average Tissue Allocation (µg/kg)	2.4	2.4	2.4	2.4	2.4	2.4
Heptachlor Epoxide	Final Monthly Average Water Allocation (µg/L)	0.0036	0.0038	0.0038	0.0038	0.0038	0.0038
	Final Annual Average Tissue Allocation (µg/kg)	1.2	1.2	1.2	1.2	1.2	1.2

1. CTR chronic toxicity criteria for the protection of aquatic life are used, unless otherwise noted. Available data indicates that Category-2 constituents are not currently exceeding acute or chronic targets.
2. Tissue Threshold Residue Levels (TTRLs), derived from CTR human health criteria.
3. No chronic criteria exist. Acute criteria are used.
4. No chronic or acute criteria exist. Drinking water standard of 3500 µg/L adopted by Florida and Arizona is applied. No marine or fish tissue standards exist.
"NA" Allocations are not necessary because the constituent is Category 2, not listed for the reach to which the POTW discharges, and does not have any downstream listings or exceedances.

Alternatives Considered

The following alternate approaches for assigning WLAs to POTWs were considered and discussed with US EPA, LARWQCB, and CCW stakeholders:

1. POTWs will not receive end of pipe effluent limits. Instead, receiving water concentration limits apply at discharge point of subwatershed and implementation of appropriate BMPs are required.
2. Percent reduction required for OC sediment concentration at the subwatershed discharge point is translated into equal percent reduction in effluent, and applied as end of pipe effluent limit for POTWs.
3. Sediment concentration limits for the TMDL are assigned as effluent limits for POTWs, which are measured according to streambed sediment samples taken 0-250 feet downstream of the POTW outfall.
4. All WLAs and LAs expressed as OC loads in sediment according to the product of sediment concentration limits and estimated sediment transport rates. OC loads in POTW effluent are considered equivalent to sediment loads.

Note: the State Water Resources Control Board is currently developing sediment quality guidelines. The relevant sediment quality guidelines should be incorporated into the OC Pesticides and PCBs TMDL, if appropriate.

7.4 Background Load

Background loading can be allocated to either natural sources and/or sources of loadings directly to a water body that are not attributable to a point or nonpoint source. As OC pesticides and PCBs are not naturally occurring, a background load would not be applicable under this definition. With regard to loadings that are not attributable to a point or nonpoint source, such as atmospheric and aerial deposition, as discussed in the Source Analysis Section the available studies on deposition rates could not be incorporated to determine a specific load of these sources to the CCW. As such, the background load of OC pesticides and PCBs is set equal to zero. Potential contributions from background loads are implicitly incorporated into load reductions for controllable sources.

7.5 Margin of Safety

Inclusion of a margin of safety (MOS) is necessary to ensure desired improvements in water quality are achieved. Several factors create uncertainties which could affect the accuracy of calculations made during development of this TMDL and thus the ultimate effectiveness of WLAs and LAs. The two most significant uncertainties are related to the following:

- the large proportion of non-detected values present in the CCW database, which are difficult to quantify with certainty (see Current Conditions section);
- an assumption of equal percent reduction is used for translation of fish tissue and water concentration reductions to appropriate sediment concentration reductions (see TMDL Allocation section).

A very large implicit margin of safety exists in the final WLAs and LAs for this TMDL, which results from the cumulative effect of several conservative methods employed during development of the TMDL, summarized below:

- using all years of available data for calculating required percent reductions likely over predicts current concentrations due to the effects of natural attenuation (i.e., older data reflect less degradation than newer data) -- evidence that this over prediction may be quite sizeable is presented in time series plots for the category-1 constituents (see Current Conditions section);
- selecting the greater percent reduction required of water or fish tissue concentrations as the basis for determining the percent reduction required in sediment (see TMDL Allocations section);
- ensuring protection of downstream subwatersheds from upstream inputs by reducing the allowable concentration for upstream subwatersheds where downstream allowable concentrations are lower (see TMDL Allocations section 7.2);
- selection of TELs and ERLs as numeric targets for sediment, which are the most protective of the potentially applicable sediment guidelines available (see Numeric Targets section);
- decision to use the lower of the allowable concentration (as calculated by percent reduction methodology) or the numeric target for sediment (TEL or ERL) as the WLA and LA for all reaches with 303(d) listings for sediment.

The sum total effect of these various conservative measures employed during development of the final WLAs and LAs is of sufficient magnitude that no additional MOS is required. However, compliance monitoring and special studies outlined in the Implementation Plan will examine the effectiveness of the WLAs and LAs over time, and adjustments made if necessary to ensure achievement of beneficial uses.

7.6 Attainability Analysis

Since use of all category-1 constituents considered in the OC Pesticides and PCBs TMDL has been banned and residual sources are expected to eventually degrade completely (assuming no illegal use), attainment of end goals will depend upon the magnitude of those sources which are continuous and uncontrollable, including:

1. aerial deposition from sources outside the watershed (other countries where OCs are still used);
2. residues on imported produce discharged from POTWs to local streams;
3. contaminants present in imported water;
4. continued use of dicofol, which contains ~0.1% DDT.

The following section discusses each of these sources in general terms, and then presents a likely high and low estimate for the contribution from each source (using DDT as a representative constituent).

Aerial Deposition

- Local aerial sources such as wind drift and wind erosion are in essence the same source as soil erosion to water. The difference is merely the pathway (channelized stormwater runoff versus aerial resuspension).
- DDT is still used in other countries around the globe, although the rate and effective contribution to the global atmosphere are unknown.
- Atmospheric deposition of DDT in Galveston Bay, Texas was estimated to be 1.94 ug/m^2-yr. Assuming the same deposition rate in the Calleguas Creek watershed results in a total annual deposition of 3.8 lb/yr. However, the load to water from this source in the Calleguas Creek watershed is expected to be lower for several reasons:

1. The local airshed is the Pacific Ocean, whereas the airshed for Texas includes potential DDT use areas in Mexico and the southern US.
2. The deposition rate is the gross rate, not net rate. An unquantified proportion volatilizes back into the atmosphere.
3. Much of what does not volatilize adsorbs to soil that does not erode.
4. An unknown portion of DDT degrades to compounds other than DDE and/or degrades locally before eroding to water.

Estimated Range of Contribution from Aerial Deposition:

- High estimate, assume load in Native Land runoff site (Reach 8) is entirely due to atmospheric deposition and ND is ½*DL = 0.001 ug/L * ½ * 120 cfs = 0.12 lbs/yr
- Low estimate, 2% of deposition enters water, 3.8 lb/yr * 2% = 0.08 lbs/yr

Inputs to Effluent from Imported Water and Produce

- Water imported from the State Water Project likely contains trace amounts of DDE, based on the observations that the Delta is listed as impaired for DDT, and monitoring conducted by the San Francisco Estuary Institute (see Source Assessment section). However, imported water is treated before being used in homes and on lawns, which removes hydrophobic and particle-associated contaminants.
- Residue on imported produce could contain trace amounts of DDT. The total mass of DDT from such sources cannot be reliably estimated without considerable effort. A portion of this mass conceivably also enters the wastewater system.
- POTW effluent is not considered a major contributor. POTW effluent samples throughout the watershed are 93% non-detected and do not exhibit any trend over time.

Estimated Range of Contribution from Imported Water:

- High estimate, assume effluent ND = ½*DL but exclude NDs>5 ug/L = 1.7 lbs/yr
- Low estimate, assume effluent ND is 0.0049 (1% of source water) = 0.7 lbs/yr
- Recommend effluent monitoring using low-level sampling and analytical techniques to confirm that concentrations remain low.

Dicofol Applications

- Trends in dicofol use indicates a general decrease in mass used, as shown in Figure 17 and Figure 18, in the Source Analysis Section.
- The 216 pounds of dicofol used in the CCW from 1998-2003 would have contained about 0.2 pounds of DDT. This total mass distributed over the six-year period was thus 0.03 lbs/yr. The total load in water is on the order of 30 lbs/yr, 500 times more than all of the DDT applied as dicofol.
- The actual load to water from dicofol applications is likely an order of magnitude lower owing to these factors:
  - sticks to organic material (stays in soil or harvested with plants)
  - volatilizes or wind drifts away
  - degrades naturally in soil

Estimated Range of Contribution from Dicofol Applications:

- High estimate, total mass in is total mass out = 0.03 lbs/yr

- Low estimate, assume 98% is sequestered and degraded = 0.0006 lbs/yr

Summary

The range of estimated total load in the watershed from the three main sources identified here are:

- High estimate = $0.12_{\text{[aerial dep]}} + 1.7_{\text{[imported water]}} + 0.03_{\text{[dicofol]}} = 1.85$ lbs/yr
- Low estimate = $0.08_{\text{[aerial dep]}} + 0.7_{\text{[imported water]}} + 0.0006_{\text{[dicofol]}} = 0.8$ lbs/yr

The average annual DDE load to water from all sources is estimated in the Source Analysis section as approximately 32 lbs/yr. The ongoing loads estimated here represent 2-6% of that total. Although DDE loading in water may need to decrease by more than 95% in several parts of the watershed, this rough estimate of ongoing uncontrollable sources suggests that attainment of TMDL targets might not be achievable. However, this estimate predicts the uncontrollable source load resulting from imported water using 1994 data and does not include consideration of the fact that imported water is treated before being used in many cases (see Source Analysis section). This is important to note, since the contribution of DDE from imported water represents a majority of both the high and low estimates of uncontrollable loads presented above. A special study included in the Implementation Plan section will seek to ascertain whether the final WLAs and LAs are attainable, and the WLAs and LAs will be reevaluated if necessary.

