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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
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14 June 2002

Celeste Cantú
Executive Director
State Water Resources Control Board
P.O. Box 100
Sacramento, CA 95812-0100

Gerard Thibeault
Executive Officer
Santa Ana Regional Water Quality Control Board
3737 Main Street, Suite 500
Riverside, CA 92501-3339

Dear Ms. Cantú and Mr. Thibeault:

On behalf of the U.S. Environmental Protection Agency (EPA), I am hereby transmitting EPA's toxic pollutant total maximum daily loads (TMDLs) for Newport Bay and San Diego Creek established today, June 15, 2002. TMDLs are established for the following waterbody-pollutant combinations:

Water Body	Elemental Pollutant	Organic Pollutant
San Diego Creek	Cd, Cu, Pb, Se, Zn	Chlorpyrifos, Diazinon, Chlordane, Dieldrin, DDT, PCBs,Toxaphene
Upper Newport Bay	Cd, Cu, Pb, Se, Zn	Chlorpyrifos, Chlordane, DDT, PCBs
Lower Newport Bay	Cu, Pb, Se, Zn	Chlordane, Dieldrin, DDT, PCBs
Rhine Channel, within Lower Newport Bay	Cu, Pb, Se, Zn, Cr, Hg	Chlordane, Dieldrin, DDT, PCBs

As you know, EPA is establishing these TMDLs pursuant to EPA commitments under a consent decree (*Defend the Bay v. Marcus*, C. 97-3997 MMC, October 31, 1997). Since the State of California (State) has not adopted toxic pollutant TMDLs for Newport Bay and San Diego Creek, EPA is establishing these TMDLs to meet the June 15, 2002 consent decree deadline.

I want to thank the staff of the Santa Ana Regional Water Quality Control Board (Regional Board) for their assistance in preparing these TMDLs. In particular, we appreciate their work in developing a technical analyses and draft TMDLs for selenium, diazinon, and chlorpyrifos. We also appreciate the Regional Board's assistance in developing the TMDLs for the other toxic pollutants addressed in this decision.

Federal regulations require the State to incorporate TMDLs for Newport Bay and San Diego Creek along with appropriate implementation measures, into the Santa Ana Region Basin Plan. We recognize that additional work by Regional Board staff will be necessary to prepare and adopt the toxic pollutant TMDLs and associated monitoring and implementation measures. We appreciate your commitment to complete this work in a timely manner and look forward to our continued cooperation in addressing these toxic pollutants.

Several commenters, including the Regional Board, dischargers, and environmental groups specifically requested that EPA discuss TMDL implementation recommendations when we made the final TMDL decisions. The implementation and monitoring recommendation in Section IX of the summary TMDL document are not required and are not part of the TMDL decisions being made by EPA at this time; rather, they are included to assist followup planning and implementation work by the State and local stakeholders. We understand that the State is responsible for developing implementation plans necessary to attain TMDLs.

Consistent with the State's approach to developing and implementing other TMDLs in the Newport Bay watershed for sediments, nutrients, and pathogens, EPA believes a phased, iterative approach to implementation and monitoring is appropriate to address the toxic pollutants of concern. Substantial uncertainty remains concerning pollutant sources and the relationship between pollutant loads and environmental effects in the watershed. EPA believes some specific implementation actions should be carried out to address pollutant sources which are most clearly of concern. Several of these actions are already underway or in the planning stages including:

- The sediment control plan adopted in 1997 to implement the sediment TMDLs. Efforts to reduce erosion and sediment delivery to water courses should help reduce toxic pollutant inputs because many of the toxic pollutants of concern adhere to sediments.
- The Bay Protection Toxic Cleanup Program adopted for Rhine Channel in 1997. Sediments in Rhine Channel have been identified as a toxic hot spot; therefore, we support the State's continuing efforts to secure funding to carry out remedial action.
- The phase out of diazinon and chlorpyrifos use in most urban applications. The national phase out of these pesticides should result in substantial reductions in pesticide loading to Newport Bay waters.

Several commenters expressed concern that establishment of the TMDLs will create immediate changes in pollutant control obligations of watershed dischargers, or that the TMDLs will constrain their land use management options. I would like to clarify that the TMDLs are not self-implementing, and that the rights and obligations of individual dischargers would only change based on implementation strategies adopted by the State in the future. Moreover, our analysis indicates that the pollutant control strategies currently underway in much of the watershed may be sufficient to reduce most of the toxic pollutants to safe levels, and we do not expect that further controls (primarily best management practices) would seriously disrupt existing land use and pollutant discharge plans. We appreciate your commitment to work with the local community to carefully evaluate the need for, and strategies to implement, further reductions in pollutant loading or actions to remediate contaminated sites in a timely manner.

It is also appropriate to collect and analyze additional monitoring data to improve the understanding of pollutant sources and effects, periodically review the TMDLs and implementation actions in light of new monitoring results, and revise the TMDLs and implementation actions if necessary. Depending upon the State's priorities, additional monitoring data could also assist in reviewing and, if necessary, revising the applicable water quality standards to provide the appropriate level of beneficial use protection. This combination of early actions to address clear pollutant sources and an ongoing commitment to iterative monitoring and adjustments provides an appropriate balance in followup implementation work.

When the Regional Board considers adoption of TMDLs for toxic pollutants along with associated implementation plans, the State may adopt the TMDLs identified in this decision or further assess these pollutants and adopt different TMDLs if warranted. EPA recommends that the State consider the specific areas of analytical uncertainty identified in the analysis supporting our TMDL decisions as a starting point in targeting any additional analytical work (including monitoring) planned in support of TMDL adoption. If the State adopts and EPA approves TMDLs which are different from the TMDLs established today, the State-adopted TMDLs would supercede the EPA established TMDLs.

If you have any questions regarding these TMDLs, please do not hesitate to call me or have your staff call David Smith (415) 972-3416 or Peter Kozelka (415) 972-3448.

Sincerely yours,

Alexis Strauss

Alexis Strauss 14 June 2002
Director, Water Division

enclosures

Total Maximum Daily Loads
For Toxic Pollutants
San Diego Creek and Newport Bay, California

U.S. Environmental Protection Agency
Region 9

Total Maximum Daily Loads
For Toxic Pollutants
San Diego Creek and Newport Bay, California

U.S. Environmental Protection Agency
Region 9

Established by:

Alexis Strauss
Director
Water Division
EPA Region 9

14 June 2002
Date

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I. Introduction

What Is the Purpose of This Action?

This document describes Total Maximum Daily Loads (TMDLs) being established for several toxic pollutants by U.S. Environmental Protection Agency (EPA) to help protect and restore the water quality of Newport Bay, San Diego Creek, and their tributaries. A TMDL identifies the maximum amount of a pollutant that may be discharged to a water body without causing exceedences of water quality standards and impairment of the uses made of these waters. The federal Clean Water Act requires development of TMDLs for polluted waters to assist in identifying pollutant control needs and opportunities. EPA is establishing these TMDLs pursuant to a 1997 consent decree in which EPA committed to ensure that these TMDLs would be established in 2002. EPA has worked closely with the California Regional Water Quality Control Board, Santa Ana Region (Regional Board) in the development of these TMDLs. Although the State has primary responsibility for developing TMDLs under the Clean Water Act, the State was unable to complete its formal adoption of these TMDLs by the consent decree deadline; hence EPA is required to establish the TMDLs at this time.

What Is A TMDL?

Section 303(d)(1)(A) 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 Total Maximum Daily Loads (TMDLs) for such waters. As part of California's 1996 and 1998 Section 303(d) lists, the Regional Board identified Newport Bay and San Diego Creek as water quality limited due to several toxic pollutants (in addition to other pollutants not addressed in these TMDLs) and designated this watershed as a high priority for TMDL development.

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 EPA guidance documents (e.g., EPA 1991 and EPA 2001). A TMDL is defined as "the sum of the individual waste load allocations for point sources and load allocations for nonpoint 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. A TMDL is also required to be developed with seasonal variations and include a margin of safety to address uncertainty in the analysis. In addition, pursuant to the regulations at 40 CFR 130.6, states must develop water quality management plans which incorporate approved TMDLs and implementation measures necessary to implement the TMDLs.

Upon establishment of TMDLs by EPA or the State, the State is required to incorporate the TMDLs along with appropriate implementation measures into the State Water Quality Management Plan (40 CFR 130.6(c)(1), 130.7). The Regional Board Basin Plan, and applicable state-wide plans, serve as the State Water Quality Management Plan governing the Newport Bay watershed. If the State subsequently adopts and submits for EPA approval TMDLs which are different from the TMDLs established by EPA, EPA will review the State-submitted TMDLs to determine if they meet all TMDL requirements. If EPA approves the State TMDLs, they will supercede the TMDLs being established now by EPA.

Why Is EPA Establishing These TMDLs?

The Environmental Protection Agency (EPA) 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 EPA disapproves a TMDL submitted by a state, the EPA is required to establish a TMDL for that water body.

On October 31, 1997, EPA entered into a consent decree (decree), Defend the Bay, Inc. v. Marcus, (N.D. Cal. No. C 97-3997 MMC), which established a schedule for development of TMDLs in San Diego Creek and Newport Bay. The decree required development of TMDLs for several toxic pollutants by January 15, 2002. The agreement also provided that EPA would establish the required TMDLs within ninety (90) days, if the State failed to establish an approved TMDL by the deadline. In early April 2002, the decree was modified to extend the deadline for EPA establishment of these TMDLs to June 15, 2002.

Pursuant to the decree, EPA Region 9 and the Regional Board have already established sediment and nutrient TMDLs for San Diego Creek and Newport Bay. EPA has also approved state-adopted TMDLs for fecal coliform in Newport Bay.

The RWQCB has conducted extensive analysis in support of these toxic pollutant TMDLs and has proposed to adopt TMDLs and associated implementation plans for two pesticides and selenium. However, the State of California has not yet adopted TMDLs for any of the toxic pollutants covered by the decree. Therefore, in compliance with the terms of the decree, EPA is establishing the TMDLs for these toxic pollutants in order to meet the requirements of the decree. On April 12, 2002, EPA published a public notice seeking comment on the proposed toxic pollutant TMDLs for San Diego Creek and Newport Bay. EPA carefully considered comments received during the comment period and made some changes in the final TMDL decisions. EPA also completed a responsiveness summary that describes how EPA considered each comment received.

What TMDLs Are Being Established?

EPA is establishing TMDLs for several toxic pollutants which are exceeding applicable State water quality standards: selenium; several heavy metals; and several organic chemicals including modern pesticides (i.e., diazinon and chlorpyrifos) and legacy pesticides (DDT, Chlordane etc.) and polychlorinated biphenyls (PCBs). The pesticide diazinon is being addressed by these TMDLs because the State found that it is associated with significant water toxicity in San Diego Creek and concluded that it should be addressed by EPA concurrent with the similar pesticide chlorpyrifos, which is addressed by the consent decree. These TMDLs are being developed for specific water bodies in the Newport Bay watershed for which available data indicate that water quality is impaired. Table 1-1 lists the specific water bodies and associated pollutants for which TMDLs are being established.

Table 1-1. Toxic Pollutants per waterbody requiring TMDL Development

WaterBody (Type)	Element/ Metal	Organic compound
San Diego Creek (freshwater)	Cd, Cu, Pb, Se, Zn	Chlorpyrifos, Diazinon, Chlordane, Dieldrin, DDT, PCBs,Toxaphene
Upper Newport Bay (saltwater)	Cd, Cu, Pb, Se, Zn	Chlorpyrifos, Chlordane, DDT, PCBs
Lower Newport Bay (saltwater)	Cu, Pb, Se, Zn	Chlordane, Dieldrin, DDT, PCBs
Rhine Channel, within Lower Newport Bay (saltwater)	Cu, Pb, Se, Zn, Cr, Hg	Chlordane, Dieldrin, DDT, PCBs

Table 1-1 Toxic pollutants per waterbody requiring TMDL development.

California's Section 303(d) list of impaired waters does not specifically name each of these water body-pollutant combinations. The 1996 Section 303(d) list identified Newport Bay and San Diego Creek as impaired due to metals, pesticides and priority organics. The 1998 Section 303 (d) list added "unknown toxicity" to one specific part of San Diego Creek—Reach 2. During the negotiation of the consent decree, Regional Board staff provided a more specific list of pollutants covered by these general pollutant categories used in the listing decisions, and the consent decree refers to this more specific pollutant list. In 2001-02, EPA and Regional Board staff carefully evaluated more recent water quality data to help determine whether TMDLs were needed for each of the toxic pollutants identified in the decree. As described in EPA Region 9's assessment of water quality in San Diego Creek and Newport Bay (*Decision Document* 2002), and in this summary TMDL document below, EPA and the State determined that the list of water body-pollutant combinations warranting TMDL development should be fine-tuned to reflect the best current information concerning water body impairment. Based on our assessment of the most current local data and national EPA guidance concerning arsenic, EPA has concluded that TMDLs are not needed for arsenic for waters in the Newport Bay watershed.

Why Are These Pollutants Of Concern to EPA and the State?

By definition, toxic substances are poisonous through chemical action that may result in adverse impacts to humans or other living organisms. Adverse impacts may include, but are not limited to, cellular injury, mutagenic impairment, reduced reproductive success, and carcinogenic responses. The impacts of greatest potential concern in these water bodies are: a) chemical bioaccumulation through the aquatic food chain at levels which could harm human health when we consume fish or shellfish and b) chemical concentrations in water, sediment or biota that cause adverse effects in aquatic life or aquatic-dependent species. Available data indicate that the pollutants addressed in these TMDLs were found in water column, bottom sediments, or fish tissue at potentially unsafe levels which exceed applicable water quality standards. There is no current evidence of adverse effects on human health due to consumption of contaminated fish or direct exposure to toxic pollutants. Evidence of adverse impacts to aquatic life as a result of direct or indirect exposures to these toxic pollutants is limited. However, because the pollutants addressed in these TMDLs have the potential to cause short term adverse impacts to aquatic life or long term human health and aquatic life impacts due to pollutant bioaccumulation, actions to reduce discharges of these pollutants to the aquatic environment are warranted. The TMDLs are designed to assist in targeting pollutant reduction activities.

How Are the TMDL Documents Organized?

This document provides summary information about the Toxic Pollutant TMDLs, including a description of the environmental problems, water body goals, source analysis, loading capacity (i.e., TMDL), and loading allocations for each toxic pollutant TMDL. The document also describes how other federally-required TMDL components (i.e., margin of safety to account of analytical uncertainty, and critical conditions and seasonal variations associated with water body flow and pollutant loadings) are addressed. Individual pollutants have been grouped together based on chemical characteristics as follows:

Organophosphate (OP) Pesticides—diazinon and chlorpyrifos are two organophosphate pesticides with similar sources and impairment primarily limited to San Diego Creek.
Selenium—is a toxic bioaccumulative metal, with significant groundwater sources
Metals—cadmium, copper, lead and zinc have similar aqueous behavior and affect nearly all water bodies
Organochlorinated compounds—PCBs, DDT, chlordane, dieldrin and toxaphene have similar fate (bioaccumulation) and transport mechanisms (primarily from watershed soils to freshwater and saltwater sediments) for all waterbodies.
Mercury and Chromium—are two metals with very small geographical areas of impairment.

The State and EPA initially found that arsenic was present at levels of concern in Upper and Lower Newport Bay; however, based on more recent data and new information concerning arsenic risk in saltwater bodies, EPA has now concluded that Newport Bay and its tributaries are not impaired due to arsenic pollution. This summary document includes a section describing the basis for this conclusion in greater detail. The consent decree governing development of these TMDLs contains provisions that authorize EPA to make a determination that TMDLs are not needed for individual waters and/or pollutants if available data and information support those determinations. Pursuant to these decree provisions, EPA is making the determination that arsenic TMDLs are not needed for waters in the Newport Bay watershed.

EPA has prepared several Technical Support Documents (TSDs) to accompany this summary TMDL document. The TSDs provide considerably more detailed information relevant to each pollutant (grouped together as described above). The TSDs describe chemical characteristics of each toxicant, the basis for numeric targets, a complete source analysis, an explanation of how we calculated the loading capacity and TMDLs, and related information. A TSD is also provided that discusses EPA's analysis of freshwater flows in San Diego Creek, which was used to identify the appropriate numeric targets for certain pollutants, address seasonal variations and critical conditions in flows and pollutant loads, and evaluate the best approaches for calculating pollutant loading capacities and allocations. Another TSD provides more maps of the San Diego Creek, Santa Ana-Delhi Channel and Newport Bay watersheds and analysis concerning water residence times in Upper and Lower Bay. A summary of public comments and EPA's responses to those comments is provided in another TSD.

What Happens After The TMDLs Are Established?

TMDLs are not self-implementing – they must be implemented by the State and the entities that are discharging pollutants of concern. Federal regulations require states to adopt TMDLs and associated implementation measures in the State Water Quality Management Plan (i.e., the Basin Plan) (40 CFR 130.6). The State of California's procedure for adopting TMDLs and associated implementation measures is through amendments to the Basin Plans. These amendments are developed by the Regional Board staff, then approved by the Regional Board, State Water Resources Control Board, and State Office of Administrative Law. The amendments are then submitted to EPA for approval. (If the TMDLs adopted by the State are different from the TMDLs established by EPA then the TMDLs must be resubmitted to EPA for approval.)

EPA does not establish implementation plans as part of TMDLs under currently applicable federal regulations. However, we have included several implementation recommendations (see Section IX) which are intended to assist the State and local stakeholders in devising appropriate pollutant control and monitoring plans to address these toxic pollutants.

Three general categories of pollutant sources are identified in these TMDLs:

- Nonpoint sources, which discharge pollutants through diffuse runoff from the land, primarily in response to rainfall runoff, and which are addressed by the State through a combination of voluntary and regulatory measures outlined in California's State Nonpoint Source Management Plan.
- Point sources, which discharge pollutants through discrete pipes or conveyances and which are addressed through regulatory provisions of the National Pollutant Discharge Elimination System (NPDES) permit program. Several sources of pollutant runoff from roads and urban areas in the Newport Bay watershed are addressed through NPDES stormwater permits. There are a small number of additional permitted point source discharges in the watershed which are addressed in the TMDLs, including several groundwater dewatering operations.
- Pollutants already in water body sediments, which are usually associated with contaminated sediments discharged to water bodies in the past, but which retain and release significant quantities of pollutants to the ecosystem. These contaminated sediments may be concentrated to the point where remediation or removal action is warranted to remove the contaminated material, or they may be so diffuse that remedial action would be ineffective.

The federal Clean Water Act creates federal regulatory jurisdiction only over point sources. When NPDES permits for point source discharges addressed in the TMDLs are revised, their provisions must be consistent with the requirements and assumptions of any wasteload allocations contained in these TMDLs (see 40 CFR 122.44(d)(1)(vii)(B)). Permit modification may occur when the permits are reopened or reissued. The State has some discretion in determining the appropriate permit provisions to ensure consistency.

Although the TMDLs include allocations which address nonpoint source and contaminated sediments, implementation of these allocations is usually based on the TMDL implementation plan developed by the State as part of its Basin Plan amendment process described above. The State of California has broad authority under State law to apply voluntary or regulatory approaches to addressing these source categories. Past TMDL implementation plans in California have provided for State-issued "Waste Discharge Requirements" for some nonpoint sources, remedial action plans to address contaminated sediment sites, and opportunities for voluntary action to comply with load allocations. The Regional Board is currently in the process of developing implementation plans for several of the toxic pollutant TMDLs and will address the remaining toxic pollutant TMDLs in the near future.

Environmental Setting

The Newport Bay/San Diego Creek watershed is located in Central Orange County in the southwest corner of the Santa Ana River Basin, about 35 miles southeast of Los Angeles and 70 miles north of San Diego (see Figure 1-1 in TSD—Part A). The watershed encompasses 154 square miles and includes portions of the Cities of Newport Beach, Irvine, Laguna Hills, Lake Forest, Tustin, Orange, Santa Ana, and Costa Mesa. Mountains on three sides encircle the watershed; runoff from these mountains drains across the Tustin Plain and enters Upper Newport Bay via San Diego Creek. Newport Bay is a combination of two distinct water bodies - Lower and Upper Newport Bay, divided by the Pacific Coast Highway (PCH) Bridge. The Lower Bay, where the majority of commerce and recreational boating exists, is highly developed. The Upper Bay contains both a diverse mix of development in its lower reach and an undeveloped ecological reserve to the north.

San Diego Creek flows into Upper Newport Bay and is divided into two reaches. Reach 1 is located downstream of Jeffrey Road and Reach 2 lies upstream of Jeffrey Road to the headwaters. The San Diego Creek watershed (ca. 105 square miles) is divided into two main tributaries:

- Peters Canyon Wash, which drains Peters Canyon, Rattlesnake Canyon, and Hicks Canyon Washes that have their headwaters in the foothills of the Santa Ana Mountains, and
- San Diego Creek itself, which receives flows from Peters Canyon Wash in Reach 1 and includes Bee Canyon, Round Canyon, Marshburn Channel, Agua Chinon Wash, Borrego Canyon Wash and Serrano Creek

Important freshwater drainages to Upper Newport Bay, together covering 49 square miles, include the San Diego Creek, Santa Ana-Delhi Channel, Big Canyon Wash, Costa Mesa Channel and other local drainages.

San Diego Creek is the largest contributor (95%) of freshwater flow into Upper Newport Bay, followed by Santa Ana-Delhi Channel (~5%) (ACOE 2000). Table 1-2 summarizes the drainage areas of the major tributaries.

Table 1-2 Drainage Areas of the Newport Bay Watershed

Tributary	Drainage Area (acres)	Drainage Area (%)
San Diego Creek	47,300	48
Peters Canyon Wash	28,200	29
Santa Ana-Delhi	11,000	11
Other Drainage Areas	12,000	12
Total	98,500	100

Upper Newport Bay contains one of the highest quality remaining wetland areas in Southern California. The Upper Bay estuary contains a State Ecological reserve in the upper half with habitat designated for sensitive species. Sediment capture basins exist in the Upper Bay and have been dredged periodically by Army Corps of Engineers (ACOE). Another sediment removal/ecological restoration project has been proposed and is currently being evaluated (ACOE 2000). Newport Dunes Recreation area—a small public beach—is in the lower portion of Upper Bay (outside of the Ecological Reserve) along with more small boat marinas down near Pacific Coast Highway Bridge. Historical water uses for Upper Bay included water skiing, commercial and sport fishing although it is now used mainly for wildlife habitat, preservation of rare species, marine habitat, recreation and shellfish harvesting. In Lower Bay, surrounding shores and two islands are highly urbanized with nine boatyards and many (~10,000) small boats. Rhine Channel, a dead-end reach in western side of Lower Bay, is an isolated area with poor tidal flushing and minimal storm drain input. The Regional Board has identified Rhine Channel as a toxic hotspot based on previous investigations (BPTCP 1997). The entire Newport Bay up to the mouth of San Diego Creek is subject to tidal influence.

Climate is characterized by short, mild winters, and warm dry summers. Average rainfall is approximately 13 inches per year. Ninety percent of annual rainfall occurs between November and April, with minor precipitation during summer months. In the past six years, San Diego Creek has a mean base flow rate of approximately 12 cubic feet per second (cfs) (for all flows <20 cfs). Storm events, depending on their magnitude, intensity, and antecedent conditions, can increase this daily mean flow to over 9000 cfs (Dec. 7, 1997). San Diego Creek is freshwater with wide range of hardness and small influences by the slightly saline water table (less than 1 or 2% salinity). Upper Bay is an estuary with saline water conditions during dry weather and yet there is heavy freshwater influx (from San Diego Creek and Santa Ana-Delhi Channel) during major storms. Lower Bay waters are dominated by twice-daily ocean tides via the jetty entrance, thus saline waters exist at 30 to 35 parts per thousand (ppt).

Watershed History

The description below is taken largely from Regional Board staff report prepared for its draft Newport Bay TMDLs (RWQCB 2000).

The nature of the Newport Bay watershed has changed dramatically over the last 150 years, both in terms of land use and drainage patterns. In the late 19th and early 20th centuries, land use changed from ranching and grazing to open farming. During this time the Santa Ana River flowed into Newport Bay, while San Diego Creek and the small tributaries from the

Santiago Hills drained into an ephemeral lake and the neighboring area called "La Cienega de las Ranas" (Swamp of the Frogs) and then into the River. To accommodate rural farming, the ephemeral lake and Swamp of the Frogs were drained and vegetation cleared. Channels were constructed (but often did not follow natural drainage patterns) to convey runoff to San Diego Creek and then Newport Bay. After a major flood event in 1920's, the Santa Ana River was permanently diverted into the current flood control channel which now discharges to the Pacific Ocean. As a result of these land use and drainage changes, surface and groundwater hydrology have been substantially altered from natural conditions. Following World War II, land use again began to change from grazing and open farming to residential and commercial development. As urban development in the watershed proceeded (and continues), drainages were further modified through removal of riparian vegetation and lining of stream banks to expand their capacity and to provide flood protection. These changes culminated in the channelization of San Diego Creek in the early 1960s by the Orange County Flood Control Department. The channelization isolated the San Joaquin Marsh, the last remaining portions of the historic marsh upstream of Upper Newport Bay, from San Diego Creek (Trimble 1987).

Conversion of rural farmland to residential, commercial and light industrial use has been constant in the watershed. Land use statistics supplied by Orange County demonstrate this urban development (ACOE 2000). In 1983, agriculture accounted for 22% and urban uses for 48% of the Newport Bay watershed. In 1993, agricultural uses accounted for 12% and urban uses for over 64% of the area. As of 2000, agriculture had dropped to approximately 7% (<7,500 acres), including row crops (primarily strawberries and green beans), lemons, avocados and commercial nurseries. Currently, San Diego Creek watershed is greater than 90% urbanized whereas Santa Ana-Delhi is approximately 95% urbanized. Projected land use suggests 81% urban land use, 11% open, 8% rural and no agriculture (ACOE 2000).

Land use and drainage modifications changed the nature and magnitude of toxic substance discharges to the Bay. Converting from grazing type agriculture to orchards and row crops has increased the amount of pesticide use in the watershed, resulting in discharges of pesticides from these areas. The commercial nurseries drain to Peters Canyon Wash via Central Irvine Channel and to San Diego Creek via Marshburn Channel and Serrano Creek. Tustin and El Toro military bases exist within the watershed and have historically used various toxic substances during operations. Both military sites are involved with base closure procedures and may ultimately be converted to more urban/suburban areas. Urban development introduced new sources of toxic substances, including different pesticides and metals associated with human habitation (e.g., buildings, landscaping, and motor vehicles). In addition, land use activities which cause erosion may contribute to the delivery of pesticides and other pollutants that adhere to sediments or normally remain in solid form.

Table 1-3 Land Use types in watersheds of Newport Bay

Land use type	**San Diego Creek**		**Santa Ana Delhi**		**Newport Bay**	
	Acres	**% total**	**Acres**	**% total**	**Acres**	**% total**
Agricultural/	5092	6.6	0	0	5147	5.2
Residential	11,668	15.2	5285	18.2	19420	19.7
Commercial	6381	8.3	2397	8.3	9641	9.8
Industrial	3965	5.2	1102	3.8	5263	5.4
Education/Religion/ Recreation	15,811	20.6	825	2.8	17,393	17.7
Roads	10,295	13.4	3446	11.9	15,774	16.0
Transportation	1177	1.5	99	0.3	1326	1.3
No assigned land code	440	0.6	339	1.1	936	0.9
Vacant	21,910	28.5	1060	3.7	23,462	23.9
Total	**76,739**	**99.9**	**29003**	**100**	**98,362**	**99.9**

Source: OCPFRD land use data defined by sub-watersheds to compose each watershed. (see TSD Part A)
Most accurate and recent land use data provided by OCPFRD GIS Dept., March 1, 2002.

Public Participation

The State and EPA have provided for public participation through several mechanisms. The Regional Board staff has conducted numerous technical workshops (e.g., quarterly meetings since April 2000) on its assessment of toxic pollutant TMDL needs and the specific toxic pollutant TMDLs being developed by the State. The Regional Board held several public workshops as part of their regular meetings to discuss staff TMDL proposals (January 15, September 26, and October 26, 2001). EPA staff provided updates on its TMDL development activities at several of these Regional Board meetings. On October 26, 2001, the State's draft organophosphate (OP) pesticide and Selenium TMDLs were presented before the public as part of a Regional Board meeting. These draft State TMDLs were also available via the Regional Board website after that date.

On April 12, 2002, EPA publicly noticed the availability of the proposed Toxic Pollutant TMDLs and gave the public until May 28, 2002, to provide written comments. The EPA notice of availability was published in the Orange County Register, mailed to the Basin Plan distribution list provided by the Regional Board, and posted on the EPA Region 9 TMDL website. Two public meetings were held during the public comment period – a meeting to discuss the TMDLs in general in Newport Beach on April 16, 2002, and a meeting to discuss specific technical issues in Irvine on May 9, 2002. Copies of the TMDLs and TSDs were available at the public meetings, in EPA and Regional Board offices, and on the EPA Region 9 TMDL website.

Changes in the Final TMDL Documents

Several changes were made in the final TMDLs in response to comments received during the comment period:

- The numeric targets for some pollutants were modified to follow California screening guidelines or to reflect the most recent screening value studies. The organophosphate pesticide TMDL targets are based on values calculated by the California Department of Fish and Game. The California Office of Environmental Health Hazard Assessment guidelines were applied for organochlorine pollutant fish tissue targets. More recent literature values were applied for the freshwater organochlorine sediment targets.

- The flow records used to calculate flow tiers for several pollutant TMDLs were changed to reflect a longer period of record and to incorporate more recent flow data.

- The selenium TMDLs for the highest flow tier are based on acute water quality standards because, based on analysis of the longer flow record, flow patterns necessary to apply chronic standards were not expected to occur under the highest flow tier.

- The metals TMDLs for San Diego Creek are concentration-based; the metals TMDLs for Newport Bay are both concentration-based and mass-based.

- The organochlorine pollutant TMDLs were revised based on additional modeling analysis and consideration of more recent data. The flow tier approach applied for San Diego Creek organochlorine pollutant TMDLs was slightly modified. The description of analytical methods used for the organochlorine pollutant, chromium, and mercury TMDLs was revised to more clearly explain the analytical methods.

- The allocation methods used for each TMDL were clarified.

- A new section of implementation and monitoring recommendations was added to assist the State in preparing to adopt and implement TMDLs for these pollutants.

II. Overview of TMDLs and Available Data

TMDL Components

This section describes the components of a TMDL and discusses the analytical approaches used in the Newport Bay watershed TMDLs to address each component.

The goal of the TMDL process is to attain water quality standards and protect the beneficial uses of water bodies, including aquatic habitat, fishing, and recreation. A TMDL is a written, quantitative assessment of water quality problems and contributing pollutant sources. It identifies one or more numeric targets (endpoints) based on applicable water quality standards, specifies the maximum amount of a pollutant that can be discharged (or the amount of a pollutant that needs to be reduced) to meet water quality standards, allocates pollutant loads among sources in the watershed, and provides a basis for taking actions needed to meet the numeric target(s) and implement water quality standards.

For federally established TMDLs, seven components are included:

- **Problem Statement**—a description of the water body setting, beneficial use impairment of concern, and pollutants causing the impairment.
- **Numeric Targets**—for each pollutant addressed in the TMDL, appropriate measurable indicators and associated numeric target(s) based on numeric and/or narrative water quality standards which express the target or desired condition for the water body which will result in protection of the designated beneficial uses of water.
- **Source Analysis**—an assessment of relative contributions of pollutant sources or causes to the use impairment.
- **Loading Capacity/Linkage Analysis**—a connection between the numeric targets and pollutant sources which yields calculations of the assimilative capacity of the water body for each pollutant.
- **TMDL and Allocations**— an expression of the total allowable pollutant loads as divided between pollutant sources through load allocations for nonpoint sources and wasteload allocations for point sources. The TMDL is defined as the sum of the allocations and cannot exceed the loading capacity for each pollutant.
- **Margin of Safety**—an explicit and/or implicit margin of safety must be specified to account for technical uncertainties in the TMDL analysis.
- **Seasonal Variation/Critical Conditions**—an account of how the TMDL addresses various flows and/or seasonal variations in pollutant loads and effects.

Problem Statement

EPA includes problems statements in TMDL documents to assist readers in understanding the context for TMDL development and describe the water quality standards issue(s) which prompted development of the TMDL. The problem statements identify:

- name(s) and location(s) of waterbody segments for which the TMDL is being developed,
- the pollutant(s) for which the TMDL is being developed and information about why the pollutant(s) are being addressed,

- a description of the water quality impairment or threat which necessitated TMDL development, and
- adequate background information about the watershed setting for the TMDL to help the reader understand the key water quality, pollutant discharge, land use, and resource protection issues in the watershed.

As discussed above, California's Section 303(d) listing decisions only identified general pollutant categories for toxic pollutants impairing waters in the Newport Bay watershed. The consent decree identified suspected individual pollutants of concern, but the decree provides that TMDLs need not be established for individual pollutants and/or waters if subsequent analysis indicates TMDLs are not necessary at this time. To help define the scope of these TMDL studies, EPA Region 9, with assistance from the Regional Board, completed an assessment of available monitoring data for San Diego Creek and Newport Bay to determine which chemicals warrant TMDL development. In our assessment, we reviewed available toxicity and chemical data in three critical water quality categories: water column quality, sediment quality, and fish and shellfish tissue levels. We applied a two-tiered approach whereby all available data were analyzed to determine whether there is clear evidence of impairment with probable adverse effects (Tier 1) or incomplete evidence and/or evidence of possible adverse effects (Tier 2) (EPA Region 9, 2002). If a chemical exceeded the screening criteria in Tier 1 with respect to any *one* of the water quality categories, then it was determined a TMDL is necessary. If a chemical exceeded the screening criteria in Tier 2 with respect to *two or more* categories then a TMDL is necessary. EPA also considered whether TMDLs might be necessary based on evaluation of water quality trends and conditions in water segments adjacent to a segment in question. We examined monitoring data for the past fifteen years; however, to maximize the relevance of our assessment to present-day water quality, we focused on the most recent results (since 1995). Our assessment evaluated each chemical identified in the decree for four separate water bodies: San Diego Creek, Upper Newport Bay, Lower Newport Bay and Rhine Channel. The water body-pollutant combinations for which EPA determined TMDLs are needed at this time are listed in Table 1-1.

The introduction to this document provides a basic discussion of the problems associated with exposures to toxic pollutants addressed in these TMDLs and background information on the watershed setting.

Numeric Targets and Applicable Water Quality Standards

Numeric targets identify the specific water column, sediment, and/or tissue goals or endpoints for the TMDL which equate to attainment of the water quality standards (see EPA Region 9, 2000). In some cases, multiple indicators and associated numeric target values may be needed to interpret applicable water quality standards (e.g. where there is uncertainty that a single indicator is sufficient to measure protection of designated uses). In addition, some TMDLs may incorporate multiple numeric targets to account for differences in acceptable pollutant levels in a particular water body at different time scales (e.g., short term acute toxicity effects versus long term chronic exposure effects).

Water quality standards are comprised of the designated beneficial uses made of water bodies, narrative and numeric water quality criteria (known as "water quality objectives" in California), and anti-degradation policies. Applicable standards of concern for these toxic pollutant TMDLs include the designated uses and both narrative and numeric water quality criteria, which are applied in a manner which is expected to result in protection of the designated beneficial uses.

The Regional Board Basin Plan (1995) designates the beneficial uses for Newport Bay, San Diego Creek and its tributaries. All water bodies are designated as wildlife habitat, with San Diego Creek identified as warm freshwater habitat and Upper and Lower Bay identified as estuarine and marine habitat, respectively. The recreation beneficial uses are designated for all of Newport Bay and San Diego Creek. Upper and Lower Bay are also designated for commercial and sport fishing, preservation of biological habitats—spawning, reproduction, development, rare, threatened and endangered species, recreation, and shellfish harvesting. The specific beneficial uses of San Diego Creek and Newport Bay are identified in Appendix A-1 at the end of this summary document.

These toxic pollutant TMDLs focus on two of the most sensitive designated aquatic life and wildlife beneficial uses of concern in the watershed—RARE and WILD. One primary objective is to protect the special biological and wildlife habitat of the Newport Bay Nature Preserve and Ecological Reserve, in the upper part of Upper Newport Bay. The Nature Preserve is considered a critical estuary of Southern California. The Upper Newport Bay Nature Preserve consists of approximately 1,000 acres of open space and is home to seven rare or endangered bird species: Light-footed clapper rail, Belding's savannah sparrow, least tern, brown pelican, peregrine falcon, black rail, and California gnatcatcher. Two endangered plants, the salt marsh birds-beak and the rare Laguna live-forever, are also found at the reserve. The second objective is to reduce build up of toxicants in fish and shellfish within all water bodies, thereby minimizing the potential for adverse impacts associated with wildlife and human consumption of contaminated food. Seventy-eight species of fish inhabit the Upper Newport Bay waters, including the California halibut and barred sand bass—two popular sport fishes.

Narrative water quality objectives considered for each TMDL are specified by the 1995 Regional Board Basin Plan:

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

Numeric water quality objectives for several pollutants addressed in these TMDLs were promulgated by EPA in 2000 in the California Toxics Rule (CTR). Pollutants covered by CTR objectives include selenium, cadmium, copper, lead, zinc, chromium, chlordane, dieldrin, DDT, toxaphene and PCBs. Chlorpyrifos and diazinon are not listed as toxic pollutants pursuant to Section 307(a)(1) of the Clean Water Act (see 40 CFR 401.15), and the CTR did not establish numeric objectives for those pollutants. Additionally, the CTR did not establish aquatic life objectives for mercury and the selenium and cadmium objectives were established contingent on an EPA commitment to revise the objectives promptly to better protect wildlife.

In many cases where applicable standards are expressed in numeric terms, it is appropriate to set the numeric target equal to the numeric water quality standard. For most metals addressed in these TMDLs, the numeric targets are equal to the numeric objectives in the CTR. For selenium (Se) the freshwater and saltwater water quality standards are defined by

CTR. However, EPA acknowledged in its consultations with the U.S. Fish and Wildlife Service (USFWS) that the freshwater standards for Se may not be fully protective of wildlife, and EPA committed to revisit and, if necessary, revise the Se criteria in the near future. In its draft TMDL for Se, the Regional Board proposed to apply more protective Se targets based on USFWS recommendations. In the draft TMDL document, EPA proposed TMDLs based on the promulgated CTR standards, but invited comment on the alternative approach of basing the Se TMDLs on the more protective targets proposed by the Regional Board. The final TMDLs are based on the promulgated CTR standards. (See section IV—Se TMDL for further discussion.)

In some cases, it is necessary to interpret a numeric standard in terms other than the method through which the standard is expressed as long as the target(s) can be shown to relate back to achieving the water quality standard(s). For some pollutants (e.g., bioaccumulative toxins) or receiving water settings (e.g. embayments), it often makes more sense from the standpoint of source control and impact assessment to focus the TMDL on reductions of pollutant mass loads than solely on avoidance of exceedences of concentration-based standards. Moreover, use of sediment and/or fish tissue endpoints may provide more discriminating indicators of the beneficial use impacts of concern in a TMDL (e.g., pollutant bioaccumulation in the food chain and resultant human health or aquatic life impacts from consumption of contaminated organisms). Moreover, selection of targets based on these media enabled EPA to more completely utilize site specific data for several pollutants for which water column data were limited, consistent with the provisions of 40 CFR 130.7(c)(1)(i).

For several pollutants addressed in these TMDLs for which numeric objectives are in place (mercury, chromium, chlordane, dieldrin, DDT, toxaphene, and PCBs), the numeric targets are expressed in terms of protective sediment or fish/shellfish tissue levels. EPA's analysis of the relationship between the levels of these pollutants found in the water column, sediment, and fish/shellfish tissue found that attainment of the sediment and fish/shellfish tissue numeric targets will result in attainment of the water column numeric objectives. The sediment and tissue numeric targets are probably more protective than the numeric objectives for these pollutants. The use of sediment and tissue targets is appropriate in these cases in order to provide an implicit margin of safety to account for uncertainties in the relationship between pollutant loadings and beneficial use effects, and to ensure that both numeric and narrative standards are attained as required by 40 CFR 130.7(c)(1). In addition, EPA's decision to use sediment quality and fish tissue values as numeric targets for these pollutants is based in part on the fact that these substances are much more likely to be associated with particulate matter than to remain in the dissolved phase; that is, these compounds are either sorbed to bottom sediments or associated with extremely fine suspended sediments. Also, there are technological challenges accompanied with sampling and accurately detecting these compounds in water column samples. Therefore, these pollutants are unlikely to be detected in the water column in dissolved form even in waters where they may be present at levels of concern.

In situations where applicable water quality standards are expressed in narrative terms, it is necessary to develop a quantitative interpretation of narrative standards (EPA Region 9 2000). Since a TMDL is an inherently quantitative analysis, it is necessary to determine appropriate quantitative indicators of the water quality problem of concern in order to calculate a TMDL. It is sometimes possible to supplement water column indicators (i.e., pollutant concentrations in water) with measures in sediment or tissue media since these alternative indicators are more directly associated with the pollutant effects of concern.

Where sediment indicators are used in these TMDLs, they are based on sediment quality guidelines developed by several studies (Long et al. 1995, Smith et al.1996, MacDonald et al. 1996) and compiled by Long and MacDonald in the biological effects database system (BEDS) synthesizing many, many samples throughout North America. These sediment quality guidelines (equivalent to threshold effect levels) have been endorsed by NOAA in the screening quick reference tables (SQuiRTs) for contaminants in sediments (Buchman 1999). Where fish or shellfish tissue indicators are used, they are based on tissue screening values established by the California Office of Environmental Health Hazard Assessment (OEHHA 1999). The specific basis for these target indicators is discussed in the individual TMDL descriptions.

For the organophosphate (OP) pesticides, chlorpyrifos and diazinon, there are no promulgated water quality criteria established by EPA or the State of California. Several entities including EPA (USEPA 1986 and 2000c) and California Department of Fish and Game (CDFG 2000a) have recommended criteria values for these pollutants. To be protective of aquatic resources and to meet beneficial uses, EPA has selected the CDFG values for chlorpyrifos and diazinon at the recommendation of the Regional Board.

Source Analysis

An understanding of pollutant loading sources and the amounts and timing of pollutant discharges is vital to the development of effective TMDLs. These TMDLs provide estimates of the amounts of pollutants entering the receiving water of concern or, in some cases, the amount of pollutant that is bioavailable based on historic loadings stored in the aquatic environment. These pollutant source estimates are documented based on data analysis and modeling studies described in the individual TMDLs and associated TSDs. Source loading estimates can be categorized in many ways, including but not limited to discharge source, land use category, ownership, pollutant production process (e.g. sedimentation processes), and/or tributary watershed areas.

The source analysis for these TMDLs indicated that historical discharges of PCBs and chlorinated pesticides, all of which are no longer authorized to be used, are believed to be primarily responsible for the pollutant levels measured in Newport Bay. Metals loading is associated with historical and ongoing discharges of urban runoff. Selenium loadings are estimated to come primarily from erosion and runoff, and discharges of shallow groundwater. Discharges of OP pesticides are associated with past and ongoing uses of these pesticides for household and agriculture pest control. Some pollutant loads are also estimated to come from seawater and atmospheric deposition.

The individually permitted point sources listed below discharge into waters in the Newport Bay watershed. These TMDLs include wasteload allocations for some of these facilities. A general permit is in place to regulate discharges associated with groundwater cleanup, which affects 21 permittees and focuses principally upon total suspended sediment, petroleum hydrocarbons and chlorinated solvents. Another general permit is in place which regulates groundwater dewatering operations of 12 permittees and focuses principally on suspended sediment discharges. Finally, the statewide general permit for industrial stormwater discharges covers several facilities that may discharge in the Newport Bay watershed, including John Wayne Airport. Runoff from state highways is regulated through the statewide CalTrans NPDES permit.

Six boatyards are located around Newport Bay; all are regulated for indirect metals discharges to the sewer system. Discharges from these boatyards do not flow to the Bay. Instead, wastewater flows into sumps or into connections to the Orange County Sanitation District pre-treatment system.

Table 2-1: NPDES Permits In San Diego Creek/Newport Bay Watershed

NPDES permits in San Diego Creek watershed	**Comments**
Orange County Stormwater	MS4 Permit; Includes many cities as co-permittees
Tustin Marine Base/GW general	At present this is general permit, although RWQCB is currently drafting an individual permit
Silverado Constructors/GW cleanup	General permit, discharges under emergency conditions only
Irvine Ranch Water District	Individual permit, discharges tertiary treated water into Sand Canyon Reservoir and permit regulates stormwater overflows from Sand Canyon Reservior
Serrano Water Treatment Plant	Individual permit for a drinking water filtering plant
City of Tustin groundwater desalter	Individual permit, irregular discharges
Great Lakes Chemical/GW cleanup	Individual permit, no longer discharges
CalTrans Stormwater	Statewide permit for CalTrans facilities
Industrial Stormwater	Statewide general permit for industrial stormwater discharges

The Regional Board currently regulates three commercial nurseries through waste discharge requirements (WDRs): Bordier's, Hines and El Modeno Gardens. These nurseries are located in the upper reaches of the watershed, and their discharge (normally only during storm events) flows into Peter's Canyon Wash (for Hines and El Modeno) and Marshburn Channel (for Bordier's) before reaching the main stem of San Diego Creek. The Regional Board is currently evaluating whether WDRs are needed for two other nurseries (Nakase Nursery and AKI nursery). There are some unpermitted nurseries that are smaller in size than the permitted nurseries. Runoff from other agricultural operations in the watershed, including row crops, orchards, and vineyards, is not currently regulated.

Loading Capacity/ Linkage Analysis

The loading capacity is the critical quantitative link between the applicable water quality standards (as interpreted through numeric targets) and the TMDL. The loading capacity reflects the maximum amount of a pollutant that may be delivered to the water body and still achieve water quality standards. The linkage analysis investigates the relationship between pollutant loadings and water quality effects in order to calculate loading capacities for each pollutant and water body. The loading capacity sections discuss the methods and data used to estimate loading capacity. A range of methods were used to derive the loading capacities for the various pollutants, including predictive water quality models and linkage methods based principally on data analysis. The individual TMDLs and associated TSDs describe the linkage analysis in detail.

TMDLs and Allocations

For each pollutant and water body, this document identifies the necessary TMDL (total allowed pollutant amount) and its components: appropriate wasteload allocations for point sources and load allocations for nonpoint sources and natural background. The TMDLs and associated wasteload and load allocations are expressed in quantitative terms as required by federal regulations.

TMDL calculation methods are summarized in this document and described in greater detail in the TSDs. Separate wasteload and load allocations are identified for point and nonpoint sources, respectively. In cases where it is feasible, individual wasteload allocations are established for each existing point source discharge, including permitted stormwater discharges. For several pollutants, insufficient information was available to support delineation of individual WLAs for each NPDES-permitted discharge. Therefore, the TMDLs include wasteload allocations for a category of "other NPDES permittees." This wasteload allocation category covers discharges under the following permits:

- Tustin Marine Base groundwater
- Silverado Constructors
- Irvine Ranch Water District
- Serrano Water Treatment Plant
- City of Tustin desalter
- Great Lakes Chemical
- Statewide Industrial Stormwater
- Statewide Construction Stormwater

EPA is establishing the grouped allocations for the "other NPDES permittees" category based on the following assumptions, which are discussed here to provide information to assist in implementing the allocations through the NPDES permitting process. The State, in consultation with the permittee(s) where appropriate, should gather data and information necessary to characterize the discharge flows and, if feasible, the loads of the specific pollutants for which allocations are established. The State should consider this new data and information when it considers adoption of the TMDLs and associated implementation plans for these toxic pollutants. If this categorical wasteload allocation is not subdivided when the State adopts the TMDLs, we assume that when any permit in this category is considered for revision or reissuance, the State should prepare an analysis as part of the permit fact sheet that (1) identifies the specific proportion or amount of the categorical wasteload allocation that can be discharged by the individual discharger, and (2) shows that the sum of all discharges covered by these permits will not exceed the total categorical wasteload allocation and is otherwise consistent with the TMDLs. Several alternative approaches are available to the State to apportion available loading amounts among the facilities covered in this wasteload allocation category (see *Technical Support Document for Water Based Toxics Control*, (EPA-505-2-9-001), March, 1991, pp. 68-69 for guidance on allocation criteria).

In the absence of additional analysis by the State in support of individual permitting actions consistent with the assumptions discussed above, we assume that available loading capacity identified in the categorical wasteload allocation is to be divided equally among the 8 permitted discharges. We expect that the followup State analysis in support of TMDL adoption or permit reissuance may result in different divisions of allocation capacity depending upon the combination of discharge flows, loads, and timing associated with each permitted discharge.

Load allocations for nonpoint sources may be expressed as specific allocations for specific dischargers or as "gross allotments" to nonpoint source discharger categories (40 CFR 130.2). TMDLs usually provide separate load allocations for natural background loads. Separate load allocations for background loads are calculated for the Newport Bay metals TMDLs; however, insufficient information is available to support a conclusion that these loads are completely natural. Separate natural background allocations are inappropriate for pesticides and organochlorine compounds because they of anthropogenic origin and because all known loading sources are accounted for in the TMDL analysis. Separate background allocations could not be calculated for selenium, chromium and mercury because insufficient information was available to support these calculations. Background levels of selenium associated with groundwater inputs to surface water may be significant; however, the physical and hydrological structure of the watershed has been highly altered as a result of hydrologic modifications, groundwater pumping, irrigation practices, and water imports to the watershed. As a result, it would be very difficult to estimate "naturally occurring" selenium discharge levels. Background levels of chromium and mercury are not expected to be substantial.

Allocations may be based on a variety factors. Federal regulations do not establish specific criteria which must be considered in dividing and allocating any available loading capacity between contributing sources. Criteria applied to determine the division of available pollutant loading capacity include:

- <u>Organophosphate Pesticides:</u> All allocations are concentration-based and are applied equally to all discharge sources.
- <u>Selenium:</u> Allocations were divided in proportion to land use areas of the different allocation categories for nonpoint sources and in proportion to discharge flow rates for point source categories. Consideration of flow rates in freshwater bodies, directly linked to precipitation events, is included.
- <u>Metals:</u> Load allocations and the stormwater wasteload allocation for San Diego Creek were generally divided in proportion to land areas associated with each source category. In defining the wasteload allocations for San Diego Creek, we considered the relative discharge flows associated with the different dischargers. We also included an undefined sources load allocation as a gross allotment to account for apparent loadings that could not be associated with other source categories.
- <u>Organochlorine Compounds:</u> Allocations to terrestrial watershed sources were generally divided in proportion to land use areas of different allocation categories, with some consideration of the feasibility of reducing loads for DDT. Newport Bay allocations are expressed as net available loads, taking into account as background loads loadings already allocated for "upstream" segments. For this reason, the allowable loads as expressed in the allocation tables in the TMDL document do not increase cumulatively in a downstream direction. The division of available loading capacity between terrestrial and in-Bay sediment sources was done in proportion to the percentage of total loads associated with watershed versus in-Bay sediment sources.
- <u>Mercury and Chromium:</u> Allocations to watershed sources were generally divided in proportion to land use areas of different allocation categories. Allocations between

watershed sources and in-Bay sediment sources were divided in proportion to the percentage of estimated contributions from new sources and resuspended sediments.

TMDLs (and thus, load allocations and wasteload allocations) can be expressed as *"mass per time, toxicity, or other appropriate measure"*, depending on the type of waterbody and the sources that contribute to impairment. The TMDLs for all pollutants except diazinon and chlorpyrifos are expressed in terms of mass loads per time, and the TMDLs for the pesticides diazinon and chlorpyrifos are expressed in terms of water column concentrations. It is appropriate to express these pesticide TMDLs in terms of water column concentrations because these pollutants cause adverse effects on aquatic life through relatively short term exposures. These pollutants are relatively short-lived in the environment before they break down into less toxic forms, and they do not bioaccumulate through the food chain in the same way several of the other pollutants addressed in these TMDLs do. Therefore, the water column concentrations of these pesticides are of greatest concern in preventing adverse ecosystem effects.

Margin of Safety

A margin of safety is incorporated in each TMDL analysis in order to account for uncertainty in the relationship between pollutant loads and water quality effects.

The margin of safety can be implicit (i.e., incorporated into the TMDL analysis through conservative assumptions) or explicit (i.e., expressed in the TMDL as a portion of the loadings) or a combination of both. The TMDLs described in this document include a margin of safety discussion for each pollutant that describes the basis for the provided margin of safety and shows why it is adequate to account for uncertainty in the TMDL. The document discusses sources of uncertainty in the analysis and how individual analytical assumptions or other provisions adequately account for these specific sources of uncertainty.

For all pollutants except metals, a 10% explicit margin of safety was applied to account for uncertainties in the analysis. An explicit margin of safety is appropriate for each TMDL because there is significant uncertainty in the analysis of pollutant effects, loads, fate (i.e. chemical transformations and degradation following discharge), and transport in the watershed. The data supporting the TMDLs were somewhat limited. For metals, a 20% explicit margin of safety was applied to account for (1) these analytical uncertainties and (2) the consideration that the metals TMDLs are expressed in terms of dissolved metals although it is likely that total metals loading levels are somewhat higher than dissolved metals loads, and that total metals loads may be of concern as a cause of sediment toxicity.

For all pollutants, the TMDLs also incorporate an implicit margin of safety because numerous conservative assumptions were made to ensure that the analytical methods applied are environmentally protective. Each TMDL section describes sources of uncertainty in the analysis and the assumptions made which provide an implicit margin of safety.

Seasonal Variations and Critical Conditions

TMDL must describe the methods used to account for seasonal variations and critical conditions (e.g., stream flows, pollutant loadings, and other water quality parameters) in the TMDL(s) [40 CFR 130.7 (c)]. In the semi-arid climate of Southern California there are two seasons—dry weather during most of the year and intermittent wet weather events typically between November and March. This two-season climate creates significant differences in flow through the creeks and streams. In general, 90% of the water flow occurs during less than 10% of the time; that is, most significant storm events and associated high flows usually occur during the months of December, January and February.

EPA has utilized two different approaches to seasonal variations and critical conditions in developing these TMDLs. One approach varies TMDLs on a seasonal basis. For example, the OP pesticide TMDLs (chlorpyrifos and diazinon) show there is considerable increase in pesticides applied during the dry season (when pests grow and create problems); however, aquatic impairment occurs during wet weather events as surface runoff pollutes the freshwater tributaries. OP pesticide critical conditions are explained more in section III below.

The other approach to addressing seasonal variations and critical conditions is to define critical conditions solely based on freshwater flow rates due to precipitation regardless of season. This flow based approach is applied to freshwater loading to metals, Se, and organochlorine (OC) compounds. Unlike the OP pesticides, the water quality effects associated with these pollutants are not expected to vary on a seasonal basis. In this flow-based approach, the continuous range of stream flows (measured as daily flow rates) that occur in San Diego Creek is broken down into several flow tiers. The loading capacity for each breakpoint in the flow tiers is established, and the sum of allowable loads under all tiers equals the total annual loading capacity for freshwater bodies. Thus the applicable allocation for a given source does not depend on the time of year, but on the actual stream flow (or associated sediment deposition rate for OC compounds) at the time of discharge. This flow approach is partially used for chromium and mercury TMDLs for Rhine Channel, where freshwater has little influence (6%) on deposition within that dead-end reach of Newport Bay.

To estimate the loading capacity of freshwater systems, EPA has utilized daily flow records at San Diego Creek at Campus Drive which were collected by USGS from 1977 - 79 and 1983 – 85 and Orange County Public Facilities and Resource Division (OCPFRD) from 1985 to present. EPA and Regional Board staff reviewed the entire daily mean flow record set from USGS and OCPFRD. The analysis was performed on a water year basis (e.g., July 1977 to June 1978). Incomplete USGS data for the period 1979/80 to 1982/83 were not used because only partial records were available for each year. Thus, the USGS and OCPFRD records yielded 19 water years of daily mean flow records for San Diego Creek. This time span covered water years: 1977-78, 1984/85 – 2000/01. EPA used these records for calculating the flow based approach to Se, dissolved metals, organochlorine, mercury and chromium TMDLs. EPA used annual flow records for water year 1996, 1997, 1998, 1999, 2000, 2001 to determine flow inputs from Santa Ana Delhi Channel. This time span covers a reasonable diversity of rainfall conditions based on precipitation measurements from 1958 to 2001. It includes the exceptionally wet El Nino year, 1998, as well as relatively drier years, 1999 and 2000. Table 2-2 shows rainfall recorded at Tustin/Irvine Ranch gage station for each year within the time span utilized by EPA, as well as historical high and low rainfall records. These data illustrate that the data years used by EPA for this approach are reasonably representative of the entire time period. Technical Support Document—Part B gives more explanation of freshwater flows and seasonal variations.