7.7 Future Growth

Ventura County accounts for slightly more than 2% of the state's residents with a population of 753,197 (US Census Bureau, 2000). GIS analysis of the 2000 census data yields a population estimate of 334,000 for the Calleguas Creek Watershed (CCW), which equals about 44% of the county population. According to the Southern California Association of Governments (Minjares, SCAG, 2004), growth in Ventura County averaged about 51% per decade from 1900-2000; with growth exceeding 70% in the 1920s, 1950s, and 1960s (Figure 29).

YEAR	POPLN	INCREASE
1900	14,000	--
1910	18,000	28.6%
1920	29,000	61.1%
1930	55,000	89.7%
1940	70,000	27.3%
1950	115,000	64.3%
1960	199,000	73.0%
1970	376,000	88.9%
1980	529,000	40.7%
1990	669,000	26.5%
2000	753,000	12.6%

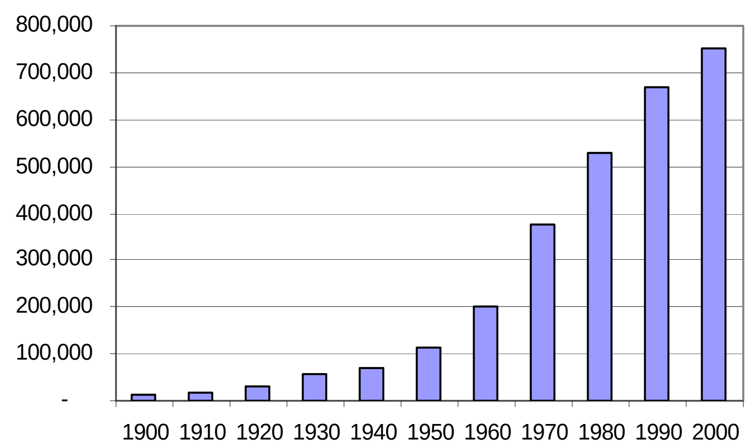


Figure 29. Population Growth in Ventura County, 1900-2000 (SCAG, www.scag.ca.gov/census/pdf/ventura.pdf)

Although Moorpark is expected to remain the smallest city as measured by population, it is also expected to have the highest growth rate from 2000-2020 (Table 71). Both Moorpark and Camarillo are predicted to experience greater than 30% growth in those years. Thousand Oaks is expected to have the lowest growth rate of the CCW cities during that same time period, and is likely to be surpassed by Simi Valley as the most populous city in the watershed by 2020 (Minjares, SCAG, 2004). In general, smaller cities in the watershed are likely to grow faster than larger cities.

Table 71. Growth Projections for CCW Cities and Region, 2000-2020 (Minjares, SCAG, 2004)

City / County / CCW	2000 Popln (July) [1]	2005 Popln (projected)	2010 Popln (projected)	2020 Popln (projected)	% Increase 2000-2010	% Increase 2000-2020
Moorpark city	31,528	37,611	42,618	43,730	35%	39%
Camarillo city	57,478	63,179	67,507	76,842	17%	34%
Simi Valley city	112,190	125,456	131,198	140,902	17%	26%
Thousand Oaks city	117,418	126,272	129,992	132,925	11%	13%
Ventura County	758,054	821,045	865,149	929,181	14%	23%
CCW [2]	336,121	364,051	383,607	411,999	14%	23%

[1] Projected values for July of 2000. Actual census values from April 2000 were slightly lower (Ventura County population was 753,197).
[2] Values in this row represent a rough estimate, calculated as 44% of the value for Ventura County (based upon the fact that current CCW population is approximately 44% of Ventura County total population).

Growth Management Efforts

Ventura County has been actively involved in growth management for several decades and continues to implement a range of growth management measures such as: urban growth boundaries, ballot-initiative zoning, and encouragement of higher density and mixed-use development. The Save Open Space and Agricultural Resources initiative (SOAR) that was passed in 1998 is one such growth management policy. Ventura County's SOAR initiative aims to preserve farmland, open-space and rural areas by establishing a City Urban Restriction Boundary beyond which urban development is controlled (Figure 30). County voter approval is required before any land located outside the City Urban Restriction Boundary can be developed for non-agricultural purposes.

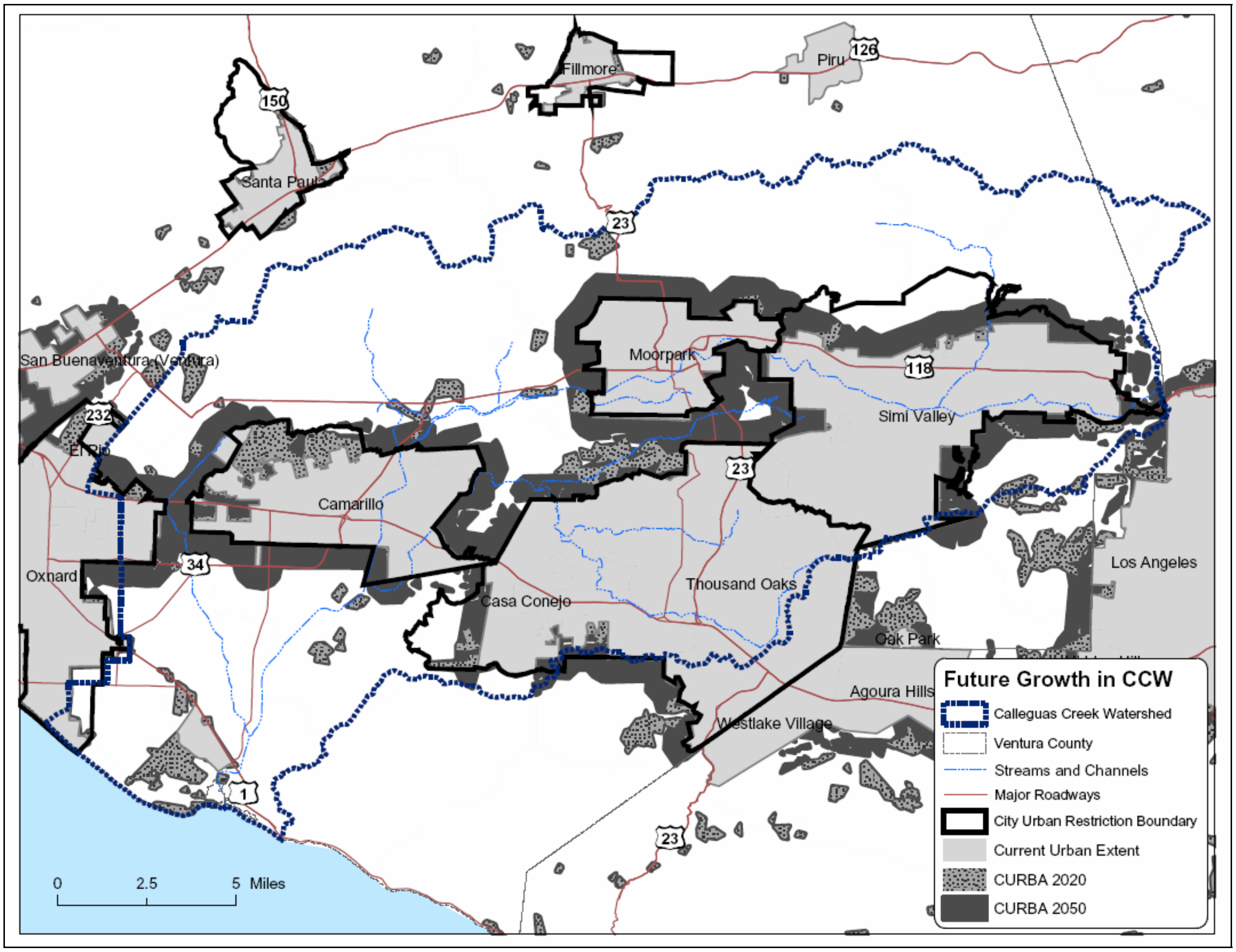


Figure 30. Potential for Urban Growth in Ventura County, based on Ventura County's City Urban Restriction Boundary and California Urban and Biodiversity Analysis (CURBA).

The results of California Urban and Biodiversity Analysis (CURBA) for lands within the Calleguas Creek Watershed for the years 2020 and 2050 are also shown in Figure 30 (Landis et al, 1998). CURBA uses an urban growth model to predict future land-use scenarios, and a habitat loss and fragmentation analysis model to estimate the effects of various land use policies upon biodiversity (only results from the urban growth model are presented here). The urban growth model calculates future urbanization probabilities for all undeveloped sites in a given area, according to such factors as: proximity to highways, proximity to city boundaries, site slope, and site development constraints. The CURBA results shown here seem to have been heavily influenced by the “development constraints” variable, as evidenced by the fact that predicted growth is highly correlated with the City Urban Restriction Boundaries established by the SOAR initiative. Since SOAR is due to expire in 2020, it does not provide permanent protection for open space or farmland.

Effects of Growth Upon OC pesticides and PCB Concentrations

Given the projections discussed in the preceding paragraphs and the presence of growth management measures such as SOAR, it seems almost certain that significant population growth will occur in and around present city limits until at least 2020. Since most of the listed OCs in the CCW have been banned, this growth shouldn’t increase their use, although it might affect residual sources from past use. Urban application of those OC pesticides which are still legal (dacthal and endosulfan) might increase, but overall use could decrease because urban expansion tends to reduce total acreage of agricultural land.

Population growth may result in greater OC loading to POTW influent. The load will increase proportionally to the population increase if it is assumed that future domestic water use per person and future pesticide load per household are approximately equal to current water use and pesticide loads. Under those assumptions, the volume of wastewater discharged by POTWs would also increase proportionally to population growth. Increased flow from POTWs should not result in impairment of the CCW as long as effluent concentration standards are met for any given plant. If daily concentration limits are allowed to rise over time, a net increase in OC loading from POTWs could occur.

As urban development occurs, construction activities could have a range of effects upon OC loading to the CCW. Exposure of previously vegetated or deeply buried soil might lead to increased rates of degradation and volatilization. Grading of land to prepare for construction renders soil more vulnerable to erosion and leads to increased sedimentation of streams, which could increase OC loading into streams in the CCW since OCs are known to adhere strongly to sediment. Conversely, urbanization of open space and/or agriculture areas will effectively bury potential sources of OC laden sediments.

Future growth could result in increased OC concentrations in groundwater in the CCW. This concern is potentially relevant in the case of dacthal, which is still in use and has been found in groundwater. The effects of future growth upon PCB loads are unknown, but not likely to prove significant since atmospheric deposition and accidental spills in the past are the primary loading pathways for PCBs. Any increase of currently used OCs to the CCW that occurs as a result of population growth will be offset to some degree by decreased inputs from banned OCs as their presence attenuates due to fate and transport processes.

8 IMPLEMENTATION PLAN

California Water Code section 13360 precludes the Regional Board from specifying the method of compliance with waste discharge requirements. However, California Water Code section 13242 requires that the *Basin Plan* include an implementation plan to describe the nature of actions to be taken and a time schedule for action. This section describes the proposed implementation plan to meet numeric targets for OC pesticides and PCBs in the CCW, including BMPs which will be implemented to reduce erosion and sediment transport. The Implementation Plan includes the following elements:

- Source control activities to reduce any active sources of OC pesticides and PCBs in the watershed;
- Implementation and evaluation of agricultural best management practices (BMPs) in the watershed;
- Special studies to identify sediment transport and OC content and areas where BMP implementation may be more effective.
- Monitoring for OC pesticides and PCBs in water, fish tissue, and sediment throughout the watershed.

For the majority of constituents covered by this TMDL (including all category-1 constituents) use has been completely banned for many years. As demonstrated in the Current Conditions and Linkage Analysis sections, the trends for OC pesticides and PCBs in all media (water, sediment, and tissue) are generally decreasing in concentration over time. Consequently, these pollutants will eventually be almost completely removed from the watershed through degradation, transport to the ocean, volatilization, and other mechanisms (continuing and uncontrollable sources are discussed in Section 7.6, Attainability Analysis). The focus of this implementation plan is the identification of actions that will help accelerate this process without impacting other beneficial uses in the watershed.

Restoring impaired beneficial uses will take many years due to the large quantity of OC residues present in the watershed and the highly persistent nature of these chemicals. Additionally, implementation of BMPs to control sediment and OC transport are related to the implementation strategies for addressing siltation and the Toxicity and Nutrient TMDLs. Therefore, implementation of this TMDL will be phased to allow for evaluation of the impacts on OC concentrations from implementation of BMPs for related TMDLs and to assess the impacts of controlling sediment on streambed erosion and in-stream beneficial uses.

8.1 Waste Load Allocation Implementation

This section discusses the application of final WLAs for the municipal separate storm sewer systems (MS4s) and POTWs, the method for determining compliance with the final WLAs, implementation actions that will be undertaken to achieve the allocations, and the implementation schedule. The final WLAs will be included in NPDES permits in accordance with the compliance schedules provided in Table 73, subject to the following condition:

> WLAs may be revised prior to the dates they are placed into permits and/or prior to the dates of final WLA achievement. Any revisions to these WLAs are to be based on the collection of additional information as described in the Special Studies and Monitoring Section.

Municipal Separate Storm Sewer Systems (MS4s)

A group concentration-based WLA has been developed for MS4s. USEPA regulation allows allocations for NPDES-regulated stormwater discharges from multiple point sources to be expressed as a single categorical WLA when the data and information are insufficient to assign each source or outfall individual WLAs (40 CFR 130). The grouped allocation will apply to all NPDES-regulated municipal stormwater discharges in the CCW.

Stormwater WLAs will be incorporated into the NPDES permit as receiving water limits measured at in-stream discharge points for each subwatershed and will be achieved through the implementation of BMPs as outlined in the implementation plan. Compliance will be determined through the measurement of in-stream water quality, sediment, and fish tissue measurements at the base of each subwatershed. To facilitate stormwater co-permittees measuring compliance in all six of the subwatersheds, additional monitoring stations will be needed in four of the subwatersheds (Mugu, Conejo, Las Posas, and Arroyo Simi).

Because all of the category-1 constituents have been banned, stormwater co-permittees activities are not adding any new loads of the constituents to the watershed. Therefore, the implementation plan for MS4s includes activities that reduce the mobilization of OC pesticides and PCBs to the receiving waters. The following implementation actions will contribute to achievement of the WLAs.

Collection Program

In coordination with POTWs and the Toxicity TMDL implementation plan, stormwater co-permittees will develop and implement a collection program for all banned OC pesticides and PCBs. In other areas of the country, collection programs for OC pesticides have resulted in the proper disposal of large amounts of OC pesticides. As part of the Great Lakes Binational Toxics Strategy, 578,000 pounds of banned pesticides were collected between 1990 and 1998 in Michigan and 9700 pounds of DDT were collected in Ohio between 1993 and 1998 (USEPA, 1999). Therefore, residents in the CCW may have stored OC pesticides that could be collected through existing household hazardous waste programs. This collection program will prevent future use and improper disposal of these banned pesticides.

Construction Site BMPs

Stormwater co-permittees will continue to oversee and regulate active construction sites to minimize disturbed areas and sediment losses. If areas where relatively high concentrations of OC pesticides and/or PCBs are found within the watershed (see Special Study section), then additional activities will be undertaken to reduce erosion and transport of OCs from these areas during construction.

Evaluation and Modification of Existing Sediment Activities

Stormwater co-permittees are involved in many activities that collect, transport, and remove sediment from the watershed. The permittees will conduct an evaluation of sediment-related activities in the watershed and identify activities that might facilitate the mobilization of OC pesticides and/or PCBs to receiving waters and those that reduce the mobilization. For those activities that might facilitate mobilization, an examination of alternatives will be conducted and modifications to current processes implemented if feasible. Additionally, the increased application of activities that reduce the mobilization of pesticides and other pollutants should be considered.

Due to the persistence of OC pesticides and PCBs, concentrations of these chemicals in fish tissue and sediment are likely to persist for many years even after implementation of the activities presented above. Additional activities that could be undertaken to remove contaminated sediment from the watershed (dredging, removing topsoil) are likely to have significant impacts on wildlife and agricultural beneficial uses. Additionally, natural attenuation is occurring in the watershed and the concentrations of these pesticides are declining. Therefore, to allow time for evaluation of reductions in loadings attributable to BMP implementation from the Toxicity and Nutrient TMDLs, conduct of special studies, the implementation of additional BMPs if necessary to address OC Pesticides and PCBs, and natural attenuation to reduce concentrations, phased allocations have been assigned for MS4 discharges as shown in Table 66 in the TMDL Allocations section and an implementation schedule has been provided in Table 73.