Table 2-2. Annual Precipitation Records at Tustin-Irvine Ranch Station

Water Year *	Rainfall (inches)	Water Year	Rainfall (inches)	Water Year	Rainfall (inches)	Water Year	Rainfall (inches)
1958-59	5.03	1971-72	5.02	1983-84	10.47	1995-96	11.17
1959-60	9.6	1972-73	14.9	1984-85	10.25	1996-97	16.19
1960-61	4.13	1973-74	9.81	1985-86	14.42	1997-98	34.72
1961-62	13.07	1974-75	12.36	1986-87	8.79	1998-99	8.6
1962-63	5.76	1975-76	5.11	1987-88	11.14	1999-00	8.8
1963-64	9.38	1976-77	10.2	1988-89	8.17	2000-01	14.6
1964-65	10.28	1977-78	27.96	1989-90	5.93	Summary	
1965-66	12.68	1978-79	18.59	1990-91	11.23	Min:	4.13
1966-67	14.22	1979-80	20.75	1991-92	17.18	Max:	34.7
1967-68	8.58	1980-81	8.47	1992-93	27.09	Mean:	13.03
1968-69	19.91	1981-82	13.22	1993-94	10.23	Median:	10.8
1969-70	8.48	1982-83	25.92	1994-95	24.65	Count:	42

*Source: OCPFRD; *Water years run from July 1 to June 30 of the following year.*
Rainfall data for water year 1970-71 not available

Available Data

Monitoring data used in these TMDLs came from numerous sources. Much of the analysis has been summarized in a Regional Board staff report describing the monitoring results in relation to water quality objectives, sediment guidelines and fish tissue screening values (SARWQCB 2000). EPA has included data from a few more recent studies and focused on monitoring results compiled over the past five years to assess present day water quality conditions. EPA has also reviewed ten years of sediment data and nearly twenty years of fish tissue results to determine long-term trends. Finally, the Regional Board has several projects currently in progress with the Southern California Coastal Research Water Project (SCCWRP). The studies relevant to these toxics pollutant TMDLs address sediment toxicity in Newport Bay (2001a), fish bioaccumulation in Newport Bay (2001b) and freshwater toxicity in San Diego Creek at Campus Dr. (2001c). Preliminary results for two studies (2001a, 2001b) were available as of Dec 1, 2001 and (where feasible) some data were included in these TMDLs. A summary of all monitoring data, the waterbodies sampled, measured parameters and citation/abbreviation is provided in Table 2-3.

Table 2-3 Overview of monitoring data

Organization	Period of record	Geographic Scope	Measured Features	Measured Parameters and comments
Lee & Taylor (2001a) 319(h) report (for SA RWQCB)	Winters 1999; 2000	San Diego Creek Watershed	stormwater runoff	Se; metals and OP pesticides in watershed, Draft report provided May 2001

Hibbs & Lee Se Study	1999	San Diego Creek; Groundwater	Surface and groundwater	Se in groundwater and SDCreek
Lee & Taylor (2001b) 205(j) report (for SA RWQCB)	1997-'99	San Diego Creek Watershed	Surface water toxicity	Toxicity and pesticides in watershed
CDPR Red Imported Fire Ant (RIFA) study	1999-present	San Diego Creek Watershed	Surface water	Toxicity and pesticides Insecticides and OP pesticides in watershed; toxicity and chemical concentrations
IRWD (1999) Database	Fall 1997 --March 1999	San Diego Creek; Upper and Lower Bay (10 sites)	Surface water; sediments	metals and organics using appropriate sampling and analytical techniques, one day composites, year round, no storm events
OCPFRD (2000) (NPDES annual report)	1996-2000	All freshwater tributaries, San Diego Creek; Upper and Lower Bay, Rhine Channel	Surface water; sediments	7 metals, some organics, dry and wet weather events; some four consecutive day sampling; semi-annual sediment data
Orange County Coastkeeper (1999)	Oct. 1999	Rhine Channel (2 sites); Lower Bay (1 site)	Sediments	Metals, sediment core in Rhine
Ogden Env. (1999, for City of Newport Beach)	June 1999	Lower Bay (12 sites)	Sediment	Metals; few priority organics in dredge studies
BPTCP (1997) (for SWRCB/ NOAA/EPA)	1994; '96	Upper and Lower Bay (18 sites total)	Sediment triad study	Metals; many organics; toxicity; benthic comm. Index
Bight '98 (coordinated by SCCWRP)	1998	Lower Bay (11 sites; not Rhine).	Sediment triad study	chemistry; toxicity; benthic comm. index; interstitial porewater data for AVS & SEM
Cal. Dept. Fish & Game	1999-2000	San Diego Creek watershed	Sediment; Fish tissue	OP Pesticides; insecticides in sediment and fish tissue as part of Red Imported Fire Ant project
Calif. Fish Contamin. Study (CFCS) (for SWRCB/ OEHHA)	1999–2000	Upper and Lower Bay	(sport) Fish tissue	Preliminary results for three metals; many organics in fish fillets with skin off
State Mussel Watch (SMW) (for SWCRB)	1980-2000	mostly Upper and Lower Bay	Shellfish tissue	Metals; organics in resident or transplanted mussels, no recent data in SDC
Toxic Substance Monitoring (TSM) (for SWRCB)	1983–1998	all Newport Bay waterbodies	Fish tissue	Total metals; organics in whole fish with skin on
SCCWRP (2001a) Sediment Toxicity Study (for SA RWQCB)	On-going	Upper and Lower Bay; including Rhine Channel (10 sites)	Sediment; Water Toxicity	chemistry; toxicity; benthic comm. index, some preliminary results available
SCCWRP (2001b) Fish Study (for SA RWQCB)	On-going	Upper and Lower Newport Bay	Fish tissue	Four metals; priority organics, sportfish samples in 2001; ecological risk samples in 2002
SCCWRP (2001c) Freshwater Study (for SA RWQCB)	On-going	San Diego Creek (1 site)	Freshwater Toxicity	TIEs for metals in Winter 2002; Se bioaccumulation study

III. Organophosphate (OP) Pesticide TMDLs

TMDLs are required for chlorpyrifos and diazinon for San Diego Creek. To address impairment specified in the 1998 Section 303(d) list, the TMDLs for San Diego Creek address both Reach 1 and Reach 2, unless otherwise explicitly indicated. A TMDL is also required for chlorpyrifos in the Upper Newport Bay. TMDLs are required despite recent re-registration agreements to phase out certain uses of these two OP pesticides by 2006 (EPA 2001b, 2000b). A large portion of information presented here and in the Technical Support Document – Part C is based on the OP Pesticide draft TMDLs written by Regional Board staff (SARWQCB 2001a).

Problem Statement

San Diego Creek

Water column acute and chronic toxicity to aquatic life in San Diego Creek and its tributaries has been identified and attributed largely to diazinon and chlorpyrifos through toxicity identification evaluation (TIE) studies. Over 300 toxicity tests have been performed on 123 water samples collected from the Newport Bay watershed. Toxicity occurred during virtually all monitored storm events and is viewed primarily as a wet weather problem. Dry weather toxicity was generally confined to upper reaches of the watershed (near the foothills) and diluted or otherwise remediated in downstream locations (Lee and Taylor 2001a, b). These TMDLs are structured to prevent toxicity under all flow conditions.

Average diazinon concentrations in San Diego Creek during baseflow (200 ng/L) and stormflow (445 ng/L) have exceeded the chronic numeric target of 50 ng/L. Ninety-five percent of the observed concentrations were also above the acute numeric target of 80 ng/L. Average chlorpyrifos concentrations in San Diego Creek during baseflow (111 ng/L) and stormflow (87 ng/L) have exceeded the chronic numeric target (14 ng/L). At least 59% of the observed concentrations also exceeded the acute numeric target of 20 ng/L.

Upper Newport Bay

Evidence exists indicating water column toxicity due to chlorpyrifos in Upper Newport Bay. This is restricted to storm events when freshwater inputs from San Diego Creek and Santa Ana Delhi linger in the Upper Bay (Lee and Taylor 2001a, b). Average chlorpyrifos concentrations observed in Upper Newport Bay (43.3 ng/L) have exceeded the saltwater chronic numeric target of 9 ng/L during stormflow conditions, and 80% of the concentrations exceeded the acute numeric target (20 ng/L). Toxicity attributed to chlorpyrifos does not extend into Lower Bay. Diazinon does not appear to cause toxicity in saltwater bodies such as Upper or Lower Newport Bay.

Bioaccumulation

In San Diego Creek watershed, fish tissue concentrations of chlorpyrifos have consistently remained orders-of-magnitude below the OEHHA screening value (10,000 ppb) for fish consumption. Diazinon fish tissue concentrations have exceeded the OEHHA screening value of 300 ug/kg only once (440 ug/kg), according to Toxic Substances Monitoring data.

Mussel tissue concentrations of both OP pesticides have never exceeded the OEHHA screening values. Therefore, there is no compelling evidence of bioaccumulation of these substances to levels of concern, an observation consistent with monitoring from other studies (CDFG 2000, EXTOXNET).

In short, there is conclusive evidence that diazinon and chlorpyrifos are causing acute and chronic toxicity in San Diego Creek and that chlorpyrifos causes toxicity in Upper Bay. Toxicity predominantly occurs during storm events and certainly affects lower level aquatic organisms such as *Ceriodaphnia* (Lee and Taylor 2001a, b).

Numeric Targets

At present, there are no promulgated water quality criteria for chlorpyrifos and diazinon. For these TMDLs, EPA has selected the numeric targets from recommended acute and chronic criteria derived by the California Dept. of Fish and Game for chlorpyrifos and diazinon in freshwater and saltwater (CDFG 2000a). These numeric targets serve as the quantitative interpretation of the narrative water-column quality objective as specified in the Basin Plan (1995). These numeric targets will be protective of aquatic life in San Diego Creek and Upper Newport Bay and sufficient to remove impairment caused by OP pesticide toxicity. Target concentrations are shown in Table 3-1; saltwater chronic and acute targets for diazinon are not applicable since TMDLs are not required for this pollutant in any of the saltwater bodies covered by these TMDLs.

Table 3-1 Selected Numeric Targets

		Concentration (ng/L)	
Pesticide	**Criterion**	**Freshwater**	**Saltwater**
Diazinon	Chronic	50	N/a
Diazinon	Acute	80	N/a
Chlorpyrifos	Chronic	14	9
Chlorpyrifos	Acute	20	20

from Calif. Fish & Game (2000a)
chronic means 4-consecutive day average

Source Analysis

This section of the TMDL presents a synopsis of the major sources of diazinon and chlorpyrifos to San Diego Creek and chlorpyrifos to Upper Newport Bay. This synopsis focuses on water column concentrations from several studies conducted in the watershed targeting aquatic life toxicity associated with pesticides (Lee and Taylor 2001a; 2001b; DPR studies). These studies were not detailed enough to identify discrete sources, but it appears that diazinon and chlorpyrifos are problems attributed to agricultural and residential use. Investigations of DPR pesticide use reports provide some estimates of pesticide applications by land use within the watershed; however this does not comprehensively depict all sources in San Diego Creek. Additional analysis via land use information indicates that residential contributions are also significant. The synopsis is presented below, whereas the reader will find a more complete source analysis in the Technical Support Document – Part C.

Diazinon

Within freshwater bodies of San Diego Creek, monitoring results show extremely high detection frequency (>98%) of diazinon during storm events. This detection frequency decreases slightly (89%) during dry weather or base flow conditions. Maximum concentrations were observed in Hines Channel (which drains into Peters Canyon Channel, and is tributary to San Diego Creek Reach 1).

At virtually all the locations, the median stormflow concentration is significantly higher than the median baseflow concentration. Since stormwater runoff constitutes about 80% of the volume of water discharged to Newport Bay on an annual basis, this would indicate that the overwhelming majority of the pesticide load would derive from stormflow rather than baseflow. The average concentration is actually higher for baseflow, but this is biased by a few very high detections from 1998 near nurseries. These results have not been observed in later sampling and the nurseries have subsequently instituted measures targeted at reducing pesticide runoff.

Chlorpyrifos

Chlorpyrifos was detected less frequently (in 45% of samples) than diazinon. This is due in part, to the lower solubility of chlorpyrifos, and its greater affinity for sediment. The lower mobility of chlorpyrifos results in lower concentrations in the drainage channels. According to DPR Pesticide use database, over twice as much chlorpyrifos is applied as compared to diazinon (per pound of active ingredient).

Sample locations monitoring residential areas tended to have lower chlorpyrifos concentrations. Chlorpyrifos was not detected at three of the residential locations under both baseflow and stormflow conditions. The detection frequency, and maximum concentrations detected at another partly residential location (Santa Ana Delhi Channel) were low. The only residential site with relatively high chlorpyrifos concentrations was Westcliff Park (stormflow), but the baseflow concentrations were relatively low.

California DPR Pesticide Use Database

The California Department of Pesticide Regulation (DPR) Pesticide Use database provides information by county about application of pesticides by various licensed pesticide users. For the Newport Bay watershed, diazinon and chlorpyrifos applications have been estimated to comprise one-fifth the total reported for Orange County (because the watershed acreage is one-fifth that of Orange County). In addition, land use analyses indicate that commercial nurseries and residential areas are associated with high pesticide application rates, and much higher detection in water during wet weather. Urban uses account for over 90% of total diazinon and chlorpyrifos use in the Newport Bay Watershed, with residential use by homeowners accounting for roughly half the estimated total of 10,700 lbs of diazinon and 24,000 lbs of chlorpyrifos used in the watershed in 1999. Similar studies reported in literature of pesticide use and water monitoring results have indicated that residential hotspots (individual homes) can account for most of the diazinon runoff from a neighborhood (Scanlin and Feng 1997; Cooper 1996).

Based on data from investigations carried out from 1996-20001, about 36 pounds of diazinon is discharged annually to San Diego Creek, mostly during storm events. This is less than 0.4% of the estimated diazinon mass applied in the watershed. About 8 pounds of chlorpyrifos is discharged annually to San Diego Creek and Upper Newport Bay, with most of the load delivered during storm events. This amounts to about 0.03% of the applied chlorpyrifos mass. Available data and studies indicate that in normal use, OP pesticides break down quickly and therefore only a small percentage of the total amount applied is available to runoff to waterbodies. However, even small amounts of these pesticides are enough to cause acute and chronic toxicity in receiving water bodies.

In summary, surface runoff is the source of virtually all loadings. Contributions from sediment remobilization and groundwater are negligible, however, loading from atmospheric deposition to Upper Newport Bay is potentially significant, though not well quantified. The chemical properties of diazinon and chlorpyrifos ensure that they do not accumulate in the environment. Runoff derived from urban land uses accounts for about 88% of the diazinon baseflow load, and 96% of the stormflow load. Agricultural sources (including nurseries) account for the remainder of the load. For chlorpyrifos, runoff derived from urban land uses accounts for about 85% to 88% of the baseflow and stormflow loads, while agriculture (including nurseries) accounts for about 12% to 15% of the load. On a per acre basis, different land uses contribute diazinon and chlorpyrifos runoff at fairly equal rates within the watershed and distinct source areas are not readily identifiable. Median concentrations from 14 sampled drainage channels across the watershed did not exhibit large differences.

Although it appears that some of the nursery/agricultural locations yield higher chlorpyrifos concentrations than the residential areas, it should be noted that the nursery monitoring locations are selected to monitor undiluted nursery discharge, very close to where the chlorpyrifos is used. In contrast, runoff from individual homes where chlorpyrifos is applied is not monitored; rather the monitoring location is further away within a channel thereby collecting mixed/diluted runoff from many homes. In addition, because of the inherent immobility of chlorpyrifos, and its tendency to adsorb to sediment, higher chlorpyrifos concentrations are most likely to be encountered in areas nearby to where it is applied, before it partitions out of the aqueous phase and settles out along with the sediment.

Loading Capacity/Linkage Analysis

These OP pesticide TMDLs use a concentration-based loading capacity and allocations for diazinon and chlorpyrifos. The concentration-based loading capacity will address the problems of aquatic toxicity within the watershed and Upper Newport Bay. Because diazinon and chlorpyrifos are generally not known to bioaccumulate, there is no need to establish the loading capacity via mass based units. These concentration-based TMDLs will protect aquatic life from short-term exposure via acute targets and long-term exposure via chronic targets.

The concentration-based loading capacity values are exactly the same as those selected as the numeric targets (see Table 3-1). For San Diego Creek, the loading capacity for diazinon has two components: the chronic or 4-day average concentration (50 ng/L), and a maximum 1-hour average (acute) concentration of 80 ng/L. The loading capacity for chlorpyrifos in San Diego

Creek also has two components: the chronic or 4-day average concentration (14 ng/L), with a maximum 1-hour average (acute) concentration of 20 ng/L. For Upper Newport Bay, the loading capacity for chlorpyrifos has two components: the chronic or 4-day average concentration (9 ng/L), and a maximum 1-hour average (acute) concentration of 20 ng/L acute.

As discussed above regarding the numeric targets, this loading capacity (including the margin of safety discussed below) will result in achievement of the narrative water quality objective for aquatic toxicity because these numeric targets arise from aquatic toxicity tests completed during the development of these recommended water quality levels.

TMDL and Allocations

The TMDLs for diazinon and chlorpyrifos are being established at levels equivalent to the loading capacities identified above. We have also utilized concentration-based allocations for both wasteload allocations (WLA) and load allocations (LA). The WLA applies to point sources in the watershed, and includes the NPDES permittees. The LA applies to non-point sources such as agriculture, open space and atmospheric deposition.

For these OP pesticide TMDLs, EPA has established an explicit (10%) margin of safety (discussed below); therefore the concentration-based allocations are calculated as 90% of the numeric target level for each pesticide under acute and chronic exposure conditions. For example, the numeric target for diazinon under short term, acute conditions is 80 ng/L. The wasteload and load allocations are set at 72 ng/L, after subtraction of 8 ng/L to provide the 10% margin of safety.

Allocations for Freshwater Water Bodies

Table 3-2 presents the concentration-based freshwater allocations for chlorpyrifos and diazinon; these apply to all point sources (wasteload allocations) and to all non-point sources (load allocations). The diazinon allocations apply to freshwater discharges into San Diego Creek Reach 1 and Reach 2. The chlorpyrifos allocations apply to freshwater discharges into San Diego Creek (Reach 1 and Reach 2) and discharges into other freshwater tributaries into Upper Newport Bay including Santa Ana Delhi Channel, Big Canyon Channel and other drainages to Upper Bay. This includes discharges from agricultural and residential lands, including flows from the storm water systems. These limits apply regardless of season and flow; i.e., at all times of the year.

Table 3-2: Diazinon and Chlorpyrifos Allocations for San Diego Creek

Category	**Diazinon (ng/L)**		**Chlorpyrifos (ng/L)**	
	Acute	Chronic	Acute	Chronic
Wasteload Allocation	72	45	18	12.6
Load allocation	72	45	18	12.6
MOS	8	5	2	1.4
TMDL	**80**	**50**	**20**	**14**

Allocations for Upper Newport Bay

Table 3-3 presents the saltwater allocations for chlorpyrifos; these apply to all point sources (wasteload allocations) and to all non-point sources (load allocations). It applies to saltwater allocations in Upper Newport Bay, defined from San Diego Creek at Jamboree Rd. down to Pacific Coast Highway Bridge. These limits apply regardless of season and flow; i.e., at all times of the year.

Table 3-3. Chlorpyrifos Allocations for Upper Newport Bay

Category	**Acute (ng/L)**	**Chronic (ng/L)**
Wasteload allocation	18	8.1
Load allocation	18	8.1
MOS	2.0	0.9
TMDL	**20**	**9**

Chronic means 4-consecutive day average

Needed Reductions

Table 3-4 summarizes the estimated needed concentration based (load) reductions for diazinon and chlorpyrifos in order to achieve the TMDL numeric targets in San Diego Creek. Multiple samples are available from five separate storm events in the watershed from 1997-2000. The storm average concentrations in Table 3-4 are the maximum single storm averages at the San Diego Creek-Campus station. The difference between the current load and the allocation is the needed reduction. Chlorpyrifos concentrations may have begun to decline in 2000 and 2001, based on indications of a reduction in usage from the DPR database as well as from the Sales and Use Survey (Wilen 2001) conducted in late 2000. To date, there are no clear indications of declining trends in diazinon usage in the watershed. This table indicates the estimated needed reduction during average storm flows. As discussed above, the majority of the pesticide load derives from stormflow.

Table 3-4. Needed Load (concentration based) Reductions for San Diego Creek.

Constituent	**San Diego Creek Campus Station**		**Allocation**		**Needed Reduction**	
	Storm Average (ng/L)	Max (ng/L)	Chronic (ng/L)	Acute (ng/L)	Chronic (ng/L)	Acute (ng/L)
Chlorpyrifos	120	580	12.6	18	90%	97%
Diazinon	848	960	45	72	95%	93%

Phase out agreements

Diazinon – In January 2001, USEPA released a revised risk assessment and an agreement with registrants to phase out most diazinon uses (USEPA 2001b). Under the agreement, all indoor uses will be terminated, and all outdoor non-agricultural uses will be phased out over the next few years. In addition, on a national basis, about one-third of the agricultural crop uses will be removed. Within the Newport Bay watershed, non-agricultural and non-nursery uses account for over 90% of the diazinon use in Orange County. It is thus likely that the EPA agreement will result in the cessation of most diazinon use in the Newport Bay watershed soon after the outdoor non-agricultural use registration expires on December 31, 2004.

Chlorpyrifos – In June 2000, the EPA published its revised risk assessment and agreement with registrants for chlorpyrifos (USEPA 2000b). The agreement imposes new restrictions on chlorpyrifos use in agriculture, cancels or phases out nearly all indoor and outdoor residential uses, and also cancels non-residential uses where children may be exposed. Application rates for non-residential areas where children will not be exposed will be reduced, and public health use for fire ant eradication and mosquito control will be restricted to professionals. In Orange County, residential use likely accounts for over 90% of total chlorpyrifos use. Thus, it appears that over 90% of the current chlorpyrifos use in the Newport Bay watershed will be eliminated by the EPA agreement. Retail sales are scheduled to stop by December 31, 2001, and structural uses will be phased out by December 31, 2005.

While these agreements should result in significant decreases in OP pesticide use and the resulting discharge concentrations to the waterbodies, additional measures may be necessary to achieve the reductions set forth above.

Seasonal variation/Critical conditions

Pesticide usage correlates roughly with the season, with increasing usage in the warmer months due to increased pest activity. However, runoff into the drainage channels is greatest during the wet season, and higher pesticide concentrations are observed during storm events. The higher pesticide concentrations primarily account for the toxicity observed in stormwater samples collected in the watershed. The chronic criteria used as the basis for the numeric targets are designed to ensure protection of aquatic life during all stages of life, including the most sensitive stages. Because the TMDL is being expressed as a concentration, a detailed analysis of critical conditions is unnecessary. The concentration-based allocations (Table 3-2 and 3-3) will apply and be protective during all flow conditions and seasons.

Margin of Safety

An explicit 10% margin of safety was applied to the recommended criteria derived by the CDFG (2000a) and EPA (1986) for diazinon and chlorpyrifos. This explicit margin of safety is intended to account for uncertainties in TMDL calculation methods and concerning pesticide effects (e.g., potential additive and synergistic impacts from exposure to multiple OP pesticides) that may aggravate water quality impacts due to diazinon and chlorpyrifos usage in the watershed.

In addition to the explicit margin of safety, conservative assumptions were used in applying the numeric targets within the watershed. These conservative assumptions serve as implicit margins of safety to provide additional protection for aquatic life and minimize aquatic toxicity.

1. No adjustment was made to reflect the possibility of pesticide breakdown from point of discharge to San Diego Creek. Scientists have measured that half-lives of diazinon and chlorpyrifos in water range from a few days up to six months, therefore some degradation is likely to be occurring after application and within flowing waters. Assuming discharges are

within the specified concentration-based allocations, and that such degradation (via biotic and abiotic processes) occurs, there will be sufficient protection for aquatic life.

2. No adjustment was made to reflect the possibility of mixing and dilution within the drainage channels. In particular, the dilution capacity provided by groundwater seepage has not been factored into the TMDLs.

IV. Selenium TMDLs

TMDLs are required for selenium (Se) for San Diego Creek, Upper Bay, Lower Bay, and Rhine Channel. Much of the work presented below and in the Technical Support Document—Part D for Selenium is based on the Se draft TMDLs written by Regional Board staff (2001b).

Problem Statement

Selenium is a naturally occurring element that persists in soils and aquatic sediments and readily bioaccumulates through the food chain at levels that can cause adverse effects on higher level aquatic life and wildlife including fish and birds that prey on fish and invertebrates. Selenium can become mobilized and concentrated by weathering and evaporation in the process of soil formation and alluvial fan deposition in arid and semiarid climates (Presser, 1994). Moreover, selenium may be leached from sediments as a result of irrigation practices, elevation of the groundwater table, or other modifications in the natural hydrologic regime.

Dissolved selenium concentrations in San Diego Creek at Campus, and in tributaries to San Diego Creek, consistently exceed the chronic (4-day average) CTR criterion for freshwaters (5 μg/L). This has been observed in numerous studies, which also cite occasional exceedances of the acute (1 hour max.) criterion (Hibbs and Lee 1999, IRWD 1999, Lee and Taylor 2001a). Dissolved selenium concentrations in Newport Bay do not exceed the CTR saltwater criterion (71 μg/L); nonetheless, fish tissue data indicate that selenium loadings *may* be causing toxicity or contributing to conditions threatening wildlife in Upper and Lower Bay (see next paragraph). Freshwater and saltwater toxicity tests (designed for metals and trace elements such as selenium) are currently in progress (SCCWRP 2001a, b).

In the majority of aquatic sediment samples analyzed from Newport Bay watershed, selenium concentrations are below levels of concern (2—4 mg/kg dry) as defined by Enberg et al. (1998). Mussel and fish tissue concentrations from all waterbodies are below the screening value (20 mg/kg wet) for protection of human health as established by OEHHA (1999). However, these same tissue results are within the range of levels of concern (4 – 12 mg/kg dry) for toxicological and reproductive effects to wildlife (Enberg et al. 1998 and Henderson et al. 1995). In San Diego Creek, tissue concentrations of selenium in small whole fish show an increasing trend from 1983 to 2000 (TSM 2000). Fish fillet results in Newport Bay do not appear to have the same trend and maximum levels barely approach 4 mg/kg dry (TSM database), which is below reported levels of concern. Studies of avian reproductive success, specifically including selenium concentrations in eggs, have not been completed.

Numeric Targets

As discussed in Section II, the California Toxics Rule (CTR) includes numeric water quality standards (objectives) for selenium which are designed to protect aquatic life (USEPA 2000a). EPA and Regional Board staff have re-evaluated freshwater flow histories for nearly 20 water year records (see TSD part B). These records have been divided into four flow tiers as shown in Table 4-3 for San Diego Creek. Our re-evaluation indicates that mean water residence time of 4 consecutive days occurs in flow rates below 814 cfs. Thus the CTR chronic target (5 μg/L) applies to base, small and medium storms. During the large flows, shorter residence time (<4 days) exists and so an acute value is applied, 20 μg/L. EPA has incorporated this high flow (or "large storm") value into selenium targets, flow tiers and loading capacity.

Mean water residence time in the Bay also exceeds 4 days on average. Because the more stringent chronic standards are applied based on a 4 day averaging period, EPA has determined that it is appropriate to apply the chronic selenium standards at three of four flow tiers in San Diego Creek and in Newport Bay. These are equivalent to the chronic freshwater and saltwater objectives included in the CTR. The acute freshwater objective is from National Toxics Rule (NTR, USEPA 1997) and is applied for the highest flow tier for San Diego Creek because the frequency of flows in this tier exceeds 4 days fewer than once in three years on average.

EPA is currently engaged in a process of revising its national criteria recommendations for selenium based, in part, on the USFWS opinion concerning the CTR. However, the numeric objectives for selenium water column concentrations have not yet been changed, and it is not clear whether the freshwater criteria will need to increase or decrease in order to protect aquatic life and aquatic dependent species. On one hand, several commenters supported the option of basing the TMDLs on more stringent targets based on the analysis provided by USFWS. On the other hand, several commenters identified site specific characteristics of Newport Bay watershed which could support a conclusion that objectives less stringent than the CTR would be protective. In light of these uncertainties concerning the need to either lower or raise the selenium standard, we concluded that it would be appropriate to set the TMDLs based on the existing numeric standard. The evidence that the CTR objectives are not be protective of San Diego Creek was not definitive enough to warrant selection of more stringent target values.

Freshwater targets

EPA is applying two numeric targets for different freshwater flow conditions in San Diego Creek. Based on re-evaluation analysis of daily flow records for water years 1977/78 and 1985 to 2001, EPA divided all observed flows into 4 flow categories or tiers: baseflow (≤ 20 cubic feet/second (cfs)), small flows (between 20 and 181 cfs), medium flow (between 181 and 814 cfs), and large flow (>814 cfs). EPA is basing these TMDLs on a different period of flow record than proposed in the draft TMDLs because we have concluded that the flow record for 1978/79 and 1983/84-2000/01 reflects more recently available data and is more reflective of long term flow patterns. The percentage of flows in the base, small and medium flow categories that exceeded 4 days in duration during this period far exceeded the once in 3 year recurrence interval that is assumed in calculation of selenium criteria. Therefore, it was appropriate to apply the more protective chronic standard under these flow conditions. During the high flows associated with large storms, the duration does not extend to four days more than once in 3 years on average, so it is appropriate to apply an acute target concentration for the high flow tier (20 μg/L, based on National Toxics Rule [USEPA 1999]). The Technical Support Document—Part B provides a complete explanation of these flow tiers and the associated mean annual flow volumes for calculating loads.

Saltwater target

The numeric target for dissolved selenium in saltwater is 71 μg/L from CTR (USEPA 2000a). The USFWS concurred with this saltwater value in its review of the CTR. Therefore, this target is expected to result in protection of all designated uses in Newport Bay. Additionally, since San Diego Creek is the major contributor of freshwater flows to Newport Bay (>95%), reductions of selenium in the creek should also result in reductions in the Bay.

Table 4-1. Numeric targets for Selenium in San Diego Creek and Newport Bay (μg/L).

Waterbody/type	**Total Se***		**Dissolved Se#**
	Acute	**Chronic**	
San Diego Creek/freshwater	20	5	N/a
Newport Bay & Rhine Channel/saltwater	N/a	N/a	71

*Total recoverable = unfiltered sample
#dissolved = <0.45 μm filter

Source Analysis

Several monitoring studies, completed with a specific focus on selenium during short time periods, provide most of our current understanding of selenium sources (IRWD 1999, Hibbs and Lee 2000, Lee and Taylor 2001a). The synopsis is presented below; the Technical Support Document—Part D presents a more thorough source analysis and description of these studies.

An investigation of selenium sources shows that shallow groundwater is a significant and constant source of selenium to surface waters in the San Diego Creek watershed (Hibbs and Lee 2000). Groundwater may seep into surface waters via natural processes or it may be pumped as part of groundwater cleanup or dewatering operations which discharge into surface waters. Thus selenium contributions to the watershed include both non-point sources (seepage) and point sources (cleanup and dewatering). Surface channels immediately downstream of nurseries were found to have low selenium concentrations during base flow conditions (Hibbs and Lee 2000, Lee and Taylor 2001a).

San Diego Creek contributes the largest load of selenium among all tributaries to Newport Bay (Lee and Taylor 2001a). Of the load from San Diego Creek, Peters Canyon Wash, which conveys selenium from selenium-laden shallow groundwater, represents the major source in dry weather. These sources may include runoff from hillsides, open spaces, agricultural lands, and commercial nursery sites. High concentrations were found in nursery channels during rain events, although it remains unclear if the selenium sources are from the commercial nurseries or from sources existing upstream of the nurseries. During rain events, the selenium load from the upper reach of San Diego Creek was comparable to that from Peters Canyon Wash, suggesting runoff from open space is a significant source during rain events. Low concentrations were found in nursery channels during baseflow conditions.

Table 4.2 Reported Selenium conc. in San Diego Creek and Santa Ana-Delhi Channel (µg/L)

Location	Lee and Taylor* 5/31/00	Hibbs and Lee¥ 10/31/99	IRWD@ 12/97–3/99
San Diego Creek (at Campus Dr.)	22.1	19	42.5
Santa Ana-Delhi (at Irvine Ave.)	11.9	---	---

*Lee and Taylor (2001a) results for unfiltered samples
¥Hibbs and Lee (1999) results for dissolved sample
@ IRWD (1999) result is arithmetic average of time period indicated, dissolved sample

Urban runoff is found to contain very low selenium concentrations (< 1.5 µg/L) (Lee and Taylor 2001a). Atmospheric deposition of selenium is not significant compared to loading from San Diego Creek and other freshwater tributaries (Mosher and Duce 1989). The concentration of selenium in ambient seawater (0.080 µg/L) is unlikely to cause ecological impacts (Nriagu, 1989), and seawater is not believed to comprise a significant source of selenium loading to Newport Bay.

Figure 4-1 summarizes the sources of selenium in the watershed. The significance of these sources varies both on discharge location and season of the year. Nursery runoff shows moderate concentrations (~10 µg/L) in dry weather and are potential sources during storms (Lee and Taylor 2001a). There is some evidence that runoff from open space, hillsides, and agricultural lands are significant sources during rain events although this evidence is inconclusive. Groundwater seepage/infiltration, treated groundwater discharges, and groundwater dewatering discharges represent significant and constant sources.

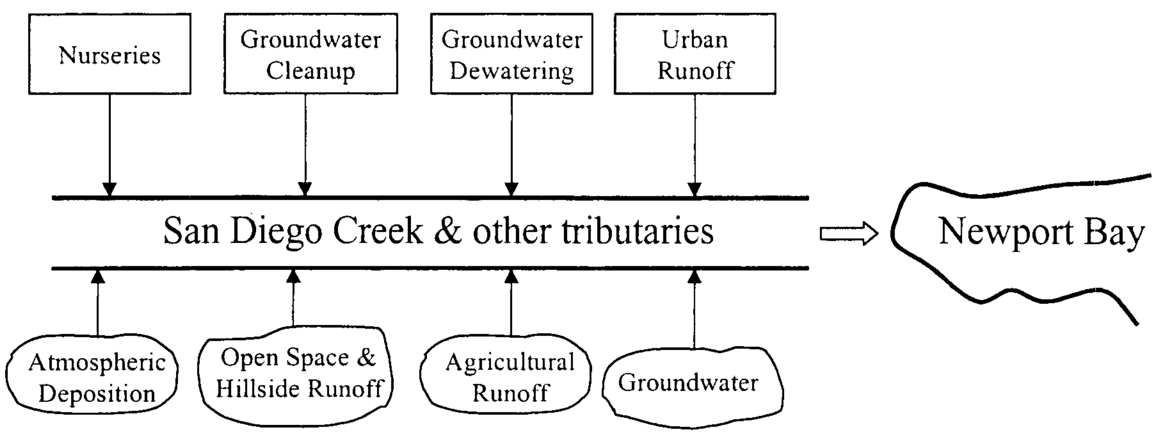

Figure 4.1 Sources of selenium in the Newport Bay/San Diego Creek watershed. (Nurseries have been grouped with agricultural runoff in Table 4-5 for allocations.)

Loading Capacity/Linkage Analysis

The loading capacities and associated TMDLs and allocations for selenium are expressed as mass loads per time. Different approaches were used to calculate loading capacities for the freshwater and saltwater water bodies in the watershed.

San Diego Creek

This TMDL uses a flow-based approach to determine the loading capacity for selenium in San Diego Creek. This approach addresses contributions of selenium under various flow regimes or tiers. Four flow tiers were chosen based on a statistical analysis of daily flow records for San Diego at Campus Drive. (See Technical Support Document – Part B for more explicit information about freshwater flows.) Specific loading capacities for each flow tier are calculated from the desired selenium concentration (i.e., the numeric target) and the annual mean flow volume associated with each tier (Table 4-3). The sum of loads in these four tiers constitutes the total loading capacity for San Diego Creek per year.

Table 4-3 Flow based tiers and corresponding volumes in San Diego Creek

Flow tier	**Corresponding flow (cfs)**	**Flow Volume* associated with tier (million cubic ft.)**	**Se conc. with tier (ug/L)**	**Loading capacity per tier@ (lbs/yr.)**
Base flow	0—20	275.4	5	86
Small flows	21—181	347.5	5	108.4
Medium flows	182—814	357.6	5	111.6
Large flows	>814	468.8	20	585.4
Total annual amount		**1449.4**		**891.4**

*Annual mean volume based on USGS & OCPFRD records for water years: 1978, 1984 to 2001.
@Se per tier (lbs/yr) = flow volume (ft^3/yr) x desired Se target (ug/L) x conv. factor (6.243×10^{-8} lbs x L/mg x ft^3)

Newport Bay

The loading capacity for Newport Bay is presented in Table 4-4. This loading capacity is calculated using the selenium saltwater numeric target (71 μg/L) and the volume of water in Newport Bay. (Mean volume is 19 million cubic meters based on low and high tide estimates [RMA 1999]).

Table 4-4 Loading capacity of San Diego Creek and all Newport Bay waterbodies

Waterbody	**Loading capacity (lbs/yr.)**
San Diego Creek and tributaries	891.4
Santa Ana Delhi	185.3¥
Upper and Lower Bay and Rhine Channel	232,000*

¥Se value determined via similar method to those used for San Diego Creek but flow records for Santa Ana Delhi Channel were for water years 1995/96 – 00/01
*based on calculation of the CTR saltwater chronic value (71 μg/L) and the volume of Newport Bay water, adjusted to account for daily water movement into and out of the Bay from the Pacific Ocean.

TMDL and Allocations

EPA is setting the TMDL equal to the loading capacity for each waterbody presented above (Table 4-4). For this TMDL, EPA has defined wasteload allocations (WLAs) for point sources and load allocations (LA s) for non-point sources. Allocations for San Diego Creek are inclusive and have been sub-divided into categories presented below and allocations outlined in

Table 4-5. The loading capacity for Santa Ana Delhi has been defined to set an upper limit on selenium contributions from that waterbody into Newport Bay.

TMDL = Σ (wasteload allocations) + Σ (load allocations) + Margin of Safety

Sub-categories of allocations for Se in San Diego Creek.

Wasteload allocations	Load allocations
Groundwater cleanup Groundwater dewatering Urban runoff	Groundwater (background) Nurseries & Agricultural runoff Open space and hillside runoff Atmospheric deposition

EPA adopted the selenium allocation scheme developed by Regional Board staff for their draft selenium TMDL. Wasteload and load allocations are assigned based on the following general guidelines:

- Allocations among source categories are assigned in proportion to the relative significance of the sources, and indicated by available data concerning reported monitoring concentrations, discharge flow rates, and Se loading (see Source Analysis section), and/or acreage of land uses. In general, significant sources require larger reductions in loading than minor sources to attain the numeric target.
- Within the same source category, allocations for individual dischargers are prorated based on land area.
- For each flow tier, allocations are assigned based on the nature of each source. For example, runoff from hillside, open space, and agricultural lands is minimal in dry season but loads dramatically increase during high stream flows associated with wet weather. Loading from shallow groundwater is likely to change because creeks may change from gaining streams (water input from groundwater during dry weather) to losing streams (surface runoff percolates into shallow groundwater areas) as a result of high water level in the creeks during and/or immediately after rain events.
- Atmospheric deposition is not given a specific allocation due to the very low loading from this source (see TSD, pg. D-12). Any loading from atmospheric deposition is less than the explicit margin of safety discussed below and can be considered accounted for in the explicit MOS.
- Discharges from groundwater cleanup and groundwater dewatering are significant sources and loading from those operations depends on their location. However, the quantification of loading from individual discharges is not feasible at this time due to lack of Se data in effluent from those operations. In this TMDL, allocations are assigned as group allocations groundwater cleanup discharges and groundwater dewatering discharges. In addition, a separate wasteload allocation is provided to account for future new groundwater dewatering discharges.

Table 4-5 shows the wasteload and load allocations for San Diego Creek. The estimated current annual load is considered as the current load of selenium at Campus Drive based on IRWD monitoring data (4/98-3/99). The selenium TMDLs and allocations are expressed in mass-based annual loads. Daily loads could be calculated by dividing the annual TMDLs and allocations by 365. However, annual loading-based TMDLs and allocations are more appropriate because prospective adverse effects associated with selenium are associated more with long term mass loadings and bioaccumulation effects than with short term or acute effects. An explicit margin of safety (MOS) of 10% was included to account for uncertainty in the analysis and ensure compliance with water quality objectives.

Table 4-5 Se allocations for San Diego Creek watershed

Source	Loading capacity (lbs/year)					Current load #	Estimated reductions
	Tier 1	Tier 2	Tier 3	Tier 4	Annual total*		
WLA							
MCAS Tustin	1.6	2.0	1.8	7.9	**13.2**		
GW clean up	6.2	7.8	7.5	36.9	**58.4**		
Silverado GW	3.1	3.9	4.0	21.1	**32.1**		
GW dewatering	3.9	4.9	4.5	21.1	**34.3**		
Future GW facilities	0.4	0.5	0.5	2.6	**4.0**		
Stormwater Permit	0.4	1.0	1.0	5.3	**7.6**		
WLA subtotal	15.5	20.0	19.3	94.8	**149.7**		
LA							
All nurseries	3.1	3.9	4.0	21.1	**32.1**		
Ag runoff	5.4	7.3	8.0	44.8	**65.6**		
Undefined sources @	53.4	66.4	69.1	366.2	**555.0**		
LA subtotal	61.9	77.6	81.1	432.0	**652.6**		
Total allocations	77.4	97.6	100.5	526.8	**802.3**	**2443**	67%
MOS					**89.1**		
Total TMDL					**891.4**		

* sum of loading capacity for San Diego Creek only (based on 5 ug/L applied to all flow tiers)
\# undefined sources includes: open space and hillside runoff, shallow GW and saltwater Se
¥ current load based on IRWD Se data (1998-99) and corresponding OCPFRD flow records
§ other GW facilities refers to future permits

Seasonal variation/Critical conditions

As previously described, EPA is calculating these selenium TMDLs based on freshwater flow rates instead of seasons. The flow rates correspond to flow tiers which address the continuous range of San Diego Creek flow rates throughout the year. In this flow-based approach, allocations are based on in-stream flow rates which are influenced by precipitation and runoff. Given that storm events may occur at any time of the year, the corresponding elevated stream flows are addressed by this flow-based approach.

Margin of Safety

In this TMDL, an explicit margin of safety is used to account for other technical uncertainties. The margin of safety is set at 10% of the annual loading capacity (ca. 89 lbs/year). Some of the uncertainty associated with calculation of the TMDL for selenium relates to freshwater flow rates. Given the revised time period (nearly 20 years of daily flow records for San Diego Creek), this uncertainty has been reduced. That is, the draft TMDLs were based on five years of OCPFRD flow data, whereas these final TMDLs are based on flow records for 19 years that better represent the range of flows during wet and dry water years.

V. Metals TMDLs

TMDLs are required for dissolved copper, lead and zinc in San Diego Creek, Upper Bay, Lower Bay and Rhine Channel. TMDLs are required for cadmium in San Diego Creek and Upper Bay only. Information related to these metal TMDLs can be found in two Technical Support Documents, Part B which describes freshwater flows and Part E which describes metals source analysis and methods used to determine loading capacity and existing loads.

Problem Statement

Cadmium, Copper, Lead and Zinc—Dissolved heavy metal concentrations in San Diego Creek and other freshwater tributaries exceeded CTR standards during wet weather only. More specifically, cadmium, copper and lead results exceeded chronic CTR values; copper and zinc data exceeded acute CTR values (OCPFRD 2000). Water column concentrations measured in Newport Bay are highly variable. In general OCPFRD results exceed water quality standards and these data are much higher than data reported by IRWD (1999) which rarely exceed saltwater CTR values. While direct comparison of these results is not feasible, EPA has identified some quality control problems with metals analyses in saltwater by OCPFRD's contract lab and has concluded that they should be considered with caution in TMDL development.

Sediment metal concentrations generally increase along the gradient from freshwater to saltwater with maximum levels found in Rhine Channel. Sediment toxicity has been repeatedly observed in sediment and porewaters of Upper and Lower Bay, including Rhine Channel (BPTCP 1997; Bay et al. 2000, SCCWRP 2001a). Porewater is water found within the bottom sediments. Evidence of degraded benthic organisms also exists in these saltwater bodies. The cause of toxicity and benthic degradation is unknown, however a statistical correlation was found between sediment and porewater toxicity to amphipods and sea urchin larvae and elevated copper, lead and zinc sediment concentrations (BPTCP 1997). Toxicity identification evaluation (TIE) studies of saltwater bodies are currently in progress (SCCWRP 2001a).

Bioconcentration of copper and zinc has been observed in mussels within Lower Bay and Rhine Channel (SMW 2000). However, fish tissue concentrations of these metals are not elevated relative to respective metal screening values defined by OEHHA (1999). Cadmium, Copper, Lead and Zinc may bioconcentrate in lower organisms but these metals generally do not bioaccumulate and therefore are not likely to threaten organisms higher in the food chain such as fish-eating birds.

Numeric targets

In freshwater systems, the dissolved cadmium, copper, lead and zinc water quality criteria are hardness dependent as defined in CTR (USEPA 2000a). Like many flowing freshwater bodies in southern California, San Diego Creek waters exhibit a wide range of flow rates and hardness levels. Monitoring data show that low flow rates have high hardness values (e.g., 20 cfs corresponds to ≥400 mg/L hardness) whereas high flow rates have lower hardness (e.g., 814 cfs corresponds to 236 mg/L hardness). This inverse relationship between flow rate and hardness influences both acute and chronic metals numeric targets.

Based on re-evaluation of freshwater daily flow records measured at San Diego Creek at Campus (see TSD part B), EPA has identified four flow tiers for fresh water segments for use in TMDL calculation. A hardness value is defined for each flow tier which is used to calculate the associated acute and chronic targets for dissolved metal. (Table 5-2). For the baseflow tier, EPA used the maximum hardness value (400 mg/L) as allowed in CTR (USEPA 2000). A review of available data indicated that actual hardness associated with flows in these tiers often exceeds 400 mg/L; however, the CTR caps the allowable hardness value that can be used to calculate the resulting hardness. For the small and medium flow tiers EPA selected the highest flow value within this tier to determine the corresponding hardness value. For large flows, EPA used the median flow rate value to determine the corresponding hardness value.

EPA is identifying numeric targets and TMDLs for both chronic and acute conditions. It is appropriate to set TMDLs for chronic conditions in the lower three flow tiers based on an analysis of flow durations. The chronic standards for metals were calculated based on the assumption that flows of 4 days or longer in duration would reoccur no more than once in three years on average. Our analysis of the flow records showed that in each of the lower three tiers, the recurrence frequency of flows lasting 4 days or longer was greater than once in three years. For the highest flow tier, the recurrence frequency of flows lasting 4 days or longer was less than once in three years. Therefore, TMDLs are set for the high flow tier based solely on acute standards, which apply regardless of flow duration.

It was appropriate to calculate TMDLs for Newport Bay based on chronic targets because average water residence time in the Bay was estimated to exceed 4 days under all likely flow conditions. The investigation of precipitation, flow rates and the relationship to hardness is explained more thoroughly in the Technical Support Document—Part B.

Table 5-1. Flow based tiers and corresponding hardness values in San Diego Creek.

Flow tier	Corresponding flow rate (cfs)	Flow volume associated with tier # (million cubic ft.)	Flow rate used to determine hardness	Corresponding Hardness (mg/L)
Base flow	0 - 20	275.4	N/a*	400
Small flows	21 - 181	347.5	181	322
Medium flows	182 - 814	357.6	814	236
Large flow	>814	468.8	1595	197

mean volume for each tier based on daily flow records for 19 water years: 1977/78, 83/84 to 00/01. (combination of USGS and OCPFRD data)

* flow rate not used for these tiers; hardness determined by CTR (max = 400 mg/L)

Freshwater bodies

For freshwater bodies in San Diego Creek, EPA calculated the hardness-based dissolved metals numeric targets (Table 5-2) using equations provided in CTR. EPA is identifying targets representing concentrations of the metals in the water column for each flow tier. As discussed above, we are identifying targets for both acute and chronic conditions for base, small and medium flows and for acute conditions only in large flows (>814 cfs). Given that water residence time is longer than four days during most of the year, we anticipate the chronic targets will be most important for compliance, however, the acute targets also set an upper limit for input concentrations. The Technical Support Document - Part E presents a step-by-step discussion of how numeric targets were calculated based on CTR equations for each pollutant, fresh water flow rates, and corresponding hardness values.

Table 5-2. Metals Numeric Targets (ug/L) based on flow tiers for San Diego Creek.

Dissolved Metal	Base Flows (<20 cfs) hardness @ 400 mg/L		Small Flows (21 - 181 cfs) hardness @ 322 mg/L		Medium Flows (182 -815 cfs) hardness @ 236 mg/L		Large Flows (>815 cfs) @ 197 mg/L
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute
Cd	19.1	6.2	15.1	5.3	10.8	4.2	8.9
Cu	50	29.3	40	24.3	30.2	18.7	25.5
Pb	281	10.9	224	8.8	162	6.3	134
Zn	379	382	316	318	243	244	208

Note: actual ambient hardness must be determined for each monitoring sample regardless of which flow condition exists

Saltwater bodies

In saltwater systems, EPA uses the chronic dissolved metals numeric targets to develop mass based TMDLs. Saltwater targets are straightforward since hardness is not involved. The dissolved saltwater targets are outlined in Table 5-3. Additional numeric targets have also been selected to address toxicity in saltwater sediments. These sediment targets are the threshold effect levels for saltwaters as defined by NOAA SQuiRTs (Buchman 1999). Sediment metal concentrations below these target values are likely to alleviate toxicity to benthic organisms. Both dissolved water column and sediment targets apply for Cu, Pb and Zn within Upper Bay, Lower Bay and Rhine Channel, and for Cd only in Upper Bay.

Table 5-3. Numeric targets for metals in Newport Bay

Metal	Dissolved saltwater acute target (ug/L)	Dissolved saltwater chronic target (ug/L)	Alternate target in saltwater sediments (mg/kg dry)
Cd*	42	9.3	0.67
Cu	4.8	3.1	18.7
Pb	210	8.1	30.2
Zn	90	81	124

(Source: CTR values for dissolved metals in saltwaters; NOAA TEL values for sediments)
*Cd value applies to Upper Newport Bay only

EPA also considered setting targets for both fresh water and salt water in terms of total metals instead of dissolved metals due to the potential concern that particulate metals could become bioavailable. There are several reasons for selecting dissolved metal targets. The existing numeric standards are expressed in the CTR in terms of dissolved metals (EPA 2000a). The CTR rationale is that dissolved forms are the most bioavailable to aquatic organisms. Particulate/dissolved metal ratios were estimated from OCPFRD stormwater data and could be used to translate these dissolved metal mass loads into total loads. However, these translator values developed from paired metals data are close to unity. For example, we calculated a site-specific translator ratio for copper of 1.16 total Cu to dissolved Cu; this is reasonably close to the generic EPA value that dissolved is roughly 80% of total concentration. Therefore, dissolved metals measures are probably fairly good predictors of total metals concentrations. Moreover, we have incorporated an extra explicit margin of safety to account for the possibility that a focus on dissolved metals does not fully account for total metals concentrations. EPA recognizes the Sediment TMDLs already established for these waterbodies will augment efforts to reduce total metal loadings into the saltwater bodies and help to achieve the sediment targets to protect benthic organisms by reducing discharges of metal-contaminated sediments.

Source Analysis

This section summarizes our analysis of the major sources of dissolved cadmium (Cd) for San Diego Creek and Upper Newport Bay and for dissolved copper (Cu), dissolved lead (Pb) and dissolved zinc (Zn) within all water bodies of Newport Bay. This synopsis draws conclusions from several different studies which report concentrations of metals in the water column and sediments of all water bodies. Where applicable this synopsis also presents information about inputs of copper from sediments and from recreational boats moored in Newport Bay. The Technical Support Document—Part E presents a more thorough presentation of all monitoring results and source analysis pertaining to metals.

Within San Diego Creek and its tributaries, metal inputs are heavily influenced by rainfall and stream flow rates. Base flow conditions yield approximately 25% of total loadings, storm events yield approximately 55% of total loadings, the remainder is associated with low and medium flows. Surface runoff is estimated to be the largest source of metals; this includes both natural and man-made contributions. A recent study of pollutant inputs from tributaries within the San Diego Creek watershed concluded that the largest metals inputs come from "urban stations", whereas agricultural and open space exhibit the lowest loadings (Lee and Taylor 2001a). The difference could be as much as five fold higher for urban areas based on estimates of total copper per acre of runoff (see Table E-7 in TSD – Part E). While this study does provide a basis for estimating the relative importance of metals loadings from different land uses within the watershed, insufficient data were available to accurately estimate annual loads from each source.

Currently, the only published annual metal loading estimates from freshwater tributaries are based on total (unfiltered) metal concentrations (OCPFRD 2000). These estimates for Cu, Pb and Zn indicate that San Diego Creek contributes up to ten times more of each metal than Santa Ana-Delhi Channel. Within San Diego Creek, inputs from Peters Canyon Wash and the rest of the San Diego Creek drainage are about the same. Table 5-4 summarizes these estimates for San Diego Creek and Santa Ana-Delhi Channel for the 1998 and 1999 water years. (The 1998 water year is defined from July 1997 to June 1998.) These results show considerable variability due to different rainfall amounts and fluctuating freshwater flows during each water year. The 1998 water year is considered an extremely wet year (38.4 inches of rainfall) due to El Nino conditions; whereas, 1999 water year is considered relatively dry (8.8 inches) relative to average annual rainfall (13.3 inches).

Another study of surface water runoff during storm events has approximated the relative contribution of metals associated with natural sources such as soil minerals versus the metal inputs from anthropogenic activities. The authors used results from unfiltered (i.e., total metal) samples in the Santa Ana River watershed and report the anthropogenic contribution is metal specific: Cd (63% human-caused), Cu(42%), Pb (35%) and Zn (33%) (Schiff and Tiefenthaler

2000). Total metals loading estimates in Table 5-4 have also been adjusted based on these results to report the approximate load believed to be associated with anthropogenic activities.

Table 5-4 Estimates of Total metal loadings from two freshwater inputs to Upper Bay

Metal	**Site**	**1998 water year (OCPFRD)**	**Adjusted* 1998 results (Man-made)**	**1999 water year (OCPFRD)**	**Adjusted* 1999 results (Man-made)**
		Total load (lbs.)	Total load (lbs.)	Total load (lbs.)	Total load (lbs.)
Cu	San Diego Creek	15,087	6261	1643	682
	Santa Ana -Delhi	1643	682	185	77
Pb	San Diego Creek	10,385	3977	449	172
	Santa Ana -Delhi	1297	497	124	47
Zn	San Diego Creek	63,021	20,985	3784	1260
	Santa Ana -Delhi	7031	2341	805	286

Source: 1998 and 1999 water year results from OCPFRD 2000
*Adjustments made from man-made approximations reported by Schiff and Tiefenthaler 2000

Several other sources of metals exist in the watershed: runoff from open spaces, nursery and agricultural applications, groundwater dewatering and cleanup, and atmospheric deposition. Monitoring data exist for background dissolved metals concentrations in surface runoff from hillsides and open spaces. EPA has selected wet weather results from the San Joaquin Channel site (Lee and Taylor 2001a) to serve as proxy for these open spaces because the area upstream from this site is essentially undeveloped. Much of the metals loading associated with open spaces is probably naturally occurring; however, it is likely than some portion of loads from these areas is human caused (e.g., from atmospheric deposition or historic land use activities). Based on State pesticide use reports (CDPR 1999) for some nurseries, applications of copper sulfate appears as the most prominent metal containing substance used in nurseries; nonetheless annual metal applications are small (e.g., 72 lbs/yr) relative to watershed wide surface runoff estimates (ranging from 1643 to 15,087 lbs/yr, Table 5-4). To date, reliable dissolved metal concentrations in shallow ground waters have not been reported. Atmospheric deposition—onto the watershed land surface and into San Diego Creek and other freshwater tributaries—has already been included within surface runoff estimates. It is considered minimal in comparison to other contributions to surface runoff because there are no likely local airborne sources of these metals.

For the salt waters of Upper and Lower Newport Bay, including the Rhine Channel, the largest ongoing sources of most dissolved metals (except for copper) are estimated to be the freshwater-borne loads from San Diego Creek (95% of freshwater-related loads), Santa Ana-Delhi Channel (<5%) and other drainages (<1%). Ambient surface seawater may be the next most significant source. Concentrations of dissolved metals in seawater collected off the Southern California coast range from 0.06 ug/L for Pb, 0.1 ug/L for Cd, 0.2 ug/L for Cu, to 2.4 ug/L for Zn (pers. commun., R. Gossett). The influence of ambient seawater on metal levels within Newport Bay depends on marine tides and freshwater flows from the watershed. During high tides and low freshwater flows, surface seawater contributions could be relatively higher, yet low tides concurrent with dramatically higher freshwater inputs during storm events would yield much lower ambient seawater contributions.

The phenomenon of dissolved copper inputs to marine waters from recreational boats has been repeatedly monitored in San Diego Bay as reported in the draft TMDL for dissolved Cu for Shelter Island yacht harbor (San Diego RWQCB 2001). Using mass loading calculations presented in that TMDL and local data concerning boats in Newport Bay, passive leaching from recreational boats and underwater hull cleaning are estimated to comprise the most significant sources (>80%) for dissolved Cu into Lower Bay, Rhine Channel and, to some extent, Upper Bay.

To date, no study within Upper Bay has examined whether sediment resuspension or porewater fluxes contribute significant metals loads to the water column. Porewater concentrations measured in Lower Bay (not including Rhine Channel) suggest that Cu levels are elevated enough to create potentially negative impacts (Bight '98). Levels for the other metals are within the range of concentrations observed in ambient seawater and well below the dissolved saltwater numeric targets.

Air deposition of metals is traditionally assessed in two parts—indirect and direct. Indirect deposition, where metals are deposited onto dry land areas and then washed into streams via surface runoff, has already been included as part of the freshwater inputs from San Diego Creek, Santa Ana Delhi Channel and other drainages to Newport Bay. Direct deposition, where metals directly enter the water surface, comprises less than 1% of metal contributions to Upper and Lower Bay and can be considered accounted for in the explicit margin of safety.

Loading Capacity/Linkage Analysis

In the draft TMDLs, EPA outlined two options for defining dissolved metals loading capacity and associated TMDLs. These two options were to apply a concentration based or a mass based approach for to each water body. Based on our review of public comments and further analysis, we are establishing TMDLs based on concentration for San Diego Creek and both concentration and mass loads for Newport Bay as discussed below.

San Diego Creek and tributaries

The metals loading capacities and TMDLs for San Diego Creek are set on a concentration basis for dissolved metals. The rationale for addressing dissolved metals is that dissolved metal forms are the most bioavailable to aquatic organisms. These metals are generally not know to bioaccumulate from one organism to the next, nor has sediment toxicity attributed to metals in the Creek been reported; therefore, long term mass loading which could contribute to bioaccumulation or sediment toxicity concerns is less of an issue in San Diego Creek. For these reasons, a concentration-based approach is more appropriate for these pollutants. These concentration-based loading capacity will protect aquatic life from short term exposure via acute targets (for all flow conditions) and longer term exposure via chronic targets (for flows <814 cfs).

These concentration based loading capacity values are hardness dependent. Freshwater systems experience a wide range of flows and individual hardness conditions. In the future, it will be necessary to measure actual ambient hardness concurrent with each metals monitoring sample (grab or composite) in order to help determine compliance with the TMDLs. The CTR sets an upper limit for hardness is 400 mg/l; the lower recommended limit is 25 mg/l.

The acute and chronic targets and associated loading capacities and TMDLs apply to base, small and medium flows. However, targets, loading capacities, and TMDLs for the highest flow tier (>814 cfs) are based on acute standards only. As discussed above, this approach is based on our review of flow records for San Diego Creek to examine the duration of elevated flows and the frequency of chronic conditions (See TSD Part B for freshwater flow).

Newport Bay

For Upper and Lower Bay, including Rhine Channel, the loading capacities were calculated by multiplying the chronic numeric target by the volume of water in the Bay, accounting for water exchange rates between Newport Bay and the Pacific Ocean. The loading capacities are based on the saltwater dissolved metals targets (Table 5-3). The mass-based loading capacity for all of Newport Bay is shown in Table 5-5a. (A complete description of this calculation is presented in TSD – Part E.)

The rationale for setting mass-based metals TMDLs and allocations is to address observed sediment toxicity in all areas of Newport Bay. Over longer time frames, cumulative metals discharges are of concern in embayments and possibly fresh water waterbodies because metals may associate with sediment and accumulate in bottom sediments, where they may contribute to sediment toxicity and associated ecosystem impacts. The alternate metals sediment targets (Table 5-3) will help to evaluate acceptable conditions for benthic organisms.

Mass based allocations set a definitive upper limit on the amount of each metal allowed to be discharged from San Diego Creek into Newport Bay, which would probably be most effective in addressing long term sediment toxicity concerns. Loading contributions from San Diego Creek and Santa Ana Delhi Channel were calculated by multiplying the chronic numeric target for base, small and medium flow tiers and acute target for large flow tier (see Table 5-1) by the mean annual water flow volume associated with each tier to yield an allowable mass load for each flow tier. This approach is similar to that presented in the Se TMDLs. (An example of this calculation for dissolved copper is provided in the TSD – Part E.) The sum of all four tiers yields the upper limit to the mass-based loading capacity for San Diego Creek (Table 5-5a).

Table 5-5a. Mass-based dissolved metal loading capacity for Newport Bay

Dissolved Metal	Upper and Lower Bay including Rhine Channel Dissolved load (lbs/yr)
Cd	14,753*
Cu	11,646
Pb	27,136
Zn	285,340

*Cd load applies to Upper Bay only, where volume of Upper Bay is approximately 40% of the total volume of Newport Bay

To ensure that Newport Bay is protected from potential adverse effects of short term metals loading "spikes", the loading capacities and associated TMDLs for Newport Bay are also defined in terms of the concentration-based water quality standards for the Bay. In the absence of this complementary approach, it would be possible for the Bay to meet the annual loading-based TMDL and still exceed water quality standards on a short term basis. The concentration based TMDLs are listed in Table 5.5b

Table 5.5b Concentration-based dissolved metal loading capacity for Newport Bay

Metal	Dissolved saltwater acute loading capcity (ug/L)	Dissolved saltwater chronic loading capacity (ug/L)
Cd*	42	9.3
Cu	4.8	3.1
Pb	210	8.1
Zn	90	81

TMDLs and Allocations

The freshwater dissolved metals TMDLs are concentration–based; whereas the saltwater TMDLs are both mass-based and concentration-based. The TMDLs and allocations may be expressed in terms of the following general equation:

TMDL = Σ (wasteload allocations for point sources) + Σ (load allocations from non-point sources and background) + Margin of Safety

San Diego Creek

As discussed in the loading capacity section, EPA is expressing the San Diego Creek metals TMDLs on a concentration basis. The freshwater allocations are equivalent to the concentration-based targets, reduced by 20% to provide the margin of safety discussed below (see Table 5-6 for freshwater TMDLs and allocations). These allocations apply to all freshwater discharges to San Diego Creek, Santa Ana-Delhi Channel, Big Canyon Channel, East Costa Mesa Channel and other drainages. This includes discharges from agricultural, urban and residential lands, including flows from the storm water systems. These allocations would apply at all times of the year. Because flow tiers for the freshwater channels other than San Diego Creek were not specifically calculated, it is assumed that the same TMDLs applicable to San Diego Creek during different flow conditions apply to the other channels at the same times. For example, when flow is 50 cfs in San Diego Creek, the "small flows" TMDLs and allocations listed in Table 5-6 apply in all the other freshwater channels in addition to San Diego Creek.

Table 5-6. Metals WLAs, and LAs in (ug/L) (based on flow tiers for San Diego Creek)

Dissolved Metal	Base Flows (<20 cfs) hardness @ 400 mg/L		Small Flows (21 - 181 cfs) hardness @ 322 mg/L		Medium Flows (182 -815 cfs) hardness @ 236 mg/L		Large Flows (>815 cfs) @ 197 mg/L
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute
Cd	19.1	6.2	15.1	5.3	10.8	4.2	8.9
Cu	50	29.3	40	24.3	30.2	18.7	25.5
Pb	281	10.9	224	8.8	162	6.3	134
Zn	379	382	316	318	243	244	208

Values are 80% of freshwater numeric targets in Table 5-2
Note: actual ambient hardness must be determined for each monitoring sample regardless of which flow condition exists

The wasteload allocations apply to the following NPDES discharges:

- Orange County Stormwater
- CalTrans
- Other NPDES Discharges (see Section II, p. 19 for description of this allocation category)

The load allocations apply to the following source categories:

- Agricultural runoff (including nurseries)
- Air deposition
- Other sources (includes open space runoff, background, and undefined sources).

Newport Bay

Table 5-7a presents the mass based TMDLs and allocations for dissolved metals in Newport Bay. These allocations apply to the water column in Upper Newport Bay (defined from San Diego Creek at Jamboree Rd. down to Pacific Coast Highway Bridge), Lower Newport Bay (defined from PCH Bridge to the Newport Jetty) and to Rhine Channel (confined by line drawn from 20th St. across to Lido Beach St. to channel end). These allocations apply to the receiving waters of Newport Bay at all times of the year, regardless of freshwater flow from San Diego Creek, Santa Ana-Delhi, Costa Mesa Channel and other tributaries into Newport Bay.

Several methods were used to determine allocations. First, because NPDES boatyard permittees are not authorized to discharge into salt waters of Newport Bay, the wasteload allocation for boatyards is zero. Second, air deposition and undefined sources (background from medium and large storm runoff and ambient seawater contributions) were assigned mass loadings based on existing loading since reductions were not expected. Third, agriculture runoff was also assigned an explicit mass loading of one-half the total annual estimated loads based on the assumption that erosion control planned under the sediment TMDL implementation plan would result in approximately a 50% reduction in erosion-related metals loading, and that the small amount of metals load associated with agricultural chemical use could be reduced through use of best management practices (EPA, 1993). The allocations for the remaining sources (urban stormwater, CalTrans, other NPDES, and boats (for copper and zinc)) were based on best professional judgement, as discussed below, because insufficient data were available to accurately estimate their relative contributions to existing loads. The allocation for runoff from the watershed from urban stormwater and CalTrans facilities and discharges from the other NPDES permittee category is based on the assumption that approximately half the metals loading can be reduced through use of available management practices (EPA, 1993). The runoff allocation is divided between the Orange County stormwater permit, CalTrans permit, and other NPDES facility category based on the relative proportions of watershed land area under the jurisdiction of these three permits. The remaining allocation for boats represents a reduction in metals loadings from boats of greater than 80%, based on the assumption that changes in boat paint usage and maintenance practices could substantially reduce the direct loading of copper (and potentially zinc) into Bay waters (EPA 1993). Table 5-7b presents the concentration-based allocations for Newport Bay.

Table 5-7a. Mass-based Allocation Scheme for Metals in Newport Bay

Category	Type	Copper	Zinc	Lead	Cadmium*
WLA	Urban runoff	3,043	174,057	17,638	9,589
	CalTrans	423	22,866	2,171	1,185
	Boatyards	0	0	0	0
	Other NPDES permittees	190	17,160	1,154	596
	Sub-total	**3,656 lbs/yr**	**214,083 lbs/yr**	**20,963 lbs/yr**	**11,370 lbs/yr**
LA	Ag runoff	215	114	0	0
	Boats	4,542	1,056	0	0
	Air deposition	101	606	68	4
	Undefined (open space, existing sed.)	803	11,414	678	428
	Sub-total	**5,661 lbs/yr**	**13,189 lbs/yr**	**746 lbs/yr**	**431 lbs/yr**
MOS		**2,329 lbs/yr**	**57,068 lbs/yr**	**5,427 lbs/yr**	**2,951 lbs/yr**
Total TMDL		**11,646 lbs/yr**	**285,340 lbs/yr**	**27,136 lbs/yr**	**14,753 lbs/yr**

*values apply to Upper Bay only (estimated as 40% of Newport Bay volume)

Table 5.7b Concentration-based dissolved metal TMDLs, WLAs, and LAs for Newport Bay

Metal	Dissolved saltwater acute TMDLs and allocations (ug/L)	Dissolved saltwater chronic TMDLs and allocations (ug/L)
Cd*	42	9.3
Cu	4.8	3.1
Pb	210	8.1
Zn	90	81

The concentration based WLAs and LAs apply only to the sources which discharge directly to the Bay, including stormwater discharges from stormdrains directly to Bay segments (such as Costa Mesa Channel and Santa Ana Delhi Channel) and metals loading associated with boats. The concentration-based WLAs and LAs for San Diego Creek and the other fresh water tributaries will address short term metals concentrations associated with discharges to the fresh water system.

Seasonal Variations/Critical Conditions

These TMDLs rely on careful analysis of the full range of potential flow conditions to address seasonal variations and critical conditions in loads and flows. In general, base and low flows do not present conditions within San Diego Creek that result in either exceedances of numeric targets. This is due to higher hardness levels during low flows that mitigate metals toxicity through competitive binding by calcium and magnesium ions present in freshwater.

Wet weather conditions, which may occur at any time of the year, yield medium and large flows and a range of hardness values. High flows are more likely to produce both low hardness and higher metal levels; these conditions are the biggest threat to aquatic organisms in San Diego Creek and its tributaries. For Newport Bay, the TMDLs address long term metals accumulations which are associated with metals-caused sediment toxicity measured in the Bay. Therefore, there is no single season or critical season of greatest concern for metals loadings and effects in Newport Bay. The saltwater allocations apply during all seasons, regardless of flow.

For both San Diego Creek and Newport Bay, the approach of setting concentration based TMDLs and allocations based on chronic and acute targets helps address and mitigate any short term effect associated with brief periods of high metals loading.

Margin of Safety

EPA has applied a 20% explicit margin of safety to the dissolved metals TMDLs for both freshwater and saltwater bodies of Newport Bay watershed. This explicit margin of safety is intended to account for uncertainty concerning total (particulate and dissolved) metal loads into San Diego Creek which are transported downstream and deposit in the sediments of Upper and Lower Bay, including Rhine Channel. These metals TMDLs address aquatic life toxicity due to concentrations in the dissolved fraction; this is consistent with current regulatory status for metals as defined by CTR (USEPA 2000a). In recognition of sediment toxicity in Newport Bay correlated to elevated metals, we have selected the 20% margin of safety based on the default total/dissolved metal translator provided in CTR. Our estimates of site-specific total/dissolved translator values are fairly close to the CTR value. It is reasonable to assume that reductions in the particulate metal load will achieve the concentration-based dissolved metal targets.

In addition to the explicit margin of safety, conservative assumptions were used in applying the numeric targets within the watershed. These conservative assumptions provide an implicit margin of safety to ensure that TMDLs are set at levels that will attain applicable standards and protect aquatic life.

1. No adjustment or lowering has been made to address mixing and dilution within the drainage channels contributing to San Diego Creek. Also, there has been no consideration of precipitation (forming particulate metals forms) of dissolved metals as freshwater mixes with saltwater.

2. Chemical speciation has not been included within calculations of loading capacity nor allocations. Aquatic chemists believe the truly bioavailable metal fraction (free metal ion concentration) is much lower (at least 10 times) than dissolved metal concentration. This has been reported for Cd, Pb, Cu and Zn within freshwater and saltwater systems (Buffle 1988, Bruland 1991, Sunda et al. 1987).

3. Setting both acute and chronic-based TMDLs and allocations for San Diego Creek and Newport Bay helps ensue that short-term toxic effects are not allow to occur even if longer term mass loading-based TMDLs and allocations are met. This approach helps ensure that water quality standards will be met throughout the year.

VI. Organochlorine TMDLs

TMDLs are being established for chlordane, total DDT and total PCBs in all waterbodies: San Diego Creek, Upper Bay, Lower Bay and Rhine Channel. Dieldrin TMDLs are being established for San Diego Creek, Lower Bay and Rhine Channel. A TMDL for toxaphene is being established for San Diego Creek only. The term "organochlorine compounds" includes all of these pollutants and the phrase "organochlorine (OC) pesticides" refers to DDT, chlordane, dieldrin and toxaphene.

Additional information on the source analysis, modeling approach and relevant monitoring results for these TMDLs is provided in Technical Support Document – Part F.

Problem Statement

Use of these pollutants has been banned because of potential harm to human health and/or wildlife. However, many of the environmental concerns associated with their use and ultimate transport to the environment are directly related to their ability to persist in water, soil, and biological tissue for long periods of time after their introduction to the environment.

Monitoring results show exceedances of EPA and State fish tissue screening values, which indicate the applicable narrative water quality standards are not being met. Specifically, toxaphene exceedances (87%, n=15) of the OEHHA tissue screening value occur only in San Diego Creek (TSM). Tissue exceedances have also occurred for Chlordane (40%), Dieldrin (93%), total DDT (93%), and total PCBs (67%) in San Diego Creek (n= 15 for all, TSM). Similar elevated fish tissue concentrations indicate bioaccumulation for Chlordane, Dieldrin, total DDT and total PCBs in all saltwater bodies of Newport Bay (except for dieldrin in Upper Bay). Conclusions for Newport Bay are based on finfish and shellfish tissue results from several monitoring efforts (SMW, TSM, CFCS and SCCWRP databases, see Table 2-2). A review of tissue data for a 20 year period indicates that fish tissue concentrations are declining for the OC compounds, yet exceedances of OEHHA tissue screening values are still occurring. Freshwater and saltwater tissue concentrations show declining trends, with higher levels generally occurring in San Diego Creek than in Newport Bay. The sediment data did not exhibit clear trends, rather erratic spikes, which is common for this heterogeneous media.

Numeric Targets

As discussed in Section II, EPA evaluated the applicable water quality criteria and sediment and tissue screening levels to determine the appropriate numeric targets for these organochlorine TMDLs. We have prioritized sediment quality guidelines over tissue screening values and water column criteria. This decision is based on the following factors:

1) these pollutants are directly associated with sediments (i.e., fine particulate matter);
2) sediments are the transport mechanism for these organochlorine compounds from freshwaters to salt waters;
3) limited water column data are available to adequately describe the past or current conditions
4) attainment of the sediment targets will be protective of the water column criteria and tissue screening values.

The use of sediment criteria in this analysis yields an environmentally conservative interpretation of water quality criteria, including the narrative water quality objectives in the Regional Board Basin Plan (1995).

The numeric targets for freshwater and saltwater systems for chlordane, dieldrin, DDT, PCBs and toxaphene, are shown in Table 6-1a and 6-1b. The primary target value is based on sediment levels, and the alternate targets are provided for fish and shellfish tissues and for water column concentrations in freshwater. The specific numeric values for sediment targets were selected from NOAA Sediment Screening Quick Reference Tables (SQuiRTs) (Buchman 1999). By selecting sediment targets, EPA will address protection of benthic organisms as well as bioaccumulation of these organochlorine compounds into tissues of higher organisms such as fish, wildlife predators and humans. Sediment targets are used for TMDL development except where sediment data were not available; e.g., toxaphene in San Diego Creek. The alternate targets – fish tissue screening values from OEHHA and water column objectives from the CTR– are included in this TMDL report as means of gauging improvement in the water quality and progress towards achievement of the TMDL, and to assist in assessing the accuracy of the analysis supporting the TMDLs.

Table 6-1a. Numeric targets for organochlorine compounds for all waterbodies.

Waterbody	Pollutant	Sediment target ¥ (ug/dry kg or ppm)	Fish tissue target# (ug/kg wet or ppb)
San Diego Creek and tributaries	Chlordane	4.5	30
	Dieldrin	2.85	2.0
	Total DDT	6.98	100
	Total PCBs	34.1	20
	Toxaphene	0.1*	30
Upper and Lower Newport Bay, and Rhine Channel	Chlordane	2.26	30
	Dieldrin	0.72	2.0
	Total DDT	3.89	100
	Total PCBs	21.5	30

*this value assumes 1% total organic carbon in sediment sample
¥sediment targets equivalent to threshold effect levels (TEL) from Buchman 1999, except toxaphene from NY Dept. Environmental Conservation
#all tissue targets from OEHHA

Numeric targets for water column concentrations are provided in Table 6-1b based on CTR criteria. These concentrations apply to freshwater bodies (USEPA 2001a); numeric objectives are not available for several of the pollutants in saltwater. We used these targets when modeling the maximum allowable concentrations for water-associated loads from particulate pollutants. (See modeling and analysis section).

Table 6-1b. Freshwater column target values for organochlorine compounds.

Pollutant	CMC (acute) (μg/L)	CCC (chronic) (μg/L)
PCBs	--	0.014
DDT *	1.1	0.001
Chlordane	2.4	0.0043
Dieldrin	0.24	0.056
Toxaphene	0.73	0.0002

* DDT value cited for 4,4' DDT, but value will apply to one one isomer or sum of all isomers detected

Source Analysis

Except for PCBs and possibly small amounts of DDT, the pollutants addressed in this TMDL are no longer believed to be discharged in the watershed except in association with erosion of sediments to which these pollutants may have adhered in the past. The source analysis is therefore primarily a qualitative assessment. The assessment is based on reviews of available information on the physical and chemical properties of each chemical, the expected uses of each, the likely locations of use, and available monitoring data that characterizes current conditions in the environment. A wide range of information was evaluated to identify potential sources and to characterize contributions, including monitoring data, data from national, state and county program databases, and scientific literature. More details on the efforts to identify and characterize potential sources of organochlorine compounds are provided in the Technical Support Document – Part F.

Available data and analyses indicate that there is an existing "reservoir" of historically-deposited organochlorine pollutants in Newport Bay sediment, to which continuing relatively low levels of ongoing pollutant loads are contributing from the watershed. The main source of continuing loadings of organochlorine compounds in the Newport Bay watershed is estimated to be erosion of surface soils or in-stream sediments to which these pollutants have adsorbed (binded). Sediment-adsorbed pollutants enter Newport Bay from San Diego Creek (88%) and various smaller tributaries and local drainages (12%). The sediment load is then distributed throughout Newport Bay via internal circulation patterns under a variety of flow conditions. In preliminary results from one sampling event of sub-surface waters in Lower Bay, SCCWRP (2001a) reported detections of total PCBs and DDT. At the Turning Basin, these compounds were associated with particulate matter (PCBs = 8.86 ug/kg dry; DDT = 15.3 ug/kg dry) and in the dissolved phase (PCBs = 0.15 ng/L; DDT 0.43 ng/L). Dieldrin and Chlordane were not reported.

These organochlorine compounds may also exist in groundwater (due to percolation), may transport via volatilization (from surface soils or water surface) and as implied above they may become resuspended into the water column via physical processes in water bodies. Insufficient data were available to estimate the loads from these sources. Ground water-related loading is expected to be minor because only a small proportion of organochlorine pollutant loads generally occurs in dissolved form. On the other hand, resuspension of sediments to which organochlorine pollutants have adhered is likely to be a more important "loading" source.

Organochlorine (OC) pesticides

Because of the legacy nature of the sources of the OC pesticides, assessment of possible nonpoint sources of these types of pollutants has been based on a review of available monitoring data, historical land use practices, literature reviews, and anecdotal information. One of the major routes for the OC compounds to enter Newport Bay and its tributaries is believed to be runoff and erosion processes. Masters and Inman (2000) have examined fluvial transport of DDT and other legacy pesticides in Upper Newport Bay; they hypothesize that historic agricultural and urban applications of these compounds are the primary upstream sources. In general, these runoff and erosion processes have the ability to pick up and transport these OC pesticides and deposit them in a different location in the watershed, to stream systems, or to the Bay. The amount of transport and the locations of deposition depend on many factors, including the presence of the pollutant and the intensity and duration of the precipitation event, which drives stream flow velocity and possibly direction. Because organochlorine residuals from past applications still remain in soils, the potential still exists for these chemicals (and their degraded metabolites) to be transported into water bodies during runoff-producing rainfall events. Insufficient information exists on the specific location and actual magnitude of these sources to support precise loading estimates; therefore, we inferred existing loadings based on limited data and we estimated the pollutant distributions amongst many diffuse sources. No local "hot spots"-specific locations with highly elevated levels of OC pesticides-- were identified.

The only potentially active application of any of the OC pesticides identified is the application of Dicofol, a registered pesticide that may contains small amounts of DDT (i.e., up to .015% based on its registered formulation). The actual DDT content of Dicofol, if any, is unknown. The DPR pesticide use database indicates that Dicofol (trade name "Kelthane") was recently applied to agricultural fields within the Newport Bay watershed (502 lbs. in 1998 and 470 lbs. in 1999). Relative to other sources of DDT (i.e., residuals in soils and aquatic sediments), Dicofol is not estimated to be a significant source of DDT to Newport Bay. However, because DDT in low concentrations may pose an continuing ecological concern, it may be appropriate to further investigate and reduce possible runoff of DDT associated with Dicofol.

Polychlorinated biphenyls (PCBs)

Electrical transformers are the most common use of PCBs. Existing PCB projects such as the Hudson River project in New York and the Housatonic River project in Massachusetts have found that historical discharges caused sediment contamination and that the contaminated soils tend to collect in slow river stretches or reservoirs (GE 1999). The contaminated soils remain there until they are dredged or dislodged by storms. Based on our review of limited information about PCB spills and waste sites containing PCBs, we hypothesize that accidental PCB spills, which were most likely to have occurred at the El Toro and Tustin Air Stations as well as other hazardous waste sites, are the most likely historical loading source of PCBs. Insufficient information exists on the specific location and actual magnitude of these sources, thus we inferred existing loadings based on limited data and we estimated the pollutant distributions amongst many diffuse sources.

Modeling and Analysis

This section describes the methods used to determine the loading capacity and to estimate the existing loads for each organochlorine contaminant with respect to each waterbody. The modeling approach and various resources utilized to complete these tasks are outlined here, although more details, such as equations and specific values, are provided in the Technical Support Document – Part F. To the extent possible, we used hydrologic and modeling information previously compiled by Resource Management Associates (RMA 1997, 1998, 1999) for the U.S. Army Corp of Engineers (ACOE). This model provides sediment deposition information used to determine both loading capacities and estimate existing loads for (for the Upper and Lower Bay, including Rhine Channel. RMA model calibration results were utilized because these results incorporate circulation patterns, spatial distribution and net settling rates for each area of Newport Bay. These RMA results were generated using a wide spectrum of flow rates from San Diego Creek addressing a 12 year time span (1985 to 1997). Thus the RMA model has implicitly addressed sediment transport and resuspension in Newport Bay as well as dry and wet weather conditions and flow rates in San Diego Creek.

Within San Diego Creek, the RMA model does not provide more specific data such as spatial distribution of sediments, so sediment deposition and the corresponding pollutant load must be estimated via stream flow rates. EPA used nearly 20 water years of flow records for San Diego Creek. The time span of daily flow rates covers water years 1977/78 and 1984/85 - 00/01. This is discussed more in TSD Part B – Flow and consistent with flow records used in Se and dissolved metals TMDLs. For the OC TMDLS, three flow tiers were used -- low flow (0 to 181 cfs), medium (between 181 and 814 cfs) and high flow (>814 cfs). This was designed to represent conditions during dry weather and very light rains (low flow events), intermediate storms (medium flows) and those large storms (high flows) when extensive sediment transport occurs. Pollutants associated with fine particles (especially clay) and dissolved phase are assumed present in all three flow tiers.

Loading capacity

San Diego Creek

For the listed OC pollutants in San Diego Creek the loading capacities were calculated based on pollutant contributions from water column and sediments. The sediment associated loading capacity was determined from target sediment concentrations and sediment load estimates, which were based on regression results presented in RMA model (1997) to link flow rates with sediment loads. We estimated the associated water column loading capacity by backcalculating, from sediment loads to particulate concentrations and dissolved concentrations, using partition coefficients. Where appropriate, these water column derived loads were constrained by chronic water targets for low and medium flows and acute targets for large flows. The sum of the allowable loads in particulate form and dissolved form represents the loading capacity in San Diego Creek. The loading capacities are presented as long term annual loading estimates consistent with the patterns of sediment deposition in the system. Loading capacities for San Diego Creek are presented in Table 6-2.

Newport Bay

The loading capacity for Newport Bay relied on RMA (1998) sediment deposition budget and bottom sediment conditions with target concentrations. The Bay was sub-divided into discrete areas for which individual loading capacities were calculated and summed to provide loading capacities for each water body of the Bay (Upper, Lower and Rhine). To determine the particulate associated load, several factors were used and included: saltwater sediment target, net sediment deposition (volume), porosity, and sediment density. Sediment volume is converted to dry weight by an estimated porosity (0.65). The net loading capacities are presented as average mass per year for each water body to reflect the long-term accumulation patterns associated with sediment and pollutant accumulation in Newport Bay. Loading capacities for Newport Bay are presented in Table 6-3.

Existing Loads

San Diego Creek

A slightly different approach was required to estimate the existing loading to San Diego Creek. Due to incomplete sediment monitoring data for all organochlorine pollutants in San Diego Creek, we used recent fish tissue results (TSM data from 1998) to help estimate water and (indirectly) sediment loads. Water column associated loads were back calculated by using pollutant- and fish species- specific bioconcentration factors (BCFs). The particulate load was estimated from these water column derived values using partition coefficients. The sum of the particulate and water column associated loads yields the estimated existing loads for San Diego Creek based on the most reliable and current data for these hydrophobic compounds. Existing loading estimates for San Diego Creek are presented in Tables 6-5.

Newport Bay

The methods used to estimate existing loads in Newport Bay were similar to those described earlier for loading capacity in Newport Bay. Fortunately, more monitoring data exists for Newport Bay and, in particular recent sediment data (OCPFRD 1999/00 and SCCWRP 2001a) was maximized to give more representative or current conditions in each portion of the bay. These monitoring results were used with the RMA sediment deposition budget to yield the existing pollutant loads. Resuspension and recirculation of sediments, along with the water associated load was implicitly included since these conditions were included in the RMA approach for Newport Bay. (Upper and Lower Bay existing loads represent the sum of several individual areas, as defined in Appendix Table 3 in TSD – Part F.) The net pollutant existing loading estimates for Newport Bay segments are presented in Tables 6-6 to 6-8.

Loading Capacity/Linkage Analysis

The loading capacity for each pollutant was calculated for San Diego Creek, Upper and Lower Bay, and Rhine Channel. The loading capacity for each water body was derived as described above and in the Technical Support Document – Part F. The loading capacity was determined to define the maximum amount of loading which could occur and still result in attainment of the sediment targets, and at the same time, not exceed water quality targets. The model takes into consideration such factors as the particulate and dissolved contributions and flow rates in San Diego Creek. In Newport Bay, the loading capacities were determined via the RMA model and target sediment concentrations. The OC compound loading capacities for San Diego Creek and Newport Bay are listed in Tables 6-2 and 6-3, respectively.

The loading capacity was determined to define the maximum amount of loading which could occur and still result in attainment of the sediment targets. The model links estimates of ongoing pollutant contributions from the watershed with existing pollutant concentrations in the bottom sediments and predicts the cumulative effects in terms of future pollutant concentrations in the bottom sediments and associated trends. The model takes into consideration such factors as the existing water column concentrations (either observed or calculated based on fish or mussel tissue concentrations), data and modeling of sediment deposition into the water bodies, decay rate for a pollutant in the water column, thickness of the water column and active sediment layer, sediment resuspension rates, and sediment burial rates.

Table 6-2. Loading Capacity for San Diego Creek

Pollutant Name	Sediment Target Concentration (ug/kg dry)	Loading capacity (g/year)
Chlordane	4.5	314.7
Dieldrin	2.85	261.5
DDT	6.98	432.6
PCBs	34.1	2226
Toxaphene	0.1	8.9

Table 6-3. Estimated Loading Capacity for Newport Bay

Waterbody	Sediment Target Concentration (ug/kg dry)				Loading Capacity (g/year)			
	Chlordane	Dieldrin	DDT	PCBs	Chlordane	Dieldrin	DDT	PCBs
Upper Bay	2.26	0.71	3.89	21.5	160.4	N/A	276.5	1528.2
Lower Bay*	2.26	0.71	3.89	21.5	59.2	18.6	101.85	562.9
Rhine Channel	2.26	0.71	3.89	21.5	1.7	0.53	2.92	16.2

(This table is summary of information presented in Table F-4 in TSD – Part F.)

TMDLs and Allocations

For these organochlorine TMDLs, we have expressed the TMDLs and allocations in mass-based units (grams per year) for each waterbody. For each organochlorine compound, the loading capacity in each waterbody is equal to the sum of allocations and an explicit margin of safety. Identification of the TMDL is based on a comparison of the existing loading with the loading capacity. In situations where existing loadings are less than the loading capacity, the TMDLs and allocations are set at the existing loading levels in order to ensure that the TMDL targets are eventually met, and to ensure that pollutant levels in the sediments do not increase in the future (defined as Condition 1 in Table 6-4 below). In situations where existing loads are greater than the loading capacity, the TMDLs and allocations are set equal to the loading capacity (after subtracting the explicit margin of safety). This situation is defined as Condition 2 in Table 6-4 below. Table 6-4 identifies the decision rules applied for each water segment and OC pollutant to define the individual TMDLs.

Table 6-4. Decision rules applied to define TMDLs based on condition applicable to each waterbody/pollutant combination.

Pollutant	San Diego Creek	Upper Newport Bay	Lower Newport Bay	Rhine Channel
Chlordane	Condition 2	Condition 2	Condition 1	Condition 1
Dieldrin	Condition 2	NL	Condition 1	Condition 2
DDT	Condition 2	Condition 2	Condition 2	Condition 2
PCBs	Condition 1	Condition 1	Condition 1	Condition 2
Toxaphene	Condition 2	NL	NL	NL

NL: Not listed for this pollutant

Tables 6-5 through 6-8 summarize the existing loads, the estimated loading capacity, and the total allocation for each pollutant with respect to each waterbody. For most pollutant/waterbody combinations, the loading capacity value is less than the existing load and thus the loading capacity determines the TMDL, as seen in Table 6-4. A 10% margin of safety was subtracted from the loading capacity or existing load, whichever is smaller value.

Table 6-5. Summary of San Diego Creek Loadings and TMDL

Pollutant	Existing Load[1] (g/year)	Loading Capacity[2] (g/year)	TMDL (g/year)	Margin of Safety (g/year)
Chlordane	615.7	314.7	314.7	31.5
Dieldrin	381.8	261.5	261.5	26.2
DDT	3733.8	432.6	432.6	43.3
PCBs	282.1	2226	282.1	28.2
Toxaphene	582.1	8.9	8.9	0.9

[1] existing load based on observed data (OCPFRD 1999/00 and SCCWRP 2001a)
[2] loading capacity based on sediment targets
TMDL is lesser value of existing load or loading capacity; TMDL = Total allocation + MOS

Table 6-6. Summary of Upper Newport Bay Loadings and TMDL

Pollutant	Existing Load[1] (g/year)	Loading Capacity[2] (g/year)	TMDL (g/year)	Margin of Safety (g/year)
Chlordane	290.7	160.6	160.6	16.1
DDT	1080.2	276.5	276.5	27.7
PCBs	858.7	1528.2	858.7	85.9

[1] existing load based on observed data (OCPFRD 1999/00 and SCCWRP 2001a)
[2] loading capacity based on sediment targets
TMDL is lesser value of existing load or loading capacity; TMDL = Total allocation + MOS

Table 6-7. Summary of Lower Newport Bay Loadings and TMDL

Pollutant	Existing Load[1] (g/year)	Loading Capacity[2] (g/year)	TMDL (g/year)	Margin of Safety (g/year)
Chlordane	50.2	59.2	50.2	5.0
Dieldrin	5.9	18.6	5.93	0.59
DDT	438.4	101.85	101.8	10.2
PCBs	409.8	562.95	409.8	41.0

[1] existing load based on observed data (OCPFRD 1999/00 and SCCWRP 2001a)
[2] loading capacity based on sediment targets
TMDL is lesser value of existing load or loading capacity; TMDL = Total allocation + MOS

Table 6-8. Summary of Rhine Channel Loadings and TMDL

Pollutant	Existing Load[1] (g/year)	Loading Capacity[2] (g/year)	TMDL Allocation (g/year)	Margin of Safety (g/year)
Chlordane	0.33	1.70	0.33	0.3
Dieldrin	3.76	0.53	0.53	0.05
DDT	5.60	2.92	2.92	0.23
PCBs	70.0	16.2	16.2	1.6

[1] existing load based on observed data (SCCWRP 2001a)
[2] loading capacity based on sediment targets
TMDL is lesser value of existing load or loading capacity; TMDL = Total allocation + MOS

Tables 6-9, 6-10, 6-11, and 6-12 present the allocations for each OC pollutant-waterbody combination. The explicit margin of safety (10%) has been included for clarification. Allocations were assigned for sources to San Diego Creek primarily in proportion to land use area. The allocations to nurseries and other agriculture factor in two considerations. First, it was assumed that erosion control activities pursuant to the sediment TMDL implementation plan would result in approximately a 50% reduction in OC pollutant runoff from agriculture. In addition, these load allocations factor in a small amount of possible DDT loading associated with possible DDT content in the pesticide Dicofol. The allocations are based on the assumption that only a small fraction of Dicofol reaches water ways, and that DDT loading to waterways associated with Dicofol is a minor source. Undefined sources (existing sediments, air deposition, possible groundwater contributions) were assigned 3% based on existing loading estimates. The remaining portion (approximately 72%) was allotted to urban runoff. We estimate that erosion control practices will result in substantial reduction in OC pollutant loadings associated with eroded sediments (EPA, 1993).

PCBs are particularly stable in aquatic sediment, so we assigned a slightly higher percentage of available allocations to undefined sources (10%) and 4% to other NPDES permits because PCBs chemicals are more likely to be present in groundwater and therefore they may be contained in discharges of groundwater clean up and treatment facilities. This quantity may be modified in subsequent TMDL revisions after subsequent monitoring with adequate sampling and analytical methods to verify PCB loads.

Table 6-9. Allocations for San Diego Creek watershed

Category	Type	DDT (including Dicofol)	Chlordane	Dieldrin	PCBs	Toxaphene
WLA	Urban runoff	302.8	220.3	183.4	177.7	6.2
	Caltrans	8.7	6.3	5.2	42.3	0.2
	Other NPDES permittees	34.6	25.2	21.0	5.6	0.7
	Sub-total	**346.1 g/yr**	**251.8 g/yr**	**209.6 g/yr**	**225.6 g/yr**	**7.1 g/yr**
LA	Ag runoff	8.6	6.2	5.2	5.6	0.2
	Undefined *	34.6	25.2	21.0	22.6	0.7
	Sub-total	**43.2 g/yr**	**31.4 g/yr**	**26.2 g/yr**	**28.2 g/yr**	**0.9 g/yr**
MOS		**43.3 g/yr**	**31.5 g/yr**	**26.2 g/yr**	**28.2 g/yr**	**0.9 g/yr**
Total TMDL		**432.6 g/yr**	**314.7 g/yr**	**262.0 g/yr**	**282.0 g/yr**	**8.9 g/yr**

*undefined = existing sediments + air deposition
Total TMDL = WLA + LA + MOS

Table 6-10. Allocations for Upper Newport Bay

Category	Type	DDT (including dicofol)	Chlordane	PCBs
WLA	Urban runoff	207.4	120.5	609.7
	CalTrans	2.8	1.6	8.6
	Other NPDES permittees	2.8	1.6	8.6
	Sub-total	**212.9 g/yr**	**123.7 g/yr**	**626.9 g/yr**
LA	Ag runoff	2.8	1.6	8.6
	Undefined*	33.2	19.3	137.4
	Sub-total	**35.9 g/yr**	**20.9 g/yr**	**146.0 g/yr**
MOS		**27.7 g/yr**	**16.1 g/yr**	**85.9 g/yr**
Total TMDL		**276.5 g/yr**	**160.6 g/yr**	**858.7 g/yr**

*undefined = existing sediments + air deposition
Total TMDL = WLA + LA + MOS

Table 6-11. Allocations for Lower Newport Bay

Category	Type	DDT (including dicofol)	Chlordane	Dieldrin	PCBs
WLA	Urban runoff	76.3	12.6	4.45	303.3
	CalTrans	0	0	0	4.10
	Other NPDES permittees	0	0	0	0
	Sub-total	**76.3 g/yr**	**12.6 g/yr**	**4.45 g/yr**	**304.7 g/yr**
LA	Ag runoff	0	0	0	0
	Undefined*	15.3	32.6	0.89	61.5
	Sub-total	**15.3 g/yr**	**32.6 g/yr**	**0.89 g/yr**	**73.8 g/yr**
MOS		**10.2 g/yr**	**5.0 g/yr**	**0.59 g/yr**	**41.0 g/yr**
Total TMDL		**101.8 g/yr**	**50.2 g/yr**	**5.93 g/yr**	**409.8 g/yr**

*undefined = existing sediments + air deposition
Total TMDL = WLA + LA + MOS

Table 6-12. Allocations for Rhine Channel

Category	Type	DDT	Chlordane	Dieldrin	PCBs
WLA	Urban runoff	0.7	0.1	0.13	4.1
	Other NPDES permittees	0	0	0	0
	Sub-total	**0.7 g/yr**	**0.1 g/yr**	**0.13 g/yr**	**4.1 g/yr**
LA	Undefined*	1.9	0.21	0.34	10.5
	Sub-total	**1.9 g/yr**	**0.21 g/yr**	**0.34 g/yr**	**10.5 g/yr**
MOS		**0.3 g/yr**	**0.03 g/yr**	**0.05 g/yr**	**1.6 g/yr**
Total TMDL		**2.9 g/yr**	**0.33 g/yr**	**0.53 g/yr**	**16.2 g/yr**

*undefined = existing sediments + air deposition
Total TMDL = WLA + LA + MOS

Margin of Safety

EPA has applied an explicit 10% margin of safety to the loading capacity for these OC TMDLs. The specific mass-based margin of safety for each pollutant with respect to each waterbody is included in Tables 6-5, 6-6, 6-7 and 6-8. This margin of safety will provide additional protection for aquatic life, wildlife predators and human health. The explicit margin of safety is intended to address uncertainties in the relationship between OC pollutant loadings and environmental responses in different areas of the watershed.

In addition, EPA is providing an implicit margin of safety through the selection of several conservative analysis approaches and assumptions used to calculate the TMDLs. Insufficient information is available to specifically quantify the potential uncertainty associated with each of the assumptions used in the analysis. The parameters used in analysis were based on best available information and were selected to be conservative (i.e., most protective) where possible. The use of an explicit margin of safety and recommendation of subsequent follow-up monitoring is intended to ensure that numeric targets are successfully achieved and that the adequacy of the load allocation is evaluated over time. Key areas of uncertainty recognized in the margin of safety include the following:

- The loading capacity is calculated as a long-term annual average that results in meeting water quality standards (expressed as sediment, water column, and/or tissue targets). Because the analysis is focused on long-term predictions, periodic fluctuations are not represented, and actual loading may differ in the short-term.

- Long-term sediment deposition patterns were used to calculate the total amount of sediment deposited in each region. This long-term average value does not represent short-term or localized fluctuations in deposition rates. Periodic accumulation or scouring could be significant during large storm events. This could result in higher or lower deposition rates than the predicted sediment deposition and pollutant concentrations.

- A constant sediment porosity value was used to calculate loads associated with deposited sediment. Sediment porosity values used in the model to estimate loading capacity for San Diego Creek and Newport Bay (0.65) were slightly lower than those used to estimate historical loads (0.80) by RMA. No sediment consolidation was assumed. This resulted in a conservative assumption, since consolidation would result in a lower porosity, which would increase the load associated with deposited sediment.

Seasonal variation/Critical conditions

OC pollutants are of potential concern in the Newport Bay watershed due to possible long term loading and food chain bioaccumulation effects. There is no evidence of short term potential effects. However, pollutant loads and transport within the watershed may vary under different flow and runoff conditions. Therefore the TMDLs consider seasonal variations in loads and flows but are established in a manner which accounts for the longer time horizon in which ecological effects may occur.

These TMDLs rely on careful analysis of the full range of potential flow conditions to address seasonal variation and critical conditions in loads and flows. The sediment transport and deposition within each waterbody is driven by the velocity and sheer conditions of flow. The annual deposition is accounted for by using the sediment budget developed by RMA (1998) which incorporates various flow regimes throughout each year. The sediment budget (generated via model) represents various weather patterns and flow conditions for 12 years.

Obviously the wet weather events, which may occur at any time of the year, produce extensive sediment redistribution and transport downstream. This would be considered the critical condition for loading. However, the effects of organochlorine compounds are manifested over long time periods in response to bioaccumulation in the food chain. Therefore, short term loading variations (within the time scale of wet and dry seasons each year) are not likely to cause significant variations in beneficial use effects.

VII. Chromium and Mercury TMDLs

TMDLs are being established for chromium (Cr) and mercury (Hg) only for the Rhine Channel area of Lower Newport Bay. Additional information on the source analysis, modeling approach and relevant monitoring results for these TMDLs is provided in Technical Support Document—Part G.

Problem Statement

Chromium—Chromium levels are elevated in Rhine Channel mussel tissue samples over the tissue screening value (1.0 mg/kg wet), providing some evidence of chromium bioaccumulation (31%, n= 13). Chromium in Rhine Channel sediments are occasionally (8%, n= 13) above the sediment quality guideline (52 mg/kg dry).

Mercury—Mercury sediment concentrations in Rhine Channel are above sediment quality guidelines levels associated with negative impacts on benthic organisms in all samples tested (100%, n=6). The mercury levels in the limited number of available samples were very high (e.g., recent data shows 5.3 ppm versus PEL level 0.7 ppm). Sediment toxicity has been consistently reported for Rhine Channel (BPTCP 1997, SCCWRP 2001a) although specific contaminants causing this toxicity have yet to be identified. Mussel tissue concentrations were not above the EPA tissue screening value (0.3 mg/kg wet methylmercury), and there is no current evidence that mercury has bioaccumulated to levels of concern.

Numeric Targets

The numeric targets for chromium and mercury in Rhine Channel are presented in Table 7-1. Two targets are provided for each chemical, one for sediment and one for tissue levels. The primary target value (sediment) is for TMDL development, whereas the alternate target (tissue) is designed to provide another means of assessing desired water quality conditions of Rhine Channel.

There are several available screening values for mercury concentrations in sediment and fish tissue. For mercury in Rhine Channel, EPA applied the sediment numeric target, 0.13 mg/dry kg, as the most appropriate indicator of desired water quality. This threshold effect level (TEL) is associated with no observed effect on benthic organisms as part of a study by MacDonald et al. 1996 and cited in NOAA SQuiRTs (Buchman 1999). For comparison, the TEL value is much lower than the probable effects level (PEL = 0.696 mg/kg dry). The NOAA Effects Range-Low (ERL) value for mercury (ERL = 0.15 mg/kg dry) is close to the TEL target value. The alternate mercury numeric target is fish tissue (0.3 mg/kg wet methylmercury), from EPA proposed criteria and analysis provided in the USFWS Biological Opinion on the CTR (2000). This methylmercury target is designed to protect human health, yet it will also be effective at reducing impacts to wildlife predators due to bioaccumulation.

EPA has also evaluated the available water quality criteria and levels for sediments and fish tissue to determine the appropriate numeric target for chromium TMDL in Rhine Channel. EPA selected the sediment target (52 mg/kg dry, Buchman 1999) as the best available target to protect both wildlife predators and benthic organisms. The alternate chromium numeric target is fish tissue, 0.2 mg/kg wet (USFWS 2001). This fish tissue target is more stringent than the screening value used to evaluate State mussel watch data in order to ensure protection of wildlife predators.

Table 7-1. Numeric targets for Chromium and Mercury in Rhine Channel.

Waterbody	Analyte	Sediment target (mg/kg dry)	Alternate Fish tissue target (mg/kg wet)
Rhine Channel	Chromium (Cr)	52	0.2
Rhine Channel	Mercury (Hg)	0.13	0.3*

*mercury tissue target is interpreted as 0.3 mg/kg wet methylmercury (EPA proposed criteria and USFWS 2000)

Source Analysis

Chromium (Cr)

Probable sources of chromium include the heavily contaminated sediments existing in Rhine Channel, previous discharges by metal plating facilities near Rhine Channel, historic deposits in the San Diego Creek watershed and atmospheric deposition. The Regional Board has documented two previous investigations of metals contamination at Newport Plating Company. These investigations found extremely high levels of chromium in sediment boring samples. Furthermore, a storm drain which drains runoff from the Newport Plating facility area discharges into Rhine Channel. This facility should be considered a potential source and should receive further investigation. More complete information on this source is presented in TSD part G – Chromium and Mercury.

Chromium may also be leaching from treated wood pylons in marine areas (Weis et al. 1991). Chromium is a naturally occurring element in many area, which can be found in volcanic dust and gases. However, chromium emissions can also come from commercial and industrial facilities, resulting in chromium discharges into the atmosphere. Currently, there is not sufficient information to estimate chromium atmospheric deposition rates in the Newport Bay watershed. The heavily contaminated sediments in Rhine Channel are most likely associated with historic discharges from industrial facilities around Rhine Channel, and these legacy sources are likely to be the largest current sources of chromium.

Mercury (Hg)

No investigation has been completed to explain elevated (total) mercury sediment concentrations within Rhine Channel. Orange County Coastkeeper (1999) measured mercury concentrations in one sediment core and the results provide historical perspective. Total mercury results show lowest concentrations at the core top (3.4 mg/kg dry) and highest concentrations (11 mg/kg dry) at the bottom of the one foot long core. Other researchers have found similar sediment concentrations in Rhine Channel; SCCWRP (2001a) reports 5.3 mg/kg dry and BPTCP (1997) reports (8.7 mg/kg dry) for surface (top six inches) sediment samples. Perhaps historical uses of ship anti-fouling paints which contained mercury are responsible for elevated sediment levels based on previous activities in Rhine Channel (Regional Board 1998). Most likely the existing sediments are the largest sources of mercury in Rhine Channel.

Another potential source of mercury is the historical mining operations at the old Red Hill mine in the western part of San Diego Creek watershed (in Tustin). Historic records show mercury mining and processing occurred at Red Hill mine between 1880 and 1939 (CA Division of Mines 1976). The total amount of mercury produced is not known. Mine shafts were sealed off in 1976, though some shafts are still open and can receive storm runoff. The Red Hill mine is upgradient of the Swamp of Frogs and mine drainage may have flowed to Peters Canyon Wash. Other minor sources of Hg deposits have been mapped in the area. At this time, no additional information is available to accurately assess whether mercury from this mining location reached the Rhine Channel area. However, available evidence for all of Newport Bay suggests that mercury levels in the rest of Newport Bay are not elevated. It is unlikely that mercury loads from the upper watershed would have contributed to mercury contamination of Newport Bay sediments solely in the Rhine Channel area. Therefore, it is unlikely that discharges from the Red Hill mine area are a principal cause of mercury contamination in Newport Bay.

Based on water column measurements (IRWD 1999) of dissolved mercury (Hg) and chromium (Cr), the loads from San Diego Creek can be estimated. Analysis of previous hydrologic modeling studies for Newport Bay (RMA 1997), yields estimates of sediment transported from San Diego Creek to be deposited in the Rhine Channel annually (approx 6%). Assuming that most of the chromium and mercury is adsorbed by suspended sediment, the estimated annual loads for chromium and mercury from San Diego Creek that are delivered to Rhine Channel are about 46.9 kg/year and 0.054 kg/year, respectively (Table 7-2).

Table 7-2. Estimated Mercury and Chromium Loads from San Diego Creek.

Pollutant Name	**Year**	**Water Column Conc. (ug/L)**	**Estimated Load to Rhine Channel (kg/yr)**
Cr	'97-99	16	46.9
Hg	'97-99	0.0186	0.054

(source: water (IRWD 1999); sediment budget (RMA 1997, 1998)

Atmospheric deposition probably is contributing small amounts of mercury to the watershed; however, there are no likely nearby sources upwind of the watershed. In any event, atmospheric deposition is estimated to contribute very small amounts of mercury to Rhine Channel relative to the amounts of mercury in existing Rhine sediments as well as freshwater sediment deposition. Ambient seawater concentrations of mercury are extremely low, typically less than 1 ng/L.

Modeling

The approach to determining the loading capacities for mercury and chromium is similar to the approach used for the organochlorine compounds (TSD – Part F) and was based on an understanding of the sources of these compounds (past, present, and future) and the transport and ultimate fate of these compounds in various environmental media. Based on a review of literature sources, it was observed that mercury and chromium environmental persistence and affinity for adsorbing to sediment and accumulating in biota generally limits their presence in the water column, at least relative to sediment and biota.

Previous modeling studies, completed by RMA for the U.S. Army Corps of Engineers (USACE) have examined the circulation patterns, and transport and deposition of sediments in Newport Bay (RMA 1997, 1998). By examining model calibration results (RMA 1997) for Newport Bay from 1985-1997, the sediment deposition in Rhine Channel was estimated. The approach relies on the following key information: sediment deposition rates, deposition patterns (from the RMA (1997) model), pollutant targets (used for loading capacity) (see TSD Table G-2) and sediment moritoring data for mercury and chromium concentrations (used for existing loads) (see TSD, Table G-1 and Appendix 1) Historic pollutant loads to the bottom sediment were estimated by using observed pollutant concentrations in bottom sediments and net sedimentation rates. Sediment volume was converted to dry weight using an estimated porosity of 0.65. The loading capacities were determined by "back-calculating" the allowable load from the selected sediment target (Table 7-3) and the associated estimates of sediment loads.

Loading Capacity/Linkage Analysis

Determination of loading capacity has been described above and uses similar methods to those outlined for organochlorine TMDLs (see Section VI of this document and TSD Part G for more comprehensive explanation. These TMDLs express the loading capacities, TMDLs, and allocations in mass loading terms for Rhine Channel. Because most of the mercury and chromium loads are associated with contaminated sediments already in Rhine Channel, it will be necessary to remediate contaminated sediments in order to meet water quality standards and prevent adverse ecological effects.

TMDL and Allocations

For these TMDLs, EPA has calculated both wasteload allocations (WLA) and load allocations (LA). Inputs from historically deposited sediments and atmospheric deposition are included in load allocations. Ongoing sediment deposition (containing mercury and chromium) from San Diego Creek is addressed as a wasteload allocation because this source is generally subject to coverage under the existing NPDES stormwater permit.

For mercury, the on-going load, which is associated principally with local contaminated sediments, is higher than the estimated loading capacity. Therefore, the mercury TMDL (0.10 kg/yr)and associated allocations are set based on this loading capacity. The opposite is true for chromium, where the existing load is slightly lower than the loading capacity, therefore the chromium TMDL is based on 33.1 kg/yr. The loading capacities for chromium and mercury are expressed as annual averages (Table 7-3).

Table 7-3. Historical Loading and Estimated Loading Capacity for Rhine Channel

Pollutant	existing conc. * (mg/kg dry)	Estimated Load (kg/yr)	Sediment Target (mg/kg dry)	Loading Capacity (kg/yr)
Chromium	44	33.1	52	39.1
Mercury	5.8	4.36	0.13	0.10

* (SCCWRP 2001a)

The wasteload and load allocations (Table 7-4) were calculated based principally on best professional judgement . Most of the available loads were assigned to sediments already in Rhine Channel, which are by the far the largest source. These allocations to existing sediments reflect substantial reductions in sediment loads from in-Channel sources based on the expected effectiveness of remedial actions identified in the 1997 remedial action plan. The remaining available load was allocated roughly in proportion to the land areas associated with the remaining source categories after allocating 5% of available loads for undefined sources. Further investigation of Newport Plating facility may warrant revision of such a high allocation to sediments in Rhine Channel for Chromium.

Table 7-4. Rhine Channel Wasteload and Load Allocations (kg/yr) and % of total loads

	Mercury (Hg)	Chromium (Cr)
Wasteload allocations		
Stormwater	0.0171 (19%)	5.66 (19%)
Caltrans	0.0027 (3%)	0.89 (3%)
Boat yards	0	0
Other NPDES permittees	0.0027 (3%)	0.89 (3%)
Load allocations:		
Existing sediment	0.063 (70%)	20.85 (70%)
Undefined sources: air deposition, ambient seawater	0.0045 (5%)	1.49 (5%)
Margin of safety	0.01	3.30
TMDL	**0.1 kg/yr**	**33.1 kg/yr**

TMDL = WLA + LA + MOS

Margin of Safety

EPA has applied an explicit 10% margin of safety to the loading capacity for these TMDLs. The specific mass-based quantity for each pollutant with respect to each waterbody is included in Table 7-5. This margin of safety will provide additional protection for aquatic life, wildlife predators and human health.

A number of assumptions were used in the derivation of each TMDL. Insufficient information is available to quantify the potential uncertainty associated with each of the assumptions used in the analysis. The parameters used in analysis were based on best available information and were selected to be conservative (i.e., most protective) where possible. The use of an explicit margin of safety and subsequent follow-up monitoring is intended to ensure that numeric targets are successfully achieved and that the adequacy of the load allocation is evaluated over time. Key areas of uncertainty recognized in the margin of safety include the following:

- The loading capacity is calculated as a long-term annual average that results in meeting water quality standards (expressed as sediment, and tissue targets). Because the analysis is focused on long-term predictions, periodic fluctuations are not represented, and actual loading may differ in the short-term.

- Long-term sediment deposition patterns were used to calculate the total amount of sediment deposited in each region. This long-term average value does not represent short-term or localized fluctuations in deposition rates. Periodic accumulation or scouring could be significant during large storm events. This could result in higher or lower deposition rates than the predicted sediment deposition and pollutant concentrations.