POTWs

WLAs established for the three major POTWs in this TMDL will be implemented through NPDES permit limits. The proposed permit limits will be applied as end-of-pipe concentration-based effluent limits for POTWs. Compliance will be determined through monitoring of final effluent discharge as defined in the NPDES permit.

As discussed above for MS4 discharges, POTWs are not adding any significant new loads of OCs to the watershed. Therefore, the implementation plan for POTWs involves implementation of reasonable source control activities. The following implementation actions will contribute to achievement of the WLAs.

<u>Source Control</u>

POTWs will conduct a source control study to identify sources of detected OC pesticides and PCBs to POTW influent. These sources will be examined to determine reasonable activities that could be implemented to control sources to the POTW and to identify which sources are outside the control of local agencies. This study will be used as the basis for implementation of reasonable source control activities (such as the collection program discussed above) and for reevaluation of final WLAs if necessary due to the presence of sources that are outside the control of local agencies (i.e. aerial deposition from active sources outside the United States, residues on imported clothing, etc.).

To allow time for the source control study and implementation of any identified actions, conduct of special studies, and natural attenuation to reduce concentrations; phased allocations shown in (see Table 68 in the allocations section) and an implementation schedule (Table 73) have been assigned for POTWs discharges.

8.2 Load Allocation Implementation

LAs for OC pesticides and PCBs will be implemented in a manner consistent with the Porter-Cologne Water Quality Control Act. Through Porter-Cologne and the State's Nonpoint Source Pollution Control Program (NPSPCP), nonpoint source pollution (i.e. Load Allocations) is addressed through the following five key elements of the Policy for the Implementation and Enforcement of the NPSPCP (NPSPCP Implementation Policy):

1. A NPS control implementation program's ultimate purpose must be explicitly stated and at a minimum address NPS pollution control in a manner that achieves and maintains water quality objectives.
2. The NPS pollution control implementation program shall include a description of the management practices (MPs) and other program elements expected to be implemented, along with an evaluation program that ensures proper implementation and verification.
3. The implementation program shall include a time schedule and quantifiable milestones, should the RWQCB so require.
4. The implementation program shall include sufficient feedback mechanisms so that the RWQCB, dischargers, and the public can determine if the implementation program is achieving its stated purpose(s), or whether additional or different MPs or other actions are required.
5. Each RWQCB shall make clear, in advance, the potential consequences of failure to achieve an NPS implementation program's objectives, emphasizing that it is the responsibility of individual dischargers to take all necessary implementation actions to meet water quality requirements.

Under the NPSPCP Implementation Policy, the RWQCBs must regulate all nonpoint sources of pollution, using the administrative permitting authorities provided by the Porter-Cologne Act. One of the permitting authorities available to the LARWQCB is the adoption of a Conditional Waiver from Waste Discharge Requirements. The LARWQCB is currently in the process of developing and adopting a Conditional Waiver for Irrigated Lands (Conditional Waiver Program) to implement the state's NPSMP. Once adopted, the Conditional Waiver Program can be used to ensure implementation of allocations and meeting of numeric targets contained in this TMDL. However, until this program is adopted by the Regional Board, allocations can be implemented directly through a stand alone Basin Plan Amendment that is also consistent with the State's NPSPCP and includes all of the implementation provisions contained herein. In either case, reasonable assurance will be provided that the agricultural controls necessary to meet the LAs will be implemented.

Compliance with LAs will be measured at the monitoring sites approved by the Executive Officer of the Regional Board through the monitoring program developed as part of the Conditional Waiver, or through a monitoring program that is required as part of the Basin Plan Amendment in case the Conditional Waiver Program should not be adopted in a timely manner consistent with the TMDL implementation schedule. In either case, monitoring shall be consistent with the Calleguas Creek OC Monitoring Program (CCOCMP) which is currently under development.

Due to the strong affinity of OC pesticides and PCBs for sediment, the primary implementation strategies for this TMDL involve reducing the total quantity of sediment discharged into receiving waters and/or reducing the concentration of OCs in sediment discharged to receiving waters. Many of the BMPs that could be implemented are universally applicable for controlling the mobilization of pollutants. Therefore, the implementation of BMPs to achieve load allocations in the Nutrient TMDL, Toxicity TMDL and any future TMDLs will likely result in reductions in the discharge of OC pesticides as well. As such, the implementation schedule provides a phased approach that includes implementation of BMPs to address other TMDLs with additional BMPs required only if load allocations are not achieved.

Studies are currently being conducted to assess the extent of BMP implementation and provide information on the effectiveness of BMPs for agriculture. This information will be used to develop an Agricultural Water Quality Management Plan that will guide the implementation of agricultural BMPs in the CCW. Then, an agricultural education program will be developed to inform growers of the recommended BMPs and the management plan. The Association of Water Agencies of Ventura County and the Ventura County Farm Bureau are actively working on outreach to local growers to educate them on the upcoming requirements from TMDLs and the proposed Conditional Waiver Program.

The phased allocations presented in Table 69 in the Allocations Section and the implementation schedule shown in Table 73 will also provide sufficient time to:

- Allow implementation efforts from other TMDLs and natural attenuation to reduce concentrations of OC pesticides and PCBs in runoff;
- Allow for the completion of monitoring to verify the appropriateness of LAs;
- Identify and implement appropriate BMPs considering crop type, pesticide use, and site specific conditions; then monitor to evaluate effectiveness;
- Implement adaptive management strategies to employ additional BMPs or revise existing BMPs to meet LAs;
- Conduct special studies to evaluate alternative mechanisms for measuring compliance with LAs.

As compliance with the fish tissue and water targets are determined in-stream there is the potential for compliance with the targets without attainment of LAs. Additionally, reducing sediment discharge to the receiving waters could have downstream impacts, such as increasing streambed erosion. These impacts will be examined, and LAs may be revised prior to the final LA achievement dates. Any revisions to these LAs will be based on the collection of additional information developed through special studies and/or monitoring conducted as part of this TMDL.

8.3 Special Studies

The Implementation Plan sets forth special studies to address issues associated with OC pesticides and PCBs that currently require more data to resolve. The implementation schedule for these special studies is included in Table 73.

Special Study #1 - Calculation of Sediment Transport Rates

The Ventura County Watershed Protection District (VCWPD) has the capability to estimate sediment transport rates in the CCW, but their models currently consider only course grain sediment. OC pesticides and PCBs are carried in both course grain and fine grain sediment. The purpose of this special study is to determine sediment transport rates for both course and fine grain sediment. To the extent possible, the study will build upon existing work to estimate transport rates.

Additionally, the Natural Resources Conservation Service (NRCS) is considering a plan to create a comprehensive sediment transport model for the watershed, which will build upon their earlier work (NRCS, 1998). The special study of sediment transport rates proposed here will coordinate with the efforts of NRCS if/when their plan is initiated, and will occur independently if NRCS does not proceed. The knowledge gained from this special study will benefit both VCWPD and NRCS, as well as the OC Pesticides and PCBs TMDL and siltation listings for the CCW.

The results of the study will be used to further evaluate assumptions about the fate of sediment and OC pesticides and PCBs in the CCW. Additionally, if desired by the stakeholders, the study could be used to reevaluate the WLAs and LAs in the TMDL. The initial approach to assigning WLAs and LAs for the OC Pesticides and PCBs TMDL considers only the concentration of OCs in sediment. Eventually, improved understanding of sediment transport rates (for both fine and course sediment) resulting from this special study will allow for estimates of total OC loads in sediment, where:

TMDL = Total OC Load in Sediment = Sediment Transport Rate * OC Concentration in Sediment

Ultimately, calculating OC contributions from different subwatersheds, reaches, and/or land uses according to total mass load in sediment could allow for better targeting of implementation efforts toward areas responsible for the largest inputs of contaminants, better evaluation of the effectiveness of implementation actions, and improved assessments of issues related to siltation. Once sediment transport rates are better understood, WLAs and LAs could be calculated as mass loads.

Special Study #2 - Monitoring of Sediment Concentrations by Land Use Type

The OC Pesticides and PCBs TMDL assigns allocations for urban and agricultural runoff as in-stream sediment concentrations applied at the base of each subwatershed, because no sediment data exists specific to land uses or sources (urban, agriculture, POTWs, etc). Thus, proportional allocations within each subwatershed are not specified, and determination of individual contributions resulting in an exceedance at the base of a subwatershed will rely upon future monitoring efforts and the results of this special study.

The purpose of this special study is to identify sediment concentrations of OC pesticides and PCBs from representative land uses. The study will be conducted over the course of one year and will include monitoring of streambed sediment from urban, agriculture, and native land areas (although collection of terrestrial soil samples might also yield useful data, such collection is not feasible due to highly restricted access to private lands in the watershed). Once completed, this special study will provide the ability to assign proportional allocations within subwatersheds and will also advance understanding of processes and contributions related to fate and transport of OCs in the CCW.