- A constant sediment porosity value was used to calculate loads associated with deposited sediment. Sediment porosity values used in the model to estimate loading capacity for San Diego Creek and Newport Bay (including Rhine Channel) (0.65) were slightly lower than those used (0.80) in RMA model. No consolidation was assumed. This resulted in a conservative assumption, since consolidation would result in a lower porosity, which would increase the load associated with deposited sediment.

Seasonal variation/Critical conditions

These TMDLs rely on careful analysis of the full range of potential flow conditions to address seasonal variation and critical conditions in loads and flows. The sediment transport and deposition within each waterbody is driven by the velocity and sheer conditions of flow. The annual deposition is accounted for by using the sediment model developed by RMA (1997) which incorporates various flow regimes throughout each year. The model represents various weather patterns and flow conditions for 12 years.

As previously stated, freshwater flows from San Diego Creek and Santa Ana-Delhi Channel do not significantly transport sediments into Rhine Channel. The most important scenario may be the large flows associated with wet weather events, which may occur at any time of the year and produce extensive sediment redistribution and transportations downstream. This has yet to be verified in hydrologic modeling of chromium and mercury in Rhine Channel.

VIII. Arsenic Analysis

EPA has concluded that an arsenic TMDL is not required because available data indicate that applicable numeric water quality standards, and the best available screening guidelines used to interpret narrative standards, are not being exceeded. Although the State and EPA initially concluded that arsenic TMDLs were needed based on comparisons with older recommended screening values, we have revised our conclusions based on an updated data set and new information concerning arsenic toxicity and consumption risk. This section explains the basis for EPA's revised assessment of the need for arsenic TMDLs.

EPA's initial assessment of fish tissue monitoring results was based on comparisons with two screening values. Total arsenic concentrations in fish tissue were compared to the California OEHHA screening value (1.0 mg/kg wet for total arsenic). This screening value was developed from a human health study for chemical contaminants in sportfish from two California freshwater lakes (OEHHA 1999). OEHHA recognized that inorganic arsenic is the preferred contaminant to evaluate for potential human health risk; however, analytical methods to measure inorganic arsenic were not available during that study. OEHHA developed a plan to a) evaluate total arsenic fish tissue results against the screening value for freshwater species and b) delay further decisions about water quality impairment or potential health risk until they had actually measured inorganic arsenic in popular sportfish (pers. commun. B. Brodberg). Furthermore, OEHHA recognizes its total arsenic screening value is ill-suited for saltwater systems. EPA Region 9 has reconsidered using this *freshwater* total arsenic tissue screening value and has determined that it would be inappropriate to make final decisions based only on comparison of total arsenic in tissues with this screening value.

EPA's initial assessment also considered another fish tissue screening value, (0.026 mg/kg wet for inorganic arsenic); however no monitoring data exists for measurements of inorganic arsenic in Newport Bay fish. To enable a comparison of available data to the inorganic arsenic screening value, EPA estimated levels of inorganic arsenic present in Newport Bay fish as a percentage of total arsenic for finfish (4% of total) and for shellfish (60% of total). These percentages were based on information obtained from a literature search (for finfish, Donohue and Abernathy 1999) or discussion with analytical chemists (for shellfish, pers. commun. J. Creed). Upon further review of the screening values cited in recent EPA guidance for assessing fish advisories (USEPA 2000d), EPA has determined the 0.026 mg/kg wet inorganic screening value is incorrect and that 1.2 mg/kg wet inorganic arsenic is a more reliable risk-based screening value. Preferably this screening value should be compared to measurements of inorganic arsenic in local fish, although calculation of inorganic arsenic as a percentage of total arsenic is still acceptable.

In the process of developing these TMDLs, EPA reevaluated local fish tissue data in comparison with the new EPA screening value of 1.2 mg/kg wet inorganic arsenic based on EPA's fish advisory guidance. The most recently available set of fish tissue monitoring results was compiled from Toxics Substances Monitoring program (1995-1998), California Fish Contamination Study (1999-2000) Southern California Coastal Water Research Project (2001b) and State Mussel Watch program (1995-2000). We evaluated results from both San Diego Creek and saltwater bodies of Newport Bay but focused more on saltwater results since those results showed some exceedances with respect to the OEHHA screening value applied in EPA's earlier assessment. To be conservative and consistent with other agencies (e.g., FDA), EPA assumed that inorganic arsenic comprised 10% of total arsenic for finfish and 60% of total for shellfish. We used only one screening value, 1.2 mg/kg wet for inorganic arsenic, which is consistent with both State and Federal agencies' determination that human health risk from arsenic exposure is attributed to inorganic arsenic exposures.

The final assessment of saltwater tissue results (using calculated values of inorganic arsenic) shows no exceedances of the EPA inorganic screening value (1.2 mg/kg wet). This is true for both finfish (0%, n = 80) and shellfish (0%, n = 24). There are also no exceedances of freshwater tissue results. Table 8-1 summarizes arsenic tissue concentrations for Newport Bay. Table 8-2 provides a perspective of arsenic tissue concentrations for Newport Bay and other saltwater bodies. The raw data and calculated results for this reassessment are provided in Appendix B at the end of this summary document. Therefore, based on this revised assessment, EPA concludes that San Diego Creek and Newport Bay are not exceeding water quality standards for arsenic and that no TMDLs are needed. This result is consistent with local ambient water column data for arsenic, which indicate that Bay arsenic levels are about the same as average sea water arsenic levels.

Table 8-1. Total Arsenic results in fish tissue in Newport Bay waterbodies (mg/kg wet)

Waterbody	Collection dates	Org.	n	Min	Max	Mean	Median
San Diego Creek	1995 -- 98	TSMP	15	0.06	0.88	0.18	0.13
Newport Bay (finfish)	1995 -- 98	TSMP*	4	0.4	8.6	2.93	1.3
	1999 -- 00	CFCS	26	0.2	4.0	1.29	0.79
	2000 - 01	SCCWRP	50	0.22	8.6	1.64	0.68
(shellfish)	1995 - 00	SMW	24	0.8	2.5	1.28	1.25

*these TSMP results for individual samples, all other results are tissue composites

Table 8-2. Total Arsenic results in marine waterbodies (mg/kg wet)

Tissue	Study	n	Range	Mean	Median
Finfish	Newport Bay	80	0.2 – 8.6	1.5	0.7
	Wash State	12	0.15 – 10.7	3.5	0.9
	Donohue	77	0.2 – 65	5.1	2.1
	Great Britain	720	0.9 – 30.1	5.6	4.3
Shellfish	Newport Bay	24	0.8 – 2.5	1.3	1.3
	Wash State	10	1.0 – 6.9	2.4	2.2
	Donohue	57	0.2 – 126	15.9	4.2

Newport Bay results compiled from Table 8-1
Washington State results from Yilmazer et al. 2000
Donohue results from various North American waterbodies (1996)
Great Britain results from Collins et al. 1996

IX. Implementation Recommendations

This section provides general recommendations of implementation actions and monitoring work to assist in implementing the TMDLs and allocations identified in this decision. Several commenters, including the Regional Board, dischargers, and environmental groups specifically requested that EPA discuss TMDL implementation recommendations when we made the final TMDL decisions. The implementation and monitoring actions are not required and are not part of the TMDL decisions being made by EPA at this time; rather, they are included with the TMDLs to assist followup planning and implementation work by the State and local stakeholders. As discussed in Section I above, the State—not EPA—is responsible for developing implementation plans necessary to attain TMDLs. In its comments concerning the EPA TMDLs, the Regional Board signaled its commitment to adopt TMDLs and implementation plans for these toxic pollutants in a timely manner.

General Recommendations

The toxic pollutant TMDLs address several pollutant types which come from a variety of sources. Therefore a range of pollutant management options will be available to the State to address them. Based on information we gathered in developing the TMDLs as well as feedback obtained from the State and local stakeholders during the development of the TMDLs, we have identified several appropriate implementation approaches for different pollutants.

Consistent with the State's approach to developing and implementing other TMDLs in the Newport Bay watershed for sediments, nutrients, and pathogens, EPA believes a phased, iterative approach to implementation and monitoring is appropriate to address the toxic pollutants of concern. Substantial uncertainty remains concerning pollutant sources and the relationship between pollutant loads and environmental effects in the watershed. EPA believes some specific implementation actions should be carried out to address pollutant sources which are most clearly of concern. Several of these actions are already underway or in the planning stages. It is also appropriate to collect and analyze additional monitoring data to improve the understanding of pollutant sources and effects, periodically review the TMDLs and implementation actions in light of new monitoring results, and revise the TMDLs and implementation actions if necessary. Depending upon the State's priorities, additional monitoring data could also assist in reviewing and, if necessary revising the applicable water quality standards to provide the appropriate level of beneficial use protection. This combination of early actions to address clear pollutant sources and an ongoing commitment to iterative monitoring and adjustments provides an appropriate balance in followup implementation work.

When the Regional Board considers adoption of TMDLs for toxic pollutants along with associated implementation plans, the State may adopt the TMDLs identified in this decision or further assess these pollutants and adopt different TMDLs if warranted. EPA recommends that the State consider the specific areas of analytical uncertainty identified in the analysis supporting our TMDL decisions as a starting point in targeting any additional analytical work (including monitoring) planned in support of TMDL adoption.

It is expected to take several years for toxic pollutant levels in the watershed to decline to the point where all applicable water quality standards are fully attained. For some pollutants such as the diazinon and chlorpyrifos, the pollutant levels will probably decline quickly in response to actions to reduce their use. For some other pollutants with long residence times in the environment, or which are associated with historical discharge, there will probably be some lag time between the initiation of controls to reduce loading or remediate contaminated sites and the observation of decreased pollutant levels throughout the watershed. For these reasons, EPA supports the past State practice of identifying interim targets or benchmarks in terms of pollutant control actions, pollutant loadings and/or receiving water responses to help ensure that control actions are taken and progress is being made toward attaining water quality standards. Specification of clear interim targets also assists in the evaluation of whether the TMDLs or implementation actions need to be adjusted in the future.

EPA's TMDLs do not contain compliance timeframes or interim implementation targets because these elements are addressed by the State in the implementation planning process. EPA urges the State to work with local dischargers and stakeholders to design and carry out effective implementation actions sufficient to implement the TMDL in a timely manner.

As discussed in Section 1, the Clean Water Act creates federal regulatory jurisdiction only over point sources. Therefore, the direct implementation effect of EPA's TMDLs is that when NPDES permits for point source discharges are issued or revised for discharges to waters in the watershed, the State is required to ensure that the permits contain effluent limitations necessary to be consistent with the wasteload allocations (WLAs) contained in theTMDLs (40 CFR 122.44(d)). Permit modification may occur when existing permits are reopened or reissued, or when a new discharge source seeks a permit. NPDES permit holders should contact the Regional Board to discuss how and when action will be taken to implement applicable WLAs. The State has discretion to determine how the point source permit provisions will be made consistent with applicable WLAs. Depending upon the situation and the level of precision in the WLA, it may be appropriate to:

- incorporate numeric effluent limitations for the pollutant(s) of concern in the permit,
- identify best management practices and associated pollutant control effectiveness which demonstrate that the WLAs will be attained, and/or
- require the discharger to submit a WLA compliance plan and schedule which demonstrates how the WLA will be implemented.

In addition to addressing WLA implementation through the NPDES permitting process, the State should work with local stakeholders to identify specific actions necessary to carry out load allocations identified in the TMDLs. These actions may be based on voluntary or regulatory approaches. We note that CWA Section 319(h) nonpoint source implementation grant funds may be available to assist in implementing controls necessary to implement load allocations. Section 319(h) projects designed to implement TMDLs currently receive priority for funding. Landowners or land managers interested in seeking Section 319(h) funding assistance should contact the Regional Board staff for more information concerning the State's grant funding process.

OP Pesticide TMDL Implementation Recommendations

EPA's pesticide program has intiated a phase-out of household uses of diazinon and chlorpyrifos (EPA 2000b, EPA 2001b). It is expected that the phase-out will greatly assist in reducing the levels of these pesticides found in the waters of Newport Bay watershed. Because approximately 90% of diazinon and chlorpyrifos use in the watershed is estimated to be associated with urban and household uses, the phase-out program may be sufficient to result in attainment of the TMDLs and associated allocations. We recommend that the Regional Board continue its work with nurseries in the watershed to minimize use of these pesticides. We recommend continued monitoring in San Diego Creek and its tributaries to assess reductions in OP pesticide runoff in the next several years. If monitoring demonstrates that the urban use phase-outs are inadequate to implement the TMDLs, it may be necessary in the future to implement additional controls on agricultural uses of these pesticides in coordination with the California Department of Pesticide Regulation

We are concerned by potential conflicts between programs to reduce use of these pesticides and mandates to use these pesticides for fire ant control. EPA urges that Regional Board to work with the State Water Resources Control Board, California Department of Pesticide Regulation, California Department of Food and Agriculture, and EPA's pesticide program to assess and, if necessary, reconcile these potentially conflicting mandates concerning OP pesticide use.

Selenium TMDL Implementation Recommendations

EPA is in the process of reviewing and potentially revising the numeric criteria for Se in freshwater. In addition, other local studies are underway to assess the potential effects of Se on aquatic organisms. EPA expects to complete this review within approximately 2 years. EPA recommends that the State review and, if necessary, revise the Se TMDLs following adoption or promulgation of the revised water quality standards. Several commenters raised concerns about whether the CTR criteria are appropriate for conditions in the San Diego Creek watershed, and identified several local factors (e.g. local water chemistry) which could support consideration of alternative site specific criteria. In consultation with EPA and the State Water Board, the Regional Board should consider whether it is feasible and appropriate to assess the applicable Se water quality standards in light of these concerns, and potentially adopt site specific water quality standards.

The TMDL analysis found that the most significant sources of Se loading appear to be associated with groundwater entering surface waters (sometimes directly and sometimes through discharge from dewatering operations). Control of these sources will be difficult. However, EPA recommends that the State begin working with permitted dischargers to assess options for reducing Se discharges through discharge management practices and/or treatment technologies. The State may wish to sequence its planning activities to settle issues concerning applicable standards before carrying out actions to further tighten discharge controls.

EPA recommends that the Regional Board monitor flow and Se concentrations in discharges from cleanup and ground water dewatering operations in order to provide the basis for establishing effluent limits in the permits consistent with the TMDLs. When NPDES permits for groundwater cleanup or dewatering operations are considered, the Regional Board will need to ensure that the total allowable Se loadings do not exceed the group WLA established in the TMDL.

Metals TMDL Implementation Recommendations

Metals loading in the watershed is associated primarily with ongoing runoff from urban and undeveloped areas, and aquatic sediments containing previously discharged metals. Our recommendations address all the metals for which TMDLs are established, including mercury and chromium. EPA recommends five areas of action to address metals loading in the watershed.

First, metals levels in the Rhine Channel area are estimated to be substantially higher than in other areas of the watershed. No significant ongoing loading sources were identified, and the aquatic sediments in Rhine Channel have been identified as a significant toxic hot spot. EPA recommends aggressive action to complete and implement the contaminated sediment remediation plan initiated by the State and Regional Boards in 1997. One potential ongoing source of concern with respect to chromium loading is the Newport Plating facility. EPA recommends that the State further assess this facility and, if necessary, carry out discharge controls or remedial actions necessary to address any ongoing loadings.

Second, the source analysis indicated that copper leaching from boat paints is probably a significant source of copper loading to the Bay. In coordination with marina and boatyard operators, other Regional Boards, the State Board, and EPA, the Santa Ana Regional Board should develop specific actions to reduce the use of copper-containing boat paints or their leaching to water bodies through use of additional boat storage and maintenance practices.

Third, the Regional Board should work with the stormwater discharge permittees to further assess the potential effectiveness of available management practices to reduce metals loading in discharges of urban runoff under high and low flows. In future iterations of the stormwater permits, provision should be made to implement effective metals reduction practices, with particular emphasis on implementation of the more cost-effective methods identified. Additional work will be needed in the immediate future to more thoroughly assess and document the prospective effectiveness of available practices.

Fourth, he State adopted a sediment TMDL and implementation plan in 1999 which called for an overall 50% reduction in sediment loading from San Diego Creek through implementation of a locally developed sediment reduction plan. Reductions in sediment loading should assist in reducing loadings of total metals. EPA recommends that the State continue implementation of this sediment reduction plan and monitor to determine whether both total and dissolved metals loading levels decline over time.

Fifth, the State may wish to consider reevaluation of the metals criteria and associated TMDLs in the future based on application of criteria calculation methods which are currently under development. Metals criteria calculation protocols are nearing completion which may enable States to calculate metals standards that more accurately represent the bioavailable portion of total metals loading through consideration of water effects ratios (WERs). It may be relatively straightforward recalculate metals criteria based on local hardness and organic carbon data and revised WER equations. In light of the potential cost of extensive actions to further control metals loading from urban runoff in the watershed, EPA believes it may be reasonable to consider whether newly emerging criteria calculation methods would result in protective but easier-to-implement standards.

Organochlorine Compound TMDL Implementation Recommendations

This TMDL decision addresses two types of organochlorine compounds whose use is no longer authorized: several chlorinated pesticides (DDT, chlordane, dieldrin and toxaphene) and PCBs, which were used in electrical equipment. Because these compounds are very stable in the environment and often adhere to sediments, they may continue to reach and remain in water bodies at levels of concern for many years following their discharge to the environment. Two potential routes of environmental exposure of these compounds are of greatest potential concern—ongoing loadings from the watershed of historically deposited pollutants and exposures to organochlorine compounds already present in aquatic sediments (principally in Newport Bay). There is substantial evidence indicating that levels of these compounds in Bay sediments and aquatic organisms has declined over the past 20 years or more.

No terrestrial "hot spots" (locations with significantly elevated levels of these pollutants were located during the TMDL development process; however, limited historical information indicates that there may have been some spills (e.g., PCB spills at El Toro and Tustin Air Stations). We recommend that the State conduct more thorough investigations of potential spill sites based on the preliminary information compiled for this TMDL effort in order to determine whether there are any significant hot spot sites in the watershed warranting further remedial action.

The most likely source of ongoing loading of organochlorine pollutants is erosion of sediments to which these compounds have adhered. The State adopted a sediment TMDL and implementation plan in 1999 which called for an overall 50% reduction in sediment loading from San Diego Creek through implementation of a locally developed sediment reduction plan. EPA recommends that the State continue implementation of this sediment reduction plan and monitor to determine whether levels of organochlorine compounds continue to decline. Monitoring should examine not only the levels of organochlorine pollutants in the water column, but also sediment running into tributary streams, sediment moving down San Diego Creek, and sediments in Newport Bay.

If future monitoring indicates that declines in levels of the pollutants in the watershed are continuing or accelerating, it may be unnecessary to implement additional erosion and sediment controls. If the levels of these pollutants in sediments and tissue do not decline or actually begin to rise, the State will need to revisit and potentially revise terrestrial sediment control strategies in the watershed as a whole and aquatic sediment management strategies in the Bay.

Newport Bay sediment and tissue monitoring programs should continue to test for organochlorine pollutants. Although no obvious aquatic sediment "hot spots" were found for these pollutants (with the possible exception of Rhine Channel for some pollutants), the available data appear to indicate that the reservoir of these pollutants still found in Bay sediments far outweighs the additional loads to the Bay from the watershed. Therefore, in coordination with monitoring and assessment programs to evaluate the full suite of toxic pollutants of concern, the State should continue to consider whether any specific locations warrant remedial action to remove, cap, or otherwise immobilize Bay sediments. It is always important to consider whether the long term benefit of aquatic sediment remedial action is outweighed by the potential short term adverse effects associated with disturbing contaminated sediments. The remedial action plan adopted by the State for Rhine Channel should help reduce any ongoing availability of these pollutants at that location, and we repeat our recommendation that this remedial action plan be carried out in a timely manner.

The U.S. Army Corps of Engineers and Orange County have been examining the feasibility of removing sediment from containment basins in Upper Newport Bay (ACOE 2000). This study has refined various alternatives, obtained necessary funding and is presently entering the preconstruction, engineering and design phase. Restoration is *scheduled* to begin in 2003/2004. We recommend that the State work with the project sponsors to ensure that potential disturbance of sediments containing the pollutants addressed in this TMDL report is considered in the design process and minimized during project implementation.

Monitoring Recommendations

This action establishes TMDLs for numerous toxic pollutants, in a watershed for which several other TMDLs have previously been established. We recommend that the State work with the other State and federal agencies, the County, permitted cities, local industries, and perhaps local academic institutions to develop a coordinated monitoring program for Newport Bay and its tributary streams. While much of this work could be carried out pursuant to the NPDES stormwater permit, the scope of the monitoring needed to more fully characterize toxic pollutant trends in the watershed and the effectiveness of pollutant control strategies goes beyond the scope of traditional monitoring required under these permits. Substantial monitoring has conducted in the past but it was (with the exception of the County's monitoring) usually relatively narrow in scope in terms of pollutant coverage, geographical extent, and temporal scope. Newport Bay watershed is a good candidate for development of a more integrated and comprehensive monitoring approach which could result in a more cost-effective overall approach to monitoring than currently created by independent monitoring approaches.

We recommend that the State consider the areas of uncertainty in each TMDL analysis as discussed in the margin of safety sections and TSDs in order to identify the types of monitoring data which are most important to reduce analytical uncertainty and improve our ability to target meaningful control actions.

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XI. Glossary and abbreviations

205(j)	Section 205, part j of Clean Water Act, addresses water monitoring grants
319(h)	Section 319, part h of Clean Water Act, addresses non-point source pollution
ACOE	Army Corps of Engineers
ai	active ingredient
ambient	existing environmental conditions (or concentrations)
BAF	Bioaccumulation factor
BCF	Bioconcentration factor
BSAF	Biota-sediment accumulation factor
bgs	Below-ground surface, relates to monitoring wells
Bight '98	Southern California Bight (coastal waters) study
BMP	best management practice
BPTCP	Bay Protection and Toxic Cleanup Program
CCC	criterion continuous concentration = chronic
CDFG	(California) Department of Fish and Game
cfs	Cubic feet per second, pertains to stream flow rates
CFCS	California Fish Contamination Study (OEHHA)
CMC	criterion maximum concentration = acute
CTR	California Toxics Rule
cv	coefficient of variation
CWA	Clean Water Act
DO	dissolved oxygen
DPR	(California) Department of Pesticide Regulation
DTSC	(California) Dept. of Toxic Substances Control
ELISA	Enzyme Linked Immunosorbant Assay
EPA	U.S. Environmental Protection Agency
ERL	Effects Range-Low, sediment quality guideline for low impact
ERM	Effects Range-Median, NOAA sediment quality guideline for median negative impact
FIFRA	Federal Insecticide, Fungicide and Rodenticide Act
f_{lip}	Fraction (of organic compound associated) with lipid
f_{oc}	Fraction (of organic compound associated) with octanol
GC	Gas chromatograph
GC/MS	Gas chromatography/mass spectrometry
HPLC/MS	high performance liquid chromatography/mass spectrometry
IPM	Integrated Pest Management, part of UC-Cooperative Extension
IRWD	Irvine Ranch Water District
LA	Load allocation for non-point sources (including background)
MLLW	mean low low water
MOS	Margin of safety
NAWQA	National Water Quality Assessment Program
ng/L	Nanograms per liter (= parts per trillion)
NOAA	National Oceanic Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NY DEC	New York Dept. of Environmental Conservation
OC	Organochlorine compound; e.g., chlordane, dieldrin, DDT, PCB, toxaphene
OCHCA	Orange County Health Care Agency
OCPFRD	Orange County Public Facilities and Resources Department

OEHHA	Office of Environmental Health Hazard Assessment
OP	Organophosphate, type of pesticide
OPP	Office of Pesticide Programs
PCB	polychlorinated biphenyl
PCH	Pacific Coast Highway
PCW	Peters Canyon Wash, a tributary of San Diego Creek
PEL	Probable Effects Level, sediment quality guideline for Florida Dept. of Env. Protection
PERA	probabilistic ecological risk assessment
POTW	Publicly owned treatment works
ppb	Part per billion = ug/L (for solution concentration) or ng/g (for dry soil conc.)
ppm	Part per million = mg/L (for solution concentration) or ug/g (for dry soil conc.)
PPT	parts per thousand (salinity)
Porewater	(interstitial) water contained in sediments
RIFA	Red Imported Fire Ant
RMA	Resource Management Associates, developed hydrologic models for US Army Corp of Eng.
SA RWQCB	Santa Ana Regional Water Quality Control Board
SD RWQCB	Santa Diego Regional Water Quality Control Board
SAD	Santa Ana-Delhi Channel
SCCWRP	Southern California Coastal Water Research Program
SDC	San Diego Creek
se	standard error [as used in table column headings]
SMW	State Mussel Watch
SWRCB	State Water Resources Control Board
TAC	Technical Advisory Committee
TEL	Threshold Effects Level, sediment quality guideline (for Florida Dept. of Env. Protection)
TIE	toxicity investigation evaluation = study to identify and characterize chemicals causing toxicity
TMDL	total maximum daily load
TOC	total organic carbon
TSMP	Toxic Substances Monitoring Program (State Water Board)
TUa	acute toxic units
UCD	University of California, Davis
ug/L	micrograms per liter (= parts per billion)
US FWS	United States Fish & Wildlife Service
USGS	United States Geological Survey
WDR	Waste discharge report,
WLA	Wasteload allocation for point sources (including general stormwater permit)
WYL	San Diego Creek at Culver sampling site
xe	mean error [as used in table column headings]

Appendix A

Designated beneficial uses for Newport Bay and San Diego Creek watershed.

Water Body	MUN	AGR	IND	PROC	GWR	NAV	POW	REC1	REC2	COMM	WARM	COLD	BIOL	WILD	RARE	SPWN	MAR	SHEL	EST
Lower NB	+					x		x	x	x				x	x	x	x	x	
Upper NB	+							x	x	x			x	x	x	x	x	x	x
San Diego Creek Reach 1	+							x	x		x			x					
San Diego Creek Reach 2	+							I	I		I			I					
Tributaries of San Diego Creek	+							I	I		I			I					

x present or potential beneficial use
I intermittent beneficial use
\+ excepted from MUN

MUN = municipal and domestic supply
AGR = agricultural supply
IND = industrial service supply
PROC = industrial process supply
GWR = groundwater recharge
NAV = navigation
POW = hydropower generation
REC1 = water contact recreation
REC2 = non-contact water recreation
COMM = commercial and sport fishing
WARM = warm freshwater habitat
COLD = cold freshwater habitat
BIOL = preservation of biological habitats
WILD = wildlife habitat
RARE = rare, threatened, or endangered species
SPWN = spawning, reproduction, and/or early development
MAR = marine habitat
SHEL = shellfish harvesting
EST = estuarine habitat

Appendix B

Arsenic Fish Tissue Monitoring data

	SPECIES NAME	**Date**		**Total Arsenic**		**Inorganic Arsenic**
	Screening Value (mg/kg wet)		OEHHA =	**1.0**	EPA =	**1.2**
			#/samp.		(4% Tot. As)	(10% Tot. As)
OEHHA data ' 00						
Newport Beach	Barred Surfperch	6/00/2000	10	0.601	**0.024**	**0.060**
Newport Beach	Shiner Surfperch	06/00/2000	10	1.130	**0.045**	**0.113**
Newport Beach	White Croaker	06/00/2000	5	0.778	**0.031**	**0.078**
Newport Beach Pier	Barred Surfperch	06/00/2000	10	0.577	**0.023**	**0.058**
Newport Beach Pier	White Croaker	06/00/2000	5	0.668	**0.027**	**0.067**
Balboa Pier	Barred Surfperch	06/00/2000	3	0.911	**0.036**	**0.091**
Balboa Pier	Diamond Turbot	06/00/2000	4	3.094	**0.124**	**0.309**
Newport Jetty	Black Surfperch	06/00/2000	5	0.774	**0.031**	**0.077**
Newport Jetty	Shiner Surfperch	06/00/2000	10	0.906	**0.036**	**0.091**
Newport Jetty	Spotted Turbot	06/00/2000	5	3.673	**0.147**	**0.367**
Newport Bay/above PCH Br	Shiner Surfperch	06/00/2000	10	0.969	**0.039**	**0.097**
Newport Bay/above PCH Br	Spotted Turbot	06/00/2000	5	1.775	**0.071**	**0.177**
Newport Bay/above PCH Br	Yellowfin Croaker	06/00/2000	4	0.585	**0.023**	**0.059**
Newport Beach	Barred Surfperch	8/4/99	5	0.811	**0.032**	**0.081**
Newport Beach	California Corbina	8/4/99	5	0.449	**0.018**	**0.045**
Newport Beach	Walleye Surfperch	6/22/99	3	0.618	**0.025**	**0.062**
Newport Pier	Barred Surfperch	8/4/99	5	1.06	**0.042**	**0.106**
Newport Pier	California Corbina	8/4/99	5	0.411	**0.016**	**0.041**
Newport Pier	Spotted Turbot	6/16/99	3	2.69	**0.108**	**0.269**
Newport Pier	Yellowfin Croaker	8/4/99	3	0.529	**0.021**	**0.053**
Balboa Pier	Diamond Turbot	6/15/99	5	4	**0.160**	**0.400**
Balboa Pier	Walleye Surfperch	6/9/99	5	0.587	**0.023**	**0.059**
Newport Jetty	Spotted Scorpionfish	5/19/99	5	0.202	**0.008**	**0.020**
Newport Jetty	Spotted Turbot	5/19/99	5	3.12	**0.125**	**0.312**
Newport Bay	Diamond Turbot	5/19/99	5	1.88	**0.075**	**0.188**
Newport Bay	Shiner Surfperch	5/27/99	5	0.672	**0.027**	**0.067**
SCCWRP		**Winter '01**				
barred sand bass	Outer Lower	1	1	0.65	**0.026**	**0.065**
black perch	Outer Upper	1	2	0.53	**0.021**	**0.053**
black perch	Outer Lower	1	3	0.96	**0.038**	**0.096**
black perch	Outer Lower	2	4	0.86	**0.034**	**0.086**
black perch	Outer Lower	3	5	0.69	**0.028**	**0.069**
California halibut	Outer Upper	1	6	0.58	**0.023**	**0.058**
California halibut	Outer Upper	2	7	0.85	**0.034**	**0.085**
California halibut	Outer Upper	3	8	0.47	**0.019**	**0.047**
California halibut	Outer Lower	1	9	0.91	**0.036**	**0.091**
California halibut	Outer Lower	2	10	0.41	**0.016**	**0.041**
C-O sole	Outer Lower	1	11	5.74	**0.230**	**0.574**

C-O sole	Outer Lower	2		12	5.01	**0.200**	**0.501**
diamond turbot	Outer Upper	1		13	1.82	**0.073**	**0.182**
diamond turbot	Outer Upper	2		14	3.89	**0.156**	**0.389**
diamond turbot	Outer Upper	3		15	2.85	**0.114**	**0.285**
diamond turbot	Outer Lower	1		16	4.20	**0.168**	**0.420**
diamond turbot	Outer Lower	2		17	3.45	**0.138**	**0.345**
fantail sole	Outer Lower	1		18	0.97	**0.039**	**0.097**
shiner perch	Outer Upper	1		19	0.67	**0.027**	**0.067**
spotted sand bass	Outer Upper	1		20	0.47	**0.019**	**0.047**
spotted sand bass	Outer Lower	1		21	0.63	**0.025**	**0.063**
spotted turbot	Outer Upper	1		22	3.92	**0.157**	**0.392**
spotted turbot	Outer Lower	1		23	7.28	**0.291**	**0.728**
spotted turbot	Outer Lower	2		24	8.57	**0.343**	**0.857**
spotted turbot	Outer Lower	3		25	5.53	**0.221**	**0.553**
SUMMER 2001							
barred sand bass	Outer Lower	1	13		0.44	**0.018**	**0.044**
black perch	Outer Lower	1	10		0.50	**0.020**	**0.050**
black perch	Outer Lower	2	11		0.40	**0.016**	**0.040**
black perch	Outer Lower	3	12		0.58	**0.023**	**0.058**
California corbina	Outer Lower	1	17		1.24	**0.050**	**0.124**
California corbina	Outer Lower	2	18		1.15	**0.046**	**0.115**
California corbina	Outer Lower	3	19		1.57	**0.063**	**0.157**
California halibut	Outer Lower	1	25		0.52	**0.021**	**0.052**
diamond turbot	Outer Upper	1	20		2.52	**0.101**	**0.252**
diamond turbot	Outer Upper	2	21		2.89	**0.116**	**0.289**
diamond turbot	Outer Lower	1	22		2.12	**0.085**	**0.212**
jacksmelt	Outer Upper	1	1		0.51	**0.020**	**0.051**
jacksmelt	Outer Upper	2	2		0.53	**0.021**	**0.053**
jacksmelt	Outer Upper	3	3		0.58	**0.023**	**0.058**
kelp bass	Outer Lower	1	4		0.49	**0.020**	**0.049**
spotfin croaker	Outer Lower	1	23		0.68	**0.027**	**0.068**
spotfin croaker	Outer Lower	2	24		0.93	**0.037**	**0.093**
spotted sand bass	Outer Lower	1	14		0.22	**0.009**	**0.022**
spotted sand bass	Outer Lower	2	15		0.24	**0.010**	**0.024**
spotted sand bass	Outer Lower	3	16		0.25	**0.010**	**0.025**
yellowfin croaker	Outer Lower	1	5		0.36	**0.014**	**0.036**
yellowfin croaker	Outer Lower	2	6		0.34	**0.014**	**0.034**
yellowfin croaker	Outer Lower	3	7		0.47	**0.019**	**0.047**
yellowfin croaker	Inner Lower	1	8		0.49	**0.020**	**0.049**
yellowfin croaker	Inner Lower	2	9		0.27	**0.011**	**0.027**
TSMP data '95--'98							
Upper NB/Dunes	Brown Sm. Shark (F)	6/10/98	1		8.620	**0.345**	**0.862**
Upper NB/Dunes	Diamond Turbot (F)	6/20/97			1.480	**0.059**	**0.148**
NB/Rhine Channel	Chub Mackerel (F)	7/11/97			0.427	**0.017**	**0.043**
NB/Rhine Channel	Black Croaker (F)	6/18/95			1.200	**0.048**	**0.120**

(Data is for Individual Filet Samples)

saltwater finfish results

count	80		
max	8.62	**0.34**	**0.86**
mean	1.59	**0.06**	**0.08**
median	0.78	**0.03**	**0.08**

				Tot. As	Inorg. As
State Mussel Watch	mussels				
Upper Newport Bay					(60% of As Total)
UNB/Mariner's Drive	TCM	1/27/97		1.10	**0.018**
UNB/Mariner's Drive	TCM	3/24/98		1.70	**0.028**
UNB/Mariner's Drive	TCM	NA			
UNB/Mariner's Drive	TCM	2/2/00		0.90	**0.015**
UNB/ PCH Bridge	TCM	1/30/95	NA		
UNB/ PCH Bridge	TCM	1/17/96		1.40	**0.023**
UNB/ PCH Bridge		NA	NA		
UNB/ PCH Bridge	TCM	3/24/98		1.40	**0.023**
UNB/ PCH Bridge	TCM	3/29/99		1.40	**0.023**
UNB/ PCH Bridge	TCM	2/2/00		1.00	**0.017**
Lower Newport Bay					
LNB/Turning Basin	TCM	1/30/95	NA		
LNB/Turning Basin	TCM	1/17/96		1.20	**0.020**
LNB/Turning Basin		na	NA		
LNB/Turning Basin	RBM	3/24/98		0.80	**0.013**
LNB/Turning Basin	TCM	3/29/99		1.30	**0.022**
LNB/Turning Basin	TCM	2/2/00		1.00	**0.017**
LNB/Police Docks	RBM	3/24/98		1.10	**0.018**
LNB/Entrance	TCM	3/29/99		2.50	**0.042**
Rhine Channel					
Rhine Ch./Crows Nest	TCM	1/30/95	NA		
Rhine Ch./Crows Nest	TCM	1/17/96		1.20	**0.020**
Rhine Ch./Crows Nest	TCM	1/27/97		1.20	**0.020**
Rhine Ch./Crows Nest	TCM	3/24/98		1.60	**0.027**
Rhine Ch./Crows Nest	TCM	3/29/99		1.50	**0.025**
Rhine Ch./Crows Nest	TCM	2/2/00		1.10	**0.018**
Rhine Ch./End	TCM	1/30/95	NA		
Rhine Ch./End	TCM	1/17/96		1.30	**0.022**
Rhine Ch./End	TCM	1/27/97		1.30	**0.022**
Rhine Ch./End	TCM	3/24/98		1.40	**0.023**
Rhine Ch./End	TCM	3/29/99		1.30	**0.022**
Rhine Ch./End	TCM	2/2/00		0.90	**0.015**
Rhine Ch./Upper	TCM	2/2/00		1.00	**0.017**

(Data is for Composite Mussel Samples)

Saltwater shellfish results

count	24	
max	2.50	**0.04**
mean	1.28	**0.02**
median	1.25	**0.02**

			Tot. As	Inorg. As	
TSMP data '96--'98				**4%**	**10%**
San Diego Creek					
San Diego Creek/Michelson	Red Shiner	6/9/98	0.344	**0.014**	**0.034**
Peters Canyon Channel	Red Shiner	6/9/98	0.116	**0.005**	**0.012**
San Diego Creek/Barranca	Red Shiner	6/9/98	0.200	**0.008**	**0.020**
Delhi Channel	Striped Mullet	6/9/98	0.882	**0.035**	**0.088**
San Diego Creek/Michelson	Red Shiner	6/19/97	0.134	**0.005**	**0.013**
Peters Canyon Channel	Red Shiner	6/19/97	0.057	**0.002**	**0.006**
Peters Canyon Channel	Red Shiner	6/19/97	0.063	**0.003**	**0.006**
San Diego Creek/Barranca	Red Shiner	6/19/97	0.148	**0.006**	**0.015**
Delhi Channel	Red Shiner	6/18/97	0.085	**0.003**	**0.009**
San Diego Creek/Michelson	Red Shiner	11/6/96	0.06	**0.002**	**0.006**
San Diego Creek/Michelson	Red Shiner	11/6/96	0.07	**0.003**	**0.007**
Peters Canyon Channel	Red Shiner	11/6/96	0.15	**0.006**	**0.015**
San Diego Creek/Michelson	Red Shiner	6/17/95	0.150	**0.006**	**0.015**
San Diego Creek/Michelson	Red Shiner	6/17/95	0.170	**0.007**	**0.017**
Peters Canyon Channel	Red Shiner	6/17/95	0.090	**0.004**	**0.009**

Freshwater finfish results

count	15		
max	0.88	**0.04**	**0.09**
mean	0.18	**0.01**	**0.02**
median	0.13	**0.01**	**0.01**

Part A—Relevant Maps/Figures

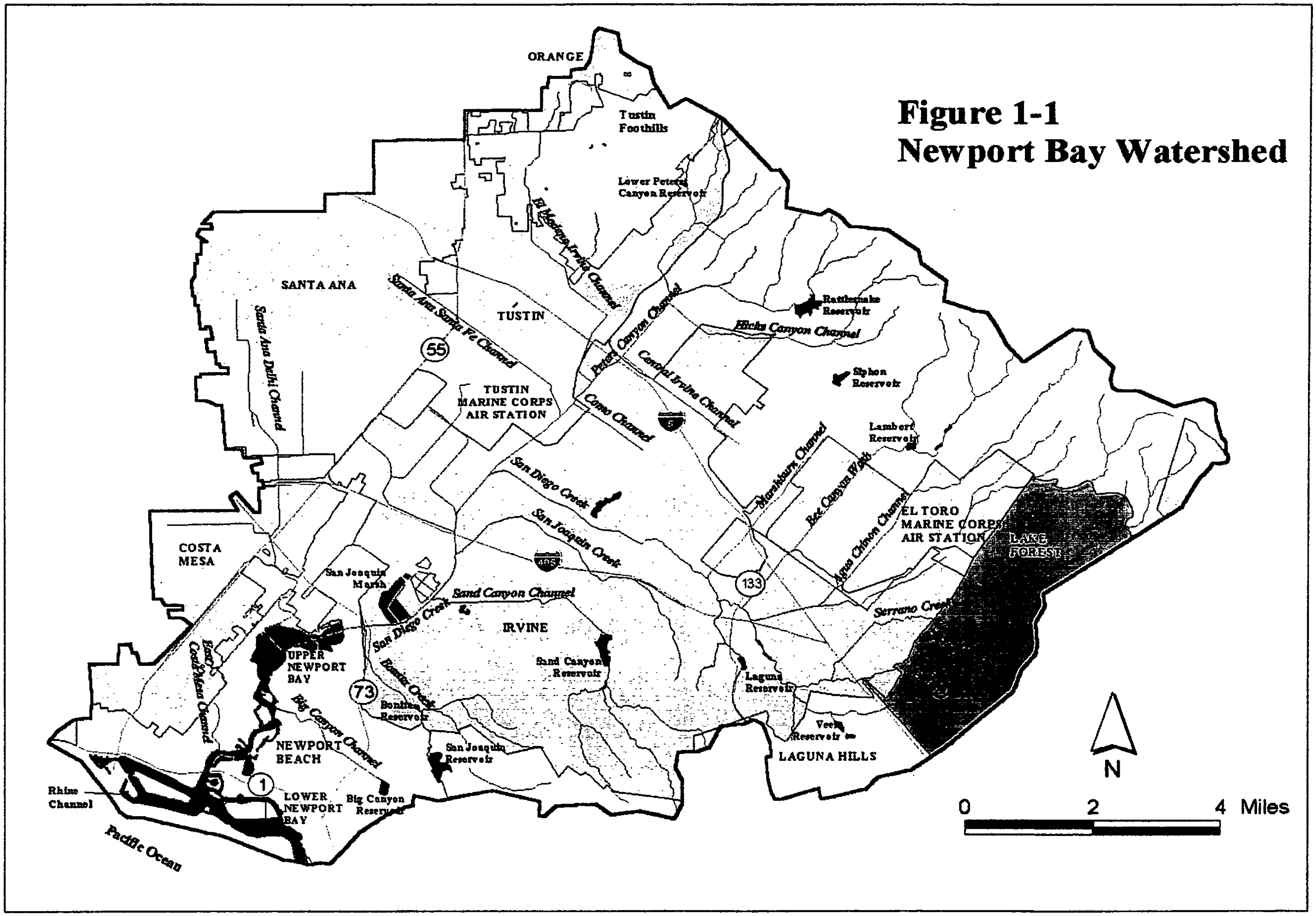


Figure 1-1
Newport Bay Watershed
ORANGE
Tustin Foothills
Lower Peters Canyon Reservoir
SANTA ANA
TUSTIN
Santa Ana Delhi Channel
Santa Ana Santa Fe Channel
El Modena Irvine Channel
Peters Canyon Channel
Rattlesnake Reservoir
Hicks Canyon Channel
Central Irvine Channel
Siphon Reservoir
TUSTIN MARINE CORPS AIR STATION
Como Channel
Lambert Reservoir
Marshburn Channel
Bee Canyon Wash
San Diego Creek
San Joaquin Creek
Agua Chinon Channel
EL TORO MARINE CORPS AIR STATION
LAKE FOREST
COSTA MESA
San Joaquin Marsh
Sand Canyon Channel
Serrano Creek
IRVINE
UPPER NEWPORT BAY
Sand Canyon Reservoir
Laguna Reservoir
Big Canyon Channel
Bonita Creek
Bonita Reservoir
Veeh Reservoir
NEWPORT BEACH
San Joaquin Reservoir
LAGUNA HILLS
Rhine Channel
LOWER NEWPORT BAY
Big Canyon Reservoir
Pacific Ocean
55
5
405
133
73
1
N
0
2
4 Miles

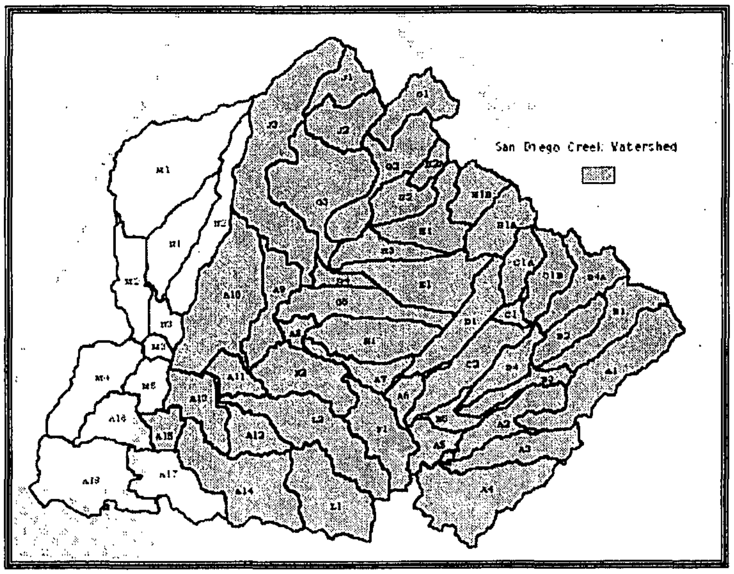


Figure A-2. San Diego Creek watershed land use data (as of January 2001). (Source: OCPFRD GIS Dept.)

San Diego Creek Land Use# - Jan 2001

Landuse	Acres	Total sq_miles	% using sq miles	% using acres
Agricultural	5091.9	7.96	6.55	6.54
Commercial	6381.4	9.97	8.20	8.20
Education and Religion	203.2	0.32	0.26	0.26
Industrial	3965.5	6.2	5.10	5.10
No Available Data	21910.0	34.23	28.15	28.16
Recreational	237.2	0.37	0.30	0.30
Residential-Income	11668.2	18.23	14.99	14.99
Trans., Comm. and Utility	1177.2	1.84	1.51	1.51
Vacant Land	15811.3	24.71	20.32	20.32
Roads*	11369.7	17.76	14.61	14.61
Total watershed	77818.5	121.59	100.00	100.00

#Does not include Santa Ana-Delhi and subwatersheds A15, A16, A17, A18

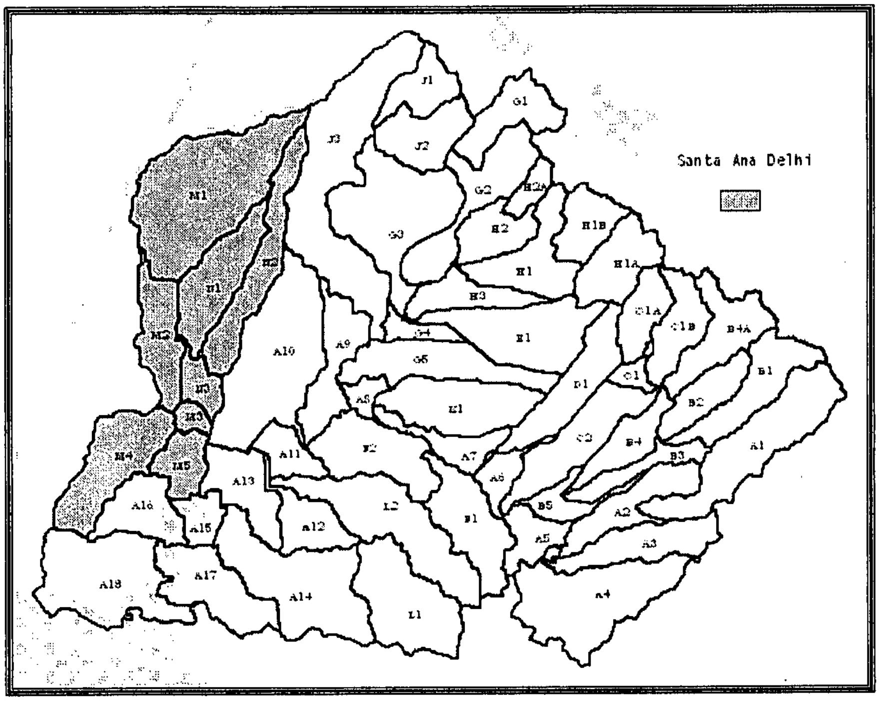


Figure A-3. Santa Ana Delhi watershed land use data (as of January 2001) (Source: OCPFRD GIS dept.)

Santa Ana Delhi = sum of sub-watersheds N1 ,N2, N3, M1, M2, M3, M4, M5

Landuse	Acres	Total sq_miles	% using sq miles	% using acres
Commercial	2397.83	3.75	16.61	16.60
Education and Religion	160.50	0.25	1.11	1.11
Industrial	1102.27	1.72	7.62	7.63
No Available Data	1060.35	1.66	7.35	7.34
Recreational	178.15	0.28	1.24	1.23
Residential-Income	5285.79	8.26	36.58	36.58
Trans., Comm. and Utility	98.70	0.15	0.66	0.68
Vacant Land	825.17	1.29	5.71	5.71
Roads*	3338.54	5.21	23.07	23.11
Total Watershed	14448.75	22.58	99.96	100.00

*Approximate figure based on the length of the centerline and the width of the ROAD
14448.75 is the total area of the watershed

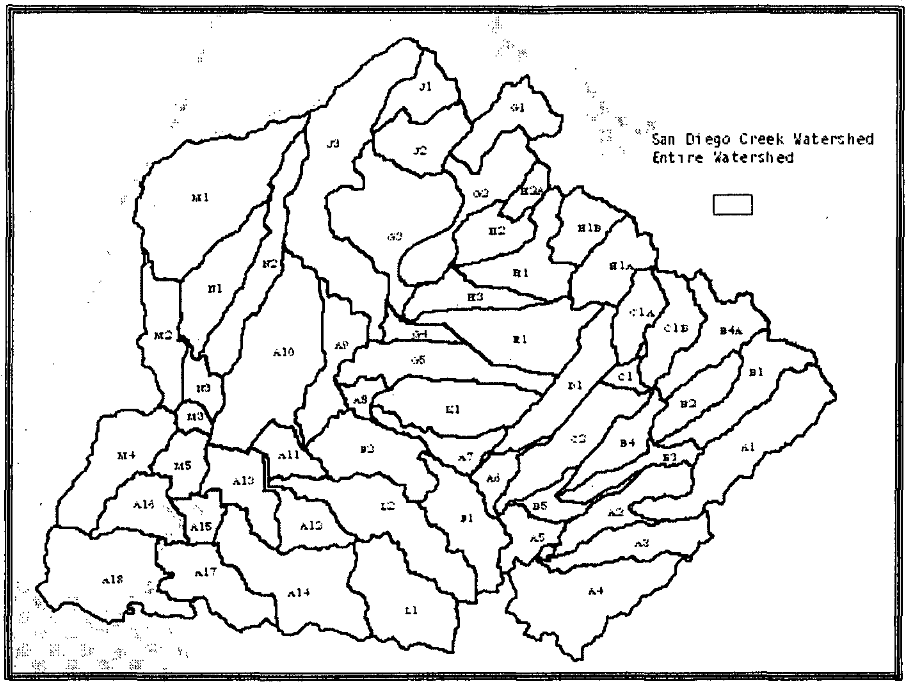


Figure A-4. Entire Newport Bay watershed land use data (as of January 2001) (Source: OCPFRD GIS dept.)