Special Study #3 - Identification of High Concentration Areas

If specific land areas with significantly elevated concentrations of OCs are found to exist, targeting implementation resources upon those areas could reduce in-stream sediment concentrations more effectively per unit of effort than other methods requiring watershed-wide implementation. Thus, identification of any such high concentration areas (HCAs) is an important goal.

Areas within the CCW where relatively higher DDT use occurred in the past have been estimated in the Source Assessment Section of this TMDL, according to examination of historical land use layers using GIS and interviews with local agricultural experts. This initial assessment will be combined with monitoring being conducted under the ongoing PRISM monitoring program conducted by Steve Bachman on behalf of United Water. The PRISM monitoring program collects runoff data from specific land use sites throughout agricultural areas of the CCW. This data will be examined spatially for evidence of HCAs. The PRISM monitoring program and special study #2 will be the primary source of information used to identify HCAs. It is not anticipated that additional monitoring, not required by other aspects of this TMDL, will be necessary to identify HCAs. Rather, the other monitoring studies will include the identification of HCAs as a goal, and the data will be analyzed for the presence of HCAs.

Special Study #4 - Examination of Food Webs, Bioaccumulation, and Wildlife Effects

WLAs and LAs for this TMDL are based upon an assumption (explained in the TMDL and Allocations Section) that a given percent reduction in the concentration of OCs in sediment will result in an approximately equal percent reduction in fish tissue and water. This assumption is based on the notion that bioconcentration factors (BAFs) in the CCW are roughly linear, which may or may not be true. Should the implementation of this TMDL not achieve the goals of reducing concentrations in fish tissue as expected or if a reevaluation of WLAs and LAs is desired, a special study may be developed to create detailed food web models, increase understanding of the biological processes affecting uptake and accumulation of OCs in the tissue of aquatic organisms, and evaluate fish consumption rates for humans and wildlife in the watershed. Work conducted as part of this special study could result in the development of a site-specific objective for one or more of the constituents in this TMDL.

This is an optional special study to be conducted if desired by the stakeholders or determined to be necessary by the Executive Officer.

Special Study #5 – Effect of BMPs Upon Sedimentation and Siltation

Implementation of BMPs to address the OC Pesticides and PCBs, Toxicity, and Nutrient TMDLs will likely result in the reduction of sediment loads to the receiving waters of the CCW. The purpose of this special study is to quantify the amount of sediment discharge that is reduced through implementation of these BMPs. This study will be coordinated with ongoing grant-funded studies in the watershed that are working to evaluate the effectiveness of BMPs and with Special Study #1.

Special Study #6 – Concentration of OCs in Simi Valley Groundwater Discharges

Groundwater pumped from the Simi Valley dewatering wells was sampled on four occasions, of which one sample had detected concentrations of DDE, lindane, and PCBs. A NPDES permit allows the discharge of pumped groundwater from these dewatering wells to the storm drain system, for the purpose of lowering the local water table. Since four samples are likely not representative of groundwater discharges from the Simi Valley dewatering wells, a special study is mandated to determine the actual contribution of OC Pesticides and/or PCBs from these groundwater discharges.

8.4 Reevaluation of WLAs and LAs

A need to revise the numeric targets, WLAs, LAs, or other aspects of the TMDL might result from any of several factors, including but not limited to:

- Information developed through special studies and/or monitoring conducted as part of the TMDL;
- The development of sediment quality objectives by SWRCB, or other water quality criteria revisions;
- Compliance with fish tissue and water column targets prior to attainment of WLAs or LAs;

- Undesired/unexpected effects of TMDL implementation efforts (i.e. increased streambed erosion as a result of BMPs which reduce sediment delivery to receiving waters);
- Inability to attain WLAs or LAs resulting from uncontrollable sources, such as the continued use of OC pesticides in other countries or aerial deposition.

Based on consideration of such issues as described above, reevaluation of the TMDL may become necessary prior to the final WLA and LA achievement dates.

8.5 Monitoring Plan

The Monitoring Plan is designed to monitor and evaluate the implementation of this TMDL and refine the understanding of current OC pesticide and PCB concentrations in water, sediment, and fish tissue. The information presented in this section is intended to be a brief overview of the goals of the Calleguas Creek Watershed TMDL Monitoring Program (CCWTMP) which is included as Attachment A. The CCWTMP is intended to parallel efforts of the CCW Nutrients TMDL and Toxicity TMDL implementation plans.

Monitoring conducted through the forthcoming Conditional Waiver Program may meet part of the needs of the CCWTMP. To the extent monitoring required by the OCs TMDL Implementation Plan parallels monitoring required by the Conditional Waiver Program, it shall be coordinated with Conditional Waiver Program monitoring conducted by individuals and groups subject to the terms and conditions of the waiver. The goals of the CCWTMP include:

1. To determine compliance with numeric targets at monitoring stations generally located at the base of the subwatersheds and at POTW discharges.
2. To determine compliance with waste load and load allocations generally located at the base of the subwatersheds and at POTW discharges.
3. To generate additional land use runoff data (water and sediment) to better understand sources of OCs and proportional contributions from various land use types.
4. To monitor the effect of implementation actions by urban, POTW, and agricultural dischargers on in-stream water and sediment quality and fish tissue concentrations.
5. To implement the CCWTMP in a manner consistent with other TMDL implementation plans and regulatory actions within the CCW.

Estimates of current concentrations and required reductions used to develop this TMDL are based on limited data. Due to the nature of the data set, assumptions were made about outputs from the various dischargers. The collection of data through the CCWTMP will increase the resolution of current data and may indicate the need to refine the WLAs and LAs.

Compliance Monitoring

Monitoring will begin within one year of the effective date of the OC Pesticides and PCBs TMDL. In-stream water column samples will be collected quarterly for analysis of general water quality constituents (GWQC) and OC Pesticides and PCBs. In-stream water column samples will generally be collected at the base of each subwatershed (Table 72) until numeric targets are consistently met at these points. At such a time as numeric targets are consistently met at the discharge point of a subwatershed, an additional site or sites within the subwatershed will be considered for monitoring to ensure numeric targets are met throughout the subwatershed.

Additional samples will be collected concurrently with receiving water samples at representative agricultural and urban runoff discharge sites as well as at POTWs in each of the subwatersheds and analyzed for GWQC and OCs. The location of the land use stations will be determined before initiation of the CCWTMP. For OC Pesticides and PCBs, environmentally relevant detection limits will be used (i.e. detection limits lower than applicable target), if available at a commercial laboratory. All efforts will be made to include at least two wet weather-sampling events during the wet season (October through April) during a targeted storm event.

Streambed sediment samples and fish tissue samples will be collected twice a year for general sediment quality constituents (GSQC) and OC Pesticides and PCBs (Table 72). Sediment samples in Mugu Lagoon will be collected once a year for similar analysis. An annual frequency was selected for Mugu Lagoon sediment sampling due to the relatively slow sedimentation rates in the lagoon in comparison to sample collection depths as discussed in the Sample Collection section of the CCWTMP.

Table 72. Compliance Sampling Station Locations.

Subwatershed	Station ID	Station Location	Sample Media		
			Water	Sediment	Fish Tissue [1]
Mugu Lagoon	01_11_BR	11th Street Bridge	X	X	X [2]
	01_BPT_1	Located near entrance to lagoon		X	
	01_BPT_3	Located in the eastern arm of the lagoon		X	
	01_BPT_6	Located in the eastern part of the western arm		X	
	01_BPT_9	Located near 17th street in far side of western arm		X	
	01_BPT_15	Located in central part of the lagoon		X	
	01_SG_74	Located in central part of the lagoon in mudflat area		X	
Calleguas	03_CAMAR	Calleguas Creek at University Drive	X	X	X
	03D_CAMR	Camrosa Water Reclamation Plant	X		
Revolon Slough	04_WOOD	Revolon Slough East Side of Wood Road	X	X	X
Las Posas	06_SOMIS	Arroyo Las Posas off Somis Road	X	X	X
	06D_MOOR	Moorpark Wastewater Treatment Plant	X		
Arroyo Simi	07_HITCH	Arroyo Simi East of Hitch Boulevard	X	X	X
	07D_SIMI	Simi Valley Water Quality Control Plant	X		
Conejo	9A_HOWAR	Conejo Creek at Howard Road Bridge	X	X	X
	9AD_CAMA	Camarillo Water Reclamation Plant	X		
	10D_HILL	Hill Canyon Wastewater Treatment Plant	X		

1 Attempts will be made to collect fish tissue samples in the same location as water and sediment samples. However, samples may be collected elsewhere if no fish are found at pre-established sample stations.
2 Fish tissue sampling locations in Mugu will be determined in conjunction with biologists prior to sample collection.

Reporting and Modification of CCWTMP

A Monitoring Report will be prepared annually within three months after the completion of the final event of the sampling year. An adaptive management approach to the CCWTMP will be adopted as it may be necessary to modify aspects of the CCWTMP. Results of sampling carried out through the CCWTMP and other programs within the CCW may be used to modify this plan, as appropriate. These modifications will be summarized in the annual report. Possible modifications could include, but are not limited to the, following:

- The inclusion of additional land use stations to accurately characterize loadings;

- The removal of land use stations if it is determined they are duplicative (*i.e.,* a land use site in one subwatershed accurately characterize the land use in other subwatersheds);
- The inclusion of additional in-stream sampling stations;
- Discontinuation of analysis of sediment fractions; and,
- The elimination of analysis for constituents no longer identified in land use and/or in-stream samples.

If a coordinated and comprehensive monitoring plan is developed and meets the goals of this monitoring plan that plan should be considered as a replacement for the CCWTMP.

8.6 Implementation Schedule

Table 73 presents the overall implementation schedule for the Calleguas Creek Watershed OC Pesticides and PCBs TMDL. A concerted effort was made to incorporate ongoing efforts in the CCW with the overall implementation schedule. For instance, two studies assessing concentrations of pesticides in agricultural discharges and agricultural BMPs in Ventura County were initiated in the fall of 2003 and are expected to be completed in 2006. It is possible these studies will provide sufficient information to determine whether or not HCAs are present in the watershed and the quantification of sediment discharge reductions through BMP implementation.

Since the ultimate step to reduce/eliminate the discharge of most OC pesticides and PCBs, banning usage, has already occurred, the implementation schedule presented in Table 73 provides sufficient time to allow implementation measures and natural attenuation to reduce concentrations in the CCW. In addition, time is allotted for the completion of special studies and the reevaluation of the TMDL, if necessary. Finally, implementation actions being undertaken to address the Nutrient and Toxicity TMDL and siltation listings in the CCW may result in compliance with the allocations in this TMDL. Therefore, the schedule allows time for implementation and evaluation of these actions and implementation of additional activities if necessary.

Table 73. Implementation schedule for the Calleguas Creek Watershed OC Pesticides and PCBs TMDL.

Item	Implementation Action [1]	Responsible Party	Tentative Date
1	Effective date of phased OC waste load allocations. [2]	POTW Permittees, MS4 Permittees	Effective date [2]
2	Effective date of phased OC load allocations. [2]	Agricultural Dischargers	Effective date [2]
3	Implement Calleguas Creek Watershed OC Monitoring Program.	POTW Permittees, MS4 Permittees and Agricultural Dischargers	Within 1 year of effective date
4	Develop and implement source identification and control study.	POTW Permittees	Within 1-3 years of effective date.
5	Develop and implement collection program for all banned OC pesticides and PCBs.	POTW Permittees, MS4 Permittees	Within 3 years of effective date.
6	Special Study #1 – Calculation of sediment transport rates in the CCW	Agricultural Dischargers, MS4 Permittees	Within 5 years of effective date
7	Special Study #2 – Monitoring of sediment by source / land use type (SS#2 is part of SS#1 in the Basin Plan Amendment)	Agricultural Dischargers, MS4 Permittees	Within 2 years of effective date
8	Special study #3 – Identifying High Concentration Areas (HCAs)	Agricultural Dischargers, MS4 Permittees	Within 5 years of effective date.
9	If HCAs are found, implement additional erosion control measures in those areas.	MS4 Permittees	Within 7 years of effective date.
10	Evaluate sediment activities in the CCW to determine impacts on OC transport to receiving waters.	MS4 Permittees	Within 3 years of effective date.
11	If appropriate, implement changes to sediment activities in the CCW to minimize OC transport.	MS4 Permittees	Within 3 years of completion of the evaluation study
12	Identify and implement appropriate BMPs and the extent to which BMPs are currently implemented in the CCW.	Agricultural Dischargers	Within 3 years of effective date
13	Development of an Agricultural Water Quality Management Plan in conjunction with the Conditional Waiver for Irrigated Lands, or (if the Conditional Waiver is not adopted in a timely manner) the development of an Agricultural Water Quality Management Plan as part of the Calleguas Creek WMP.	Agricultural Dischargers	Within 3 years of effective date.
14	Implement educational program on BMPs identified in the Agricultural Water Quality Management Plan.	Agricultural Dischargers	Within 5 years of effective date
15	Begin implementation of BMPs appropriate for other related CCW TMDLs.	Agricultural Dischargers	Within 6 years of effective date
16	Evaluate effectiveness of those BMPs for controlling OC runoff.	Agricultural Dischargers	6 years from effective date
17	If needed, implement additional BMPs or revise existing BMPs to address any issues not covered by implementation efforts of related CCW TMDLs (Nutrients, Toxicity, siltation listings)	Agricultural Dischargers	7 years from effective date
18	Special Study #4 (optional) – Examination of food web and bioconcentration relationships throughout the watershed to ensure protection of wildlife is achieved. (SS#4 is SS#6 in BPA)	Interested Parties	To be conducted if necessary prior to the end of the implementation period
19	Special study #5 – Effects of BMPs on Sediment and Siltation	Agricultural Dischargers, MS4 Permittees	6 years from effective date
20	Based on the results of items 1-19, Regional Board will consider reevaluation of the TMDLs and WLAs and LAs if necessary.	Regional Board	Within 2 years of the submittal of information necessary to reevaluate the TMDL
21	Evaluation of degradation rates (SS#5 in BPA)	POTWs, Agricultural Dischargers, MS4 Permittees, US Naval Base	12 years
22	Achievement of Final WLAs and LAs	Agricultural Dischargers, POTW Permittees, and MS4 Permittees	2025 [3]

[1] The Regional Board regulatory programs addressing all discharges in effect at the time this implementation task is due may contain requirements substantially similar to the requirements of these implementation tasks. If such requirements are in place in another regulatory program including other TMDLs, the Executive Officer may revise or eliminate this implementation task to coordinate this TMDL implementation plan with other regulatory programs.

[2] Interim WLAs and Interim LAs are effective immediately upon TMDL Adoption. WLAs will be placed in POTW NPDES permits as effluent limits. WLAs will be placed in stormwater NPDES permits as in-stream limits. LAs will be implemented using applicable regulatory mechanisms.

[3] Date of achievement of WLAs and LAs based on the estimated timeframe for educational programs, special studies, implementation of appropriate BMPs, and predicted trends of natural attenuation. The conditional waiver will set the timeframes for the BMP management plans.

8.7 Adaptive Management

Implementation of the OC Pesticides and PCBs TMDL will operate within an adaptive management framework where compliance monitoring, special studies, and stakeholder interaction guide the process as it develops through time. Compliance monitoring will generate information critical for measuring progress toward achievement of WLAs and LAs, and may suggest the need for revision of those allocations in some instances. Additionally, data from ongoing monitoring could reveal necessary adjustments to the implementation timeline and may serve to initiate reevaluation when appropriate. Special studies will increase understanding of specific conditions/processes in the watershed, allowing for more accurate prediction of results expected from various implementation efforts. Thus, adaptive management allows this TMDL to be an ongoing and dynamic process, rather than a static document.

Leadership of the adaptive management program will involve individuals from a range of groups. The LARWQCB will oversee compliance monitoring and any potential need for reevaluation of this TMDL. Individual stakeholders or stakeholder groups may contribute time and expertise to special studies. The Ventura County Watershed Protection District has significant resources and personnel dedicated to improving the understanding of sediment transport in watersheds of the region, including the CCW. United Water is involved in a program to monitor effects upon water quality from various agricultural land uses, which will likely generate information beneficial for the efficacy of the Implementation Plan. Many stakeholders have been working together since 1996 toward the development of a Watershed Management Plan for Calleguas Creek. The purpose of the Watershed Management Plan is to develop a strategy for addressing a variety of needs in the watershed, including: flood control, erosion and sedimentation, water quality, water resources, and habitat. When developed, this plan should identify mechanisms for addressing the water quality issues within the watershed, including 303(d)-listed pollutants. As such, the plan will serve as the ultimate implementation plan for all of the TMDLs within the watershed.

8.8 Economic Analysis of Implementation

Water Code Section 13000 requires the State and Regional Boards to regulate so as to achieve the highest water quality that is reasonable, based on consideration of economics and other public interest factors. Water Code Section 13141 requires that prior to the implementation of any agricultural water quality control program; an estimate of the total cost of the program and identification of potential sources of financing shall be included in any applicable regional water quality control plan. An analysis of the impacts of implementing these TMDLs with respect to costs, benefits, and other public interests factors is presented below.