Entire Newport Bay watershed

Landuse	Acres	Total sq_miles	% using sq miles	% using acres
Agricultural	5146.911	8.04	5.21	5.21
Commercial	9640.795	15.06	9.75	9.75
Education and Religion	406.257	0.63	0.41	0.41
Industrial	5263.535	8.22	5.32	5.35
No Available Data	23461.998	36.66	23.74	23.85
Recreational	529.514	0.83	0.54	0.54
Residential-Income	19420.282	30.34	19.64	19.74
Trans., Comm. and Utility	1326.735	2.07	1.34	1.35
Vacant Land	17393.645	27.18	17.60	17.68
Roads*	15773.57	24.64	15.95	16.04
Total watershed	98847.148	154.45	99.49	99.93
	98363.242	**153.67**		

*Approximate figure based on the length of the centerline and the width of the ROW

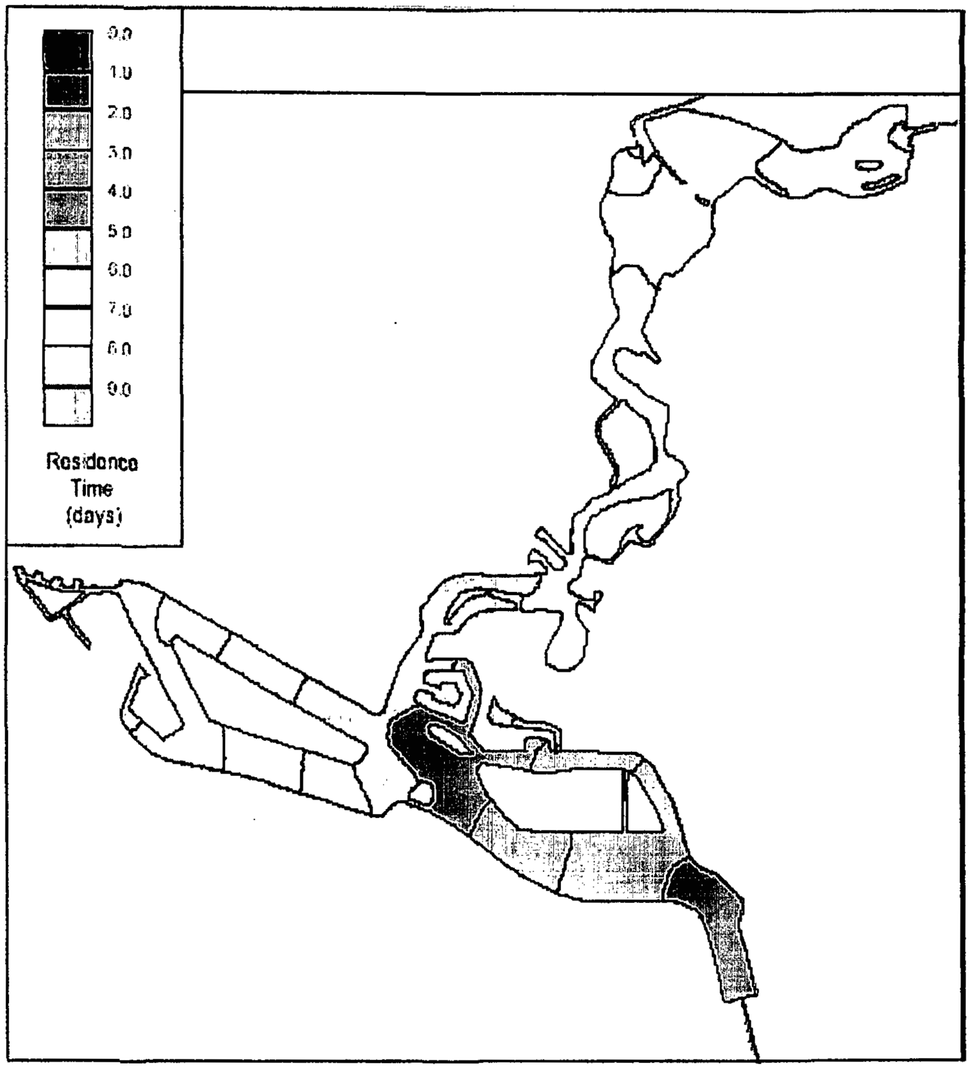


Figure A-5. Residence time for Newport Bay during neap tide conditions. (Source: RMA 2001)

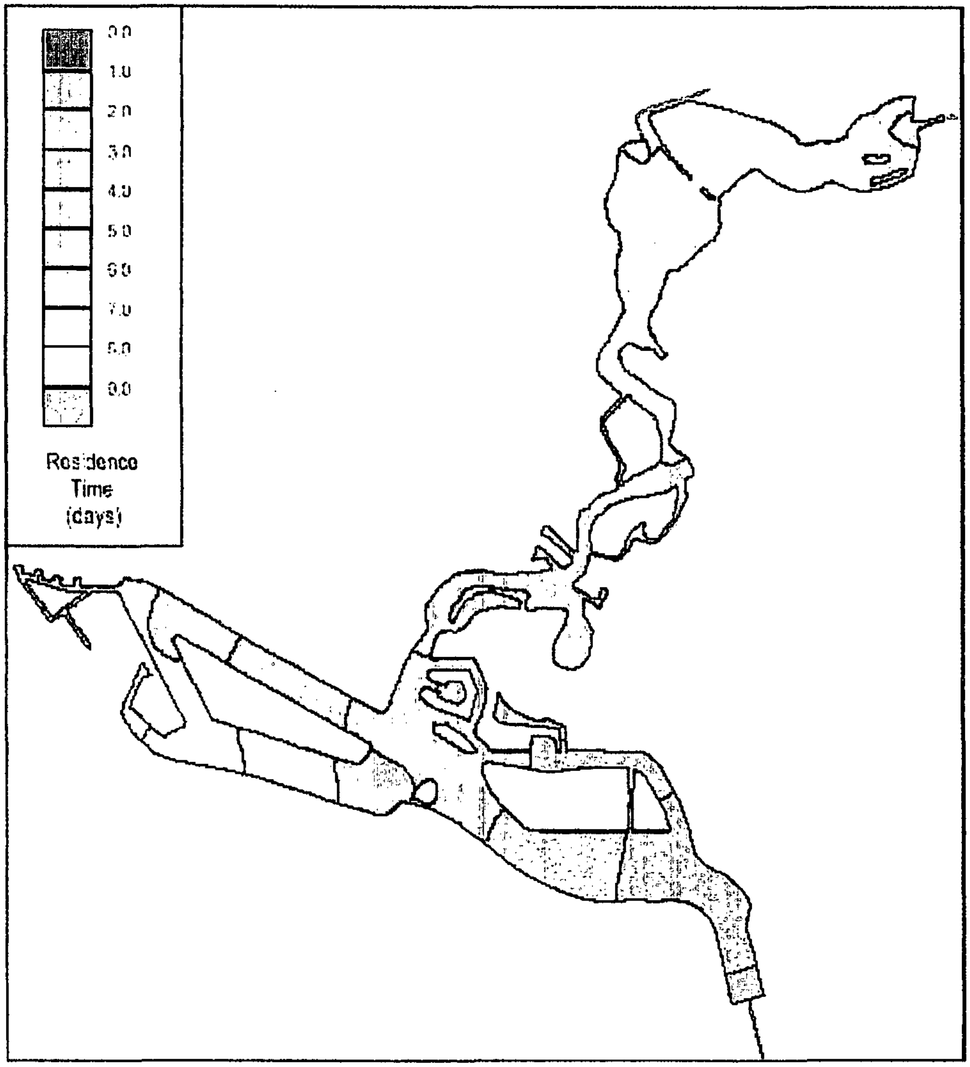
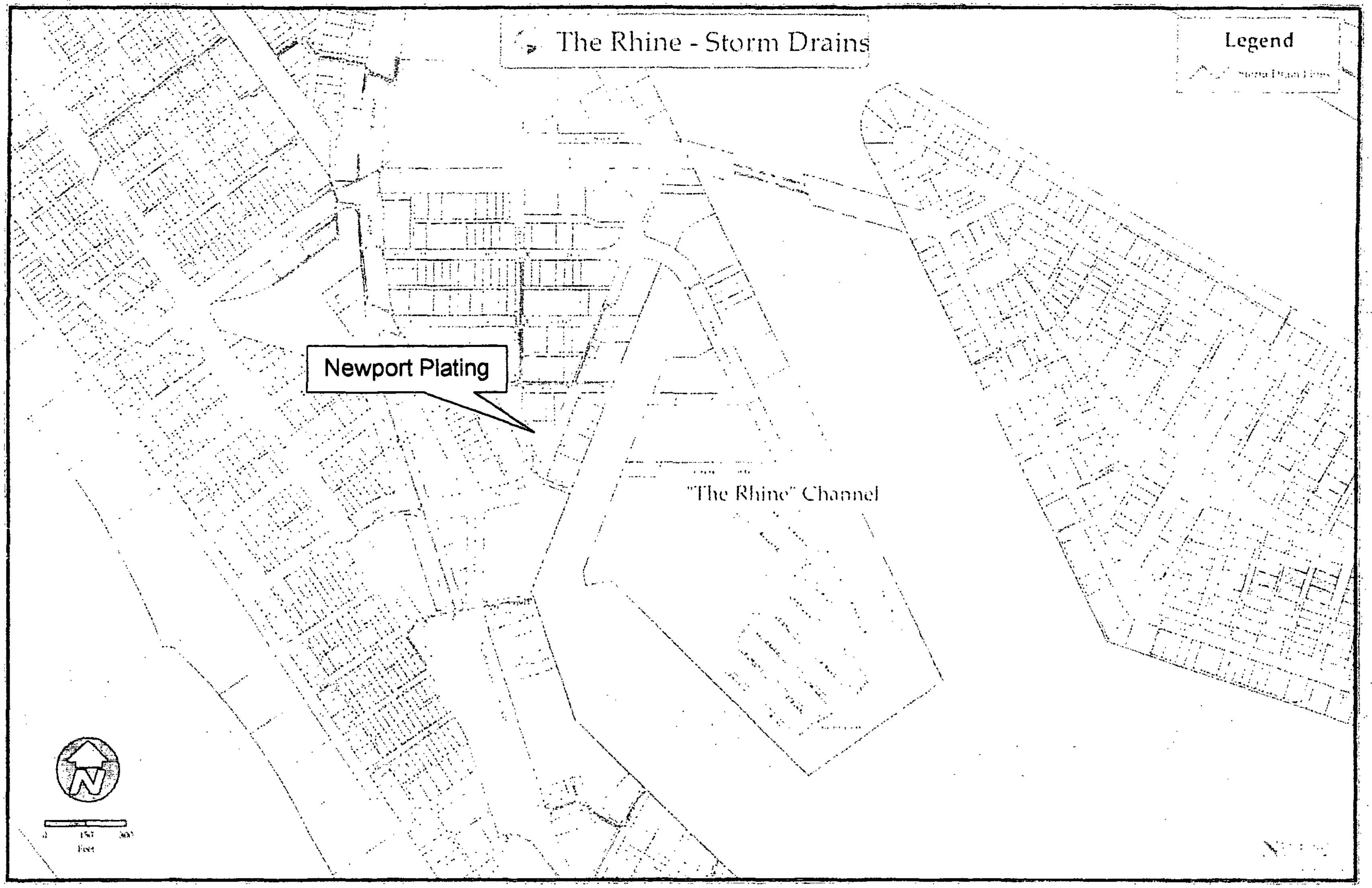


Figure A-6. Residence time for Newport Bay during spring tide conditions. (Source: RMA 2001)


The Rhine - Storm Drains
Legend
Newport Plating
"The Rhine" Channel
Feet

Part B—Freshwater flow and seasonal variation

This Technical Support Document (TSD) provides additional analysis of freshwater flows in San Diego Creek and other tributaries that flow into Newport Bay. This TSD examines rainfall records, daily stream flow rates, flow-based tiers and associated flow volumes, and how hardness is associated with flow rates.

Overview

In the semi-arid climate of Southern California there are two seasons—dry weather occurs during most of the year and intermittent wet weather events occur typically between November and March. This two-season climate creates significant differences in freshwater flow through the creeks and streams. In general, storm events yield both high flow rates and high flow volumes; the vast majority of flow volume occurs during the months of December, January and February. Nonetheless, some storms occur in other months of the year.

EPA Region 9 has evaluated the merits of developing TMDLs for each pollutant (or group of pollutants) by using the seasonal variation approach (i.e., loading determined for wet versus dry weather seasons) or by using a flow-based approach. In the flow-based approach, the continuous range of stream flow that occurs at each target site is broken down into ranges or tiers. This incorporates high flows that may occur outside of the wet season as well as low flows that happen in between rain events. Thus the applicable loading capacity and total allocation for a given pollutant does not depend on the time of year, but on the actual stream flow at the time of discharge. A flow-based approach is used in the TMDLs.

The following discussion concentrates on establishing flow tiers for San Diego Creek, since it is the most significant source of freshwater (and associated pollutants) to Newport Bay. The flow-based approach is applied to Se and metals TMDLs where four flow tiers have been identified: baseflows, small flows, medium flows and large flows. This interpretation of four tiers comes from analysis of nearly twenty years daily flow rate records for San Diego Creek at Campus Drive (USGS and OCPFRD data). For metals, flow rate is indirectly related to measurements of in-stream hardness. The flow-based approach is also applied to the organochlorine, chromium and mercury TMDLs, whereby two tiers were applied: mean flow and high flow. Further details are provided below.

Annual precipitation

Precipitation during a water year (defined from July 1 to June 30) will influence the total flow volume within each freshwater system. Average annual rainfall is 13 inches based on the Tustin/Irvine Ranch rain gage station; a site often used for precipitation analysis within the Newport Bay watershed. During water year 1998, 34.7 inches of rain fell (El Nino conditions), whereas in 1999, 8.6 inches of rain fell. Table B-1 summarizes rainfall records at Tustin/Irvine Ranch from 1958/59 to 2000/01.

Table B-1. Annual Precipitation Records at Tustin-Irvine Ranch Station

Water Year *	Rainfall (inches)	Water Year	Rainfall (inches)	Water Year	Rainfall (inches)	Water Year	Rainfall (inches)
1958-59	5.03	1971-72	5.02	1983-84	10.47	1995-96	11.17
1959-60	9.6	1972-73	14.9	1984-85	10.25	1996-97	16.19
1960-61	4.13	1973-74	9.81	1985-86	14.42	1997-98	34.72
1961-62	13.07	1974-75	12.36	1986-87	8.79	1998-99	8.6
1962-63	5.76	1975-76	5.11	1987-88	11.14	1999-00	8.8
1963-64	9.38	1976-77	10.2	1988-89	8.17	2000-01	14.6
1964-65	10.28	1977-78	27.96	1989-90	5.93	Summary	
1965-66	12.68	1978-79	18.59	1990-91	11.23	Min:	4.13
1966-67	14.22	1979-80	20.75	1991-92	17.18	Max:	34.7
1967-68	8.58	1980-81	8.47	1992-93	27.09	Mean:	13.03
1968-69	19.91	1981-82	13.22	1993-94	10.23	Median:	10.8
1969-70	8.48	1982-83	25.92	1994-95	24.65	Count:	42

*Source: OCPFRD; *Water years run from July 1 to June 30 of the following year.*
Rainfall data for water year 1970-71 not available

Annual flow volumes

Orange County Public Facilities and Resources Department (OCPFRD) has established stream gages at several locations in the Newport Bay watershed. Based on annual flow data from different sites, San Diego Creek is by far the largest freshwater contributor (95%) to Upper Newport Bay and it drains over three-quarters of the entire Newport Bay watershed. The remaining freshwater contributions are from Santa Ana/Delhi Channel (<5%), Costa Mesa Channel (<1%), and Big Canyon Creek (undetermined) and other minor storm drains.

As can be expected, total flow volumes for each stream or tributary are directly related to annual precipitation. For example, the total flow volumes recorded for San Diego Creek at Campus were 90,267 acre-ft. in water year 1997/98 (due to El Nino conditions) and 17,330 acre-ft in water year 1998/99 (due to slightly below normal annual rainfall). Within San Diego Creek, nearly equal flows have been recorded for Peters Canyon Wash (BARSED station) in comparison to San Diego Creek at Culver (WYLSED station), 38% and 35% respectively. Other channels (Lane Channel, Big Canyon, Sand Canyon, etc.) have very limited data and have not been adequately quantified.

Daily Flow Records

Daily flow records for San Diego Creek at Campus (OCPFRD data) reveal a wide range of flow rates. In dry weather baseflows range typically range from 8 to 15 cfs; whereas, in wet weather, daily storm flows can fluctuate between 800 and 9,000 cfs (cubic feet per second). During the El Nino year, San Diego Creek registered the highest momentary peak flow (43,500 cfs on Dec. 6, 1997) in recent history. Records for Santa Ana-Delhi show average dry weather flows between 1 and 2 cfs and daily storm flows ranging from 100 to 1,370 cfs. The momentary peak discharge at Santa-Ana Delhi station for the El Nino season was 6,450 cfs.

EPA and Regional Board staff reviewed San Diego Creek at Campus daily flow records from two sources: USGS, who installed the gaging station in fall 1977 and OCPFRD who took over in fall 1985. We selected daily flow records corresponding to water year records. For example, July 1, 1978 to June 30, 1979 is water year 1979. This approach yielded 19 water year records for San Diego Creek at Campus Dr: three water years by USGS (78/79, 83/84, 84/85) and 16 water years by OCPFRD (1985 to 2001). Incomplete

USGS data for the period 1979/80 to 1982/83 were not used because only partial records were available for each year.

OCPFRD provided comments and alternate analysis of flow tiers based on recent daily flow records and precipitation records (1996 to 2001) for four nearby rainfall stations in the watershed. This analysis was based on four flow tiers as originally proposed in the draft Toxics TMDLs. The maximum base flow was determined to be approximately 20 cfs, based on comparison of rainfall and daily flow data. OCPFRD comments along with their analysis of records for 1996 to 2001 are highlighted here:

- Six years of flow and rainfall records were used (WY 1995/96 – 2000/01) and chosen due to reliability and representative nature of both rainfall and daily flow records over this period. Prior to the mid-1990s, base flows recorded at San Diego Creek at Campus Dr. were generally greater than current conditions. This is likely attributable to greater discharges stemming from nursery and agricultural operations and authorized discharges by Irvine Ranch Water District.
- Flow records were from the San Diego Creek at Campus Drive station. Daily rainfall records were derived from four Automated Local Evaluation in Real Time (ALERT) rainfall stations in the watershed (El-Modena-Irvine at Michelle, Sand Canyon at I-5 freeway, Peters Canyon Wash at Barranca Pkwy., and SDCreek at Culver). ALERT data were preferred over rainfall data from Tustin-Irvine precipitation records since rainfall amounts from ALERT stations more closely corresponded with daily mean flow determinations (12 midnight to 12 midnight).
- These six years of data provide a reliable picture of rainfall and daily flows in that it includes on very wet year (WY 1997/98) and two drier than average years (WY 98/99 and 99/00).
- Four flow tiers were partitioned from daily flow records based on corresponding rainfall data. Small storms correspond to >0″ to 0.24″, medium storms correspond to 0.25 to 0.74″, large storms correspond to >0.75″.
- Rainfall-runoff relationships by their nature are not precise, yet this basic analysis is more robust than methods provided in draft Toxics TMDLs. It is very rare to have daily mean flow above 20 cfs when no precipitation has occurred.

Flow Tiers for Se and Metals TMDLs

EPA and Regional Board staff evaluated daily flow records for 19 water years at San Diego Creek at Campus to determine the flow tiers used in developing Se and metals TMDLs. We utilized the rainfall-runoff information outlined by OCPFRD above and extended the analysis to include all available complete water year records; i.e., water years 1978/79, 1983/1984, 1984/85 and so on up to 2000/01. The rainfall-runoff breakpoints for each flow tier, and the associated percentiles are: base flows (0-20 cfs) correspond to 0″ rainfall (90^{th}%), small flows (21-181 cfs) correspond to <0.25″ rainfall (96^{th}%), medium flows (182-814 cfs) correspond to rainfall between 0.25″ and 0.75″ (99^{th}%), and large storms (>814 cfs) correspond to >0.75″ rainfall.

Flow volumes associated with each tier were calculated by summation of daily flow rates within each tier for all 19 water years. Table B-2 provides summary statistics for each of the flow tiers. Table B-3 provides a synopsis of the mean annual flow volume for each tier and the corresponding hardness values in San Diego Creek.

Table B-2. Flow rate summary statistics for flow tiers
San Diego Creek at Campus Station (1978/79 and 1983/84 to 2000/01 water years)

Flow Tier	Flow Rates (cfs)	Number of Days		Measured Flow Rate Statistics (cfs)				
		Total (days)	Annual Avg (days/year)	Min	Max	Mean	Std	Median
Base Flows	≤ 20	4,557	240	2	20	13.3	3.42	13
Small Flows	> 20 to ≤ 181	2,129	112	20	181	35.9	24.8	28
Medium Flows	> 181 to ≤ 814	198	10.4	182	808	397	170	365
Large Flows	>814	56	2.95	835	9,220	1,841	1,284	1,595
Non-Large Flows	≤814	6,884	362.32	2	808	31.3	71.4	16

Table B-3. Flow based tiers and corresponding hardness values in San Diego Creek.

Flow tier	Corresponding flow rate (cfs)	Mean annual flow volume associated with tier # (million cubic ft.)	Flow rate used to determine hardness	Corresponding Hardness (mg/L)
Base flows	≤ 20	275.4	N/a	400
Small flows	> 20 to ≤ 181	347.5	181	322
Medium flows	> 181 to ≤ 814	357.6	814	236
Large flows	>814	468.8	1595	197

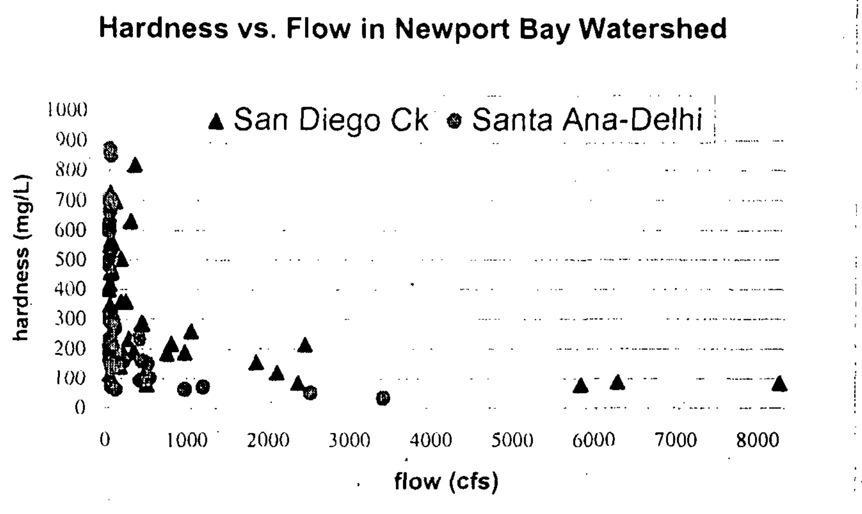
Mean annual volume for each tier based on daily flow records for 19 water years: 1977/78, 83/84 to 00/01 (combination of USGS and OCPFRD data).

Flow rate and Hardness values

To develop metal (Cd, Cu, Pb and Zn) TMDLs, EPA examined monitoring data (OCPFRD 1997 to 2000) collected during high and low flow sampling events to evaluate in-stream hardness values relative to flow rates. The paired data consist of composite samples of hardness results along with the corresponding composite flow rates. An indirect relationship exists between flow rate and hardness such that higher flow rates correspond with lower hardness values, and lower flow rates often have higher hardness values (Figure B-1). Of foremost concern, lower hardness values are associated with lower dissolved metals water criteria. Thus when storm events occur, flow rates are high, hardness is low and the correspondingly low dissolved metals criteria are most likely to be exceeded in freshwater systems.

The paired data show relatively high hardness values are observed during lower flows; in fact these values are often above 400 mg/L. However, for base flows, EPA used the maximum hardness value (400 mg/L) as allowed in CTR (USEPA 2000). To determine the hardness value associated with small, medium and large flow tiers, EPA used a linearization technique to transpose observed flow rates to the corresponding hardness values. (Hardness vs. natural log (flow rate) yields a linear relationship.) For the small and medium flows EPA selected the highest flow value within this tier to determine the corresponding hardness value. For large flows, EPA reviewed daily flow rates for 4-consecutive days and used the highest (4 day) mean flow rate to determine the corresponding hardness value. (See example for copper below.)

Figure B-1. Hardness vs. flow rate for two freshwater streams. (OCPFRD data)



Note: Linear equation for hardness and flow at San Diego Creek: $y = -57.742 (\ln[x]) + 622.5$
(Linear equation for Santa Ana Delhi Channel: $y = -102.43 (\ln[x]) + 713.41$)

Here is an explanation of the sequence of steps to determine metals criteria associated with each flow tier. We use small flow tier and dissolved copper criteria as an example.

1. Range of flow is 21 to 181 cfs. Choose highest flow rate within the tier = 181 cfs.
2. Use linear equation to find corresponding hardness value....start with natural log (flow rate)
3. For SDCreek, hardness = -57.742 (ln [flow])+ 622.5
4. Use this hardness value (322 mg/L as $CaCO_3$) in CTR equations to determine acute and chronic criteria for each metal.
5. Dissolved chronic Copper criteria = e(0.8545[ln(hardness)]-1.702)*0.96 =24.3 ug/L

Determination of dissolved metal numeric targets based on hardness

Once, the hardness value for each flow tier was determined, the dissolved metal numeric targets were based on (water quality criteria) equations presented in CTR (USEPA 2000). The hardness value for each flow tier yielded two possible dissolved numeric targets—the acute value and thechronic value. The acute value applies to one-day exposures, whereas the chronic value applies to exposures lasting 4-consecutive days. EPA reviewed daily flow records during the same 19 water years described above and observed that elevated flows (>181cfs) occur for 4-consecutive days or longer. This happens repeatedly within a water year (e.g., four times in WY 1997/98) as well as over the 19 years of daily flow records. Therefore, EPA selected both acute and chronic water quality criteria within base, small and medium flow tiers to serve as numeric targets for dissolved metals in San Diego Creek.

Similar methods of flow analysis were applied to daily flow records for Santa Ana Delhi Channel, however the time span covered only six water years: 1995/96 to 2000/01. Breakpoints in flow rates for Santa Ana Delhi were determined via similar percentages as those used for San Diego Creek: 90%, 96% and 99%. Table B-4 show corresponding flow rates, associated flow volumes, and hardness values for each flow tier.

Table B-4. Flow based tiers and corresponding hardness values in Santa Ana Delhi Channel.

Flow tier	Corresponding flow rate (cfs)	Flow volume associated with tier # (million cubic ft.)	Flow rate used to determine hardness	Corresponding Hardness (mg/L)
Base flows	0 – 3.5	49.3	N/a	400
Small flows	3.6 – 39	47.1	39	338
Medium flows	39.1 - 165	22.3	165	190
Large flows	>165	118.7	329	120

mean volume for each tier based on daily flow records for 6 water years: 1995/96 to 00/01 (OCPFRD data); chronic conditions for base, small, and medium flows, and acute for large flows

Flow Tiers for Organochlorine TMDLs

For the organochlorine TMDLs, we evaluated daily flow records for San Diego Creek at Campus Dr. We utilized the same 19 water year records as described above (USGS and OCPFRD database). Three flow tiers were defined to accommodate the range of flows: low flow (base and small flows), medium flow and high flow. The low flow rate (15 cfs) was determined from median value of all flow records < 181 cfs. The medium flow rate (365 cfs)was determined from the median value of flows between 181 and 814 cfs. The high flow rate was the median value (1595 cfs) within the large flows >814 cfs. For calculations of total annual flow and consequently the annual loads, the low flow rate was applied for 352 days, the medium flow rate for 10 days and the high flow rate for 3 days. Direct application of these three flow tiers was used to estimate loading capacity and existing loads of organochlorines within San Diego Creek only. More information can be found in Technical Support Document – Part F.

Part C—Organophosphate (OP) Pesticides

Introduction

This technical support document (TSD) provides additional information relevant to the development of the chlorpyrifos and diazinon TMDLs described in the TMDL summary document. In this TSD, Section I describes physical and chemical properties as well as the environmental fate of chlorpyrifos and diazinon. Section II follows with a usage analysis. Section III gives a summary of the monitoring data collected to date and an analysis of the major sources of chlorpyrifos and diazinon to San Diego Creek and Upper Newport Bay. Section IV presents calculations of current load estimates.

The source analysis focuses on water column concentrations, as these were associated with aquatic life toxicity and impairment of beneficial uses in San Diego Creek and Upper Newport Bay. Several investigations have been conducted in the watershed to characterize aquatic life toxicity associated with pesticides. These studies were not detailed enough to identify discrete sources; however, it is clear that diazinon and chlorpyrifos discharges are associated with nonpoint source runoff from areas where these pesticides are applied.

A large portion of information presented in this Technical Support Document was extracted from the OP Pesticide DRAFT TMDL written by Regional Board staff (2001a).

I. Physicochemical properties and environmental fate

The environmental fate of chlorpyrifos and diazinon can be inferred from their physical properties. Table C-1 presents properties for diazinon and chlorpyrifos along with several other pesticides that occasionally contribute to the aquatic life toxicity in San Diego Creek. In general, diazinon and chlorpyrifos are a more significant water quality threat because of the combined properties of higher toxicity, mobility, and persistence. Carbaryl for example, is mobile but less toxic and less persistent than diazinon and chlorpyrifos.

Table C-1. Pesticide properties

Pesticide	Ceriodaphnia LC 50 (ng/L)	Solubility (mg/L)	Adsorption coefficient	Soil half-life	Water half-life
Bifenthrin	78	0.1	1,000,000	7 days to 8 mos.	n/a
Carbaryl	3,380	40	300	7-28 days	10 days
Chlorpyrifos	60	2	6070	2-4 months	1-2.5 months
Diazinon	440	40	1000	2-4 weeks	6 months
DDT	4,700	<1	100,000	2-15 years	1-2 months
Malathion	1,140	130	2.75	1-25 days	< 1 week

Source: EXTOXNET Pesticide Information Profiles; CDFG (2000)
n/a=not available

Relative to most pesticides, diazinon is fairly soluble and mobile in aquatic systems. It is only weakly bound by sediment. In contrast, chlorpyrifos is much less soluble and has a much higher potential to adsorb to soil and sediment.

Diazinon
In general, diazinon is relatively persistent in aquatic environments with a half-life of about six-months under neutral pH conditions. The pH of the channel network in the Newport Bay watershed is generally between 7.5 and 8, a range that would maintain the stability of diazinon. In soil, the diazinon half life is shorter owing to greater microbial degradation.

For diazinon, the major routes for dissipation appear to be biodegradation , volatilization, and photolysis (USEPA 1999a). Degradation is fastest from bare soil, followed by vegetation, and aquatic environments. Biodegradation from impervious urban areas (walkways, pavement) would be slowest due to the relative absence of microbes. This indicates that diazinon may accumulate in residential areas until rainfall runoff carries it into the drainage channel network. In a residential runoff survey conducted in the Castro Valley Creek watershed, diazinon was found in all samples as long as seven weeks after application.

Diazinon dissipation half-lives did not appear to be correlated with formulation type (granular, wettable powder, or emulsifiable concentrate). The reported diazinon formulations in Orange County for 1999 are listed in Table C-2. The liquid formulations are likely to be the most mobile as they are already in soluble form. The granules would likely remain available until a storm event washed the remaining active ingredient into the storm drains.

Table C-2. Diazinon Formulations for Reported Uses in Orange County, 1999

Formulation	Use (lbs. ai)	Percent
Emulsifiable concentrate	14,776	60.4%
Granular/Flake	4675	19.1
Wettable Powder	2720	11.1
Flowable Concentration	1969	8.1
Liquid Concentration	275	1.1
Dust/Powder	36.8	0.2
Pressurized Liquid/Sprays/Foggers	0.465	0
Solution/Liquid (Ready to use)	0.184	0
Total	24,452	100%

ai =active ingredient

Regardless of the formulation used, runoff is likely to occur only after significant rainfall or irrigation. Aside from runoff, a potentially significant discharge could occur through improper disposal of old or leftover material. The degree of knowledge concerning proper disposal varies considerably and it is unlikely that homeowners apply the exact amount needed in a manner that does not cause runoff.

Large-scale aerial spray applications may drift and result in significant offsite migration. These are generally applied to orchard crops in the Central Valley and, as Table C-2 shows, they are not a significant application in Orange County.

There is evidence that the amount of diazinon in a watershed that reaches a receiving waterbody is generally less than one percent of that applied (Scanlin and Feng 1997). Thus, relatively limited instances of improper use (e.g. inappropriate disposal, excess outdoor application) could account for a large portion of the observed concentrations in the drainage channels.

Chlorpyrifos

Compared to diazinon, chlorpyrifos has a shorter half-life in water, but a longer half-life in soil. This is due in part to its higher adsorption coefficient, which results in chlorpyrifos partitioning out of the aquatic phase as it is bound by sediment and soil.

Table C-3 shows the chlorpyrifos formulations used in Orange County in 1999. As with diazinon, concentrates, powders, and granular/flake formulations account for over 99% of the uses. These formulations require mixing/preparation prior to use.

Table C-3. Chlorpyrifos Formulations used in Orange County, 1999

Formulation	Use (lbs. ai)	Percent
Emulsifiable concentrate	70,067	87.6%
Granular/Flake	6571	8.2
Wettable Powder	2281	2.9
Flowable Concentration	996	1.2
Liquid Concentration	38.1	0
Dust/Powder	35.1	0
Pressurized Liquid/Sprays/Foggers	1.58	0
Solution/Liquid (Ready to use)	0.103	0
Total	79,990	100%

ai = active ingredient

Of the top four formulations used in Orange County, only the granular/flake formulation would act to slowly release the active ingredient into the water, while the other formulations would enhance mobility. The lower release rate would result in lower concentrations over time.

Dissipation of chlorpyrifos from water takes place through sorption, volatilization, and photolysis. Chemical breakdown (hydrolysis) rates increase with increasing temperature and pH. Adsorbed chlorpyrifos is subject to degradation by UV light, chemical hydrolysis, and biodegradation.

II. Pesticide Usage

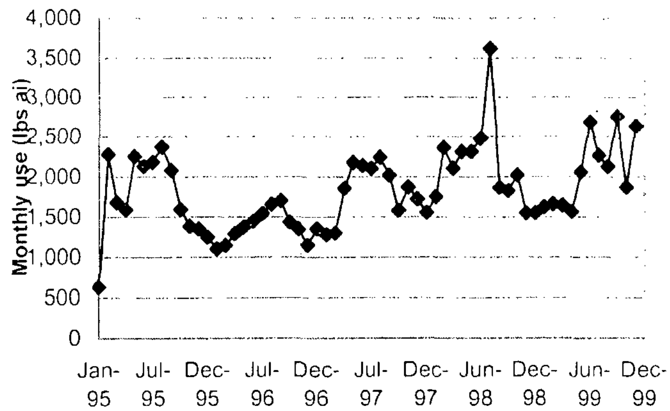
The CDPR requires records of all pesticide applications except for residential use by homeowners. These records are compiled and reported on a county-by-county basis. The Newport Bay watershed occupies 20% of Orange County, and it is assumed here that 20% of the pesticide use reported for Orange County occurred within the Newport Bay watershed.

Diazinon

As shown in Figure C-1, reported diazinon use in Orange County has remained fairly steady over the past five years. Seasonally correlated increases in diazinon use are apparent in the summer months in response to increased pest activity.

As noted above, residential use by homeowners is not reported in the CDPR database. Information on national pesticide usage by homeowners is available from the USEPA Pesticide Industry Sales and Usage Market Estimates report. On a national basis, 75% of the diazinon used in the US each year is for non-agricultural purposes, with 39% used by homeowners outdoors and 3% used by homeowners indoors (USEPA 1999b). Total homeowner use is therefore about 42% on a national basis.

Figure C-1: Reported Diazinon Use Orange County: 1995-1999



In Orange County, the total agricultural use is likely less than the national average due to urbanization of the watershed. Thus homeowner uses probably account for more than the 42% reported nationally. A more specific estimate of the unreported homeowner use can be obtained by assuming the national ratio of homeowner use to total non-agricultural use (42/75, or 56%) is applicable to Orange County. Since data on the total non-agricultural diazinon use in Orange County is reported to the CDPR on a yearly basis, the national ratio can be used to estimate the unreported homeowner use in Orange County. Estimating the unreported homeowner use at 56% of total non-agricultural use results in a figure of 29,119 lbs. active ingredient (ai) for 1999. This would amount to 54% of total use (including agricultural use) in Orange County; somewhat higher than the national figure of 42% reported by USEPA.

Tables C-4 and C-5 present the reported and estimated unreported diazinon use in Orange County. For 1999, the total diazinon use in the Newport Bay watershed would be one-fifth of the Orange County total, or approximately 10,714 lbs. ai, while the estimated residential use would be about 5,824 lbs. ai.

Table C-5 indicates that urban uses accounted for over 97% of diazinon use, while agricultural uses (including nurseries) accounted for the remainder. Data from the Sales and Use Survey in the Newport Bay watershed (Wilen 2001) indicate that unreported residential diazinon use in 2000 was about 7,864 lbs. ai; about 32% larger than the estimate of 5,919 lbs. presented above using separate national data. This would suggest that total urban uses account for more than the 97% indicated in Table C-5.

Table C-4: Reported and Estimated Diazinon Use
Orange County: 1995-1999 (lbs. ai)

Use	1995	1996	1997	1998	1999
Structural	17,463	14,046	18,892	23,076	22,085
Nursery	1,037	839	803	1,212	1,144
Agriculture	2,004	746	1,363	865	429
Landscape	1,030	762	595	612	789
Other non-residential	9.8	46.2	1.6	1.7	5.3
Reported subtotal	21,543	16,439	21,655	25,766	24,452
Estimated Unreported Residential Use	23,548	18,905	24,804	30,150	29,119
Total	45,092	35,344	46,458	55,915	53,571

ai = active ingredient

Tables C-4 and C-5 show a decline in agriculture use from 1995 to 1999, both in absolute and percentage terms. The land use data also show a similar pattern, and the decline in agricultural diazinon usage may be a reflection of the continuing conversion of agricultural land to urban uses in Orange County and the Newport Bay watershed.

Table C-5: Reported and Estimated Diazinon Use
Orange County: 1995-1999 (percent)

Use	1995	1996	1997	1998	1999
Structural	38.7%	39.7%	40.7%	41.3%	41.2%
Nursery	2.3%	2.4%	1.7%	2.2%	2.1%
Agriculture	4.4%	2.1%	2.9%	1.5%	0.8%
Landscape	2.3%	2.2%	1.3%	1.1%	1.5%
Other non-residential	0.0%	0.1%	0.0%	0.0%	0.0%
Estimated Residential	52%	53%	53%	54%	54%
Total	100%	100%	100%	100%	100%

USEPA Phaseout of Certain Diazinon Uses

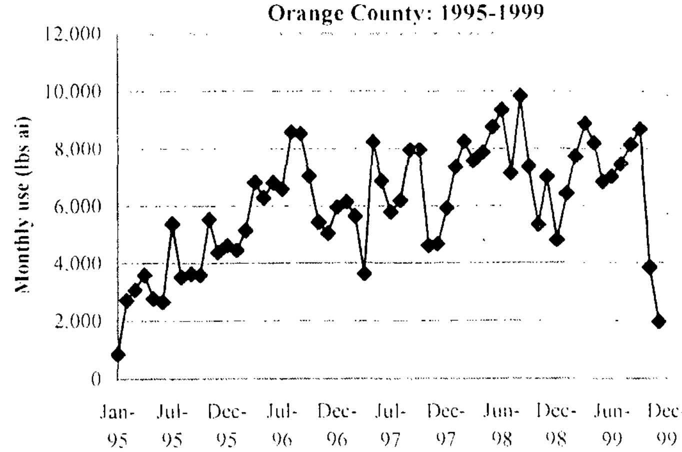
In January 2001, USEPA released a revised risk assessment and an agreement with registrants to phase out most diazinon uses (USEPA 2001b). Under the agreement, all indoor uses will be terminated, and all outdoor non-agricultural uses will be phased out over the next few years. Indoor uses will be banned after December 31, 2002. The EPA expects that these actions will end about 75% of the current use of diazinon. In addition, on a national basis, about one-third of the agricultural crop uses will be removed. For the San Diego Creek/Newport Bay watershed, the percentage reduction in agricultural usage will be higher (ca. 55%) due to the particular crops that are grown in the watershed.

The usage data in Table C-5 show that non-agricultural and non-nursery uses account for over 90% of the diazinon use in Orange County. It is thus likely that the EPA agreement will result in the cessation of most diazinon use in the Newport Bay watershed soon after the outdoor non-agricultural use registration expires on December 31, 2004.

Chlorpyrifos

Figure C-2 shows the reported chlorpyrifos use in Orange County from 1995 to 1999. As with diazinon, higher use tends to occur in the dry season, and is likely correlated with increased pest activity during warmer weather. An increasing trend from 1995 to 1998 is apparent followed by a sharp drop in 1999. This drop may be due to the agreement between EPA and the manufacturers to begin phasing out certain uses of chlorpyrifos (see below).

Fig C-2: Reported Chlorpyrifos Use
Orange County: 1995-1999



Tables C-6 and C-7 show the reported and estimated unreported chlorpyrifos use in Orange County. While overall chlorpyrifos use declined in 1999, nursery use increased by 300 percent. The significant increase in chlorpyrifos use by nurseries is likely due to the requirements imposed by the CDFA under the Red Imported Fire Ant (RIFA) program. Runoff of the solution from the treatment area is not permitted (CDFA 1999).

Table C-6: Reported and Estimated Chlorpyrifos Use Orange County: 1995-1999 (lbs. ai)

Use	1995	1996	1997	1998	1999
Structural	38,263	72,174	69,865	88,985	74,904
Nursery	652	772	971	994	2,913
Agriculture	1,414	952	1,450	645	1,132
Landscape	1,446	1,230	1,374	1.082	1,005
Other non-residential	7	268.5	1.6	1.6	35.3
Reported subtotal	41,782	75,396	73,662	91,707	79,990
Estimated Residential	21,663	40,185	38,859	49,128	41,424
Total	63,445	115,580	112,520	140,835	121,414

ai = active ingredient

Unreported (residential) chlorpyrifos use can be estimated by determining the national ratio of unreported home use to licensed (non-agricultural) use as reported in the USEPA Market Estimates Report (USEPA 1999b). Nationally, in 1995/96, the residential use was estimated at 2-4 million lbs. ai, while the licensed (non-agricultural) use was estimated at 4-7 million lbs. ai. Using the midpoints of these ranges, the ratio of residential use to licensed non-agricultural use is 0.545 on a national basis. Applying this ratio to the licensed non-agricultural use in Orange County reported to the CDPR for 1999 (75,944 lbs. ai) yields an estimate of 41,424 lbs. ai unreported residential use (Table C-6). This indicates that the unreported residential use was roughly 34% of the total use in 1999 (Table C-7). Total chlorpyrifos use in the Newport Bay watershed for 1999 would be approximately 24,300 lbs. ai (one-fifth of the Orange County total).

Data from the Sales and Use Survey (Wilen 2001) indicates that retail sales of chlorpyrifos in the Newport Bay watershed may have declined to as little as 546 lbs. ai on an annual basis in 2000. This compares to the estimated residential use of 8,285 lbs. ai (one-fifth of the Orange County total) presented in Table C-6 for 1999. The decline in chlorpyrifos use appears to be a continuation of the trend shown in Figure C-2 toward the end of 1999, and is likely related to the re-registration agreement for chlorpyrifos (see below).

Table C-7: Reported and Estimated Chlorpyrifos Use Orange County: 1995-1999 (percent)

Use	1995	1996	1997	1998	1999
Structural	59.2%	61.9%	61.3%	62.7%	60.6%
Nursery	1.0%	0.7%	0.9%	0.7%	2.4%
Agriculture	2.2%	0.8%	1.3%	0.5%	0.9%
Landscape	2.2%	1.1%	1.2%	0.8%	0.8%
Other non-residential	0.0%	0.2%	0.0%	0.0%	0.0%
Reported subtotal	66%	65%	65%	65%	66%
Estimated Unreported Residential Use	34%	35%	35%	35%	34%
Total	100%	100%	100%	100%	100%

An analysis of chlorpyrifos sales data provided by Dow AgroSciences indicates that treatment for wood protection accounts for 70% of urban use (Giesy et al. 1998). Typical applications involve subsurface injection of chlorpyrifos at relatively high concentrations. Another 14% of urban use was categorized as home use (indoor pests, pet collars, lawns and gardens, building foundations, and other structural applications), while non-residential turf applications accounted for 7% of urban use.

USEPA Phaseout of Certain Chlorpyrifos Uses

In June 2000, the EPA published its revised risk assessment and agreement with registrants for chlorpyrifos (USEPA 2000b). The agreement imposes new restrictions on chlorpyrifos use in agriculture, cancels or phases out nearly all indoor and outdoor residential uses, and also cancels non-residential uses where children may be exposed. Application rates for non-residential areas where children will not be exposed (golf courses, road medians, industrial plant sites) will be reduced. Public health use for fire ant eradication and mosquito control will be restricted to professionals. Non-structural wood treatments will continue at current rates. Since the EPA estimates that about 50% of the chlorpyrifos use (both licensed and unreported) takes place at residential sites, the agreement is likely to result in at least a 50% decrease in chlorpyrifos use.

In Orange County, residential use (reported and unreported) likely accounts for over 90% of total chlorpyrifos use (most of the reported use is for structural protection applied in and around homes). Thus, it appears that over 90% of the current chlorpyrifos use in the Newport Bay watershed will be eliminated by the EPA agreement. Retail sales are scheduled to stop by December 31, 2001, and structural uses will be phased out by December 31, 2005.

As noted above, the CDPR data, and the Sales and Use Survey data (Wilen 2001) indicate that chlorpyrifos use has been declining sharply within the last two years. This is likely due to the warning from EPA that retailers should not purchase stock unless they were able to sell it by December 31, 2001. A survey conducted in northern California in late 2000 noted, " Chlorpyrifos products have become increasingly difficult to find" (TDC Environmental 2001). It should be noted that the available water-quality data for the Newport Bay watershed, is largely from 1996-2000, and not directly correlated to the latest usage data from 2000-2001.

III. Source Analysis

This section presents an analysis of the sources of diazinon and chlorpyrifos in the Newport Bay Watershed. Each chemical summary includes monitoring data and a discussion of diazinon and chlorpyrifos sources categorized by land use. Point sources and non-point sources are also discussed in a separate section.

Diazinon Data Summary

Table C-8 summarizes the results of diazinon sampling in the Newport Bay watershed. The sampling programs are described in Section 2. The table shows the high diazinon detection frequency, particularly during stormflow. The observed diazinon concentrations are similar to those observed in urban watersheds elsewhere in California. The mean values for both baseflow and stormflow exceeded the chonic numeric target, while 86% of the diazinon concentrations observed in the watershed drainage channels exceeded the acute numeric target.

Table C-8. Summary of Diazinon Sampling Results

Source	Count	# of Detects	Det. Freq.	Min.	Max.	Mean	Median
Water Samples (ng/L)							
Drainage Channels (All Flows)	198	185	93%	<40	10,000	471	220
Baseflow	104	93	89%	<40	10,000	473	160
Stormflow	94	92	98%	<50	7990	451	357
Upper Newport Bay	26	26	100%	197	720	386	357
Rainfall	1	1	--	--	13	--	--
Sediment Samples (ug/kg)							
Drainage Channels	98	2	2%	<10	49	--	--
Newport Bay	64	2	3%	<0.4	60	--	--

Freshwater Numeric Targets: acute = 80 ng/L; chronic = 50 ng/L (CDFG 2000a)

For comparison, the median diazinon concentration in the Santa Ana River downstream of Prado dam was 100 ng/L (USGS 2000), and the detection frequency was 99% (72 of 73 samples). The USGS also reported stormflow concentrations as significantly elevated relative to baseflow concentrations.

The low detection frequency for the sediment samples is in accordance with the moderately low diazinon adsorption coefficient, and its relatively high solubility. All the sediment detections were reported from samples collected in 1994, and diazinon has not been detected in subsequent semi-annual sediment sampling.

Table C-9 presents the data summarized by waterbody group. Highest concentrations occur in the upstream tributary channels to San Diego Creek. The maximum concentrations collected in 1998 from Hines Channel (which drains to Peters Canyon Channel) were three baseflow samples with concentration ranging from 2,500 to 10,000 ng/L. The maximum concentration of six baseflow samples collected in Hines channel during 2000, was 323 ng/L, indicating either a decrease in usage or more effective runoff control.

Table C-9: Diazinon Results by Waterbody Group

Waterbody	Count	Results (ng/L)				Exceedances	
		Min	Max	Mean	Median	Above acute	Above chronic
Tributaries to SDC Reach 2	24	40	7,990	817	256	96%	92%
Tributaries to SDC Reach 1	21	49	628	226	134	86%	67%
Tributaries to P CC	41	40	10,000	791	271	83%	78%
Peters Canyon Channel	15	170	820	390	367	100%	100%
SDC Reach 1	59	50	960	301	215	95%	92%
Tributaries to UNB	35	40	2,250	357	202	94%	91%

SDC=San Diego Creek; PCC=Peters Canyon Channel; UNB=Upper Newport Bay
Freshwater Numeric Targets: acute = 80 ng/L; chronic = 50 ng/L

The similarity in median concentrations indicates that there are no clearly dominant areas of the watershed with regard to diazinon loading to San Diego Creek and Upper Newport Bay. Concentrations in Peters Canyon Channel are somewhat elevated relative to the other segments of the drainage network. This was also a conclusion of the 319h study (Lee and Taylor 2001a)

San Diego Creek Reach 2: There were no sampling stations within Reach 2 of San Diego Creek. However, 24 samples were collected from tributary channels (Bee Canyon and Marshburn Slough). These samples were collected several miles upstream of where these channels join San Diego Creek and were mainly targeted at monitoring nursery discharges. The median concentration for these samples was 256 ng/L, with maximum concentrations of 7,990 ng/L during stormflow and 2,320 ng/L during baseflow. Over 90% of the observed concentrations exceeded the acute and chronic numeric targets.

San Diego Creek Reach 1: The main tributary to San Diego Creek Reach 1, (aside from Reach 2), is Peters Canyon Channel. Median diazinon concentrations in Peters Canyon Channel (367 ng/L) were higher than in San Diego Creek (208 ng/L). The median concentration for other tributaries to San Diego Creek was 143 ng/L. All 15 samples collected within Peters Canyon Channel exceeded both the acute and chronic numeric targets, while in the tributaries to Peters Canyon Channel, the percentages exceeding the acute and chronic numeric targets were lower, 78% and 83% respectively. Over 90% of the observed concentrations within Reach 1 exceeded the acute and chronic numeric targets.

Upper Newport Bay: The median concentration for drainage channels discharging directly to Upper Newport Bay (East Costa Mesa, Westcliff Park, Santa Ana Delhi) was 202 ng/L. The CDFG has not recommended criteria for diazinon in saltwater, however, the LC-50 for the commonly used test species (*Mysidopsis bahia*) is 4,200 ng/L, and the observed diazinon concentrations were all below this level, with a maximum of 720 ng/L. The USEPA (2000a) has published draft recommended acute and chronic criteria for diazinon in saltwater (820 ng/L and 400 ng/L respectively). The maximum and average results from Upper Newport Bay were below the respective draft USEPA saltwater CMC and CCC.

Diazinon Sources Categorized by Land Use

Tables C-10a and C-10b present the diazinon results by sampling location along with the land use pattern in the monitored sub-watershed. The locations in Table C-10a are sorted according to median stormwater runoff concentration, while in Table C-10b, they are sorted according to median baseflow concentration. Several of the locations were sampled for only baseflow or only stormflow conditions.

Table C-10a: Land Use and Diazinon Stormflow Concentrations
Newport Bay Watershed: 1996-2000

Station	Land Use	Count	Stormflow Results (ng/L)			
			Min	Max	Avg.	Median
Bonita Creek at San Diego Creek	Residential	7	69	628	424	456
Central Irvine Channel - Monroe	Ag-Residential	2	90	810	545	545
Drain at Bee Canyon and Portola Pkwy.	Nursery	7	126	7,990	1,625	599
East Costa Mesa Channel - Highland Dr.	Residential	2	370	560	465	465
El Modena-Irvine Channel upstream of Peters Canyon Channel	Residential	1	330	330	330	330
Hines Channel - Irvine Blvd.	Ag-Nursery	9	199	810	455	324
Marshburn Slough - Irvine Blvd.	Nursery	7	96	291	168	136
Peters Canyon Channel - Barranca	Mixed	10	202	426	321	309
San Diego Creek - Campus Dr.	Mixed	25	96	960	445	375
San Diego Creek - Harvard Av.	Mixed	2	200	280	240	240
San Joaquin Creek - Univ Dr.	Agricultural-Open	2	<50	<50	<50	<50
Sand Canyon Ave - NE corner Irvine Blvd.	Agricultural	2	70	110	90	90
Santa Ana Delhi Channel - Mesa Dr.	Residential-Urban	10	64	375	171	174
Westcliff Park	Residential	7	174	1,079	692	678

At virtually all the locations, the median stormflow concentration is significantly higher than the median baseflow concentration. Since stormwater runoff constitutes about 80% of the volume of water discharged to Newport Bay on an annual basis, this would indicate that the overwhelming majority of the pesticide load would derive from stormflow rather than baseflow. The average concentration is actually higher for baseflow, but this is biased by a few very high detections from 1998 near nurseries. These results have not been observed in later sampling and the nurseries have subsequently instituted measures targeted at reducing pesticide runoff.

Although the sampling network is not detailed enough to identify individual sources (aside from nurseries), two conclusions are apparent:

(1) Stormflow concentrations are virtually always higher than baseflow concentrations. This is particularly the case in the non-agricultural areas.
(2) Residential areas tend to yield the highest stormwater runoff concentrations while the nursery areas tend to yield the higher baseflow concentrations.

Studies reported in the literature indicate that residential hotspots (individual homes) can account for most of the diazinon runoff from a neighborhood. Samples collected from the near vicinity of these residential hotspots (prior to dilution in the storm drain), showed concentrations above 10,000 ng/L (Scanlin and Feng 1997). Such detailed sampling and analysis for pesticides has not been completed in residential areas of the Newport Bay watershed. The residential run-off reduction study is currently in progress but results were not available for these TMDLs.

Table C-10b: Land Use and Diazinon Baseflow Concentrations
Newport Bay Watershed: 1996-2000

Station	Land Use	Count	Baseflow Results (ng/L)			
			Min	Max	Avg.	Median
Bonita Creek at San Diego Creek	Residential	12	49	332	139	114
Central Irvine Channel - Bryan St	Ag-Residential	5	117	1,940	722	570
Central Irvine Channel - Monroe	Ag-Residential	2	90	840	465	465
Drain at Bee Canyon and Portola Pkwy.	Nursery	7	93	2,320	977	637
East Costa Mesa Channel - Highland Dr.	Residential	1	210	210	210	210
El Modena	Nursery	3	<40	310	146	87
El Modena-Irvine Channel upstream of Peters Canyon Channel	Residential	1	180	180	180	180
Hines at Weir	Nursery	5	<40	45	41	<40
Hines Channel - Irvine Blvd.	Ag-Nursery	10	47	10,000	2,129	862
Marshburn Slough - Irvine Blvd.	Nursery	1	<40	<40	<40	<40
Peters Canyon Channel - Barranca	Mixed	4	170	820	533	570
San Diego Creek - Campus Dr.	Mixed	28	<50	570	200	160
San Diego Creek - Coronado St.	Mixed	2	94	365	230	230
San Diego Creek - Harvard Av.	Mixed	2	<50	<50	<50	<50
Santa Ana Delhi Channel - Mesa Dr.	Residential-Urban	6	<50	340	149	125
Westcliff Park	Residential	9	<40	2,250	432	215

Chlorpyrifos Data Summary

Table C-11 summarizes the chlorpyrifos results. The detection frequency is lower than for diazinon. This is due in part, to the lower solubility of chlorpyrifos, and its greater affinity for sediment (Table C-1). As discussed in Section I, the lower mobility of chlorpyrifos results in lower concentrations in the drainage channels, despite the fact that over twice as much chlorpyrifos is applied as compared to diazinon (lbs. ai) (Tables C-4 and C-6),

The average values for stormflow and baseflow exceed the chronic numeric targets. Within the drainage channels, 44% of the chlorpyrifos results exceeded the freshwater chronic target (14 ng/L), while 92% of the samples collected in Upper Newport Bay were over the saltwater chronic target (9 ng/L).

Table C-11. Summary of Chlorpyrifos Sampling Results

Source	Count	# of Detects	Det. Freq	Min.	Max.	Mean	Median
Water (ng/L)							
Drainage Channels (All flows)	198	89	45%	ND	770	139	<50
Baseflow	104	36	35%	ND	670	162	<40
Stormflow	94	53	56%	ND	770	123	50
Upper Newport Bay	24	24	100%	2	132	43.3	41.5
Rainfall	1	1	--	--	23	--	--
Sediment (ug/kg)							
Drainage Channels	2	2	100%	17	29	--	--

Freshwater Numeric Targets: acute = 20 ng/L; chronic = 14 ng/L (CDFG 2000a)
Saltwater Numeric Targets: acute = 20 ng/L; chronic = 9 ng/L (CDFG 2000a)

The sediment data for chlorpyrifos is reflective of the higher soil adsorption coefficient relative to diazinon. Although chlorpyrifos analyses were not presented in the OCPFRD data, chlorpyrifos was detected in both sediment samples collected by the CDFG (2000b).

Table C-12 presents the chlorpyrifos data summarized by waterbody group. Detection frequencies were low, particularly in the upper reaches of the watershed. Detection frequencies were higher in Peters Canyon Channel and its tributaries, where a large proportion of the samples were from undiluted nursery discharges. Comparison to the acute and chronic numeric targets is difficult because they are set at levels below the analytical reporting limit used for most of the sampling/monitoring programs. In Table C-12, all detections exceeded the acute and chronic targets.

Table C-12. Chlorpyrifos Results by Waterbody Group

Waterbody	Count	Results (ng/L)			Detection Frequency*
		Max	Mean	Median	
Tributaries to SDC Reach 2	24	121	51	<40	33%
Tributaries to SDC Reach 1	21	770	95	<40	10%
Tributaries to P CC	41	670	108	50	54%
Peters Canyon Channel	15	420	83	57	60%
SDC Reach 1	59	580	102	57	59%
Tributaries to UNB	35	231	47	<40	37%
Upper Newport Bay	24	132	43.3	41.5	100%

SDC = San Diego Creek; PCC = Peters Canyon Channel; UNB=Upper Newport Bay
* The reporting limit for chlorpyrifos in freshwater was above the acute and chronic numeric targets, therefore all detected concentrations in freshwater exceeded the numeric targets.

San Diego Creek Reach 2: There were no samples collected from within Reach 2, however, samples collected from tributary channels discharging into Reach 2 had a low detection frequency (33%) and a maximum concentration of 121 ng/L.

San Diego Creek Reach 1: Samples collected from locations in Reach 1 of San Diego Creek (at Campus, Coronado, and Harvard streets) had a relatively high detection frequency and the highest median concentration, along with Peters Canyon Channel. This may indicate that the greater part of the chlorpyrifos loading is derived from Peters Canyon Channel and its sampled tributaries (Hines, Central

Irvine). However, the maximum chlorpyrifos concentrations occurred in two samples collected from San Joaquin Creek, which discharges directly into Reach 1 of San Diego Creek.

Upper Newport Bay: Chlorpyrifos was detected in all samples collected in Upper Newport Bay, where a lower detection limit was employed. Eighty percent of the results exceeded the acute numeric target, while 92% exceeded the chronic numeric target. The samples were collected over several days during a storm event in January 1999. The chlorpyrifos concentration that saltwater organisms are exposed to is largely dependent on the degree of mixing between saltwater and freshwater in the upper bay. In the case of the storm sampled in January 1999, a freshwater lens persisted for several days in the upper bay. Chlorpyrifos concentrations were inversely correlated with salinity. Overall, the observed concentrations were lower in Upper Newport Bay than in San Diego Creek.

Chlorpyrifos Sources Categorized by Land Use

Tables C-13a and C-13b present the chlorpyrifos results by sampling location along with the land use pattern in the monitored sub-watershed. The locations in Table C-13a are sorted according to median stormwater runoff concentration, while in Table C-13b, they are sorted according to median baseflow concentration.

Stations sampling runoff derived from mixed land use areas tended to have the highest chlorpyrifos concentrations under both baseflow and stormflow conditions. A major exception was the data from San Joaquin Creek. This creek was sampled during two separate storm events in February, 2000. (Baseflow samples were not collected). The results were the two highest chlorpyrifos concentrations (770 ng/L and 470 ng/L) in the entire dataset. This sample was also associated with very high concentrations of carbaryl that were determined to originate from agricultural fields planted with strawberries that were treated with pesticides immediately prior to a rainfall event.

Chlorpyrifos was not detected in the two stormflow samples collected at the second non-nursery agricultural location (Sand Canyon Ave - NE corner Irvine Blvd). Therefore, it may be prudent to avoid assigning a median concentration to the entire watershed for non-nursery agriculture based on this limited data set.

It is difficult to draw strong conclusions from the data in Tables C-13a and C-13b due to the limited number of samples at most of the locations, and the large number of non-detect results. The chlorpyrifos results also do not correlate well with the diazinon results; the locations with the higher diazinon concentrations do not generally yield the higher chlorpyrifos concentrations. The sampling locations at Westcliff Park and the Central Irvine Channel at Monroe were the only locations among the top seven stormflow results for both chlorpyrifos and diazinon. The baseflow results had a somewhat better correlation, but overall the data suggest differing usage patterns for chlorpyrifos and diazinon.

Sample locations monitoring residential areas tended to have lower chlorpyrifos concentrations. Chlorpyrifos was not detected at three of the residential locations under either baseflow or stormflow conditions. The detection frequency, and maximum concentrations detected at another partly residential location (Santa Ana Delhi Channel) were low. The only residential site with relatively high chlorpyrifos concentrations was Westcliff Park (stormflow), but the baseflow concentrations were relatively low.

Although it appears that some of the nursery/agricultural locations yield higher chlorpyrifos concentrations than the residential areas, it should be noted that the nursery monitoring locations are selected to monitor undiluted nursery discharge, very close to where the chlorpyrifos is used. In contrast, runoff water quality data from individual homes or from distinct residential neighborhoods were not available. Rather data were collected from drainage channels receiving mixed/diluted runoff from many residential neighborhoods. In addition, because of the relative immobility of chlorpyrifos, and its tendency to adsorb to sediment, higher chlorpyrifos concentrations are most likely to be encountered only near areas where it is applied, before it partitions out of the aqueous phase and settles out along with the sediment.