The WLA Implementation Plan focuses on education, collection, water conservation, and monitoring to expedite the removal of OC Pesticides and PCBs from the watershed. Table 74 summarizes the goals of the education/collection program as well as estimated costs for the WLA implementation actions.

Table 74. Waste Load Allocation Implementation Plan actions and Cost Estimates

Implementation Action and Goals	Estimated Cost
Develop and implement urban educational and collection program. The goals of this program are: 1. Provide information on: • Bans and restrictions on use of OC pesticides and PCBs. • The harmful effects of OC pesticides and PCBs. • The proper use and disposal of pesticides. • Alternative pest control techniques including integrated pest management. • Methods for reducing urban water use and runoff. • Household hazardous waste collection program to collect any remaining OC pesticide and PCB stocks. 2. Assess effectiveness of program for achieving WLAs.	$150,000/year for a minimum of three years
Develop and implement source identification and control program	$10,000 for source identification. Additional costs could arise from actions to control identified controllable sources.
If identified, implement additional construction controls in HCAs.	$2400/yr [1]
Evaluate and if identified, implement changes to sediment activities in watershed.	$10,000 for evaluation of sediment activities. Additional

[1] Estimated based on 4 hours of inspection time at $60/yr at 10 construction sites.

As presented in the LA Section, BMPs will likely be necessary to reduce agricultural loads to achieve LAs. The LA Implementation Plan focuses on education, water conservation, and implementation of BMPs. Table 75 summarizes the goals of the programs and studies as well as estimated costs. Since the implementation plan for the OC Pesticides and PCBs TMDL has a much longer timeline for completion than other related TMDLs in the CCW (Nutrients, Toxicity, Sediment), implementation actions put in place by the other TMDLs will likely accomplish many or even all of the necessary goals for the OCs TMDL. The estimates of cost shown in Table 75 are the costs of the full program of implementation. It is expected that these costs will cover implementation for all of the related TMDLs and are therefore not separate costs to be added together for each TMDL.

Table 75. Load Allocation Implementation Plan Actions and Cost Estimates

Implementation Action and Goals	Estimated Cost [1]
Develop and implement an Agricultural Water Quality Management Plan. The goal of this action is to develop a management plan to address identified water quality impairments and meet water quality objectives.	$700,000
Identify appropriate BMPs and the extent to which BMPs are currently implemented in the CCW. The goal of this action is to complete studies to determine the most appropriate BMPs for the CCW given crop type, pesticide, site specific conditions, as well as the critical conditions as well as the current BMPs utilized in the CCW and the extent to which they are currently implemented.	This work is currently being conducted and will not require additional funding.
Develop and implement agricultural BMP education program. The goals of this program are to: 1. Provide information on: • BMPs identified in the aforementioned studies as well as other BMPs deemed to be effective at reducing runoff to water bodies given crop type, pesticide, site specific conditions, as well as the critical conditions. • Bans and restrictions on use of OC pesticides and PCBs. • The harmful effects of OC pesticides and PCBs. • The proper use and disposal of pesticides. • Alternative pest control techniques including integrated pest management. • Methods for reducing water use and runoff. 2. Assess effectiveness of program.	$75,000/year for a minimum of three years
Implement BMPs. The goal of this action is to implement BMPs to address OC pesticides and PCBs and to assess their effectiveness for achieving LAs.	$3,300,000 - $140,000,000

1 All of the costs presented in this table represent the costs of the entire program. In many cases the implementation actions are similar for other CCW TMDLs. These are considered total costs and are not independent costs to be added for each TMDL.

Table 76 summarizes the estimated unit costs and watershed wide costs associated with implementing a wide range of possible agricultural BMPs. Currently it is unclear which BMPs have been implemented in the CCW or the extent to which those BMPs have been implemented. Because of this, in developing the estimated cost for implementing BMPs it was assumed that 1) no BMPs are implemented in the CCW and 2) BMPs are required on all agricultural lands. Cost estimates were developed by selecting the least and most expensive options by category for the low and high cost estimates, respectively. The range of estimates is likely high given the broad assumptions used.

Table 76. Estimated Costs for Applicable Agricultural Best Management Practices (BMPs) for Reducing Pesticide Loading[1,2]

Agricultural BMP	Units	Cost Range Per Unit		Cost Range For Watershed	
		Low	High	Low	High
Conservation Tillage					
No Till	acre	-$11.50	$5.70	-$227,800	$112,900
Mulch Till	acre	$11.50	$22.90	$227,800	$453,600
Contour Farming	acre	$9.20	$114.60	$96,600	$1,203,300
Contour Orchard and Other Fruit Area	acre	$114.60	$149.00	$1,203,300	$1,564,500
Crop Residue Use					
Chopping and Chopping Waste	acre	$28.70	$68.80	$568,500	$1,362,800
Mulching using min. Tillage	acre	$11.50	$28.70	$227,800	$568,500
Filter Strip					
Filter Strip (10-20 ft wide)	acre	$430	$14,326	$80,500	$2,682,500
Filter Strip (20-40 ft wide)	acre	$430	$14,326	$161,000	$5,364,900
Filter Strip (40-60 ft wide)	acre	$430	$14,326	$321,900	$10,729,900
Buffer Strip (20-30 ft wide)	acre	$487	$1,948	$182,400	$729,600
Landscaping (20-30 ft wide)	acre	$516	$4,011	$193,100	$1,502,200
Grassed Waterway	acre	$430	$14,326	$403,400	$13,412,300
Hillside Bench	acre	$40	$2,120	$421,050	$22,262,100
Irrigation Systems					
Irrigation System: Sprinkler	acre	$401	$1,261	$7,945,000	$24,971,950
Irrigation System: Trickle					
Microspray System	acre	$974	$3,667	$19,296,050	$72,643,900
Drip Irrigation	acre	$2,120	$4,126	$41,996,900	$91,723,850
Irrigation System					
Tailwater Recovery	each	$5,157	$28,652	NC	NC
Irrigation Water Management	acre	$57	$28,652	$1,135,000	$17,025,000
Runoff Management system					
Sediment Basin	each	$802	$1,150,000	NC	NC
Infiltration Trench	per foot	$17	$86	NC	NC
Sediment Trap, Box Inlet	each	$212	$974	NC	NC
			Total[3]	$3,300,000	$140,000,000

NC Not calculated as there was not a clear method for estimating the total units needed.

1 From: Calleguas Creek Watershed Erosion and Sediment Control Plan for Mugu Lagoon (NRCS, 1995).

2 Costs adjusted from 1995 to 2000 using Engineering News Record Construction Cost Index.

3 The total for the Low Cost Range determined by selecting the least expensive BMP from each subgroup. The total for the High Cost Range determined by selecting the most expensive BMP from each subgroup.

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Appendix I – Planning Species for the Calleguas Creek Watershed Evaluation Study (www.calleguascreek.org)

Common Name	Scientific name	Federal/State Status
BIRDS		
Cooper's hawk	*Accipiter cooperii*	- -/CSC
Sharp-shinned hawk	*Accipiter gentilis*	- -/CSC
Tri-colored blackbird	*Agelaius tricolor*	FSC/CSC
Southern California rufous-crowned sparrow	*Aimophila ruficeps canescens*	FSC/CSC
Bell's sage sparrow	*Amphispiza belli belli*	FSC/CSC
Golden eagle	*Aquila chrysaetos*	- -/CFP
Burrowing owl	*Athene cunicularia*	FSC/CSC
Western snowy plover	*Charadrius alexandrinus nivosus*	FT/CSC
Mountain plover	*Charadrius montanus*	FSC/CSC
Northern harrier	*Circus cyaeneus*	CSC
Yellow warbler	*Dendroica petechia brewsteri*	- -/CSC
White-tailed kite	*Elanus leucurus*	- -/CFP
Southwestern willow flycatcher	*Epimodonax traillii extimus*	FE/CE
California horned lark	*Eremophila alpestris actia*	- -/CSC
Prairie falcon	*Falco mexicanus*	- -/CSC
Merlin	*Falco columbarius*	CSC
Yellow-breasted chat	*Icteria virens auricollis*	- -/CSC
Loggerhead shrike	*Lanius ludovivianus*	FSC/CSC
Long-billed curlew	*Numenius americanus*	- -/CSC
Belding's savannah sparrow	*Passerculus sandwichensis beldingi*	FSC/CE
California brown pelican	*Pelecanus occidentalis californicus*	FE/CE
Double-crested cormorant	*Phalacrocorax auritus*	- -/CSC
Coastal cactus wren	*Campylorhynchus brunneicapillus cousei*	FSC/CSC
Coastal California gnatcatcher	*Polioptila californica californica*	FT/CSC
Light-footed clapper rail	*Rallus longirostris levipes*	FE/CE
Bank swallow	*Riparia riparia*	- -/CT
California least tern	*Sterna antillarum browni*	FE/CE
Least Bell's vireo	*Vireo bellii pusillus*	FE/CE
MAMMALS		
Ringtail	*Bassariscus astutus*	--/CFP
Coyote	*Canis latrans*	- -/- -
Yuma myotis	*Myotis yumanensis*	FSC/CSC
California mastiff bat	*Eumops perotis californicus*	FSC/CSC
Mountain lion	*Felis concolor*	- -/- -
Bobcat	*Felis rufus*	- -/- -
San Diego black-tailed jackrabbit	*Lepus californicus bennetti*	FSC/CSC
San Diego desert woodrat	*Neotoma lepida intermedia*	FSC/CSC
American badger	*Taxidea taxus*	- -/- -
Black bear	*Ursa americanus*	- -/- -

FT – Federally Threatened; FE – Federally Endangered; FSC – Federal Species of Concern (formerly Category 2 or Category 3 candidate or proposed for federal listing); CE – State Endangered; CT – State Threatened; CFP – State Fully Protected; CSC – State Species of Special Concern.