Table C-13a: Land Use and Stormflow Chlorpyrifos Concentrations
Newport Bay Watershed: 1996-2000

Station	Land Use	Count	Results (ng/L)			
			Min	Max	Avg	Median
Bonita Creek at San Diego Creek	Residential	7	<40	<40	<40	<40
Central Irvine Channel - Monroe	Ag-Residential	2	70	150	110	110
Drain at Bee Canyon and Portola Pkwy.	Nursery	7	<40	60	43	<40
East Costa Mesa Channel - Highland Dr.	Residential	2	<50	50	<50	<50
El Modena-Irvine Channel upstream of Peters Canyon Channel	Residential	1	<50	50	<50	<50
Hines Channel - Irvine Blvd.	Ag-Nursery	9	40	349	98	<50
Marshburn Slough - Irvine Blvd.	Nursery	7	45	121	74	62
Peters Canyon Channel - Barranca	Mixed	10	0	102	52	69
San Diego Creek - Campus Dr.	Mixed	25	ND	260	81	57
San Diego Creek - Harvard Av.	Mixed	2	190	310	250	250
San Joaquin Creek - Univ Dr.	Agricultural-Open	2	470	770	620	620
Sand Canyon Ave - NE corner Irvine Blvd.	Agricultural	2	<50	<50	<50	<50
Santa Ana Delhi Channel - Mesa Dr.	Residential-Urban	10	ND	55	23	18
Westcliff Park	Residential	9	<40	231	97	94

Table C-13b: Land Use and Baseflow Chlorpyrifos Concentrations
Newport Bay Watershed: 1996-2000

Station	Land Use	Count	Results (ng/L)			
			Min	Max	Avg	Median
Bonita Creek at San Diego Creek	Residential	12	<40	<40	<40	<40
Central Irvine Channel - Bryan St	Ag-Residential	5	<40	315	164	117
Central Irvine Channel - Monroe	Ag-Residential	2	<50	281	166	166
Drain at Bee Canyon and Portola Pkwy.	Nursery	7	<40	<40	<40	<40
East Costa Mesa Channel - Highland Dr.	Residential	1	<50	<50	<50	<50
El Modena	Nursery	3	<40	57	49	49
El Modena-Irvine Channel upstream of Peters Canyon Channel	Residential	1	<50	<50	<50	<50
Hines at Weir	Nursery	5	<40	63	45	<40
Hines Channel - Irvine Blvd.	Ag-Nursery	10	40	670	158	88
Marshburn Slough - Irvine Blvd.	Nursery	1	<40	<40	<40	<40
Peters Canyon Channel - Barranca	Mixed	4	50	420	144	54
Peters Canyon Channel - Walnut	Mixed	1	150	150	150	150
San Diego Creek - Campus Dr.	Mixed	28	ND	580	106	56
San Diego Creek - Coronado St.	Mixed	2	<40	<40	<40	<40
San Diego Creek - Harvard Av.	Mixed	2	50	400	225	225
Santa Ana Delhi Channel - Mesa Dr.	Residential-Urban	6	ND	50	21	12
Westcliff Park	Residential	7	<40	129	51	<40

Point Sources

There are over fifteen waste discharge requirement (WDR) and NPDES permit holders in the Newport Bay watershed. In addition, three general NPDES permit exist within the San Diego Creek watershed. Some of these permits are in the process of being rescinded.

NPDES

Most of the NPDES permits are minor permits for discharge of extracted groundwater. These are not expected to be sources of diazinon and chlorpyrifos loads to the watershed (groundwater is discussed further below), and the dischargers are not required to monitor for OP pesticides. Two NPDES permits are classified as major permits and are discussed below.

NPDES - Stormwater Runoff:
Stormwater runoff in the Newport Bay watershed is regulated by an NPDES permit for Orange County. As discussed in Section 2, the OCPFRD monitoring program does not include analysis for organophosphate pesticides. However, considerable data have been collected from stormwater runoff channels as part of the 205j, 319h, and CDPR investigations.

NPDES - Sewage Treatment Plants:
Diazinon has been found in effluent from sewage treatment plants (USEPA 1999a). This may be dues to improper disposal of surplus pesticides into sewer drains, or to indoor diazinon usage in urban areas (TDC Environmental 2001). The Newport Bay Watershed residential use survey has indicated a lack of knowledge among homeowners concerning proper disposal procedures (Wilen 2001). There are no sewage treatment plants in the Newport Bay Watershed that discharge effluent to the drainage channels or Newport Bay.

General Permits:
Three general permits have dischargers enrolled within the watershed. Two of the general permits, (groundwater cleanup, and dewatering) are for groundwater discharge. Discharges associated with these permits are not expected to be a source of diazinon or chlorpyrifos (see groundwater discussion below). The third general permit is for boatyards, and includes six enrollees located in Newport Beach. Diazinon/chlorpyrifos usage at boatyards is not expected to differ significantly from general urban uses. The permit prohibits discharge of water to Newport Bay with the exception of stormwater runoff after the first 1/10th inch of precipitation. In short, the boatyards are not regarded as a significant source of OP pesticide runoff.

Santa Ana RWQCB permits:

Nursery Waste Discharge Requirements (WDR):
There are three commercial nurseries in the Newport Bay watershed that are regulated under WDRs. WDRs are being prepared for an additional two nurseries. Together, these nurseries account for less than two percent of the area in the Newport Bay Watershed. As part of the nutrient TMDL for Newport Bay (1999) nurseries greater than five acres and discharging to tributaries that enter Newport Bay were required to institute a regular monitoring program. The monitoring program includes bi-monthly monitoring for toxicity, however, there is no requirement for analysis of OP pesticides. Several of the sampling locations for the 205j, 319h and DPR-RIFA studies were chosen to monitor discharges from nurseries to the drainage channel network. The highest diazinon results occurred in Hines channel and the Drain at Bee Canyon and Portola Parkway sampling station. These results reflect relatively undiluted discharge from agricultural (mostly nursery) areas.

Other WDRs:

Several other facilities (including three landfills) have WDRs but none are required to monitor for OP pesticides, and they are not considered to be significant sources of OP pesticide load

Groundwater

Although there are no currently available groundwater data for diazinon and chlorpyrifos in the Newport Bay watershed, groundwater does not appear to be contributing diazinon and chlorpyrifos loads to the drainage system. Diazinon and chlorpyrifos concentrations are lower downstream of areas where groundwater seeps into the drainage channels. This indicates that the groundwater serves to dilute the concentrations.

In general, diazinon and chlorpyrifos tend to dissipate from the ground surface or in the upper soil layers before percolating to groundwater. Diazinon and chlorpyrifos have not been detected in groundwater sampling conducted by the USGS in the lower Santa Ana River Basin.

Sediment Remobilization

As discussed in the fate and transport section, diazinon has a relatively low potential to adsorb to sediment while chlorpyrifos has a greater adsorption coefficient (Table C-1). Chlorpyrifos could accumulate in sediment and be gradually released into the water through desorption. This would require stability of the adsorbed chlorpyrifos, but adsorbed chlorpyrifos is still subject to chemical hydrolysis and biodegradation.

The available sediment data demonstrate that diazinon is not being bound to sediment. As shown in Table C-8, the detection frequency for diazinon in sediment samples is less than two percent.

Two sediment samples were collected by the CDFG in July/August 2000. Chlorpyrifos was detected in sediment from Hines channel (29 ng/g) and in sediment collected nine miles downstream from the nurseries in San Diego Creek (17 ng/g) (CDFG 2000b). Diazinon was not detected at either location (reporting limit of 10 ng/g dry weight)

As part of the semi-annual sampling program, the OCPFRD collected 96 sediment samples from the Newport Bay watershed and 54 sediment samples from the Bay itself from 1994-1999. Only four diazinon detections were reported. All the detections occurred in 1994, at concentrations of 40 ug/kg to 60 ug/kg. Reporting limits ranged from 35 ug/kg to 400 ug/kg. OCPFRD does not currently monitor sediment for chlorpyrifos.

Atmospheric Deposition

Diazinon is one of the most frequently detected pesticides in air, rain, and fog (USEPA 1999a). In sampling conducted in California in 1988, diazinon was detected in approximately 90% of the sites sampled. Chlorpyrifos has a vapor pressure in the same range as diazinon, and can be expected to volatilize from treated areas. It is not as commonly detected in the atmosphere however.

A rainwater sample collected in the Newport Bay watershed during the 205j studies (December 1997) was reported to have a diazinon concentration of 13 ng/L and a chlorpyrifos concentration of 23 ng/L (Lee and Taylor 2001b). For comparison, eight rainwater samples collected in the Castro Valley Creek watershed, an urban watershed in northern California, had a mean diazinon detected concentration of 58 ng/L with a maximum of concentration of 88 ng/L (Katznelson and Mumley 1997).

Higher diazinon concentrations in rainwater have been detected in agricultural areas (over 5,000 ng/L in 1994-95, and ranging from 418 ng/L to 5,463 ng/L in 14 cities located in the Central Valley) but these are likely related to aerial spray applications to orchards – a type of use that is negligible in the Newport Bay Watershed. Rainfall collected in the winter of 1992-93 in the San Joaquin basin contained up to 1,900 ng/L diazinon. The source of this diazinon is " presumed to be droplets from dormant spray applications (not volatilization from treated crops)" (Novartis 1997).

Assuming the measured rainfall concentration is representative for all storm events, and assuming no degradation during runoff, the annual diazinon load derived from rainfall would be approximately 0.7 lbs. This would be about 2% of the mean annual load at the San Diego Creek – Campus station. For chlorpyrifos, the load would be 1.3 lbs., or about 15% of the mean annual load.

It is uncertain whether this contribution is from volatilization from use within the watershed, or from aerial transport from sources outside the watershed. For estimating loads, the contribution from rainfall is already taken into account by the runoff sampling in the watershed. Direct deposition (rainfall falling directly into Upper Newport Bay) would be negligible since the area of the bay relative to the watershed is less than one percent. The diazinon load would be less than 0.0072 lbs., or less than 0.02% of the annual load to the Bay. For chlorpyrifos the load would be 0.0127 lbs. or about 0.15% of the total annual load.

IV. Approach to calculating current loads

This section presents calculations of estimated diazinon and chlorpyrifos loads to San Diego Creek and Upper Newport Bay. Because the TMDL is concentration based, the load information is presented for information purposes only and is not used as a basis for assigning allocations.

Mean annual loads were calculated using mean water column concentrations from the SDC-Campus Station. Mean annual baseflow and stormflow volumes were calculated using the flow data for the SDC-Campus station presented in Part B (Freshwater flow and seasonal variation). Baseflows are defined in Part B as flow rates less than or equal to 20 cfs at the SDC-Campus station. For the purposes of the diazinon and chlorpyrifos TMDL, stormflows are defined as flows greater than 20 cfs at the SDC-Campus station. Using these definitions, mean annual baseflow and stormflow volumes were calculated using the 19 years of flow data summarized in Part B. Loads were then determined by multiplying the mean concentrations with the mean flows. As the SDC-Campus station represents over 95% of the flow in the watershed, loads were not calculated for the other tributaries.

Diazinon

The estimated mean annual diazinon load at the San Diego Creek- Campus station is about 32 lbs (Table C-14). This amounts to about 0.3% of the estimated 10,800 lbs of diazinon (ai) that was used within the watershed in 1999. This finding is similar to the results of a recent study in the Castro Valley (urban) watershed. That study found that 0.3% of the applied diazinon (ai) was discharged into Castro Valley Creek with 90% of the load delivered by storm runoff (Scanlin and Feng 1997).

Table C-14: Estimated Existing Mean Annual Diazinon Load San Diego Creek – Campus Station

Flow	Mean Annual Flow (acre-feet)	Mean Conc. (ng/L)	Load (lbs.)	Load (%)
Base flow	6,323	200	3.43	10
Storm flow	26,950	445	32.6	90
Total	33,273	--	36.0	100

Table C-15 presents summary diazinon results categorized by land use, and estimates of the annual load for baseflow and stormflow. Only samples from locations where either urban or non-urban (agriculture, nursery) land use predominated were included in generating the table; about 40% of the samples in the data set were excluded.

Table C-15: Diazinon Concentrations and Loads by Land Use

			Results (ng/L)			Area		Load		Load
Condition	LandUse	Count	Max	Avg	Median	(acres)	(%)	(lbs)	(%)	(lbs/acre)
Baseflow	Urban	27	2,250	236	140	66,507	68%	2.4	88.4%	3.61E-05
	Agriculture	27	10,000	1,002	131	9,286	10%	0.31	11.6%	3.38E-05
	Open	---	---	---	---	21,948	22%	0.0	0.0%	0.00E+00
	Total					97,741	100%	2.7	100%	2.78E-05
Stormflow	Urban	27	1,079	400	370	66,507	68%	24.1	96.3%	3.63E-04
	Agriculture	27	7,990	627	271	9,286	10%	2.47	2.1%	2.66E-04
	Open	---	---	---	---	21,948	22%	0.0	0.0%	0.00E+00
	Total					97,741	100%	26.6	100%	2.72E-04

The total diazinon load estimated from Table C-15 is not directly comparable with the total load calculated using the average data from San Diego Creek (Table C-14) because the data sets are different. The table is simply intended to compare export rates from urban and agricultural areas. On a per-acre basis, diazinon export rates appear to be slightly higher for urban areas than for agricultural areas.

The intensive residential investigation in the Castro Valley Creek watershed (Scanlin and Feng 1997) revealed that a small number of individual residential hotspots (2% to 4% of the homes) produced the bulk of the diazinon loading to the Creek. Controlled experiments to evaluate diazinon runoff from individual homes demonstrated that even when diazinon was used properly, very high levels of diazinon would still be found in the runoff. Highest source areas were patios and driveways, followed by roof drains. These results are probably due to the lower rates of dissipation from these surfaces as compared to lawns or soil, where biodegradation would be much more significant.

Chlorpyrifos

Table C-16 presents an estimate of the annual chlorpyrifos loading to San Diego Creek and Upper Newport Bay. The total annual mass of chlorpyrifos entering Upper Newport Bay is about 8 pounds. This is about 0.03% of the estimated 24,300 lbs. ai of chlorpyrifos applied in the watershed in 1999 (one-fifth of the Orange County total given in Table C-6). This load is based on a conservative estimate of chlorpyrifos concentrations in tributaries to Upper Newport Bay. Actual concentrations in Upper Newport Bay would be reduced due to mixing and dilution.

Table C-16. Estimated Existing Mean Annual Chlorpyrifos Load
San Diego Creek – Campus Station

Flow	Annual Flow (acre ft.)	Mean Conc. (ng/L)	Load (lbs.)	Load (%)
Baseflow	6,323	111	1.91	23
Stormflow	26,950	86.8	6.36	77
Total	33,273	--	8.27	100

Table C-17 presents chlorpyrifos concentrations and loads categorized by land use for the baseflow and stormflow conditions. Compared to diazinon, urban areas contribute a lesser percentage of the stormflow chlorpyrifos load. On a per-acre basis, export rates for urban and agricultural areas are similar. The total chlorpyrifos load estimated from Table C-17 is not directly comparable with the total load calculated using the data from San Diego Creek (Table C-16). The discrepancy between the two methods results from the differing data sets.

Table C-17: Chlorpyrifos Concentrations and Loads by Land Use

		Results				Area		Load		Load
Condition	**Land Use**	**Count**	**Max**	**Det Freq.**	**Median**	**(acres)**	**(%)**	**(lbs)**	**(%)**	**(lbs/acre)**
Baseflow	Urban	27	129	14%	<40	66,507	68%	0.69	87.7%	1.03E-05
	Agriculture	27	670	35%	<40	9,286	10%	0.10	12.3%	1.03E-05
	Open	---	---	---	---	21,948	22%	0.00	0.0%	0.00E+00
	Total					97,741	100%	**0.78**	100%	8.01E-06
Stormflow	Urban	27	231	33%	<40	66,507	68%	2.61	85.1%	3.92E-05
	Agriculture	27	770	56%	50	9,286	10%	0.46	14.9%	4.90E-05
	Open	---	---	---	---	21,948	22%	0.00	0.0%	0.00E+00
	Total					97,741	100%	**3.06**	100%	3.13E-05

IV. Summary and conclusions

The following conclusions are based on data collected in Newport Bay watershed prior to implementation of EPA re-registration agreements for chlorpyrifos and diazinon:

Reported and unreported urban uses account for over 90% of total chlorpyrifos and diazinon use in Orange County and in the Newport Bay Watershed.

About 36 pounds of diazinon is discharged annually to San Diego Creek, mostly during storm events. This amounts to about 0.34% of the applied diazinon mass in the watershed. About 8 pounds of chlorpyrifos are annually discharged to Upper Newport Bay, with 77% of the load delivered during storm events. This amounts to about 0.03% of the applied chlorpyrifos mass.

Surface runoff is the source of virtually all the loadings. Contributions from sediment remobilization and groundwater are negligible, however, loading from atmospheric deposition to Upper Newport Bay is potentially significant, though not well-quantified.

On a per acre basis, different land uses contribute diazinon and chlorpyrifos runoff at fairly equal rates within the watershed. Runoff derived from urban land uses accounts for about 88% of the diazinon baseflow load, and 96% of the stormflow load. Agricultural sources (including nurseries) account for the remainder of the load. For chlorpyrifos, runoff derived from urban land uses accounts for about 85% to 88% of the baseflow and stormflow loads, while agriculture (including nurseries) accounts for about 12% to 15% of the load.

Average diazinon concentrations in San Diego Creek exceeded the chronic numeric target, and 95% of the observed concentrations were also above the acute numeric target.

Average chlorpyrifos concentrations in San Diego Creek exceeded the chronic numeric target, and at least 59% of the observed concentrations exceeded the acute numeric target. The average chlorpyrifos concentration observed in Upper Newport Bay during a storm event exceeded the saltwater chronic numeric target, and 80% of the concentrations exceeded the acute numeric target.

The diazinon re-registration agreement by EPA will likely end over 90% of current diazinon use in the Newport Bay watershed. If runoff concentrations show a corresponding decline, diazinon concentrations in San Diego Creek could decrease below the chronic numeric target (50 ng/L).

The chlorpyrifos re-registration agreement by EPA will likely end over 90% of current chlorpyrifos use in the Newport Bay watershed. If runoff concentrations show a corresponding decline, chlorpyrifos concentrations in San Diego Creek and Upper Newport Bay could decline below the respective chronic numeric targets for freshwater and saltwater.

VI. References

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Part D—Selenium (Se)

Introduction

Selenium (Se) is a natural trace element in the environment that has chemical and physical properties that are intermediate between those of metals and non-metals. It is an essential nutrient for fish, birds, animals, and humans. One of the most important features of selenium is the very narrow margin between nutritionally optimal and potentially toxic dietary exposures for vertebrate animals (Wilber 1980). Excessive amounts of selenium are found to cause toxicity in wildlife. Toxicological effects of selenium on wildlife include lowered reproduction rates, shortened life spans, and stunted growth. Many of these effects are not readily observable and detailed biological studies are required to determine whether or not selenium is negatively impacting biota in a watershed.

This Technical Support Document presents an analysis of the major sources of selenium to San Diego Creek and Upper Newport Bay. Monitoring results and preliminary data on potential sources of selenium in the watershed are reviewed. These studies were not detailed enough to identify all sources, but it is largely recognized that one of the primary sources of selenium in the watershed is from shallow groundwater that enters San Diego Creek through seeps, springs, and weepholes.

Most of the information presented in this Technical Support Document was selected from the DRAFT Selenium TMDL written by Regional Board staff (2001a).

I. Physicochemical description of chemical toxicant

Selenium exists in different environmental compartments that are atmospheric, marine, and terrestrial in nature. Heterogeneity in its distribution results in movement of selenium among those compartments (Nriagu 1989). Parent materials having the highest selenium concentrations are black shales (around 600 mg/kg dry) and phosphate rocks (1-300 mg/kg dry); both of which can potentially give rise to seleniferous soils and food chain selenium toxicity. Selenium can become mobilized and concentrated by weathering and evaporation in the process of soil formation and alluvial fan deposition in arid and semiarid climates (Presser 1994), and through leaching of irrigated agricultural soils and remobilization in irrigation water (Presser and Ohlendorf, 1987; Seiler *et al.* 1999). Selenium contamination of aquatic ecosystems is of special concern in large parts of California, and other semi-arid regions of western North America (Seiler *et al.* 1999).

Chemical Forms/ Speciation

The chemical speciation of selenium is a critical consideration in assessing selenium contamination in that the bioavailability and toxicity of selenium are greatly affected by its chemical forms. Selenium can occur in four different oxidation states: selenide (–2), elemental selenium (0), selenite (+4), and selenate (+6). In general, selenate (Se^{6+}) has a high solubility and is the most mobile in water. Selenite (Se^{4+}) is soluble in water but its strong affinity to be adsorbed to soil particles greatly reduces its mobility. Elemental selenium (Se^{0}) exists in a crystalline form and is usually incorporated in soil particles. In most surface waters, selenate and selenite are the most common chemical forms. Selenite is the most bioavailable of the dissolved phase inorganic species (Maider *et al.* 1993; Skorupa 1998). Though some data suggests that selenite is more toxic than selenate, selenate toxicity data are scant (Nagpal and Howell, 2001). A decrease in cell division and growth rates of some species of algae exposed to selenate have been shown by several studies (Davis et al., 1988; Dobbs et al., 1996; Richter, 1982). Selenate is also readily taken up by plants and thereby enters the food chain (pers. comm., D. Lemly). Organo-selenide was also found to be very bioavailable and hence potentially toxic to algae, invertebrates, and fish (Maider *et al.* 1993).

Selenium is also found with particulate matter, which may include primary producers (*e.g.*, phytoplankton), bacteria, detritus, suspended inorganic material, and sediments. Interactions and transformation of selenium between dissolved and particulate phases could be biological, chemical, and/or physical in nature. Those reactions play an important role in selenium toxicity (Luoma and Presser 2000). Since all forms of selenium may interconvert however, they should all be considered toxicologically important (T.Fan and G.Cutter, commun. 1998)

Bioaccumulation
Selenium tends to bioaccumulate in bio-tissues and causes toxicological effects. There is strong evidence that the major selenium uptake route into fish is not accumulation from water, but rather via the food chain (Fowler and Benayoun 1976; Wilber 1980; Luoma *et al.* 1992). Bioaccumulation of selenium in lower trophic level invertebrates (*e.g.*, zooplankton and bivalves) is a critical step in determining the effects of selenium since higher trophic level predators such as fish and birds feed on invertebrates. Studies have shown that uptake of dissolved selenium by invertebrates is not as important as uptake from diet (Luoma *et al.* 1992; Lemly 1993). Luoma and Presser (2000) suggested that direct uptake of particulate selenium by invertebrates via filter-feeding or deposit feeding is the primary route for selenium to enter the food web. In laboratory studies of the mussel *Mytilus edulis*, dissolved selenite (+4) is the most bioavailable form of inorganic selenium taken up from solution (Wang *et al.* 1996). However, Luoma *et al.* (1992) showed that the uptake rate of dissolved selenite explained less than 5% of the tissue concentrations of selenium accumulated by the clam *Macoma balthica* at concentrations typical of the San Francisco Bay-Delta. The role of dissolved organic selenides in selenium bioaccumulation is not as well understood as availability of inorganic selenium, but it is unlikely that its uptake rate is greater than uptake rates from food (Luoma and Presser 2000).

II. Monitoring Results

Surface Waters and Groundwater
IRWD monthly monitoring data from 12/1997 to 3/1999 (Figure D-1) indicate consistent violation of the numeric target (5 µg/L) in San Diego Creek at Campus Drive. Figure D-1 shows selenium concentrations in relation to flow rate. No strong correlation is found. However, daily loads estimated from concentrations and flow data seem to exhibit a pattern when plotted as a function of flow rate (Figure D-2). In general, the estimated daily load shows an increasing trend with flow rate at the low end of the flow spectrum. There are too few data points to determine the load pattern at high flow rates.

The monitoring data at Campus Drive provides an estimation of loading to Newport Bay. This estimate uses a statistical method to calculate annual load. The calculation methodology is summarized in Section IV of this document. As discussed in the TMDL summary document, the annual load of selenium is estimated to be 2,443 lbs/year (4/1/98 - 3/31/99) with a dry season load of 1,196 lbs (4/1/98 - 9/30/98) and a wet season load of 1,247 lbs (10/1/98 – 3/31/99). Detailed calculations and data used are shown in Section IV of this TSD (see Table D-3).

III. Source Analysis

Selenium Source Identification Study
Hibbs and Lee (2000) investigated sources of selenium in the Newport Bay/San Diego Creek watershed. The study area is shown in Figure D-3. The study presents convincing evidence that groundwater is a significant source of selenium to San Diego Creek and Newport Bay. At the watershed scale, the study

shows that selenium concentrations exceed the numeric target in most of the surface and groundwater samples collected, and that they exhibit spatial heterogeneity (Figure D-4). Concentrations in groundwater range from below 4 μg/L (method detection limit) to 478 μg/L. A statistical analysis shows that selenium concentrations in groundwater samples were generally found to be higher within the boundaries of a historical marsh (" Swamp of the Frogs" or " La Cienega de las Ranas") than in other areas. Radioisotope analysis on the water samples suggest that high selenium concentrations in groundwater result from oxidation and leaching of subsurface soils in the saturated zone underlying the old marsh area.

Monitoring of nursery discharge shows selenium concentrations in most runoff samples (6 out of 7) were below detection limits (*i.e.*, < 4 μg/L). One sample was detected at 7 μg/L from Bordiers Nursery. Surface water monitoring shows that discharges containing less than 10 μg/L selenium were mostly urban and agricultural runoff. Surface channels and drains with particularly high concentrations coincide with areas where high selenium groundwater samples were collected. Those channels include Como Channel (38 to 42 μg/L), Valencia Drain at Moffett Drive (25 to 40 μg/L), Warner Drain (24 to 33 μg/L), and the circular drains at Irvine Center Drive (141 to 162 μg/L) and at Barranca Parkway (107 μg/L). Channel inspection and chemical composition analysis indicate that those drainage channels collect considerable amounts of groundwater.

Three drainage channels (San Diego Creek above the confluence with Peters Canyon Wash, Como Channel, and Santa Fe Channel) were selected for detailed flow and chemical investigation. In these three channels, stream flows were measured at upstream and downstream gage stations. Results indicated that these channels are gaining streams in the reaches studied. Namely, the increases in flow rates result from seepage of groundwater into the surface channels.

An analysis of the flow and concentration data indicates the significance of groundwater as a source of selenium. The total selenium load from groundwater in these three reaches is approximately 0.36 lbs/day. The surface water loading of selenium at Campus Drive falls in the range of 1.6 to 4 lbs/day at low flow conditions (see Figure D-1). The comparison shows that groundwater inputs to these three reaches alone represent a significant portion (9 to 22%) of the total selenium load to Newport Bay, indicating the significance of groundwater inputs of selenium to surface water. Selenium loads from groundwater may account for up to 70% of the total selenium load in the creek under base flow conditions (pers. comm., B. Hibbs). Detailed calculations are summarized in Table D-6 (Appendix B).

Results of the study suggest that discharges from groundwater cleanup projects and shallow groundwater dewatering activities are potential sources of selenium and could be significant depending on the locations of these activities. However, selenium information is not yet available for these discharges.

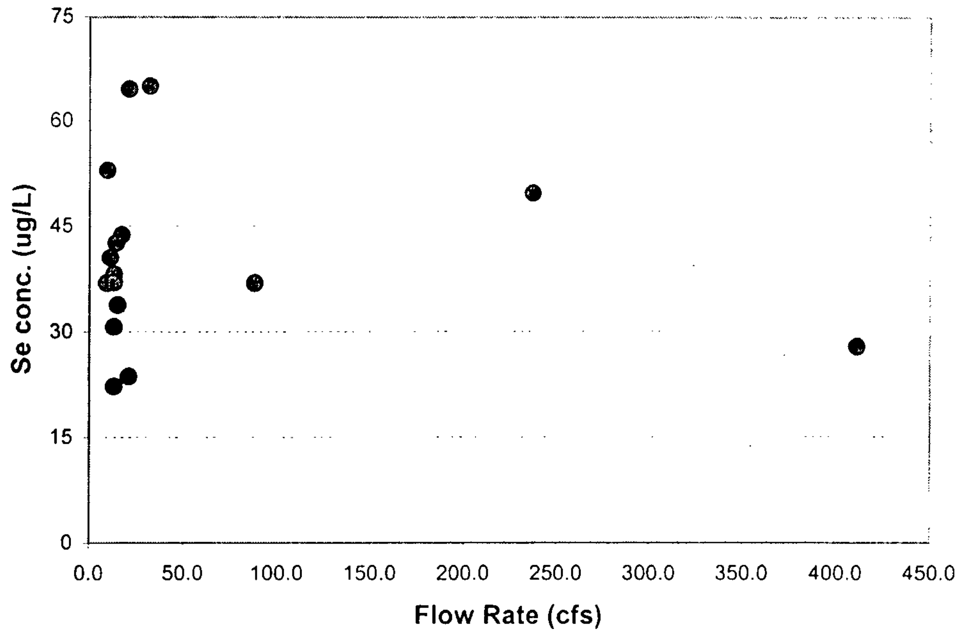


Figure D-1. Relationships between dissolved selenium concentration and flow rate at Campus Drive in San Diego Creek for March 1997 to March 1998 (selenium data: IRWD, flow data: OCPFRD).

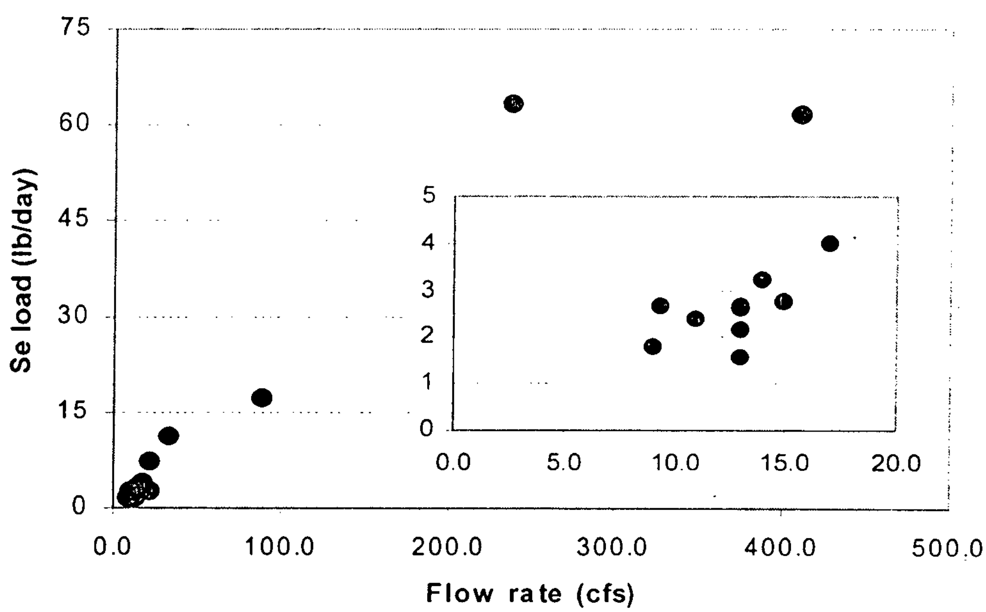


Figure D-2. Estimated selenium daily load (lbs/day) as a function of flow rate (cfs) at Campus Drive in San Diego Creek for March 1997 to March 1998 (selenium data: IRWD, flow data: OCPFRD).

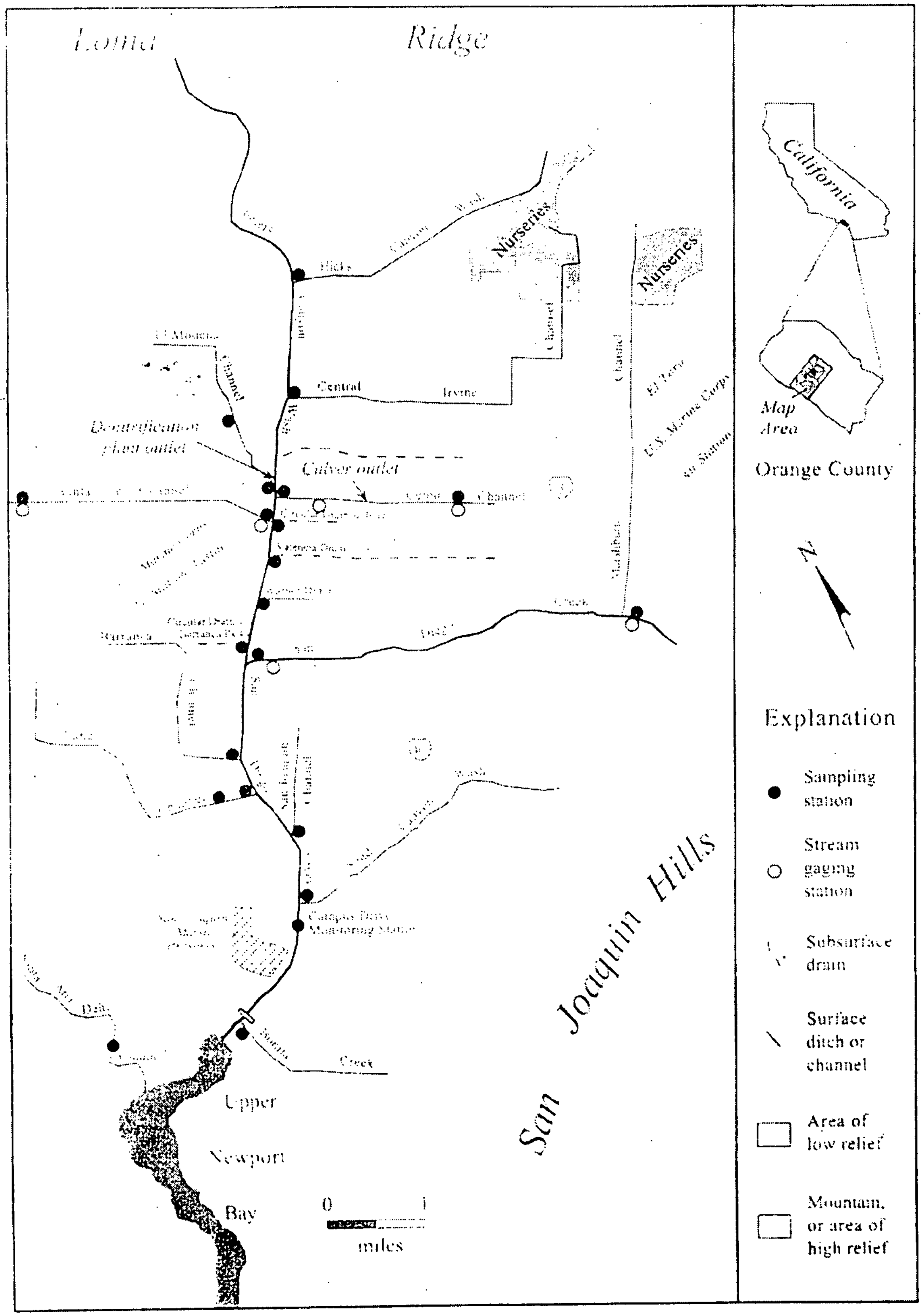


Figure D-3. Map of study area, showing the locations of water sampling stations and stream gage stations on important channels and creeks (source: Hibbs and Lee 2000).

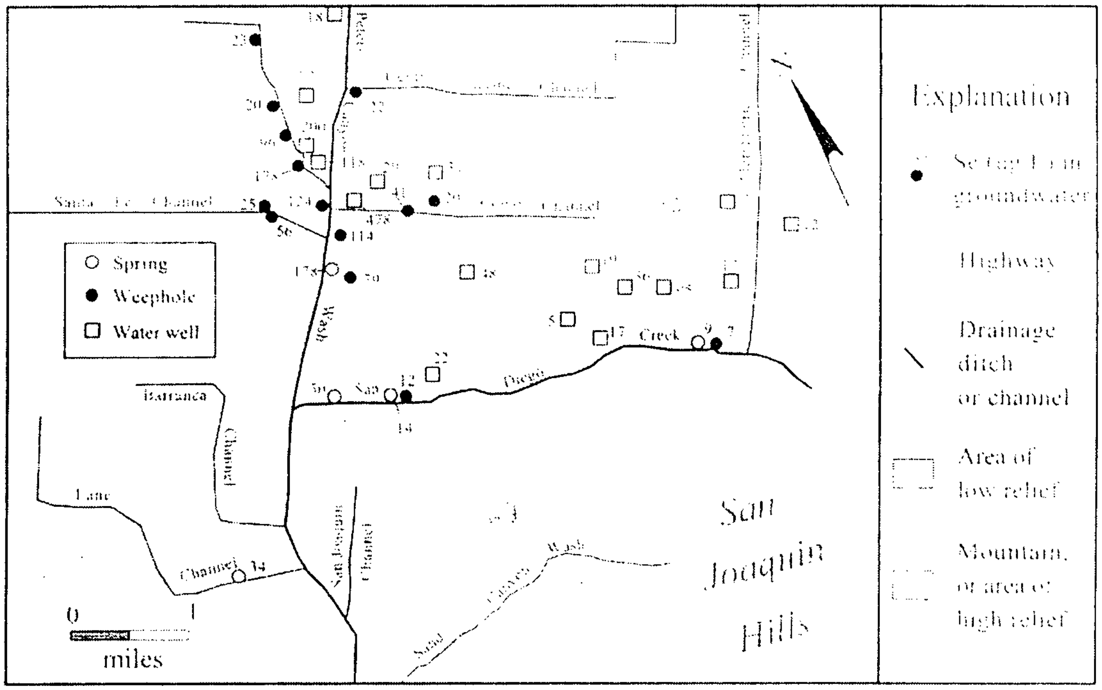


Figure D-4. Selenium concentrations in groundwater (µg/L). Sample points include water wells, weepholes, and springs (data source: Hibbs and Lee 2000).

OCPFRD Sept.1999 Peters Canyon Wash/San Diego Creek Nutrient Study
As part of the investigation of nutrient sources in the San Diego Creek watershed, OCPFRD conducted a one-week program of measurements of flow rate in tributaries of Peters Canyon Wash and reaches 1 and 2 of San Diego Creek in September 1999. The flow information allows estimation of groundwater flow inputs to surface channels at the watershed scale. Results show that the net increase in flow at Barranca Parkway in Peters Canyon Wash was approximately 0.36 cfs in the reach studied. Increases in San Diego Creek were 1.32 and 0.79 cfs for reach 1 and reach 2, respectively. These net flow increases, calculated by subtracting measured creek flow from its tributary flows, are believed to be contributions from groundwater via seepage and weepholes. The net flow increases a total of 2.47 cfs, which represents a significant portion of the Creek at Campus Drive. It should be noted that the overall contribution of groundwater to surface flow is expected to be larger since inputs of groundwater to the tributaries (*e.g.*, Como and Santa Fe Channels, Table D-6, Appendix B) are not included in the calculation.

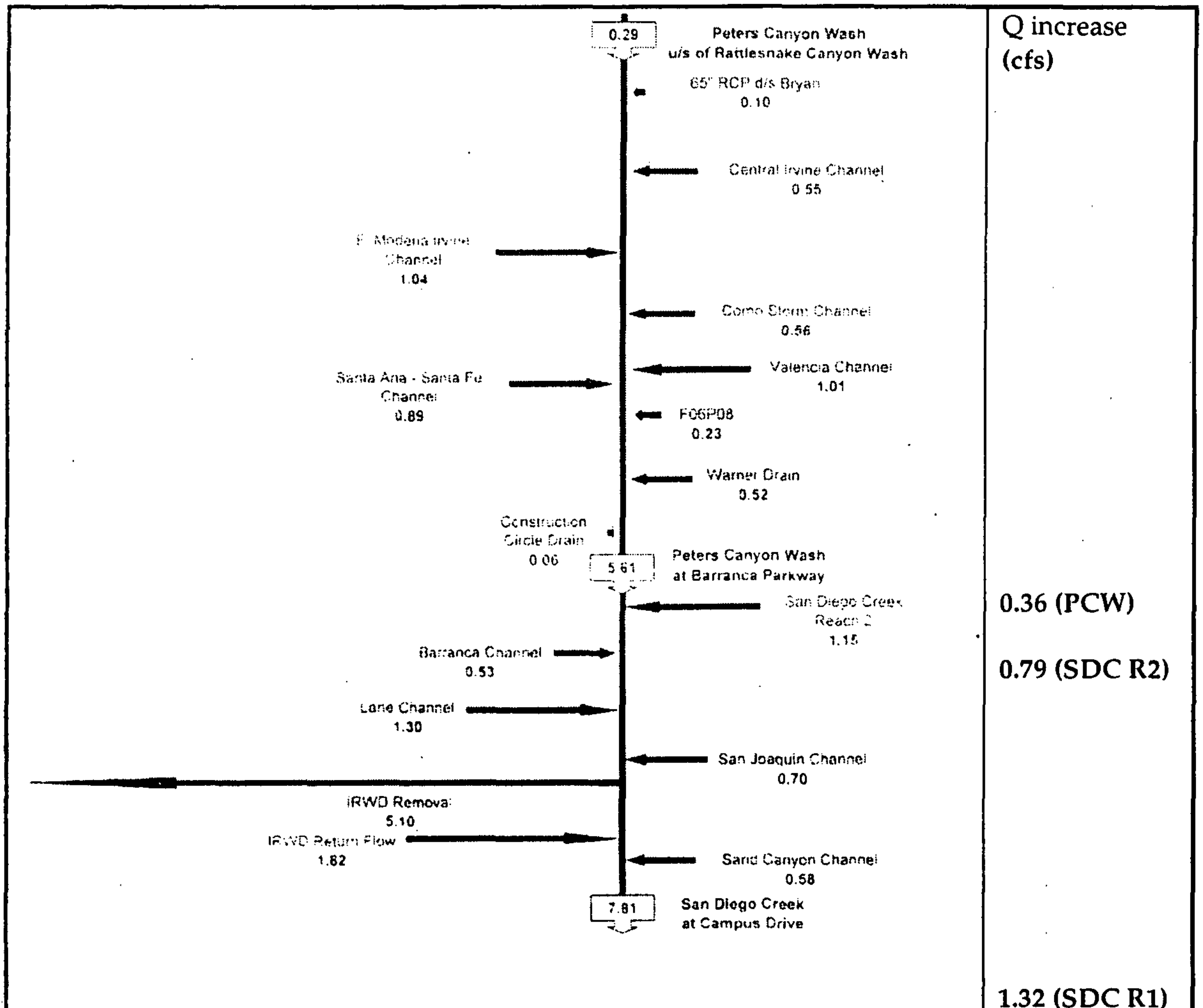


Figure D-5. Average daily flow rates (cfs) in tributaries to Peters Canyon Wash and Reaches 1 and 2 of San Diego Creek, September 12-20, 1999 (data: OCPFRD 2000).

Aquatic Toxicity Study (Lee & Taylor 2001a)
As part of the 319(h)study, Lee and Taylor (2001a) investigated sources of acute toxicity in the San Diego Creek watershed. Samples were collected on four days in 2000 – 01/25, 02/12, 02/21, and 05/31. The sampling in January and February occurred during storm events and the January sampling represents a " first-flush" event, according to flow records. The May sampling provides information under base flow conditions. Chemical analysis allows differentiation of dissolved and particulate selenium. Sampling stations and selenium concentrations are summarized in Table D-5, Appendix B. The results suggest that water-borne selenium mostly existed in dissolved forms under low flow conditions. Particulate fractions (*i.e.*, total minus dissolved) of selenium during rain events fall in a wider range than those found in dry weather (5/31/00 samples). Consistent with other monitoring data, the measured concentrations exceed the numeric target at most of the locations.

There was only one sample collected on January 25, 2000 and the total selenium concentration was 15.6 μg/L at Campus Drive. Total selenium concentrations for the rest of the sampling days are shown in Figures D-6 – D-8. These figures show spatial distributions of selenium concentrations in the watershed and allow comparisons of loading from different tributaries. Table D-1 lists estimated loads at four locations in the watershed. Several observations concerning selenium sources are summarized below:

- During rain events, high concentrations were found at Hines Channel and Sand Canyon Channel during storms (Figures D-6 and D-7), suggesting that selenium sources exist upstream of the sampling locations when rain events occur. These sources may include runoff from hillside, open fields, agricultural lands, and nurseries. The high concentrations were diluted downstream as flows increased.

- The dry weather sample collected in May (Figure D-8) from Hines Channel shows a low concentration, which is consistent with the findings in Hibbs' study. This suggests that contributions from nursery channels to the watershed are small under base flow conditions.

- The estimated loads indicate that San Diego Creek contributes a substantially higher selenium load to the Bay than Santa Ana-Delhi channel. Of the load at Campus Drive, Peters Canyon Wash is the biggest contributor of selenium in the San Diego Creek watershed in dry weather. As noted in section III of this TSD, the contribution is attributable to inputs of groundwater to Peters Canyon Wash.

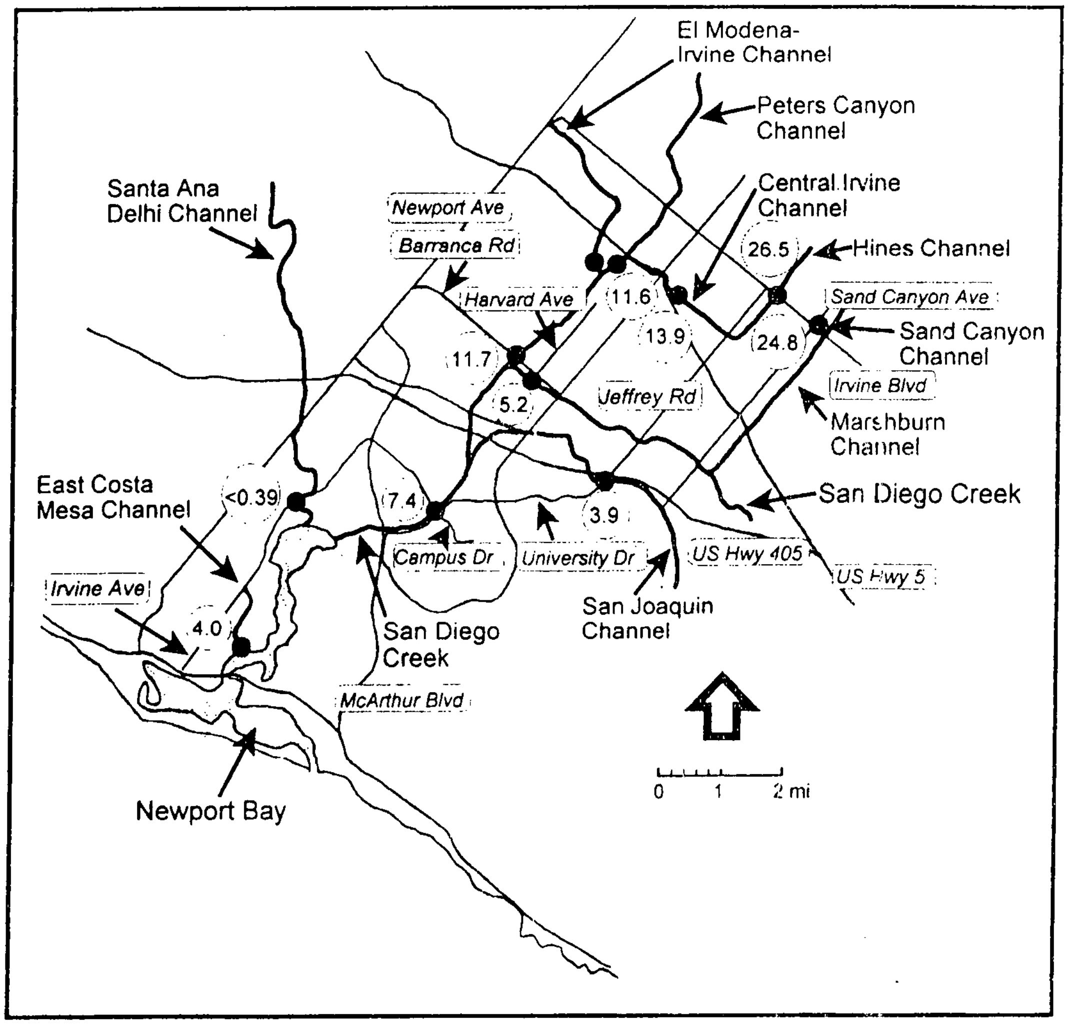
- Selenium loads at Barranca Parkway in Peters Canyon Wash did not change considerably between base flow conditions and rain events. The drainage area consists of mostly urban land uses, suggesting that urban selenium loads are not significant.

- Loading at Harvard Avenue in San Diego Creek increases substantially during rain events compared to that in base flow conditions. Estimated loads (Table D-1) are comparable to those from Peters Canyon Wash. The drainage area for Harvard Avenue in SDC covers more open space than that in Peters Canyon Wash drainage area (see Figure A-2, TSD Part A, for land uses). The seasonal variation in loading suggests that open space runoff is a potential source of selenium during rain events.

Table D-1. Calculated selenium loads from major tributaries in Newport Bay/San Diego Creek watershed

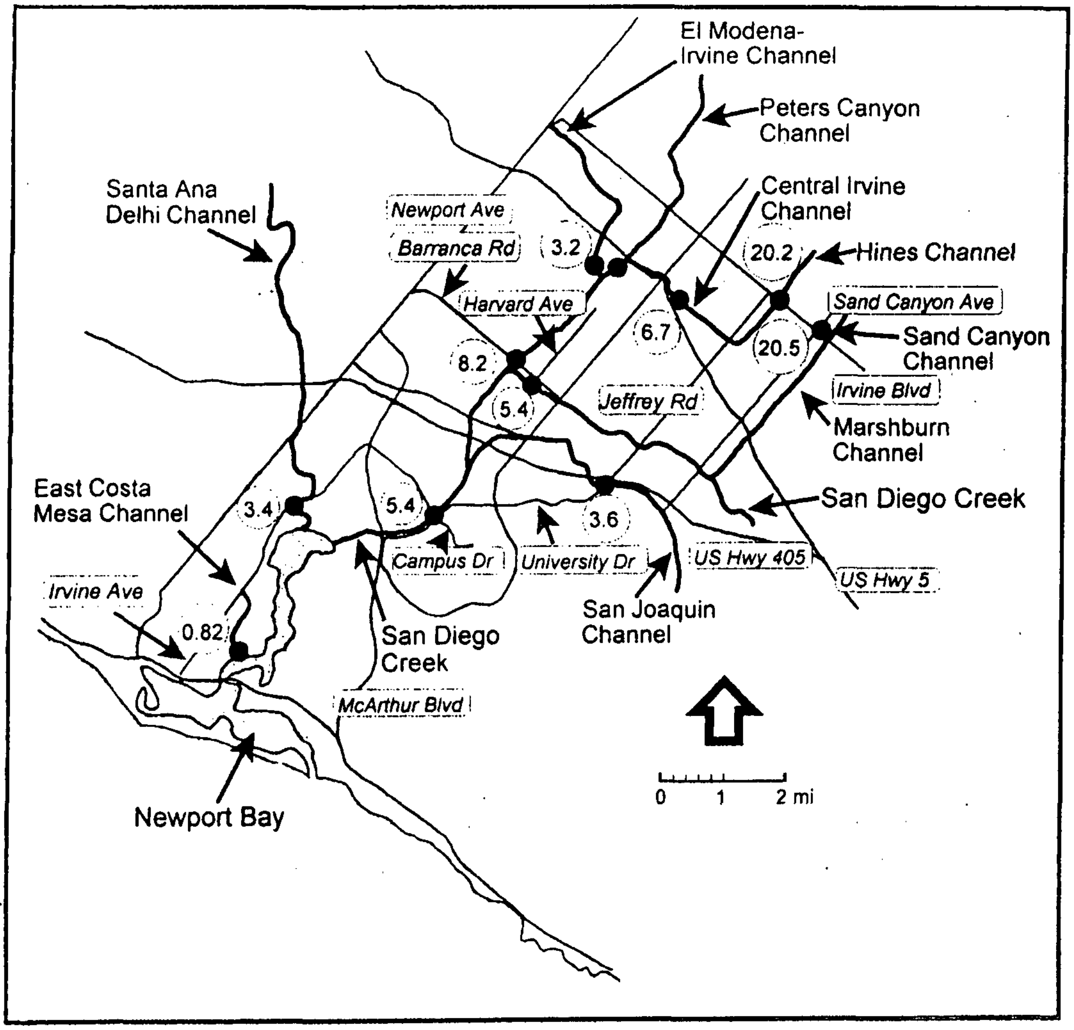
	SDC[a] @ Campus	SDC @ Harvard	PCC[b] @ Barranca	Santa Ana-Delhi
2/12/00 Conc. (µg/L)	7.4	5.2	11.7	<0.39
Flow[c] (cfs)	96.5	49.9	30.8	23.7
Load (lbs/day)	**3.86**	**1.40**	**1.95**	**<0.05**
2/21/00 Conc. (µg/L)	5.4	5.4	8.2	3.4
Flow[c] (cfs)	96.5	49.9	30.8	23.7
Load (lbs/day)	**2.81**	**1.45**	**1.36**	**0.44**
5/31/00 Conc. (µg/L)	22.1	10.1	31	11.9
Flow[c] (cfs)	14.6	3.62	8.21	3.29
Load (lbs/day)	**1.74**	**0.20**	**1.37**	**0.21.**

[a]San Diego Creek, [b]Peters Canyon Wash, [c]Monthly average flow rate
(Conc. * Flow * conversion factor = lbs/day or µg/L * ft^3/sec * 0.0054 = lbs/day)



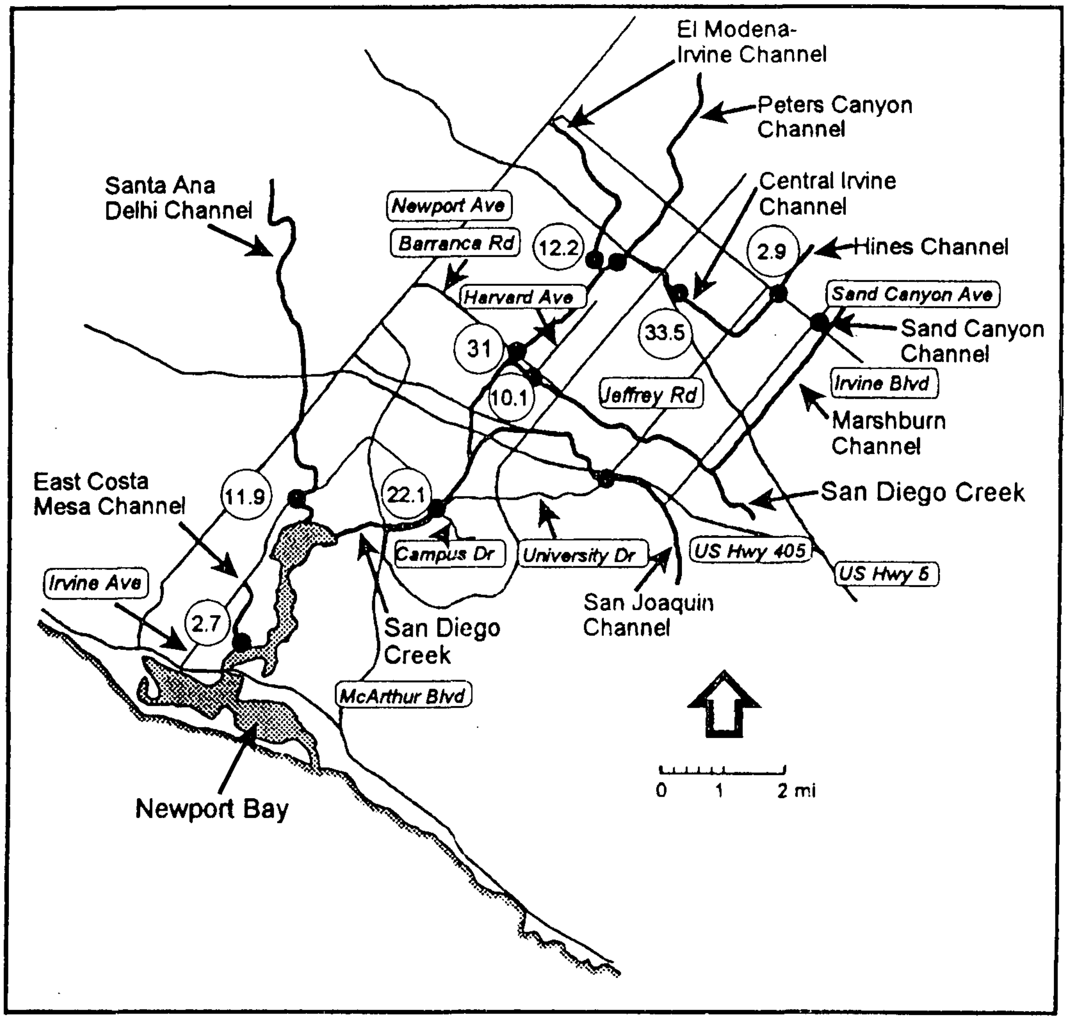
Total Selenium Concentrations (µg/L)
February 12, 2000
(Wet Weather Sampling)

Figure D-6. Spatial distribution of total selenium concentrations during a storm on February 12, 2000 (from Lee and Taylor 2001a).



Total Selenium Concentrations (µg/L)
February 21, 2000
(Wet Weather Sampling)

Figure D-7. Spatial distribution of total selenium concentrations during a storm on February 21, 2000 (from Lee and Taylor 2001a).



Total Selenium Concentrations (µg/L)
May 31, 2000
(Dry Weather Sampling)

Figure D-8. Spatial distribution of total selenium concentrations on May 31, 2000 (from Lee and Taylor 2001a)

Residential Runoff Reduction (R3) Study

The R3 study was initiated in 2000 by a multi-agency workgroup to reduce the impact of urban residential runoff and conserve domestic and reclaimed water resources. The workgroup includes the Southern California Coastal Water Research Project (SCCWRP), the Municipal Water District of Orange County (MWDOC), National Water Research Institute (NWRI), Department of Pesticide Regulations (DPR), the Irvine Ranch Water District (IRWD), and Santa Ana Regional Water Quality Control Board (SARWQCB). The study identified five isolated residential communities to allow investigation of pollutant loading strictly from residential areas. As a part of the baseline monitoring, selenium concentrations in the runoff samples collected from 11/28/00 to 7/3/01 were measured. Results show that all samples were below detection limits of the analytical methods used (1.5 µg/L and 5 µg/L). This suggests that urban runoff is not a significant source for selenium.

Background concentrations

Studies are currently in progress to more accurately assess the extent of selenium levels in various sources in the watershed. No monitoring data are available to determine the extent of selenium sources within the Bay. This might be attributed to very low selenium concentrations in seawater. On the global scale, average seawater dissolved selenium concentrations are 0.03 µg/L and 0.095 µg/L in the surface mixed layer of oceans and in deep oceans, respectively (Nriagu, 1989). In Northern California, dissolved selenium was reported to be 0.1 µg/L at Golden Gate in San Francisco Bay (San Francisco Estuary Institute 1997). These reported levels of selenium fall below the chronic seawater numeric target value (71 µg/L). Therefore, selenium input from seawater is not expected to be significant.

Atmospheric Deposition

Deposition of selenium from the atmosphere is a part of the global cycling of selenium and it represents a source to the watershed. The physical constituents of atmospheric selenium are the particle phases, predominantly less than 1 µm in diameter (Duce *et al.* 1976), and gaseous forms (Mosher and Duce 1983). Gaseous atmospheric selenium can bond to particulate material for long-range transport. Deposition of selenium from the atmosphere to the global surface occurs in both wet and dry forms. Dry deposition accounts for the exchange of particulate and gaseous material between the atmosphere and the global surface. It is usually insignificant compared to wet deposition. Wet deposition refers to rainout and washout of all forms of atmospheric selenium. It is the most important removal mechanism for selenium from the atmosphere to the earth surface. Reported rain concentrations in urban areas are in the range of 0.1 to 0.4 µg/L (Mosher and Duce 1989). Selenium load due to rainfall is then estimated to be 1.43 lbs/year to the Bay (1,363.6 acres, open water area) assuming rainfall concentration of 0.4 µg/L and annual rainfall of 11.6 in (historical average at Newport Beach Harbor Master station, OCPFRD). Therefore, atmospheric deposition is insignificant compared to the load at Campus Drive in San Diego Creek.

Summary of source analysis

In summary, existing data are limited for a thorough study and investigation of the sources and impacts of selenium to Newport Bay/San Diego Creek watershed. The data available allow preliminary assessment of the problem. Conclusions of the analysis in this report are summarized as follows:

- IRWD monitoring data provide analysis of the relationship between concentration, load, and flow rates. The monthly monitoring data at Campus Drive shows no apparent trend between concentration and flow rate. Daily load increases with flow rate and seems to reach a plateau at high flow rates during large storms. However, there were only two data points greater than 100 cfs and they are not sufficient to determine a trend at the high end of the flow spectrum. Statistical analysis of the data estimates that the annual selenium load was 2,443 lbs. from 4/1/98 to 3/31/99.

- Hibbs and Lee' s study (2000) provides convincing evidence that shallow groundwater is a significant source of selenium to surface waters in the San Diego Creek watershed. Flow increases in three drainage channels selected were attributable to contributions from groundwater. (See Table D-5 in Appendix B of this TSD.) Measurements of selenium concentrations were found to be substantially higher downstream in these channels than upstream as a result of groundwater inputs. Surface channels associated with high selenium concentrations coincide with areas where high groundwater water concentrations of selenium were found, namely, the general area of Peters Canyon Wash and its tributaries. High selenium concentrations are also found in deeper groundwater in the watershed (IRWD, comment letter, May 2002). This suggests that groundwater cleanup and dewatering operations could be significant sources of selenium to the watershed.

- The OCPFRD investigation of nutrient sources reveals the magnitude of groundwater flow input to surface water. Three major reaches (Peters Canyon Wash, both reaches of San Diego Creek) all contain significant amounts of groundwater in the channel flows.

- The 319(h) study for identifying toxicity source in San Diego Creek watershed (Lee and Taylor 2001a) provides spatial distributions of selenium concentrations in the watershed. San Diego Creek contributes the largest load of selenium to Newport Bay. Of the load from San Diego Creek, Peters Canyon Wash, which collects selenium from selenium-laden shallow groundwater, represents the major source. Nursery channels showed low concentrations during base flow conditions. However, high concentrations were found in the channels during rain events (large flows), suggesting sources existing upstream of the channels. These sources may include runoff from hillsides, open spaces, agricultural lands, and commercial nursery sites. Further studies are needed to identify the sources. During rain events, the selenium load from San Diego Creek-Reach 2 was comparable to that from Peters Canyon Wash, suggesting runoff from open space is a potential source during rain events.

- Atmospheric deposition of selenium is not significant compared to loading from San Diego Creek and other tributaries. Natural selenium concentrations in seawater are unlikely to cause ecological impacts.

Figure D-9 shows sources of selenium in the watershed. The significance of these sources varies, in part depending on the location of discharges and the season of the year (see discussion in Section III, Source Analysis). In general, groundwater seepage/infiltration represents a significant and constant source. Runoff from open space, hillsides, and agricultural lands could be significant sources during rain events. Nursery runoff contains relatively low concentrations of selenium (< 7 µg/L) in dry weather yet are potential sources during storms.

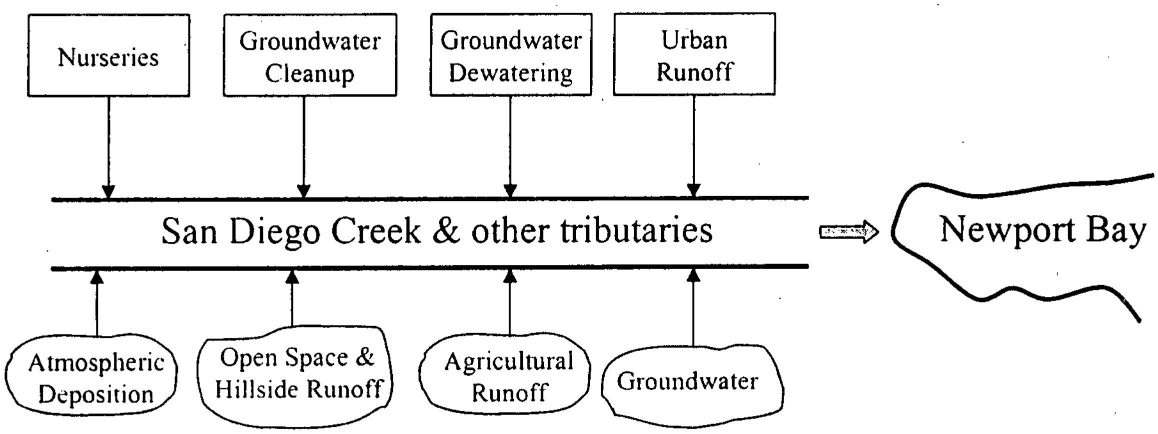


Figure D-9. Sources of selenium in the Newport Bay/San Diego Creek watershed. Sources in boxes are point sources, others are non-point sources.

IV. Approach to Calculating Loads

In southern California, a Mediterranean climate prevails, with dry summer and wet winter seasons. As a result, water bodies typically experience distinctly different seasonal flows and pollutants loads. In the dry season, surface channels in the watershed are mostly at their base flow conditions except those days when rain events take place. In the wet season, rain events occur more frequently than in the dry season. Contributions of selenium from different sources vary under different flow conditions, resulting in variations in water quality (see Section III, Source Analysis). For this reason, flow-based load allocations are developed to achieve the calculated TMDL. Specifically, the annual flow spectrum at Campus Drive in SDC is divided into four flow tiers and loading capacities for each flow tier are allocated to identified pollutant sources. The breakpoints of the flow tiers are based on a statistical analysis of flow records in San Diego Creek at Campus Drive (see TSD—Part B for freshwater flow analysis).

Computation Methodology

The following is the step-by-step procedure used in estimating the current annual and seasonal selenium loads to Newport Bay. Step *a* defines the dry and wet seasons.

a. Use IRWD monthly data for selenium concentrations at Campus Drive in San Diego Creek. The one-year window, 4/1/98 – 3/31/99, is selected for estimating annual load. **Selenium load from 4/1/98 to 9/30/98 is termed dry season load and the remainder (10/1/98 – 3/31/99) is wet season load.** Annual load is then the combination of the dry season and wet season loads.

b. Use OCPFRD daily flow record for the same time period of analysis as in step *a*.

c. Take natural log of the concentration data from step *a*.

d. Calculate means (μ) and variances (s^2) of the natural logs obtained from step *c*.

e. Use the following formula to calculate expected values *ev* (also known as mean of the concentrations) for dry and wet seasons.

$$ev = e^{\left(\mu + \frac{s^2}{2}\right)}$$

Calculate upper and lower confidence limits, x_{hi} and x_{lo} from μ, s, and standardized normal deviate, z.

$$x_{hi} = e^{(\mu + zs)}, \qquad x_{lo} = e^{(\mu - zs)}$$

The value of z corresponds to a given probability of exceedence, which can be converted to a confidence level. For a confidence level of 90%, the z value corresponding to 0.90 is 1.28 (obtained from a standard normal distribution table).

f. Calculate expected selenium loads by multiplying the expected values (mean of concentrations) from step *e* by flow volumes from step *b* for both dry and wet seasons. Expected selenium loads are converted to pounds (lbs) using conversion factor 1 µg/L*cfs = 0.0054 lbs/day.

g. Repeat step *g* to obtain 90% confidence limits for expected selenium loads for dry and wet seasons by substituting the expected values with the confidence limits from step *f*.

Table D-2. IRWD monthly monitoring data and calculated daily load based on OCPFRD flow records from April 1998 to March 1999.

Date	Flow (cfs)	Se Conc. (ug/L)	Daily Load (lbs/day)
04/16/98	20	64.57	6.97
05/21/98	18	23.68	2.30
06/16/98	24	38.12	4.94
07/07/98	9.5	40.49	2.08
08/12/98	16	33.82	2.92
09/01/98	14	30.72	2.32
10/27/98	13	43.74	3.07
11/18/98	7.7	49.61	2.06
12/15/98	3.8	36.87	0.76
01/07/99	15	36.97	2.99
02/23/99	15	42.59	3.45
03/30/99	9.4	52.91	2.69

1 μg/L*cfs = 0.0054 lbs/day.
Complete set of daily flow records for this time period are shown in Appendix A.
Samples for selenium analysis were only collected during base flow and small storm events; therefore, the calculated daily selenium loads do not reflect selenium loading during medium and large storm flows.

Table D-3. Calculations of seasonal and annual loads of selenium using IRWD monitoring data and OCPFRD flow records from April 1998 to March 1999.

Date	Conc. (ug/L)	Nat. log(conc.)		Dry 4/1/98-9/30/98	Wet 10/1/98-3/31/99	Total 4/1/98-3/31/99
04/16/98	64.57	4.17	Mean	3.60	3.77	
05/21/98	23.68	3.16	Variance, s^2	0.11	0.02	
06/16/98	38.12	3.64	s	0.33	0.15	
07/07/98	40.49	3.70	ev	38.84	43.86	
08/12/98	33.82	3.52	Total flow (cfs)	5704.5	5264.1	
09/01/98	30.72	3.42	**Total Load (lbs)**	**1196.40**	**1246.79**	**2443.18**
10/27/98	43.74	3.78				
11/18/98	49.61	3.90	x_{hi} (90%)	56.37	52.44	
12/15/98	36.87	3.61	x_{lo} (90%)	23.92	35.88	
01/07/99	36.97	3.61	Load for x_{hi} (lbs)	1736.46	1490.80	3227.26
02/23/99	42.59	3.75	Load for x_{lo} (lbs)	736.88	1020.05	1756.93
03/30/99	52.91	3.97				

s = Standard Deviation
ev = Expected Value
x_{hi} = Upper Confidence Limit
x_{lo} = Lower Confidence Limit

Table D-4. Waste Load and Load Allocation Calculations for San Diego Creek Watershed.
(This table provides additional information regarding the allocations defined in Table 4.5 of the summary document.)

Source	4/98-3/99 Loading (lbs/year)	Allocations (lbs/year)					% ALLOCATION[††] (for individual line items in box to left)			
		Tier 1	Tier 2	Tier 3	Tier 4	Annual Total	Tier 1	Tier 2	Tier 3	Tier 4
Wasteload Allocations (WLA)										
MCAS - Tustin		1.55	1.95	1.76	7.90	**13.16**	2.0%	2.0%	1.8%	1.5%
GW Cleanup		6.19	7.81	7.54	36.88	**58.4**	8.0%	8.0%	7.5%	7.0%
Silverado GTF		3.09	3.91	4.02	21.07	**32.1**	4.0%	4.0%	4.0%	4.0%
GW Dewatering		3.87	4.88	4.52	21.07	**34.3**	5.0%	5.0%	4.5%	4.0%
other GW facilities		0.39	0.49	0.50	2.63	**4.0**	0.5%	0.5%	0.5%	0.5%
Stormwater permit (MS4)		0.39	0.98	1.00	5.27	**7.6**	0.5%	1.0%	1.0%	1.0%
WLA Sub-total		15.47	20.01	19.34	94.83	**149.66**				
Load Allocations (LA)										
Hines Nursery		1.1	1.4	1.5	7.8	**11.9**	4.0%	4.0%	4.0%	4.0%
Bordiers Nursery		0.6	0.7	0.7	3.9	**5.9**	4.0%	4.0%	4.0%	4.0%
El Modeno Gardens		0.2	0.3	0.3	1.6	**2.5**	4.0%	4.0%	4.0%	4.0%
Nakase Nursery		0.4	0.4	0.5	2.4	**3.7**	4.0%	4.0%	4.0%	4.0%
AKI		0.1	0.1	0.1	0.5	**0.8**	4.0%	4.0%	4.0%	4.0%
Unpermitted nurseries		0.7	0.9	0.9	4.9	**7.4**	4.0%	4.0%	4.0%	4.0%
Nursery Sub-total		3.1	3.9	4.0	21.1	**32.1**				
Agriculture Runoff		5.4	7.3	8.0	44.8	**65.6**	7.0%	7.5%	8.0%	8.5%
Undefined Sources[1]		53.4	66.4	69.1	366.2	**555.0**	69.0%	68.0%	68.8%	69.5%
LA Sub-total		61.9	77.6	81.1	432.0	**652.6**				
Total allocations[2]	**2443[3]**	**77.4**	**97.6**	**100.5**	**526.8**	**802.3**				

Cutoff flow	Load %[†]
0 (cfs)	5 & 20[¥] (μg/L)
20	9.6%
181	12.2%
814	12.5%
> 814	65.7%

[¥]The NTR acute criterion of 20 ug/L is only applied to large flows (>814 cfs) with an average annual duration of 3 days.

89.145 MOS

891.45 TMDL

[1] Undefined Sources: Open space and hillside runoff, shallow GW, in-bay selenium. Atmospheric deposition has NOT been included as data indicates that this contribution is negligible.
[2] The flow tier total allocations are based on percentages shown in upper right hand corner (see †). Individual allocations per tier are further calculated using values in %allocations columns (see ††).
[3] Annual load from Table D-3.

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Appendix A — Daily flow records for San Diego Creek at Campus Dr. (OCPFRD data, March 1998 to April 1999) used for calculating current selenium load estimates in Table D-2

Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)
03/01/98	88	04/20/98	22	06/09/98	20	07/29/98	18
03/02/98	75	04/21/98	22	06/10/98	19	07/30/98	15
03/03/98	80	04/22/98	22	06/11/98	32	07/31/98	16
03/04/98	65	04/23/98	22	06/12/98	45	08/01/98	15
03/05/98	37	04/24/98	22	06/13/98	21	08/02/98	15
03/06/98	38.5	04/25/98	22	06/14/98	18	08/03/98	14
03/07/98	40	04/26/98	21.5	06/15/98	17	08/04/98	15
03/08/98	34	04/27/98	21	06/16/98	19	08/05/98	14
03/09/98	33	04/28/98	21	06/17/98	21	08/06/98	15
03/10/98	31	04/29/98	22	06/18/98	19	08/07/98	16
03/11/98	31.5	04/30/98	23	06/19/98	18	08/08/98	16
03/12/98	32	05/01/98	20	06/20/98	19	08/09/98	16
03/13/98	114	05/02/98	21	06/21/98	15.5	08/10/98	15
03/14/98	465	05/03/98	21	06/22/98	12	08/11/98	15
03/15/98	42	05/04/98	24	06/23/98	16	08/12/98	16
03/16/98	39.5	05/05/98	484	06/24/98	13	08/13/98	15
03/17/98	37	05/06/98	255	06/25/98	13	08/14/98	16
03/18/98	33	05/07/98	26	06/26/98	13.5	08/15/98	14
03/19/98	31	05/08/98	26	06/27/98	14	08/16/98	13
03/20/98	32	05/09/98	19	06/28/98	13	08/17/98	14
03/21/98	31.5	05/10/98	17	06/29/98	14	08/18/98	13
03/22/98	31	05/11/98	233.5	06/30/98	12	08/19/98	14
03/23/98	26	05/12/98	450	07/01/98	12	08/20/98	12
03/24/98	24	05/13/98	678	07/02/98	9.4	08/21/98	15
03/25/98	1110	05/14/98	46	07/03/98	9.7	08/22/98	15
03/26/98	582.5	05/15/98	30	07/04/98	10	08/23/98	14
03/27/98	55	05/16/98	24.5	07/05/98	9.5	08/24/98	13
03/28/98	322	05/17/98	19	07/06/98	11	08/25/98	13
03/29/98	60	05/18/98	17	07/07/98	9.5	08/26/98	16
03/30/98	41	05/19/98	17	07/08/98	7.8	08/27/98	15
03/31/98	475	05/20/98	18	07/09/98	9.6	08/28/98	16
04/01/98	373	05/21/98	17.5	07/10/98	14	08/29/98	11
04/02/98	75	05/22/98	17	07/11/98	11	08/30/98	11
04/03/98	40	05/23/98	18	07/12/98	10	08/31/98	11
04/04/98	40	05/24/98	18	07/13/98	10	09/01/98	14
04/05/98	35	05/25/98	17	07/14/98	11	09/02/98	16
04/06/98	35.5	05/26/98	18	07/15/98	9.4	09/03/98	18
04/07/98	36	05/27/98	19	07/16/98	9.6	09/04/98	28
04/08/98	55	05/28/98	18	07/17/98	11	09/05/98	17
04/09/98	54	05/29/98	22	07/18/98	11	09/06/98	11
04/10/98	30	05/30/98	20	07/19/98	10	09/07/98	11
04/11/98	57.5	05/31/98	21	07/20/98	11	09/08/98	11
04/12/98	85	06/01/98	22	07/21/98	12	09/09/98	12
04/13/98	31	06/02/98	21	07/22/98	15	09/10/98	12
04/14/98	26	06/03/98	22	07/23/98	13	09/11/98	13
04/15/98	24	06/04/98	20	07/24/98	16	09/12/98	13
04/16/98	31.5	06/05/98	20	07/25/98	17	09/13/98	14
04/17/98	19	06/06/98	20.5	07/26/98	16	09/14/98	14
04/18/98	21	06/07/98	21	07/27/98	14	09/15/98	14
04/19/98	20	06/08/98	20	07/28/98	16	09/16/98	14

Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)
09/ 17/ 98	15	11/ 06/ 98	17	12/ 26/ 98	4.4	02/ 14/ 99	15
09/ 18/ 98	18	11/ 07/ 98	15	12/ 27/ 98	4.3	02/ 15/ 99	16
09/ 19/ 98	18	11/ 08/ 98	452	12/ 28/ 98	4.5	02/ 16/ 99	16
09/ 20/ 98	17	11/ 09/ 98	11	12/ 29/ 98	4.3	02/ 17/ 99	16
09/ 21/ 98	17	11/ 10/ 98	7.8	12/ 30/ 98	9.7	02/ 18/ 99	16
09/ 22/ 98	19	11/ 11/ 98	8.8	12/ 31/ 98	12	02/ 19/ 99	16
09/ 23/ 98	19	11/ 12/ 98	7.7	01/ 01/ 99	12	02/ 20/ 99	16
09/ 24/ 98	19	11/ 13/ 98	7.2	01/ 02/ 99	12	02/ 21/ 99	17
09/ 25/ 98	19	11/ 14/ 98	7.3	01/ 03/ 99	15	02/ 22/ 99	15
09/ 26/ 98	18	11/ 15/ 98	7.4	01/ 04/ 99	13	02/ 23/ 99	15
09/ 27/ 98	18	11/ 16/ 98	7.7	01/ 05/ 99	13	02/ 24/ 99	16
09/ 28/ 98	18	11/ 17/ 98	7.5	01/ 06/ 99	13	02/ 25/ 99	16
09/ 29/ 98	17	11/ 18/ 98	7.7	01/ 07/ 99	15	02/ 26/ 99	16
09/ 30/ 98	20	11/ 19/ 98	7.9	01/ 08/ 99	14	02/ 27/ 99	15
10/ 01/ 98	16	11/ 20/ 98	5.5	01/ 09/ 99	13	02/ 28/ 99	14
10/ 02/ 98	15	11/ 21/ 98	3.7	01/ 10/ 99	13	03/ 01/ 99	88
10/ 03/ 98	17	11/ 22/ 98	4	01/ 11/ 99	14	03/ 02/ 99	75
10/ 04/ 98	16	11/ 23/ 98	4.1	01/ 12/ 99	14	03/ 03/ 99	80
10/ 05/ 98	15	11/ 24/ 98	4.1	01/ 13/ 99	13	03/ 04/ 99	65
10/ 06/ 98	14	11/ 25/ 98	4.1	01/ 14/ 99	14	03/ 05/ 99	37
10/ 07/ 98	15	11/ 26/ 98	4	01/ 15/ 99	14	03/ 06/ 99	38.5
10/ 08/ 98	18	11/ 27/ 98	3.9	01/ 16/ 99	13	03/ 07/ 99	40
10/ 09/ 98	16	11/ 28/ 98	237	01/ 17/ 99	13	03/ 08/ 99	34
10/ 10/ 98	18	11/ 29/ 98	7.9	01/ 18/ 99	12	03/ 09/ 99	33
10/ 11/ 98	17	11/ 30/ 98	3.9	01/ 19/ 99	11	03/ 10/ 99	31
10/ 12/ 98	16	12/ 01/ 98	348	01/ 20/ 99	44	03/ 11/ 99	31.5
10/ 13/ 98	17	12/ 02/ 98	36	01/ 21/ 99	21	03/ 12/ 99	32
10/ 14/ 98	19	12/ 03/ 98	7.4	01/ 22/ 99	15	03/ 13/ 99	114
10/ 15/ 98	19	12/ 04/ 98	20	01/ 23/ 99	13	03/ 14/ 99	465
10/ 16/ 98	17	12/ 05/ 98	71	01/ 24/ 99	12	03/ 15/ 99	42
10/ 17/ 98	17	12/ 06/ 98	211	01/ 25/ 99	284	03/ 16/ 99	39.5
10/ 18/ 98	17	12/ 07/ 98	6.1	01/ 26/ 99	361	03/ 17/ 99	37
10/ 19/ 98	16	12/ 08/ 98	4.8	01/ 27/ 99	302	03/ 18/ 99	33
10/ 20/ 98	16	12/ 09/ 98	4	01/ 28/ 99	19	03/ 19/ 99	31
10/ 21/ 98	16	12/ 10/ 98	3.7	01/ 29/ 99	16	03/ 20/ 99	32
10/ 22/ 98	15	12/ 11/ 98	3.5	01/ 30/ 99	14	03/ 21/ 99	31.5
10/ 23/ 98	16	12/ 12/ 98	3.6	01/ 31/ 99	243	03/ 22/ 99	31
10/ 24/ 98	16	12/ 13/ 98	3.5	02/ 01/ 99	21	03/ 23/ 99	26
10/ 25/ 98	24	12/ 14/ 98	3.6	02/ 02/ 99	14	03/ 24/ 99	24
10/ 26/ 98	14	12/ 15/ 98	3.8	02/ 03/ 99	13	03/ 25/ 99	1110
10/ 27/ 98	13	12/ 16/ 98	3.9	02/ 04/ 99	28	03/ 26/ 99	582.5
10/ 28/ 98	14	12/ 17/ 98	3.9	02/ 05/ 99	58	03/ 27/ 99	55
10/ 29/ 98	13	12/ 18/ 98	4.1	02/ 06/ 99	16	03/ 28/ 99	322
10/ 30/ 98	13	12/ 19/ 98	14	02/ 07/ 99	14	03/ 29/ 99	60
10/ 31/ 98	12	12/ 20/ 98	24	02/ 08/ 99	13	03/ 30/ 99	41
11/ 01/ 98	13	12/ 21/ 98	5	02/ 09/ 99	38	03/ 31/ 99	475
11/ 02/ 98	13	12/ 22/ 98	5.1	02/ 10/ 99	35		
11/ 03/ 98	13	12/ 23/ 98	6.4	02/ 11/ 99	15		
11/ 04/ 98	13	12/ 24/ 98	8.8	02/ 12/ 99	14		
11/ 05/ 98	14	12/ 25/ 98	9.1	02/ 13/ 99	15		

Appendix B—Surface Channel Selenium Data (4/15/99—5/1/00)

Table D-5. Selenium concentrations in tributaries, creeks, and drains of San Diego Creek (Hibbs and Lee 2000)

Sampling Location	Date	Conc. (ug/L)
Hicks Canyon Wash at confluence with Peters Canyon Wash	05/ 28/ 99	6
Central Irvine Channel at confluence with Peters Canyon Wash	05/ 28/ 99	11
El Modena Channel at Michelle Dr	04/ 15/ 99	<4
El Modena Channel at Michelle Dr	05/ 25/ 99	5
El Modena Channel at Michelle Dr	05/ 28/ 99	9
El Modena Channel at Michelle Dr	06/ 21/ 99	7
El Modena Chanel at confluence with Peters Canyon Wash	08/ 01/ 99	11
Como Channel at confluence with PCW	05/ 28/ 99	42
Como Channel at confluence with PCW	05/ 01/ 00	38
Santa Fe Channel at confluence with PCW	06/ 21/ 99	16
Santa Fe Channel at confluence with PCW	09/ 12/ 99	15
Santa Fe Channel at confluence with PCW	05/ 01/ 00	32
Circ. Drain at Irvine Center Dr at confluence with PCW	08/ 01/ 99	162
Circ. Drain at Irvine Center Dr at confluence with PCW	10/ 31/ 99	141
Valencia (Moffett) Drain at confluence with PCW	08/ 01/ 99	25
Valencia (Moffett) Drain at confluence with PCW	10/ 31/ 99	40
Warner Drain at confluence with Peters Canyon Wash	06/ 21/ 99	33
Warner Drain at confluence with Peters Canyon Wash	08/ 01/ 99	28
Warner Drain at confluence with Peters Canyon Wash	10/ 31/ 99	24
Circ. Drain at Barranca Pkwy at confluence with PCW	07/ 05/ 99	107
San Diego Creek at confluence with PCW	04/ 15/ 99	39
San Diego Creek at confluence with PCW	04/ 15/ 99	15
San Diego Creek at confluence with PCW	04/ 15/ 99	18
Barranca Channel at confluence with SDC	06/ 21/ 99	13
Barranca Channel at confluence with SDC	10/ 02/ 99	12
Lane Channel at confluence with SDC	07/ 05/ 99	25
Lane Channel at McCabe	10/ 02/ 99	21
Lane Channel at McCabe	11/ 08/ 99	18
San Joaquin Channel at confluence with SDC	07/ 05/ 99	11
San Joaquin Channel at confluence with SDC	10/ 31/ 99	9
Sand Canyon Wash at confluence with SDC	10/ 31/ 99	5
Bonita Canyon at confluence with SDC	07/ 05/ 99	14
Santa Ana Delhi Channel at Irvine Ave	07/ 05/ 99	18
San Diego Creek at Campus Dr	10/ 31/ 99	19

Table D-6. Selenium load from groundwater in three drainage channels based on upstream and downstream flow and selenium concentration measurements. (Hibbs and Lee 2000)

Channel	Date	Upstream Flow (cfs)	Upstream Conc. (µg/L)	Downstream Flow (cfs)	Downstream Conc. (µg/L)	Load from groundwater (lb/day)
San Diego Creek Reach 2	08/28/99	1.63	4	2.32	18	0.19
Como Channel	05/01/00	0.0004	<4	0.44	38	0.09
Santa Fe Channel	05/01/00	0.019	<4	0.46	32	0.08

Note: Daily loads of selenium from groundwater are calculated by the differences in loads between downstream and upstream.

Part E—Metals (Cadmium, Copper, Lead and Zinc)

Introduction

This section of the TMDL presents an analysis of the major sources of heavy metals to water bodies of Newport Bay. Information is compiled to develop TMDLs for cadmium in San Diego Creek and Upper Bay only, and for copper, lead and zinc in all waterbodies of Newport Bay including Rhine Channel. The source analysis summarizes monitoring results to provide a preliminary assessment of metal distribution relevant to water quality problems. Although many metals analyses have been completed in all media (water, soil and fish tissue), including toxicity tests which implicate metals as toxicants, no study has been completed to date that clearly establishes the source of any specific metal. Heavy metals are generally attributed to surface runoff from open space and urban areas; yet some metal inputs come from other sources such as nurseries and other agricultural applications within the watershed as well as recreational boat hulls (for copper).

This technical support document (TSD) begins by describing the chemical characteristics of each heavy metal, including aqueous behavior in natural waters. Next monitoring results for each metal in all waterbodies are reviewed and where feasible conclusions are included. Unfortunately, water column sampling methods were not consistent and quality control and quality assurance measures not uniformly completed, so there are some limitations in comparing and interpreting these surface water results. Descriptions and estimates of background sources (natural runoff and ambient seawater) and miscellaneous sources (e.g., copper from boat hulls, nursery applications and direct atmospheric deposition) are included.

The final section of this TSD explains methods used for calculating dissolved metal loads for each water body. This includes methods for determining dissolved metal loadings via the flow-based approach for San Diego Creek as well as the approach for approximating the Newport Bay loading capacity.

I. Physicochemical description of metal toxicants

Copper and Zinc are essential elements for all living organisms but elevated levels may cause adverse effects in all biological species. Cadmium and Lead are presumed to be non-essential elements for life; more importantly, even at extremely low environmental concentrations these elements may create adverse impacts on biota. In fact molecular biology studies have demonstrated that Cd and Pb atoms may substitute for other divalent metals such as Cu and Zn within enzyme binding sites. Biochemical similarities between these atoms suggest that Cd and Pb may also compete with cell surface uptake sites or bind to sulfur and nitrogen donor atoms of various functional groups within the cell. This is more likely to occur in freshwater systems (where dissolved calcium can be low) than in saline water since calcium ameliorates divalent metal toxicity (Playle and Dixon 1993).

Dissolved metals are directly taken up by bacteria, algae, plants, and planktonic and benthic organisms. Dissolved metals can also adsorb to particulate matter in water column and enter aquatic organisms through various routes. Cadmium, copper, lead and zinc may bioaccumulate within lower organisms, yet they do not biomagnify up the food chain as do mercury and selenium (Moore and Ramamoorthy 1984). Of all of these metals, copper is considered the most potent toxin at environmentally relevant aqueous concentrations. Copper is generally more toxic to lower aquatic organisms such as phytoplankton, copepods and ciliates than to birds or mammals because the higher animals seem capable of regulating copper concentrations in tissues (USF&W 1998). Copper is more commonly found in herbivorous fish than carnivorous fish from the same location (USF&W 1998). Copper is used as an aquatic herbicide to reduce algae growth in reservoirs and also applied (via antifouling paints) to boat hulls in marinas.

Importance of speciation in natural waters

The fate and transport of metals in natural waters is influenced by the physical state and chemical complexation of each element. Physical separation methods (i.e., filters) define metals associated with the particulate, colloidal or dissolved phases. Unfiltered or " total" metal samples represent the sum of all size fractions; whereas filtered or " dissolved" samples yield metals in solution. As a general rule, particulate metal concentrations are higher than those in dissolved phase for all metals in these TMDLs. This is based in part on the inherent reactivity of negatively charged particulate matter and positively charged metal ions (Buffle 1989). As outlined in the California Toxics Rule, EPA has defined aquatic life water quality criteria for these metals based on the dissolved fraction of aqueous samples (EPA 2000a); these serve as numeric targets for these TMDLs.

Within the dissolved fraction, metals exist in various chemical forms or species (Buffle 1989). Each divalent metal may exist by itself as the free metal ion (e.g., Cu^{++}) or it may combine with other elements to form inorganic complexes such as other hydroxyl or chloride chemical species (e.g., $CuOH^{+}$ and $Cu(OH)_2$ or $CuCl^{+}$ or $CuCl_2$). Metal-organic forms may also exist dependent on presence of soluble matter such as synthetic chelators, phytoplankton exudates, humic and fulvic acids and other forms of dissolved organic carbon. Metals change chemical forms in freshwater based on pH, temperature, oxygen, organic matter, and biological activity; toxicity is affected likewise. In general, acidic soft freshwaters demonstrate high toxicity to aquatic organisms due to elevated concentrations of free metal ions (e.g., Cu^{++}), the most bioavailable forms. By contrast, slightly alkaline hard freshwaters contain free calcium (Ca^{++}) and magnesium (Mg^{++}) ions to ameliorate divalent metal toxicity. In seawater systems, aquatic chemists have discovered much more metal bound up in organic complexes as compared to inorganic complexes (Bruland *et al.* 1994). For example within estuarine systems dissolved copper results appear to contain 90 to 99% organic complexes, consequently free copper ion concentrations are ca. 100 fold lower than dissolved copper concentrations (Donat *et al.* 1994). Similar results have been estimated for Pb (70 to 95%), Zn (50 to 97%) and Cd (70 to 80%) (Muller 1996, Kozelka and Bruland 1997). Organic complexation in freshwater systems exists and presumably at lower levels in flowing systems than relatively static ones. For primary producers such as phytoplankton, ciliates, copepods, and crab larvae, bioavailability is generally correlated to the free metal ion concentration, thus toxicity is much lower in seawater systems than in freshwater bodies (Sunda et al. 1987).

Sediments contain particulate sorbed metals, often referred to as bulk sediment concentrations. Interstitial porewaters of sediments also contain metals. Such porewaters may contain acid-volatile sulfides in concentrations higher than the combination of certain metals (Cd, Cu, Pb, Ni, Zn) and render that portion unavailable and non-toxic to biota (Di Toro et al. 1992).

II. Monitoring Results

Surface waters
In the past five years, three separate studies have compiled heavy metals monitoring data for freshwater bodies of Newport Bay. Below is a brief review of each study and some comments about sampling techniques relevant to comparisons to water quality standards. As previously noted, it is difficult to make direct comparison of water measurements since quality assurance and quality control was not consistent across each study. A summary of monitoring results for each dissolved metal by waterbody is provided in Tables E -- 1(a - d).

IRWD monitoring data
From Dec. 1997 to March 1999, Irvine Ranch Water District monitored 2 stations on bi-monthly basis. In general results include both wet weather and dry weather conditions, although sampling plan did not target to collect runoff from individual storms. Individual grab samples were collected using trace metal clean techniques and filtered in the laboratory prior to analysis. Thus results are best interpreted as single snap shots of water quality in San Diego Creek and can be compared only to acute (hardness dependent) water quality standards.

319(h) monitoring data
Lee and Taylor (2001a) collected grab samples at 10 sites covering San Diego Creek and Santa Ana-Delhi Channel during three storms and one dry weather event in 2000. Trace metal clean techniques were used; however, hydrographs with indicated collection times (figures A2-8, A3-8, A3-9 therein) reveal samplers missed peak flow conditions. This study provides a decent spatial assessment of metal inputs during slightly elevated flows (ca. 200 cfs). Maximum concentrations for all three metals occur in Santa Ana-Delhi Channel, followed by Costa Mesa Channel and Hines Channel. The authors suggest that elevated concentrations in Hines Channel relative to concentrations measured downstream in San Diego Creek at Campus can be attributed to dilution as more water enters the tributary system from various channels.

OCPFRD monitoring data
Orange County Public Facilities Resource Division (OCPFRD), part of Orange County Environmental Management Agency, has been collecting water samples in the watershed for more than 15 years. For the purposes of developing this TMDL, EPA focused on recent results (past five years), which included monitoring data representing a wide range of flow conditions (i.e., 1998 was an exceptionally high water year due to El Nino conditions and 1999 was a normal water year as discussed more in Technical Support Document - Part B). Total and dissolved results, along with hardness values, for each sampling event were reported in the annual report for the NPDES stormwater permit (OCPFRD 2000). OCPFRD monitoring plans require several (minimum of five) composite samples collected each day over the course of each storm event; as well as grab samples collected throughout the hydrograph during the first flush event of each water year. Dry weather samples are individual grabs. OCPFRD staff to date has not used trace metal clean sampling techniques. Paired data from unfiltered (total metals) and filtered (dissolved metals) provides preliminary evaluation of metal translator values. These translator values were close to 1.2 and therefore we assumed dissolved metals are 80% of the total recoverable results. In addition to summary results presented in Tables E-1(a - d), noteworthy results include: elevated Cu in Lane Channel, Bonita Canyon Channel and Costa Mesa Channel, high Pb in Lane Channel and high Zn in Costa Mesa Channel.

Table E-1a. Dissolved Copper Monitoring Results by Waterbody (ug/L)

Waterbody	Collection dates	Org.	n	Min	Max	Mean	Median
San Diego Creek	1996-00	OCPFRD	91	2.1	100	16.4 ± 14	14.0
	1997-99	IRWD	32	1.7	35.8	13.0 ± 10	12.8
	2000	Lee and Taylor	4	2.4	5.5	3.8	3.5
Santa Ana Delhi	1996-00	OCPFRD	65	9.3	74	22.2 ± 12	18.1
	2000	Lee and Taylor	3	5.0	6.3	6.4	6.3
Upper Bay	1996-00	OCPFRD	83	3.4	29.0	11.0	11.0
	1997-99	IRWD	10	1.2	2.3	1.7 ± 0.4	1.7
Lower Bay	1996-00	OCPFRD	25	8.2	26.3	15.9	16.1
	1997-99	IRWD	6	0.6	3.4	2.3 ± 0.9	2.3

Table E-1b. Dissolved Lead Monitoring Results by Waterbody (ug/L)

Waterbody	Collection dates	Org.	n	Min	Max	Mean	Median
San Diego Creek	1996-00	OCPFRD	90	1.0	70	4.9 ± 10.6	2.0
	1997-99	IRWD	26	0.01	5.1	1.01	0.18
	2000	Lee and Taylor	4	0.05	0.35	0.19 ± ? ?	0.11
Santa Ana Delhi	1996-00	OCPFRD	64	1.0	45	5.3 ± 7.4	2.0
	2000	Lee and Taylor	3	0.03	0.95	0.63	0.90
Upper Bay	1996-00	OCPFRD	83	<2	<20	3.1	2.0
	1997-99	IRWD	10	0.023	0.96	0.44	0.29
Lower Bay	1996-00	OCPFRD	25	<2	<2	<2	<2
	1997-99	IRWD	6	0.03	0.89	0.45 ± 045	0.43

Table E-1c. Dissolved Zinc Monitoring Results by Waterbody (ug/L)

Waterbody	Collection dates	Org.	n	Min	Max	Mean	Median
San Diego Creek	1996-00	OCPFRD	86	5.2	640	46.6 ± 81.9	16.5
	1997-99	IRWD	38	3.5	106	13.7 ± 16.7	12.0
	2000	Lee and Taylor	4	2.6	23.1	13.1	8.2
Santa Ana Delhi	1996-00	OCPFRD	59	10.0	532	95.0 ± 102	57.4
	2000	Lee and Taylor	3	5.4	35.9	31.8	27.7
Upper Bay	1996-00	OCPFRD	83	10	100	19.9	14.5
	1997-99	IRWD	23	2.5	11.5	6.8± 3.1	5.5
Lower Bay	1996-00	OCPFRD	25	8.2	29.5	17.3	16.3
	1997-99	IRWD	13	1.1	44.4	10.6 ± 10.1	7.5

Table E-1d. Dissolved Cadmium Monitoring Results by Waterbody (ug/L)

Waterbody	Collection dates	Org.	n	Min	Max	Mean	Median
San Diego Creek	1996-00	OCPFRD	88	0.5	18	1.7 ± 2.7	1.0
	1997-99	IRWD	32	0.13	0.65	0.31 ± 0.12	0.30
	2000	Lee and Taylor	4	0.13	0.27	0.22	0.20
Santa Ana Delhi	1996-00	OCPFRD	63	<1.0	10.0	1.6 ± 2.9	1.0
	2000	Lee and Taylor	3	0.08	0.14	0.12	0.10
Upper Bay	1996-00	OCPFRD	83	<1.0	<10	1.6 ± 2.2	1.0
	1997-99	IRWD	10	0.095	0.22	0.14 ± 0.04	0.13

Sediments

Sediment monitoring results for both fresh and saltwater bodies are summarized in Tables E-2(a - d). Individual results were compared with sediment quality guidelines appropriate for each water body type; freshwater and saltwater threshold effect levels (TEL) and saltwater probable effect levels (PEL). These TEL and PEL values are from Florida Dept. of Environmental Protection study (MacDonald et al. 1996). Some freshwater sediment metal results within San Diego Creek are above TEL values, most notably Cd. But rarely, if ever, do the sediment metal levels exceed PEL values (OCPFRD 2000). No doubt during heavy storm events, Cd, Cu, Pb and Zn contaminated sediments are transported from freshwater bodies to saltwater bodies in Newport Bay; however, we do not anticipate much dissolved metal fluxes from these freshwater sediments into the San Diego Creek water column.

In saltwater bodies of Newport Bay, some sediment metal concentrations are elevated relative to TEL values. The higher frequencies of exceedances of TEL values occur in Lower Newport Bay and Rhine Channel. Maximum values always occur in Rhine Channel, especially for copper, which frequently (80%) exceeds the PEL value. This observation supports the theory that fluvial transport along the freshwater/saltwater gradient produces higher sediment metal concentrations where sediment deposition is most likely to occur.

Within each water body, sediment metal concentrations fluctuate widely and there is no systematic increase or decrease from long-term trend analyses. Part of this may be attributed to the patchy nature of sampling sediments via grabs as well as the presumption that sediments and associated contaminants shift during major storms. Based on spatial distribution of these bulk sediment chemistry results, one can generalize that metal concentrations are low in freshwater bodies and systematically increase along the saltwater gradient. (Cadmium appears to have contrasting distribution between fresh and saltwater.) Another pattern does exist within Lower Bay, metal sediment concentrations decrease along the west to east gradient. That is, the lowest values occur near Newport Jetty closest to open ocean waters. Maximum levels exist in Rhine Channel, which is not surprising given poor tidal flushing and long residence times (up to 9 days) within this dead-end reach (RMA 2001).

AVS/SEM and porewater results

Two other studies -- BPTCP (1997) and Bight ' 98 (SCCWRP in prep.) assessed relevant sediment metal parameters. In 1996, BPTCP measured acid-volatile sulfides (AVS) and simultaneously extracted metals (SEM) at one site in Rhine Channel. The SEM total was greater than AVS total (6.80 vs. 4.65) with SEMCu about 68% of SEM total value. As part of Bight ' 98, AVS/SEM and interstitial porewater concentrations were measured at 11 Lower Bay sites, excluding Rhine Channel. Since all 11 sites showed consistent results -- AVS totals were greater than SEM totals, one could assume the metals were bound to acid-volatile sulfides. However at half the sites, individual porewater concentrations showed elevated Cu concentrations relative to saltwater chronic CTR value (3.1 ppb), with two sites showing 33.3 ppb and 65.9 ppb. Porewater concentrations for Pb and Zn were below saltwater chronic values, 8.1 ppb and 81 ppb respectively.

In summary, San Diego Creek and Upper Bay sediment metals are not frequently above TEL values, except for Cd. We presume these sediments do not release metals into the water column, rather these sediments are a trap for particulate metals from the water column, thus acting as a sink. This appears to be true for Cd, Pb and Zn in Lower Bay, where porewater concentrations are low. However in the case of copper both sediment bulk levels and interstitial porewater concentrations are elevated. Therefore, benthic fluxes, both resuspension of contaminated particles and porewater releases to sediment/water interface, may be important for copper but not for other metals.

Table E-2a. Copper Sediment Monitoring Results by Waterbody (mg/ dry kg)

Waterbody	Collection dates	Org.	n	Min	Max	Mean	Median	% above TEL/PEL
San Diego Creek	91-99	OCPFRD	172	0.2	53.0	8.5	4.4	4%>TEL
	97-98	IRWD	2	1.0	2.5	--	--	
Upper Bay	91-99	OCPFRD	66	3.0	190.0	23.6	17.0	17%>TEL
	94 & 96	BPTCP	7	5.8	40.80	26.91	35.40	
	00-01	SCCWRP	10	11	58	30.9	25.5	
Lower Bay	91-99	OCPFRD	20	5.0	49.0	25.8	29.5	33%>TEL
	94	BPTCP	11	29.5	240.0	83.7	75.2	
	98	BIGHT	11	10.5	157.4	52.3	39.9	
	99	OGDEN	12	9.5	83	30.8	24	
	00-01	SCCWRP	8	9	130	64.4	63.5	
Porewater	98	BIGHT	9	1.53 ug/L	65.6 ug/L	13.03 ug/L	6.63 ug/L	
Rhine Channel	91-99	OCPFRD	18	29	530	316.5	330	82%>PEL
	94 & 96	BPTCP	2	479	505	--	--	
	00	Coastkeeper	2	170	270	--	--	
	00-01	SCCWRP	2	607	634	--	--	

Freshwater Sediment TEL value for Cu is 36 mg/dry kg.
Saltwater Sediment TEL value for Cu is 19 mg/dry /kg; PEL value is 108 mg/dry kg.

Table E-2b. Lead Sediment Monitoring Results by Waterbody (mg/ dry kg)

Waterbody	Collection dates	Org.	n	Min	Max	Mean	Median	% above TEL
San Diego Creek	91-99	OCPFRD	172	0.8	330	11.3	6.6	6%>TEL
	97-98	IRWD	2	<10	--	--	--	
Upper Bay	91-99	OCPFRD	66	3.3	47	16.8	12.8	5%>TEL
	94 & 96	BPTCP	7	14.2	29.6	20.1	20.4	
	00-01	SCCWRP	10	7	37	18.6	17.5	
Lower Bay	91-99	OCPFRD	20	5.0	36	18.5	18.1	11%>TEL
	94	BPTCP	11	14.8	114	42.6	33.3	
	98	BIGHT	11	7.1	97	37.3	19.8	
	99	OGDEN	12	9.5	51	19.6	13.5	
	00-01	SCCWRP	8	5	30	32.3	22.5	
Porewater	98	BIGHT	9	0.32 ug/L	5.13 ug/L	0.95 ug/L	0.52 ug/L	
Rhine Channel	91-99	OCPFRD	18	26	140	78.5	87.5	54%>TEL
	94 & 96	BPTCP	2	78.1	95	--	--	
	00	Coastkeeper	2	28	58	--	--	
	00-01	SCCWRP	2	72	87	--	--	

Freshwater sediment TEL value for Pb is 35 mg/dry kg.
Saltwater sediment TEL value for Pb is 30 mg/dry /kg; PEL value is 112 mg/dry kg.

Table E-2c. Zinc Sediment Monitoring Results by Waterbody (mg/ dry kg)

Waterbody	Collection dates	Org.	n	Min	Max	Mean	Median	% above TEL
San Diego Creek	91-99	OCPFRD	173	1.0	200	36.2	22.5	4%>TEL
	97-98	IRWD	2	7.4	12	--	--	
Upper Bay	91-99	OCPFRD	66	4.2	210	79.4	67.2	17%>TEL
	94 & 96	BPTCP	7	46.4	171.0	115.3	136.0	
	00-01	SCCWRP	10	48	169	115	108.5	
Lower Bay	91-99	OCPFRD	20	18.0	130.0	82.3	73.5	37%>TEL
	94	BPTCP	11	86.5	460	219.5	209.0	
	98	BIGHT	11	44.5	260	145	149	
	99	OGDEN	12	30	160	75.5	64	
	00-01	SCCWRP	8	31	248	148	152	
Porewater	98	BIGHT	9	3.85 ug/L	10.9 ug/L	6.06 ug/L	6.11 ug/L	
Rhine Channel	91-99	OCPFRD	18	86	340	198	195	38%>TEL
	94 & 96	BPTCP	2	236	303	--	--	
	00	Coastkeeper	2	77	120	--	--	
	00-01	SCCWRP	2	288	366	--	--	

Freshwater Sediment TEL value for Zn is 123 mg/dry kg.
Saltwater Sediment TEL value for Zn is 124 mg/dry /kg; PEL value is 271 mg/dry kg.

Table E-2d. Cadmium Sediment Monitoring Results by Waterbody (mg/ dry kg)

Waterbody	Collection dates	Org.	n	Min	Max	Mean	Median	% above TEL
San Diego Creek	91-99	OCPFRD	170	0.2	7.4	1.0	0.7	46%>TEL
	97-98	IRWD	2	<0.5	--	--	--	
Upper Bay	91-99	OCPFRD	66	0.2	17.0	2.4	1.4	20%>TEL
	94 & 96	BPTCP	7	0.23	1.17	0.75	0.76	
	00-01	SCCWRP	10	1	2	1.3	1	

Freshwater Sediment TEL value for Cd is 0.6 mg/dry kg.
Saltwater Sediment TEL value for Cd is 0.7 mg/dry /kg; PEL value is 4.2 mg/dry kg

Toxicity

Bay Protection Toxic Cleanup Program

The 1994 State Water Board Bay Protection and Toxic Cleanup Program (BPTCP) results showed Upper Bay, Lower Bay and Rhine Channel sediments were toxic to some forms of aquatic life (two amphipods and fertilization and embryo development of sea urchins). Toxicity was highly significant in both bulk sediments and interstitial porewater at some locations. Direct cause of toxicity was not assessed but statistical correlation was found between toxicity to two amphipod species and sea urchin larvae and elevated levels of numerous chemicals, including copper, lead, and zinc. Benthic organism degradation was also assessed in this study and there was correlation between lower infaunal index and elevated levels of copper (and other organic compounds).

Bight '98
The Southern California Bight Regional Monitoring Project (Bight ' 98, coordinated by SCCWRP) provides an integrated assessment of Southern California coastal estuaries. Sediments were highly or moderately toxic at 9 of 11 sites in Lower Newport Bay, with no toxicity at two sites close to Newport jetty. Sediment elutriate results yielded toxicity at 7 of 11 sites (Bay et al. 2000). Cause of toxicity was not determined in this study. Benthic degradation was evident at 7 of 11 sites. Correlation of toxicity and chemistry results has also not been completed, in part because some chemistry results are being validated. Nonetheless, bulk sediment metal results (discussed above) indicate elevated levels of copper, lead and zinc at some Lower Bay stations.

Southern California Coastal Water Research Project
Recently, the Southern California Coastal Water Research Project (SCCWRP) has been contracted by Regional Board to complete toxicity identification evaluations (TIEs) of salt waterbodies, including Rhine Channel. Results of this two-year project (still in progress) have consistently detected toxicity (to amphipods and sea urchin larvae) at 8 of 10 sites during September 2000 and May 2001 sampling events (SCCWRP 2001a). Bulk chemistry results are included in these Toxics TMDLs (see Tables E-2 (a -- d) above). Thorough TIE studies in Upper Bay and Rhine Channel are currently in progress and will investigate if metals and/or priority organics are possible causes.

Background

Metals are associated with open-hillside, soils, groundwater, seawater and atmospheric deposition, therefore input of metals via background sources must be evaluated and included in the development of these TMDLs.

Background metals in surface runoff
To date, the best available data for estimating the contribution from runoff of open hillside soils comes from the 319(h) study (Lee and Taylor 2001a). EPA selected dissolved metal results for San Joaquin Channel to provide metal concentrations associated with open spaces. This site was described as 90% open space and 10% agriculture (see Table E-7). No samples were collected during dry weather conditions from this site or any other viable open space site. The range and mean values from this site for two wet weather sampling events are provided in Table E-3. We acknowledge the preliminary nature of these results, yet for lack of other data, we have utilized the mean wet weather values to estimate freshwater (dissolved) loads for medium and high flow tiers.

Table E-3. Metal concentrations in natural soil runoff at San Joaquin Channel

Metal	Range (ug/L)	Mean (ug/L)
Dissolved Cd	0.13 – 0.22	0.17
Dissolved Cu	6.3 – 8.0	7.2
Dissolved Pb	0.097 – 0.13	0.11
Dissolved Zn	7.5 – 16.4	12.0

(source: Lee and Taylor 2001a)

In the summary TMDL document, EPA adjusted OCPFRD estimates of total metals stormwater loads for San Diego Creek and Santa Ana-Delhi Channel using literature values of natural versus anthropogenic contributions. This adjustment was based on information reported by Schiff and Tiefenthaler (2000) who recorded freshwater flows and measured total metals in storm runoff of Santa Ana Watershed, which neighbors the Newport Bay watershed. [This study is the best proxy since no reliable direct measurements of soil runoff within Newport Bay watershed exist to date.] This report provides an assessment of anthropogenic versus natural emissions of metals within surface runoff during the 1998 water year. Using an iron normalization technique, the authors state that Cd, Cu, Pb and Zn were most enriched (33-63%), whereas Cr and Ni were the least enriched (0.5 to 0.7%) due to anthropogenic contributions. Anthropogenic contributions of metals in surface runoff were estimated to be these amounts: 63% (Cd); 42% (Cu); 38% (Pb); 33% (Zn). Percent natural contributions, event mean concentrations (EMC) and median EMCs are summarized in Table E-4.

Table E-4. Total metal results from stormwater monitoring in Santa Ana River Basin in 1998

Metal	Estimate natural (%)	Minimum EMC (ug/L)	Median EMC (ug/L)
Total Cd	37	0.07	0.37
Total Cu	58	7.02	23.3
Total Pb	62	4.07	14.99
Total Zn	67	29.03	93.78

(source: Schiff and Tiefenthaler 2000)

These percent natural contributions have *not* been utilized for developing these dissolved metals TMDLs, since the results were derived from total metals samples.

Groundwater

Remedial Investigation/Feasibility Studies completed at El Toro MACS provide concentration ranges of background contributions of heavy metals in local groundwater. Results range from <2 ug/L for Pb, 4 ug/L for Cd, 21 ug/L for Cu, and 88 ug/L for Zn. Unfortunately these background levels are for unfiltered samples (total metals) collected without using trace metal clean techniques and therefore these results are not reliable for use for these dissolved metals Toxics TMDLs.

Other sources of groundwater data for dissolved metals from shallow (<50 bgs) monitoring wells have yet to be identified within the Newport Bay watershed.

Background metals in ambient seawater

Surface seawater contains metals due to several sources: coastal runoff, ocean upwelling, atmospheric deposition to sea surface, etc. [EPA has designated ambient surface seawater as source of metals but has opted to not differentiate between natural and anthropogenic contributions to surface seawater.] Dissolved metal concentrations in ambient surface seawater are generally quite low (either ppb or less). The range of dissolved metal concentrations in various coastal systems has been reported by Cutter (1991), with more local data supplied from samples collected offshore the Southern California Bight (pers. comm., R. Gossett). Table E-5 that summarizes dissolved metal concentrations in various seawater samples and mean results for Upper Newport Bay water column samples (IRWD 1999) are included for comparison.