Appendix II – Least Tern and Clapper Rail Data from Point Mugu Navy Base

Unpublished data from the U.S. Navy contains information about OC pesticides and PCB concentrations in California Least Tern chicks (dead from unknown causes), California Least Tern eggs (abandoned and unhatched), Light Footed Clapper Rail chicks (dead from unknown causes), Light Footed Clapper Rail eggs (abandoned and unhatched), and fish recovered from abandoned nests found on the Point Mugu Navy Base (U.S. Navy, 2000). A range of OCs were considered, including: DDD, DDE, DDT, PCBs (five aroclors), aldrin, HCH (including lindane), chlordane, dieldrin, endosulfan, endrin, heptachlor, heptachlor epoxide, and toxaphene. DDD, DDE, and HCH (beta-BHC) were the only constituents detected; and about 90% of those detections were for DDE. Those DDE data are shown in Table 77.

Table 77. DDE content in chicks and eggs of California Least Terns, Light Footed Clapper Rails, and fish found in abandoned nests on the Point Mugu Navy Base (U.S. Navy, 2000).

Client-ID	Collected	n (total)	n (detected)	Result	Units	Average Reporting Limit	Average Detected Concentration
Least Tern Chick	8/7/2000	13	13	1.3	ug/g	0.258	1.41
Least Tern Egg Contents	8/7/2000	6	6	0.48	ug/g	0.157	0.61
Fish	8/8/2000	3	1	0.12	ug/g	0.060	0.12
Clapper Rail Chick	8/7/2000	1	1	1.9	ug/g	0.083	1.90
Clapper Rail Egg Contents	8/7/2000	5	5	0.29	ug/g	0.017	0.33

Egg shell thickness of the unhatched eggs was also measured. A comparison of egg shell thickness and DDE concentration is shown in Figure 31. A relationship seems to exist between DDE concentration and egg shell thickness (although more samples are needed to provide statistical certainty), consistent with findings in the literature that thinning of eggshells may result when birds eat fish and/or other organisms contaminated by DDE, DDE, or DDT (Cox, 1991).

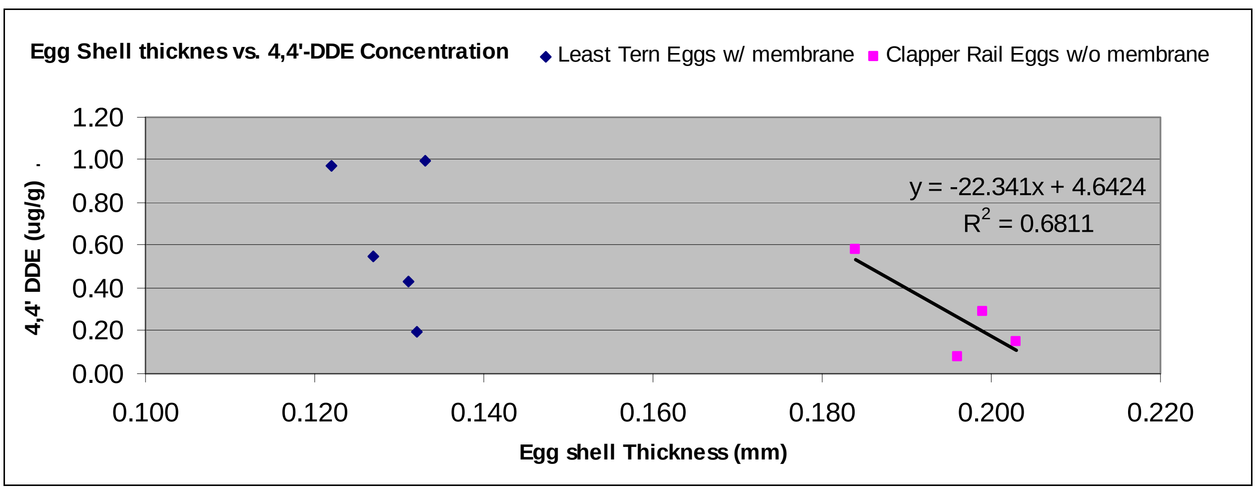

Figure 31. Plot of egg shell thickness vs. 4,4' DDE concentration in Least Tern and Clapper Rail eggs from Mugu Lagoon (U.S. Navy, 2000). All but one of the Least Tern eggs included measurable membrane and all but one of the Clapper Rail eggs did not include measurable membrane.

Appendix III - Land Use in the Calleguas Creek Watershed by Subcategory (DWR, 2000 Land Use Layer)

Name (class1,subclass1)	Acres in CCW	% of CCW	Acres of Utilized Land	% of Utilized Land
native veg	103,689.95	47.1%	--	--
urban	52,723.13	24.0%	52,723.13	47.1%
lemons	17,647.92	8.0%	17,647.92	15.8%
avocados	7,913.95	3.6%	7,913.95	7.1%
strawberries	5,261.21	2.4%	5,261.21	4.7%
peppers	3,048.93	1.4%	3,048.93	2.7%
beans(green)	2,938.90	1.3%	2,938.90	2.6%
celery	2,643.34	1.2%	2,643.34	2.4%
no data	2,491.16	1.1%	--	--
misc truck	2,307.12	1.0%	2,307.12	2.1%
flowers,nursery,xmas tree	2,295.47	1.0%	2,295.47	2.1%
onions, garlic	1,520.59	0.7%	1,520.59	1.4%
turf farms	1,424.69	0.6%	1,424.69	1.3%
golf course	1,276.71	0.6%	1,276.71	1.1%
lawn area, irr	1,132.84	0.5%	1,132.84	1.0%
mixed(4)	1,091.30	0.5%	1,091.30	1.0%
lettuce	1,039.00	0.5%	1,039.00	0.9%
citrus (misc)	846.87	0.4%	846.87	0.8%
melon,squash,cuc	818.42	0.4%	818.42	0.7%
riparian	815.14	0.4%	--	--
oranges	676.46	0.3%	676.46	0.6%
corn (field and sweet)	650.51	0.3%	650.51	0.6%
truck crops (misc)	626.95	0.3%	626.95	0.6%
water	610.72	0.3%	--	--
broccoli	512.11	0.2%	512.11	0.5%
misc field	482.23	0.2%	482.23	0.4%
cabbage	464.71	0.2%	464.71	0.4%
barley	373.14	0.2%	373.14	0.3%
tomatoes	346.09	0.2%	346.09	0.3%
mixed pasture	340.96	0.2%	340.96	0.3%
livestock feed lots	321.04	0.1%	321.04	0.3%
barren	290.32	0.1%	--	--
bush berries	244.12	0.1%	244.12	0.2%
cole crops	217.13	0.1%	217.13	0.2%
cauliflower	177.42	0.1%	177.42	0.2%
spinach	119.46	0.1%	119.46	0.1%
grain (misc)	105.67	0.0%	105.67	0.1%
sudan	73.79	0.0%	73.79	0.1%
artichoke	66.99	0.0%	66.99	0.1%
idle	121.63	0.1%	--	--
carrots	53.97	0.0%	53.97	0.0%
vinyard	41.14	0.0%	41.14	0.0%
farmsteads	38.42	0.0%	38.42	0.0%
pasture (misc)	27.52	0.0%	27.52	0.0%
pistachios	11.61	0.0%	11.61	0.0%
poultry	9.75	0.0%	9.75	0.0%
grapefruit	9.68	0.0%	9.68	0.0%
walnuts	8.19	0.0%	8.19	0.0%
misc subtropical fruit	6.63	0.0%	6.63	0.0%
wheat	5.76	0.0%	5.76	0.0%
cemetary, irr	5.47	0.0%	5.47	0.0%
total =	**219,966.22**	**100.0%**	**111,947.30**	**100.0%**