Table E-5. Dissolved metal concentrations in saline waters (ug/L)

metal	Calif. Coastal seawater (CRG Lab)	Upper Newport Bay Mean value (IRWD 1999)	Range in Coastal waters (Cutter 1991)
Dissolved Cd	0.1	0.14	0.002 – 0.095
Dissolved Cu	1.4	1.7	0.3 – 3.8
Dissolved Pb	0.1	0.44	0.004 – 0.19
Dissolved Zn	4.1	6.8	0.3 – 30

see text for references

Obviously, inputs of metals from ambient seawater need to be included when determining the background contributions of metals to saline waterbodies of Newport Bay. These inputs are contingent on tidal influences and freshwater flows from San Diego Creek, Santa Ana Delhi Channel and other drainages. During high tides and low freshwater flows, surface seawater contributions would be at their highest levels, whereas during low tides concurrent with storm events would yield much lower contributions from ambient seawater. EPA has used coastal seawater results (CRG Lab) results to approximate inputs from ambient seawater.

III. Source Analysis

OCPFRD estimates

In the 2000 *NPDES Annual Report*, OCPFRD included estimates of total metal stormwater loading from Santa Ana-Delhi Channel, San Diego Creek and two of its tributaries. These estimates are based on monitoring results of unfiltered (composite) water samples and flow measurements at each sampling station collected during wet weather events in each water year. Unfortunately, these total load results do not represent annual loads since not all storm events were samples in the water year. Estimates for 1998 are considered exceptionally high due to El Nino conditions (38.4 inches of rain); whereas 1999 is a slightly dry year (8.8 inches) in comparison to average annual rainfall (13.3 inches) at Tustin/Irvine Ranch site. Table E-6 summarizes these total stormwater load estimates, gives the mean and includes adjustments to display the man-made inputs (Zn = 33.3%, Cu = 41.5%, Pb = 38.3%) as determined by Schiff and Tiefenthaler (2000). No estimates of Cd loading are included in OCPFRD *Annual Report*.

Table E-6. OCPFRD estimates of total metal stormwater loads for San Diego Creek and Santa Ana-Delhi Channel.

Element/ Stn Name	1998 Water year (lbs)	1999 water year (lbs)	2001 water year (lbs)	mean total load (lbs)	Adjusted total load (man-made input) (lbs)
Zn @ PCW	21,575	1306	2964	8615	2869
Zn @ WYL	18,790	1582	3937	8103	2698
Zn @ SDC	63,021	3784	7900	29,908	9957
Zn @ SAD	7031	805	2175	3337	1111
Cu @ PCW	5059	332	862	2084	865
Cu @ WYL	4519	402	956	1959	813
Cu @ SDC	15,087	1643	2020	6250	2594
Cu @ SAD	1643	185	492	770	320
Pb @ PCW	2924	169	356	1150	440
Pb @ WYL	2184	166	407	919	352
Pb @ SDC	10,385	449	1188	12,022	4604
Pb @ SAD	1297	124	369	1790	686

PCW = Peter' s Canyon Wash; WYL = San Diego Creek @ Culver;
SDC = San Diego Creek@ Campus; SAD = Santa Ana-Delhi Channel
All results in represent total metals in lbs; for sampled wet weather events only
Adjusted mean = reported mean – % natural calculated from Schiff and Tiefenthaler (2000)

319(h) report

As part of the 319(h) report, Lee and Taylor (2001a) provide estimates of copper loadings based on grab sampling results during two separate storm events in 2000. The authors state that in general the metals data exhibit the highest contributions from " urban stations" and agriculture/ open space exhibiting the lowest loadings. They acknowledge the impracticality of making load calculations using grab samples [their methods] as opposed to composite samples [OCPFRD methods], stating " rigorous total load calculations would include the use of constituent concentrations calculated from flow-weighted composite samples taken over the entire runoff hydrograph...Copper loads may be better characterized by OCPFRD NPDES permit stormwater runoff data than the limited single grab sample analysis performed here." Nonetheless, using copper data from Feb. 21, 2000 storm event and corresponding flow data from OCPFRD, the authors estimate metal loadings from specific areas of the watershed. More intriguing are the approximations of total copper loads per acre of tributary drainage area; these provide an estimate of the relative contributions of land uses that are represented at each sampling site. Table E-7 summarizes the dissolved and total copper loads as well as the dominant land use associated with each sampling station.

Table E-7. Land Uses and Total Copper loads for One Storm Event (Feb. 21, 2000)

Sampling station	Dissolved Cu Load (lbs.)	Total Cu load (lbs.)	Total Copper per acre (lbs./acre x 10^{-5})	Dominant land use
San Diego Creek @ Campus	16	159	234	Mixed residential, agricultural, nursery
San Diego Creek @ Harvard	10	169	629	Mixed residential, agricultural, nursery
Peters Canyon Wash @ Barranca	7	39	136	Mixed residential, agricultural, nursery
Hines Channel @ Irvine Blvd	0.2	0.6	94	Nursery, agricultural
San Joaquin Channel @ University	0.2	1.2	136	Agricultural, open space
Santa Ana Delhi	8	28	252	Residential, commercial
El Modena-Irvine Channel	4	8	104	Residential, commercial
Sand Canyon Avenue	N/a	N/a	59	Agricultural
East Costa Mesa @ Highland	N/a		91	Residential, commercial
Central Irvine Channel	N/a	N/a	101	Agricultural, residential, nursery

(Source: Lee and Taylor 2001a)

For the purposes of these *dissolved* metal TMDLs, it is possible to convey dry weather load estimates provided by Lee and Taylor as part of the same 319(h) study (2001a). These dry weather results are based on one filtered grab sample collected during one sampling event and extrapolated use of stream flow volumes (OCPFRD data) recorded during the entire dry season. Table E-8 summarizes the dissolved copper results and for comparison, we include our estimates of dissolved Cu load from the baseflow and small flow tiers as calculated in section IV of this TSD.

Table E-8. Dissolved Copper loads within Newport Bay watershed

Sampling station	Estimated dry weather Dissolved Cu load* (lbs.)	Baseflow and small flow tier Dissolved Cu Load # (lbs.)
San Diego Creek @ Campus	122.5	1031
San Diego Creek @ Harvard	N/a	--
PetersCynWash @ Barranca	77.65	--
Santa Ana Delhi	238.4	163

*estimated (based on one dry season sample and dry flow records for entire year), source Lee and Taylor 2001a);
#value approximated from chronic targets for base and small flow tiers multiplied by associated flow volumes used in these TMDLs

Metal inputs from Point Sources vs. Non-point sources

Within the Newport Bay watershed, one can reasonably assume the vast majority of metals contributed to fresh and saltwater bodies arise from non-point sources. There are no direct discharges from wastewater treatment plants into San Diego Creek and Newport Bay as is typically true for other waterbodies. There are some discharges of groundwater treatment (cleanup or dewatering) facilities. One study performed in Santa Clara California, identified some of the (non-point) sources of heavy metals from an urban watershed – Lower San Francisco Bay (Woodward-Clyde 1998). Urban road runoff from roads is believed to be the largest contributor of cadmium (tires), copper (brakes and tires), lead (brakes, tires, fuels and oils) and zinc (tires, brakes, auto frame). Secondary contributions come from contaminated sediments, atmospheric deposition and miscellaneous sources, such as antifouling paints from recreational boats. All of these are likely to exist in the Newport Bay watershed.

The possibility remains that individual sites with elevated metal levels may contribute metals to neighboring surface waters, via surface runoff or contaminated groundwater flows. To unveil such contaminated sites EPA has conducted a comprehensive survey of existing databases listing contaminated sites within the Newport Bay watershed. Databases included USEPA National Priority List (NPL), Comprehensive Environment Responsibility, Compensation, and Liability System (CERCLIS), California Department of Toxic Substances Control (DTSC) Calsites and Orange County hazardous material or incidental spill sites (E&I sites). A complete list of sites and associated toxicants is presented in Appendix A. Discussion below narrows the complete survey to information relevant only to metal (Cd, Cu, Pb, Zn) contamination. Information is presented for future exploration/verification of possible metal contaminated runoff from these sites.

Of the Federal sites (NPL and CERCLIS), where preliminary investigations have been completed, only two, Orange Coast Plating and El Toro Military Base, have been shown to have metal contamination. The Orange Coast Plating facility (in Santa Ana) was remediated via soil excavation and surface paving in 1987. It is currently under State regulation and seems unlikely to release trace metals into surface runoff.

Review of RI/FS documents pertaining to El Toro MCAS identified several " hot spots" for heavy metal contamination. Three sites in particular have soil samples with levels in excess (as high as 60x) of background levels. Battery disposal area had high Pb (923 mg/kg dry) and Zn (288 mg/kg dry); Drop Tank Drainage area had high Zn (1760 mg/kg dry) and Cu (548 mg/kg dry) and Materials Management area had high Zn (507 mg/kg dry). No excessive levels of Cd existed in these results. Remediation has either occurred or is planned (pers. comm., M. Smits). To establish if these or other heavy metal hot spots at El Toro are indeed sources one would have to investigate surface runoff during various storm conditions from MCAS base into Marshburn Channel, Borrego Canyon Wash and Agua Chinon Wash. Therefore uncertainty exists if heavy rainfall and subsequent runoff from El Toro sites would transport dissolved and particulate metals into nearby channels, and eventually flow into San Diego Creek.

Tustin Marine Corp Air Station has already remediated metal hotspots (Pb soils); therefore, heavy metal releases into surface runoff and San Diego Creek waterways are believed to be minimal.

Thirty two California DTSC Calsite facilities are located within the watershed, three of which are associated with metal contamination (Appendix A). Two Calsites have very small quantities (Pb soils in planter boxes) and have undergone voluntary cleanups.

Three of twenty four County E&I sites – emergency incidents and industrial clean-ups – were listed for metal contamination; however, these sites (Appendix A) have been remediated or cited that small quantities of surface runoff contamination is likely.

Atmospheric deposition

Deposition of airborne particles may be responsible for contributing specific heavy metals to Newport Bay. Deposition can occur directly as particles settle onto the wet surface or indirectly as they settle on land and are subsequently washed or blown into Upper and Lower Bay. These toxic chemicals are then added to the burden of chemicals in water surface microlayer (a 50 micron boundary layer between atmosphere and water), the water column and/or the sediments. The resultant increase in toxicity may affect aquatic life in Newport Bay. For these TMDLs we have included direct deposition of metal—via both dry and wet processes to surface waters of Upper and Lower Bay, including Rhine Channel. We have not included indirect deposition (fallout or washout to watershed land and subsequent fluvial transport) since it is included in surface runoff concentrations which have already been measured and corrected by background levels.

Average rainfall at Tustin/Irvine weather station is 13 inches per year. EPA used literature cited values from metal deposition studies of San Francisco Bay (Tsai et al. 2001) and Santa Monica Bay (Stolzenbach, et al. 2001). Those studies provide mean dry and wet deposition results for Cu, Pb and Zn. Other studies have included assessments for Cd (Sweet et al. 1997; Golomb et al.1997) which were very small corresponding values so we have disregarded air deposition of Cd for this TMDL. In short this contribution is minimal relative to Cd inputs from other sources, e.g., tributary loading and sediment remobilization.

Saltwater body surface area estimates included mean tidal area of Upper Bay (372.5 acres = 1.5 million sq. meters), Lower Bay (790.2 acres = 3.2 million sq. meters) and Rhine Channel (15.2 acres = 61,000 sq. meters) (GIS data, City of Newport Beach).

Table E-9 Direct Deposition of Metals to surface of Newport Bay

Metal	Dry Dep (ug/m2/day)	Wet Dep (ug/L)	Total air dep. (lbs/yr)
Cd	0.061*	0.4*	3.5
Cu	0.29	2.16	100.7
Pb	0.16	1.47	68.4
Zn	53.57	8.7	606.1

(source: *Tsai et al. 2001; all other values from Stoltzenbach et al. 2001)

Recreational Boats (for Cu)

EPA has utilized information from San Diego RWQCB Dissolved Copper TMDL (for Shelter Island Yacht Basin) to estimate copper inputs from recreational boats to Newport Bay. The San Diego TMDL, currently in draft status, provides dissolved copper loading equations for both passive leaching from wetted hull surfaces and from underwater hull cleaning (i.e., wiping down the wetted surface to remove marine growth). Briefly, EPA has applied local conditions (number of moored boats) for Newport Bay, assumed similar mean boat length and wetted surface area and used equations from the San Diego TMDL to give preliminary estimates of dissolved copper loads per year. Passive leaching contributes approximately 35,000g/day (77 lbs/day) and hull cleaning about 27,279 g/day (60 lbs/day). More explicit details for these calculations are provided in Section IV of this TSD.

Summary of Monitoring results and Source analysis

- In freshwater bodies, water column measurements of dissolved metals exceed water quality standards during wet weather events. Sediment metal concentrations rarely exceed TEL values in freshwater bodies, except for Cadmium. Sediment metal levels generally increase along the freshwater to saltwater gradient, with maximum levels found in Rhine Channel. Porewater results indicate fluxes of dissolved copper may occur at levels of concern within Lower Bay, but this is unlikely for other metals. Transport of metals from fresh to saline systems may contribute to toxicity problems observed in Newport Bay sediments.
- OCPFRD loading estimates, uncorrected for anthropogenic inputs and based on unfiltered composite samples collected during storm events, demonstrate direct relationship with flow conditions; i.e., heavy storm years yield high metal loads in surface runoff. Inputs from San Diego Creek (90%) far outweigh those from Santa Ana-Delhi Channel (10%). For two tributaries of San Diego Creek, Peters Canyon Wash (54%) contributes slightly more heavy metals than those from waters upstream of San Diego Creek at Culver (46%).
- Lee and Taylor (2001a) estimates of metal loading are generally lower than OCPFRD' s, however there are differences in sampling techniques and collection approach (grabs versus composites). Dissolved metal levels are much lower than those measured in total (unfiltered) metals samples. It is difficult to utilize the 319(h) results to approximate stormwater loads of dissolved metals due to lack of adequate monitoring during peak flows (Lee and Taylor 2001a). Nonetheless, dramatic decreases in metal concentrations during all weather conditions may occur if trace metal clean sampling methods are utilized by all those sampling for metals in surface or groundwaters with Newport Bay and the surrounding watershed.
- Assessment has included ambient surface seawater results as well as approximate open space runoff contributions. Based on unfiltered samples, total metal results may be adjusted to demonstrate anthropogenic contributions, Zn = 33%, Pb = 38%, Cu = 42%, Cd = 63% (Schiff and Tiefenthaler 2000). To date, no useful groundwater results exist within the San Diego Creek watershed. Air deposition and ambient seawater sources are deemed to be minor sources to Newport Bay.
- Using TMDL studies nearly completed in San Diego Bay, recreational boat hulls may be the single largest contributor of dissolved copper in saltwater bodies of Newport Bay. Our extrapolation of methods presented in the San Diego yacht harbor for passive leaching and underwater hull cleaning suggest as much as 80% of all copper inputs to Newport Bay. These preliminary results suggest that dissolved copper from boat hulls is a significant non-point source in Lower Bay and may be carried into Upper Bay with tidal flows.

Table E-10. Summary of (estimated) metal inputs to San Diego Creek (lbs/yr)

	Cd	Cu	Pb	Zn
Stormwater[1]	N/a	6250	12,022	29,908
Groundwater[2]	Unknown	Unknown	Unknown	Unknown
Nurseries/ Other ag.[3]		214		4
Open space runoff[4]	221	622	335	12,392
Total	>221	>7086	>12,357	>42,304

[1] total metal loads from stormwater samples -- not adjusted (OCPFRD 2000)
[2] inputs from groundwater could be significant although reliable monitoring data from numerous sites in the watershed are required for assessment
[3] value is approximation of total metals applied to all agriculture crops in watershed, equivalent to twice the value of total metals applied by three nurseries in 1996 (Lee and Taylor 2001b)
[4] dissolved metals, based on San Joaquin Channel mean concentration reported in 319 (h) study (Lee and Taylor 2001a) multiplied by medium and large flow tier volumes.

Table E-11. Summary of Total metal inputs to Newport Bay (lbs/yr)

	Cd	Cu	Pb	Zn
freshwater[1]	N/a	7020	13,812	33,245
Recreational Boats [2]	negligible	50,114	negligible	Unknown
Air deposition[3]	3.5	101	68.4	606
Ambient seawater[4]	389	777	233	9330
Porewater[5]	negligible	Unknown	negligible	negligible
Total	393	58,002	14,113	43,181

[1] sum of total metal loads from stormwater samples collected in 2000 from San Diego Creek and Santa Ana-Delhi (OCPFRD)
[2] preliminary estimate of dissolved copper from passive leaching and hull cleaning (see TSD section IV)
[3] estimate for direct deposition of metal to surface waters of Newport Bay only (see TSD section IV)
[4] estimate of dissolved metal inputs from ocean based on local data (pers. comm. R. Gossett) and approximate ocean volume into Newport Bay (see section IV on Newport Bay " bathtub model")
[5] porewater results from Bight ' 98 study (SCCWRP in prep)

IV. Approach to calculating mass-based Loading Capacity

Freshwater loads of dissolved metals

In the DRAFT summary TMDL document, EPA selected to use the flow based approach to determine mass based dissolved metal loads in freshwater bodies. In this approach, the continuous range of river flow that occurs at each target site is broken down into ranges or tiers. Target dissolved metal concentration multiplied by volume associated with each tier gives the dissolved metal load per flow tier; the sum equals the loading capacity. The applicable allocation for a given source does not depend on the time of year, rather on the actual creek flow at the time of discharge and associated hardness value. So flow rate determines hardness which in turn dictates the appropriate metals criteria or target. Complete discussion of freshwater flows in San Diego Creek and Santa Ana Delhi are presented in TSD Part B – Flow.

Here is an explanation of the sequence of steps to determine metals criteria associated with each flow tier. We use small flow tier and dissolved copper target as an example.

1. Range of flow is 21 to 181 cfs. Choose highest flow rate within the tier = 181 cfs.
2. Use linear equation to find corresponding hardness value....start with natural log (flow rate)
3. For San Diego DCreek, hardness = -57.742 (ln [flow])+ 622.5
4. Use this hardness value (322 mg/L as $CaCO_3$) in CTR equations to determine acute and chronic criteria for each metal.
5. Dissolved <u>chronic</u> Copper criteria = e(0.8545[ln(hardness)]-1.702)*0.96 =24.3 ug/L

Table E-12. Calculation of dissolved metal loading capacity for San Diego Creek (at Campus)

Copper	Range of Flow rates (Q)	Hardness applied (mg/L)	Flow volume (ft3)	Target metal conc. (mg/L)	loading per tier (lbs)	% total
baseflow	Q <20	400	275,411,823	0.0293	503.78	23%
Small flow	20<Q<181	322	347,504,437	0.0243	527.18	24%
Medium flow	181<Q<814	236	357,632,336	0.0187	417.51	19%
Large flow	Q > 815	197	468,824,589	0.0255	746.35	34%
			1449,373,185 Total volume		2194.83 lbs/yr	

Flow volume per tier is based on 19 water year average: 1977/78, 1984/85 to 2000/01
Target metal concentration is hardness dependent.

This methodology was utilized for calculating dissolved metal load estimates from Santa Ana-Delhi Channel too. Chronic conditions applied to base, small and medium flows, acute conditions applied to large flows. Daily flow records for Santa Ana-Delhi Channel covered six water years: 1995/96 – 2000/01. Using method outlined in Table E-12, dissolved copper inputs from Santa Ana-Delhi Channel would be approximately 303 lbs/yr. Thus total freshwater inputs from SAD and SDC would be less than 2499 lbs/yr. This is a conservative estimate based on chronic concentrations for much of the year, whereas higher concentrations may exist and be tolerated by freshwater organisms during short term (acute) exposures.

Dissolved metal loads in Newport Bay via "ba thtub model"
The following information and equations were used to evaluate loading capacities in Newport Bay. We did not differentiate between Upper & Lower Bay & Rhine Channel since these water bodies are inherently intertwined when considering dissolved constituents. As you can see this " bathtub model" incorporates data for dissolved and total metal concentrations, freshwater flows, ebb and flood tides, and the volume of the Bay

The mass balance of water and pollutant can be written as follows:

$$\frac{dV}{dt} = (Q_0 - Q_b + Q_f)$$

$$\frac{dVC}{dt} = Q_0 C_0 - Q_b C + L_f + L_l - Av_s F_d C_T$$

where
C = dissolved pollutant concentration (mg/L)
C_T = total pollutant concentration (mg/L)
Qf = freshwater inflow
Q_0 = the quantity of water that enters the bay on the flood tide through the ocean boundary that did not flow out of the bay on the previous ebb tide (m^3/T)
Q_b = the quantity of water leaving the bay on the ebb tide that did not enter the bay on the previous flood tide (m^3/T)
V = volume of the bay
T = period of dominant tidal period (day)
L_f = loading from upstream (g/day)
L_l = loading from local area (additional sources within the bay; e.g., boats) (g/day)
A = surface area of the bay
v_s =net settling velocity (m/day)
F_p = fraction of particulate pollutant

At steady state

$$Q_b = Q_0 + Q_f$$

$$Q_b C + Av_s F_p C_T = Q_0 C_0 + L_f + L_l$$

The volume of new ocean water entering the bay on the flood tide can be determined by using ocean tidal exchange ratio (R_0) as

$$Q_0 = R_0 Q_T$$

where R_0 = exchange ratio and Q_T = total volume of ocean water entering the bay on the flood tide. The exchange ratio can be estimated from salinity data (Fischer et al. 1979)

$$R_0 = \frac{S_f - S_e}{S_0 - S_e}$$

Where S_f = average salinity of ocean water entering the bay; S_e =average salinity of bay water leaving the bay; and S_0 = Salinity at ocean side. The volume of mixed bay water Q_b leaving the bay on the ebb tide can be determined by using tidal exchange ratio (R_b)

$$R_b = \frac{S_f - S_e}{S_f - S_b}$$

where S_b is salinity of mixed bay water.

The flushing time (residence time) T_L can be calculated as follows:

$$T_L = \frac{V_b}{Q_b}$$

Where V_b = mean volume of the bay (19 million m^3 from RMA 2001). The exchange ratio R_0 can be estimated from the salinity observation data (RMA 1999). The ratio varies from 0.20 to 0.30. It can also be estimated through model calibration. The ratio used in the model is 0.25. Use median freshwater input of 16cfs, Q_b can be estimated.

Assume 0.80 as dissolved fraction of copper. ($C+0.2\,C_T = C_T, C_T = 1/0.8C$.)
Therefore, $C_T = 1.25\,C$ and the pollutant concentration in the bay can calculated as follows:

$$C = \frac{Q_0 C_0 + L_f + L_l}{Q_b + 1.25 A v_s F_p}$$

Let C_c be the criteria of Cu in the Bay, the loading capacity can be estimated as

$$Load = C_c(Q_b + 1.25 A v_s F_p) - Q_0 C_0$$

The results are listed in Table E-13.

Table E-13 "Bathtub" Model Results for dissolved copper

Bay volume (m^3)	Con. at ocean side (ug/L)	Exchange ratio	Volume entering Bay$_0$ (m^3/day)	Freshwater Cu Loading (lbs/yr)*	Estimated concentration (ug/L)	Criteria (ug/L)	Loading capacity (lbs/yr)
19000000	1.4	0.25	4,830,918	2499	3.03	3.1	11646

* This estimate assumes substantial reductions (>five fold) in copper loading from hull leaching and boat maintenance.

Calculations of direst atmospheric deposition load to Newport Bay

For these TMDLs, atmospheric concentrations reported in scientific literature were utilized for each metal to estimate the overall mass deposition into the Bay, F. There are two types of direct deposition: dry and wet. Dry deposition involve the transport and surface accumulation of particulate air contaminants during periods without precipitation. Wet deposition involves the removal of pollutant from the atmosphere via various precipitation processes ("w ashout"). Both dry and wet deposition are considered in this general equation.

$$F = C * V * S$$

Where

C	=	ambient air concentration (ug/m^2/day or ug/L)
V	=	deposition velocity (m/yr)
S	=	total surface area for deposition (m^2)

Table E-14. Direct Air Deposition of metals to Newport Bay surface waters

	dry (ug/m2/day)	wet (ug/L)	total dry (g/yr)	total wet (g/yr)	total air load (g/yr)	total air load (lbs/yr)
Cd	0.061	0.11	3.34E+01	1574.85	1.61E+03	3.5
Cu	0.29	2.16	5.04E+02	45153.29	4.57E+04	100.7
Pb	0.16	1.47	2.78E+02	30729.32	3.10E+04	68.4
Zn	53.57	8.7	9.31E+04	181867.42	2.75E+05	606.1

Pesticide Use Reports

Pesticide Use Reports for three nurseries (Bordier' s, El Modeno, and Hines) show relatively small amounts of copper (about 20, 15, and 72 lbs. respectively) per year and even smaller amounts of zinc (2 lbs. or less). (source: Lee and Taylor 2001b)

Methods to estimate Cu loads from boat hulls

EPA has utilized information compiled by San Diego RWQCB as part of the Dissolved Copper TMDL for Shelter Island Yacht Basin (SD RWQCB 2001 and references therein). The Shelter Island TMDL is nearly complete and has relatively robust data to support their estimates of leaching off boat hulls. Typically owners rely on copper-based antifouling paints to minimize algae growth on boat hulls, thus both passive leaching and underwater hull cleaning result in release of dissolved copper into Newport Bay. Common maintenance practices involve underwater hull cleaning about once per month, with much less frequent removal for dry-dock repainting. [Above water hull cleaning or dry-docking occurs within boatyards and discharges containing copper from antifouling paints are regulated by diversion into pre-treatment systems and then sewer drains or into local sumps.]

EPA has assumed that similar boat maintenance practices occur in Newport Bay harbors. Further we use the same assumptions about mean boat length and wetted surface area as presented in the Shelter Island Yacht Basin Dissolved Copper TMDL. One difference is applied--approximately 10,000 boats are moored in Newport Harbor (pers. comm., T. Melum). We recognize this extrapolation of methods and values from one location to another may not be construed as exact science; however, it does serve as first approximation until further site specific data has been accomplished.

The Shelter Island Dissolved Copper Draft TMDL includes information from boat studies performed in 1994 and 1995. Additional studies are currently in progress to refine these preliminary studies and establish more substantial data sets for hull cleaning and passive leaching. Results from these additional studies were not available for these Newport Bay Toxics TMDLs. References included below are from the Shelter Island Dissolved Copper TMDL. Adjustments for *data applicable to Newport Bay are in italics.*

Passive Leaching

In San Diego Bay, the majority of recreational vessels are sailboats that range in length from 30 to 40 feet (9.1 to 12.2 meters) (Conway and Locke 1994, Southwestern Yacht Club 2000). In the SIYB, the average size recreational vessel is 40 feet in length (12.2 meters), with a beam width of 11 feet (3.4 meters) (Bay Club 2000, Half Moon Marina 2000, Southwestern Yacht Club 2000, Conway and Locke 1994). Average wetted hull surface area is calculated based on this average size vessel, which is then used to calculate the amount of passive leaching over time per vessel. Wetted hull surface area is calculated using the following equation: Wetted hull surface area = (Overall length)*(Beam height)*(0.85) (Interlux 1999).

Dissolved copper loading from all of the recreational vessels in the SIYB is calculated from the average number of vessels known to reside there. Copper loading from passive leaching is calculated as follows:

Annual copper load (kg/yr.) = P*S*N, and S = L*B*0.85

Where:
P = Passive leaching rate
N = Number of boats
S = Wetted hull surface area = Overall length*Beam*0.85
L = Average length
B = Average beam height
Given:
P = 10 $\mu g/cm^2/day$
N = 10,000 (number of boats moored in Newport Bay)
L = 12.2 m (= 40 ft)
B = 3.4 m
Wetted hull surface area = (Overall length)*(Beam height)*(0.85)
Wetted hull surface area = (12.2 m)*(3.4 m)*(0.85) = 35.3 m^2
Annual load = (10 $\mu g/cm^2/day$)*(35 m^2)*(*10,000* vessels)*(10,000 cm^2/m^2)*(kg/10^9 μg)(365 day/yr.)

Estimates of Copper load from passive leaching in Newport Bay= 12,775 kg/year (35,000 g/day).

Hull Cleaning

Underwater hull cleaning (hull cleaning) is a common maintenance practice designed to prevent buildup of marine organisms on a ship' s hull. Although antifouling paints are effective at halting growth, some growth does occur which will build up over time. This growth may be removed from recreational vessel hulls either through haul-out at a boatyard, or manually while the boat is in-water using underwater hull cleaning techniques (SCCWRP 2000). It has been estimated that almost all of the pleasure crafts in the Shelter Island Yacht Harbor undergo periodic underwater hull cleaning (SCCWRP 2000).

The physical process of removing marine growth on a ship' s hull underwater results in a release of dissolved copper from the paints. The amount of copper released from hull cleaning is dependent on cleaning frequency, method of cleaning, type of paint, and frequency of painting. It was been estimated that underwater hull cleaning takes place in San Diego Bay about ten times a year for regularly maintained recreational boats (Conway and Locke 1994). (*this rate is also assumed to apply to boats in Newport Bay)* In addition, it was determined that painting frequency varies from one to three years, with most vessels being repainted every two years (Johnson et al 1998, Conway and Locke 1994). However, there are no known published studies that quantitatively compare release rates based on paint age, paint type, or method of cleaning. It is reasonable to assume that those frequently painted vessels with higher copper content paints will release more copper during hull cleanings. It is also reasonable to assume that more abrasive cleaning techniques tend to release more copper. However, published studies that provide quantitative estimates of copper loading from underwater hull cleaning are limited, particularly for recreational vessels.

Prior to the hull cleaning, dissolved copper concentrations in the vicinity of the boat averaged 12 µg/L. During the hull cleaning, average concentrations increased from 12 µg/L to 56 µg/L. Concentration levels decreased to 17 µg/L within five minutes after the cleaning ended, and levels returned to background within ten minutes. Researchers found that the copper contaminant plume moved with the current, and that the degree of plume contamination was dependent upon fouling extent and exertion by the diver (McPherson and Peters 1995). Based on the results, the authors concluded that underwater hull cleaning generates elevated concentrations in the vicinity of the operation, which return to background levels in a short time (within minutes).

More studies are needed to fully evaluate the environmental impacts of underwater hull cleaning over a range of environmental conditions and cleaning techniques. The Southern California Coastal Water Research Project Authority (SCCWRP), in collaboration with the Regional Board, is currently investigating environmental effects of antifouling paints and underwater hull cleaning activities in San Diego Bay as part of a two-year research grant. Funding for this research was provided by the State Water Resources Control Board (SWRCB) through the USEPA 319(h) Nonpoint Source Implementation Grant Program. Results from this study should provide greater information about the environmental impacts from underwater hull cleaning.

<u>Calculations</u>

Copper loading from hull cleaning was calculated from information provided in the studies by PRC (1997) and McPherson and Peters (1995). In the McPherson and Peters study, an underwater hull-cleaning event was monitored for dissolved copper concentrations in the resulting plume. Plume concentrations ranged from 40 µg/L to 83 µg/L, with a mean of 56 µg/L. Prior to the hull-cleaning event, concentrations in the SIYB averaged 12 µg/L (McPherson and Peters 1995). Equations for the determination of plume and copper concentration in the plume were provided by PRC (1997).

Plume concentration (P_c) = (Total plume concentration) – (Background concentration)

$$P_c = (56\ \mu g/L) - (12\ \mu g/L) = 44\ \mu g/L$$

Plume volume (P_v) = L_p*W_p*D_p

$P_v = (L_b + 6\ m + 6\ m)*(W_b + 6\ m + 6\ m)*(6\ m)$

$P_v = (24.2\ m)*(15.4\ m)*(6\ m) = 2236\ m^3$ per cleaning event

Where:
P_c = Plume concentration
P_v = Plume volume
L_p = Average plume length
W_p = Average plume width
D_p = Average plume depth
L_b = Average boat length
W_b = Average boat width
D_p = Average plume depth

Given:
L_b = 12.2 m
W_b = 3.4 m

Annual copper load = N_h*P_v*P_c*N_v
= $(10/yr.)*(2236\ m^3)*(44\ \mu g/L)*(10{,}000\ vessels)*(kg/10^9\ \mu g)*(1000\ L/m^3)$

Where:
N_h= Number of hull cleaning events/year
P_v = Plume volume
P_c = Plume concentration
N_v = Number vessels

Given:
N_h = 10/year
P_v = 2236 m^3
P_c = 44 µg/L
N_v =10,000 estimated occupancy

Estimates of Copper load from hull cleaning in Newport Bay = 9838 kg/year (27,279 g/day)

New Cd criteria:
EPA has recently issued a revised ambient water quality criteria for dissolved cadmium (EPA 2001a). While the State of California has yet to adopt this criteria, it is useful to provide the equations to determine the freshwater dissolved criteria as well as the corresponding revised concentration based allocations for San Diego Creek.
Dissolved acute Cadmium criteria = e*(1.0166[ln(hardness)]-3.924)*0.908
Dissolved chronic Cadmium criteria = e*(.7409[ln(hardness)]-4.719)*0.873

Table E-15. Current dissolved Cd Numeric Targets (ug/L) based on flow tiers for San Diego Creek.

Dissolved Metal	Base Flows (<20 cfs) hardness @ 400 mg/L		Small Flows (21 - 181 cfs) hardness @ 322 mg/L		Medium Flows (182 -815 cfs) hardness @ 236 mg/L		Large Flows (>815 cfs) @ 197 mg/L
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute
Current Cd	19.1	6.2	15.1	5.3	10.8	4.2	8.9
Proposed Cd	7.7	0.64	6.3	0.55	4.6	0.45	3.9

Proposed Cd targets based on recently revised ambient water quality criteria (EPA 2001a)

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Appendix A: DTSC Calsite facilities within Newport Bay watershed

Site ID number	Facility Name	Address	City	Chemicals of concern	Comment
30970007	Tustin Parcel	Corner of Edinger Ave. And Harvard Ave.	Tustin	Pesticides near housing project; Elevated As in shallow soil samples	Nfa for pesticides (1994); As area under investigation (2001)
Same (?)	Tustin Parcel	Corner of Barranca Pkwy and Harvard Ave.	Tustin		Maybe same site as above
30970004	Costa Mesa Air National Guard	South of Presidio Dr.	Costa Mesa	Waste fuel, paint, oil, solvents	Active site; Sampling plan submitted 6/01
30970002	Tustin Marine Corps Air Station	Edinger Avenue	Tustin	Numerous chemicals have been remediated, MTBE plume, As soil	DTSC active site
30790003	Orange County International Raceway	15000 Sand Canyon Avenue	Irvine	Waste oils	Converted to commercial sites (1991) Nfa by DTSC (1994)
30750008	G & H Radiator Service	120 S. Main Street	Santa Ana	Auto radiator waste	Nfa by DTSC (1994)
30510001	Avalon Chemical Company Incorporated	1230 Saint Gertrude Place	Santa Ana	Solvents, acids, bases	Referred to RCRA (1995)
30490110	Edison/Santa Ana II	N.W. of 2nd St. and Sycamore St.	Santa Ana	PAHs, VOCs, heavy metals	DTSC approved RI/FS in 2001, vol. cleanup
30490108	Southern California Gas/Santa Ana I	Corner of Minnie St. and E. Walnut	Irvine	PAHs and Pb	Preliminary endangerment assess. in 1997, still DTSC site
30490008	Coyote Canyon Sanitary	South of Bonita	Irvine	On-site disposal	Referred to County and RWQCB (1989)

Site ID number	Facility Name	Address	City	Chemicals of concern	Comment
	Landfill	Canyon on Coyote Canyon			
30370015	Ford Aerospace Corporation	1000 Ford Road	Newport Beach	Haz. Material handlers, TSD facility	Referred to RCRA (1995)
30360252	Universal Circuits	1800 Newport Circle	Santa Ana	VOCs, heavy metals in soil	Referred to County (1995)
30360188	Engineered Electronics Company	1441 E. Chestnut	Santa Ana	TSD large facility generator	Nfa by DTSC (1996)
30360052	Hughes, Connecting Devices Division	17150 Van Karman	Irvine	(Poor drum storage)	Nfa by DTSC (1982); Referred to RCRA (1995)
30360008	Metropolitan Circuits Inc.	1261 Logan Avenue	Costa Mesa	Cu and metals in soil	Soil remediation in 1995, Nfa by DTSC
.30350177	B & D Metal Finishing	1901 Westminister Avenue	Garden Grove	Solvents	Referred to County (1984)
30350014	Audio Magnetics	2602 Michelson	Irvine	VOCspill (1976)	Nfa by DTSC (1984)
30340301	Rheem Metals	1722 S. Santa Fe Street	Santa Ana	Uncertain	Soil removed 1982, certified clean by DTSC (1982)
30340300	Circuit One	2101 Grand Ave.	Santa Ana	Pb, sludge waste, acids, bases	PEA complete (1984); Nfa by DTSC (1994)
30340067	Smith Tool Company	17871 Von Karman	Irvine	Waste oil and metals	Referred toRWQCB (1995); Nfa by EPA and DTSC
30340061	Rockford Aerospace Products	17300 Redhill	Irvine	Waste oil, cyanides, acids, solvents	Referred to County (1991)
30340054	Orange Coast Plating	2515 S. Birch St.	Santa Ana	Metal sludge, acids, cyanide	Site inspection approved by EPA (1997); Nfa by

Site ID number	Facility Name	Address	City	Chemicals of concern	Comment
					RWQCB (1999)
30340013	Embee Plating	2144 South Hathaway	Santa Ana	VOCs, metals, solvents, acids	Referred to RWQCB (1995)
30330070	Aluminum Forge	502 E. Alton	Santa Ana	Waste oil and mixed oil	Referred to County after EPA and DTSC deem Nfa (1991)
30300129	Newport Adhesives Composites	1822 Reynolds Avenue	Irvine	TCE, PCE, TPHs,	PA completed (1996), no action since
30280534	Extruded Plastics Company	2201 S. Standard	Santa Ana	Unspecified liquids	Referred to RWQCB (1982)
30280530	Exotic Material, Inc.	2930 Bristol St.	Costa Mesa	Wate oil, solvents, acids	Nfa (1994)
30280469	Holchem DBA Service Chemical	1341 E. Maywood St.	Santa Ana	Uncertain	Site is residential area (1982)
30280370	Zeus Manufacturing	2970 Airway Avenue	Costa Mesa	Solvents, metals, acids	PA done by EPA (1988) Nfa by DTSC (1995)
30280149	McKesson Chemical	1302 Industrial Drive	Tustin	Pseticides and solvents in drums	Nfa by DTSC (1994); referred to County
30280073	Tibbetts Newport Company	2337 Birch St.	Santa Ana	Pesticide containers, paint sludge	Referred to County (1987)
30280006	Consolidated Thermoplastics	2520 S. Birch St.	Santa Ana	Pb, Cr, waste oil, solvents	Nfa by EPA (1989); Nfa by DTSC (1989)

Nfa = no further action; PEA = preliminary endangerment assessment
DTSC contact, Carole Mah, (916) 323-3397

Appendix A (cont.): Orange County Health Care Agency comments on DTSC Calsites.

SITE NUMBER	SITE NAME	OCHCA INFORMATION
30970007	Tustin parcel	No information
30970004	National Guard	Clean up closed 6-93, clean operation
30970002	MCAS	DTSC clean up no HCA involvement
30790003	O C Raceway	No info, not a current site
30750008	G&H Radiator	No info, not a current site
30510001	Avalon chemical	No info, not a current site
30490110	Edison	No info, not a current site
30490108	SC Gas	No info, not a current site
30490008	Coyote landfill	Landfill closed 1991, regular LEA monitoring
303700015	Ford Aerospace	Facility closed 1998
30360252	Engineered Electronic	No info, not a current site
30360052	Hughes	Clean operation
30360008	Metro Circuits	Velie Circuits, clean site
30350177	B&D metal	No info, not a current site
30350014	Audio magnetics	No info,not a current site
30340301	Rheem Metals	No info, not a current site
30340300	Circuit One	Active clean up, no problems
30340067	Smith Tool	Clean up closed 4-86
30340061	Rockford Products	No info, not a current site
30340054	Orange Coast Plate	Clean up referred to DTSC 11-95
30340013	Embee Plating	Clean up referred to DTSC 5-96, clean opera
30330070	Aluminum Forge	Clean up closed 10-87
30300129	Newport Composites	Clean facility
30280534	Extruded Plastics	No info, not current site
30280530	Exotic Material	No info, not current site
30280469	Holchem	No info, not current site
30280370	Zeus	Chart Industries, clean site
30280149	McKesson	No info, not current site
30280073	Tibbetts Newport	No info, not current site
30280006	Consolidated Therm	No info, not current site

PART F. Organochlorine (OC) Compounds

This support document provides the technical details of the accompanying TMDL document and has been provided for readers interested in the approach, the assumptions, and the data used to develop the organochlorine TMDLs. The organization of this document is as follows:

Section I Pollutant Properties, outlines the chemical and physical properties of the organochlorine compounds for which TMDLs have been developed. Because of the persistent nature of these pollutants and their known impact on the environment, there is a substantial body of literature available that describes their properties. This section provides a summary of the values used to characterize the pollutant properties used in the TMDL analysis.

Section II Calculation of Loading Capacities and Existing Loads, outlines the process and scientific rationale used to calculate the loading capacities and existing loads and presents the calculations for each of the organochlorine compounds. For each compound, all equations, input parameters, and assumptions have been included, along with text that describes how the information was used in the analysis.

Section III References, includes complete citations for each of the references included in the document.

Appendix 1, Data Analysis and Source Assessment, includes the data used to support the organochlorine TMDL analysis.

I. Pollutant Properties

The organochlorine compound TMDLs have been presented in a single document because, as a class of compounds, they possess unique physical and chemical properties that influence their persistence, fate, and transport in the environment. Although these properties differ among the organochlorine compounds, they all exhibit an ability to resist degradation, associate with sediments or other solids, and to accumulate in the tissue of invertebrates, fish, and mammals. In fact, it is their unique properties that have contributed to both their efficacy as pesticides and industrial products and their persistence and accumulation in the environment. Because these unique properties are important factors in identifying and applying the technical procedures used to calculate the TMDLs, this section has been included to provide a better understanding of each of the compounds. The summaries have been developed by reviewing published reports and are focused on the properties that influence their behavior in the environment. This information provides a better understanding of these compounds and supports the TMDL analysis through the selection of values to represent environmental processes.

Polychlorinated biphenyls

Polychlorinated biphenyls (PCBs) are mixtures of up to 209 individual chlorinated compounds (known as congeners). An important property of PCBs is their general inertness; they resist both acids and alkalis and have thermal stability. This made them useful in a wide variety of applications, including dielectric fluids in transformers and capacitors, heat transfer fluids, and lubricants. In general, PCBs are relatively insoluble in water, and the solubility decreases with increased chlorination. Photolysis is the more significant process of degradation than hydrolysis or oxidation. Degradation can occur under both aerobic and anaerobic conditions. The greater the chlorine content of the PCB, the longer the half-life, ranging from days to years (ATSDR

Although it is now illegal to manufacture, distribute, or use PCBs, these synthetic oils were used for many years as insulating fluids in electrical transformers and in other products such as cutting oils (GE, 1999). In 1976, the manufacture of PCBs was prohibited because of evidence they build up in the environment and can cause harmful health effects. Products made before 1977 that may contain PCBs include old fluorescent lighting fixtures and electrical devices containing PCB capacitors, and old microscope and hydraulic oils. Historically, PCBs have been introduced into the environment through discharges from point sources and through spills and accidental releases. Although point source contributions are now controlled, nonpoint sources may still exist. For example, refuse sites and abandoned facilities may still contribute PCBs to the environment. Once in a waterbody, PCBs become associated with solid particles and typically enter sediments (Wisconsin DNR, 1997).

DDT

DDT (1,1,1-trichloro-2,2-bis(p-chlorophenyl)ethane) is an insecticide that was once widely used on agricultural crops and to control disease-carrying insects. Because of potential harm to wildlife and human health, the use of DDT was banned in the United States in 1972, except for public health emergencies. One pesticide, Dicofol, is a currently registered pesticide and an active source of DDT. Dicofol was permitted to contain up to 15% DDT until 1987, afterwards only 0.015% DDT is allowed as the active ingredient. DDT is still used in some other countries.

DDT degrades into two metabolites: DDD and DDE. DDD was also historically used as a pesticide, but its use has also been banned. One form of it has been used medically to treat cancer of the adrenal gland. DDE has no commercial use. DDT has a half-life in air of less than 2 days and does not dissolve easily in water. Other characteristics include:

- DDT adheres strongly to soil particles and does not move quickly to ground water—its half-life in soil ranges from 2–15 years.
- DDT will evaporate from soil and surface water into the air and is broken down by sunlight or by microorganisms in soil or surface water.
- DDT in soil usually breaks down to form DDE or DDD.
- DDT accumulates in plants and in the fatty tissues of fish, birds, and animals.

Chlordane

Chlordane was used as a pesticide in the United States from 1948 to 1988. Because of concern about environmental and human health impacts, EPA banned the use of chlordane in 1983 except to control termites; all uses have been banned since 1988. Until 1983, chlordane was used as a pesticide on crops such as corn and citrus and on home lawns and gardens. The following characteristics of chlordane affect its fate in the environment:

- Chlordane adheres strongly to soil particles at the surface and is not likely to enter groundwater.
- Chlordane has the ability to stay in the soil for over 20 years.
- Chlordane can leave soil by evaporation to the air.
- Chlordane does not dissolve easily in water.
- Chlordane accumulates in the tissues of fish, birds, and mammals.

Dieldrin

Dieldrin is an insecticide that was used from 1950 to 1970 on crops such as corn and cotton. Because of concerns about damage to the environment and the potential harm to human health, EPA banned all uses of dieldrin in 1974 except to control termites. In 1987, EPA banned all uses. Characteristics of dieldrin that affect its fate in the environment include:

- Dieldrin binds tightly to soil and slowly evaporates to the air.
- Dieldrin breaks down very slowly.
- Dieldrin in soil can accumulate in plants.
- The pesticide, Aldrin, rapidly changes to Dieldrin in plants and animals.
- Dieldrin is stored in body fat and leaves the body very slowly.

Toxaphene

The insecticide Toxaphene contains over 670 chemicals and was one of the most heavily used insecticides in the United States until 1982, when it was banned for most uses. All uses were banned in 1990. It was used primarily in the southern U.S. to control insect pests on cotton and other crops. It was also used to control insect pests on livestock and to kill unwanted fish in lakes. Toxaphene may enter the environment from hazardous waste sites or by evaporation. Other characteristics that affect its fate in the environment include the following:

- Toxaphene does not dissolve well in water, so it is more likely to be found in air, soil, or sediment at the bottom of lakes or streams, than in surface water.
- Toxaphene breaks down very slowly in the environment.
- Toxaphene accumulates in fish and mammals.

Summary of Organochlorine Compound Properties

All organochlorine compounds addressed in this analysis have properties that contribute to their ability to concentrate in biota and magnify in the food chain. These chemicals also have considerable persistence in soils and sediment. Although information on exactly how long these chemicals persist in the environment varies depending on the environmental conditions, they are all found in several media in Newport Bay and San Diego Creek despite the lack of active sources. Consistent with their physical properties, these chemicals are typically not observed in the water column but instead are observed in sediment and fish and mussel samples, as indicated by data collected as part of the CA State Mussel Watch program (SMW 1993 - 2000). Data collected over 20 years shows evidence of declining fish tissue concentrations for these compounds; however, this trend is uncertain in freshwater and saltwater sediments.

The three key properties of the organochlorine compounds used to calculate the TMDLs include:

- Octanol-water partition coefficients (Kow) are a laboratory-measured property that provides a measure of the tendency of a substance to prefer non-aqueous or oily environments rather than water and is used as an indicator of the degree to which a substance will bioaccumulate.
- Organic carbon/water partition coefficients (Koc) describe the ratio of a compound adsorbed to solids and in solution, normalized for organic carbon content.
- Bioconcentration factors (BCF) the ratio between the concentration of the chemical in an organism's tissues to the concentration in the surrounding water.

Appropriate values for the TMDL analyses were identified through a search of local, regional, and national values presented in the literature. For this TMDL the following values were selected as shown in Table F-1 and associated references below.

Table F-1. Summary of Properties of the Organochlorine Compounds

	Total PCBs	Total DDT	Chlordane	Dieldrin	Toxaphene
Log Kow	6.261[a]	p,p' DDT = 6.610[b] p,p, DDE = 6.956[c] p,p DDD = 6.217[d]	6.32[e]	5.401[d]	5.5[e]
Log Koc[g]	6.15	p,p' DDT = 6.498 p,p DDE = 6.838 p,p DDD = 6.111 **Mean DDT = 6.48**	6.21	5.31	5.4
BCF[f]	270,000	363,000	37,800	2,993	52,000

[a] Mean of 20 congener values cited for PCB cited in de Bruijn et al. (1989)
[b] mean of two values cited in USGS (2001) One value from de Bruijn et al. (1989) and one value from Brooke et al. (1990)
[c] USGS (2001) from de Bruijn et al. (1989)
[d] de Bruijn et al. (1989)
[e] "Southerland" EPA report
[f] references for the BCF values are presented in Table F-4.
[g] The following general equation was used for converting Log Kow to Log Koc.
Log Koc = 0.00028 + log Kow (0.983) (Hoke et al. 1994).

Review of Sediment Targets

As discussed in the TMDL document, the Santa Ana Regional Board Basin Plan (1995) includes narrative water quality objectives for each of the pollutants addressed in this document (see section II in the summary document). However, to calculate the loading capacities, it was necessary to select a numeric endpoint protective of the narrative standards. The rationale for selecting the numeric endpoints is presented in section VI of the summary document. The endpoints are listed in Table F-2.

Table F-2. Sediment Targets Used in the TMDL Analyses

	PCBs (µg/kg)*	DDT (µg/kg)*	Chlordane (µg/kg)*	Dieldrin (µg/kg)*	Toxaphene (µg/kg)*
San Diego Creek	34.1	6.98	4.5	2.85	0.1
Upper Newport Bay	21.5	3.89	2.26	NR	NR
Lower Newport Bay	21.5	3.89	2.26	0.71	NR
Rhine Channel	21.5	3.89	2.26	0.71	NR

NR: TMDL not required for these pollutant-waterbody combinations
* dry weight

II. Calculation of Loading Capacities and Estimate of Existing Loadings

General Conceptual Approach

The loading capacity for each pollutant represents the maximum loading that a waterbody can assimilate and still meet and maintain water quality standards. For the organochlorine compounds addressed in these TMDLs, long-term loadings at or below the loading capacities should eventually result in reduction in concentrations of these compounds in bottom sediment to levels protective of the standards. A review of available data (see Appendix 1 for a summary of the data used in the TMDL analysis) indicates that bottom sediments currently exhibit elevated organochlorine compound concentrations and it is believed that these elevated levels are primarily associated with the past use and disposal of products containing these compounds. The higher the current concentrations in bottom sediments, the longer it will take to meet standards, even if external sources are reduced.

The approach to determining the loading capacities for each of the organochlorine compounds was similar and was based on an understanding of the sources of these compounds (past, present, and future) and the transport and ultimate fate of these compounds in various environmental media. Based on a review of literature sources, it was observed that organochlorine compound environmental persistence and affinity for adsorbing to sediment and accumulating in biota generally limits their presence in the water column, at least relative to sediment and biota. Additionally, because these compounds are no longer used in the watershed (with the exception of small amounts of DDT associated with Dicofol applications) the primary sources are assumed to be sediment loading associated with watershed runoff and resuspension and transport of previously deposited in-stream sediments. The loading capacities were determined by "back-calculating" the allowable load from the selected sediment target (Table F-2) and the associated estimates of sediment loads.

The calculation of existing organochlorine compound loads, which are not required components of the TMDLs, allows for a relative comparison the estimated current loading to the calculated loading capacity. In contrast to the calculation of the loading capacities, which was accomplished through back calculation from the sediment targets, the existing loadings were based on review and analysis of available multi-media data.

The methodologies used to calculate the loading capacities and existing loads for San Diego Creek and Newport Bay are discussed the following section with separate subsections for each methodology.

Calculation of San Diego Creek Loading Capacity and Existing Loads

Figure F-1 presents a schematic of the approach used to calculate the loading capacity and existing loads for San Diego Creek. The approach relies on the following key information:

- Flow data from gaging station at Campus Drive (USGS and OCPFRD data)
- Suspended sediment concentrations from the RMA modeling study regression analysis (RMA 1997)

- Sediment targets (see Table F-2)
- Partition coefficients (see Table F-1)
- Acute and chronic criteria from the California Toxics Rule (EPA 2000a)
- Fish tissue concentrations (for calculating existing loads)
- Pollutant-specific bioconcentration factors (BCFs)

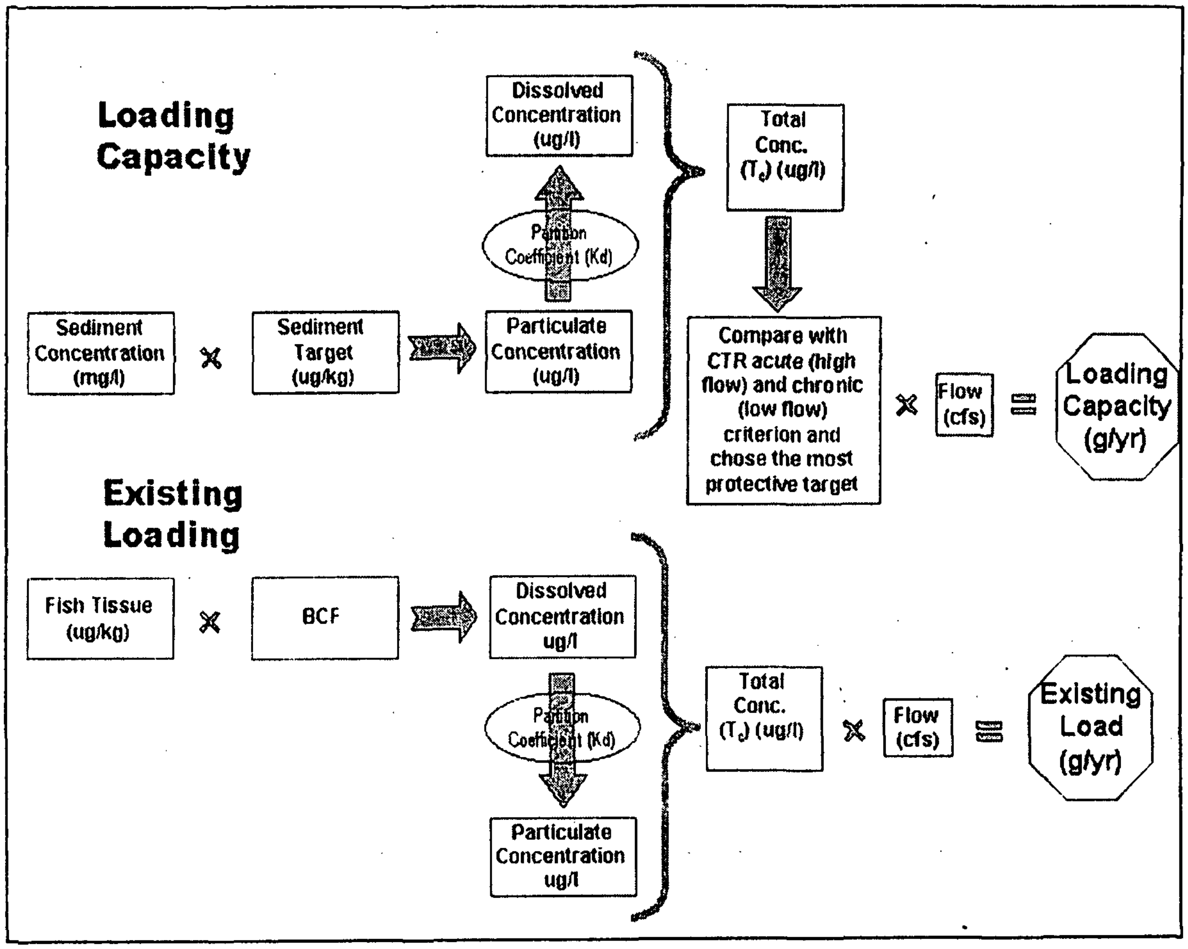

Figure F-1. Approach to Developing Loading Capacities and Existing Loads in San Diego Creek

The analyses for the loading capacity and the existing loads were based on the same general procedures but the availability of data dictated several differences, notably the use of available fish tissue data and bioconcentration factors in the calculation of existing loads. The remainder of this section outlines the procedures, parameters, and values used in the calculation of loading capacities and existing loads.

Loading Capacity

The loading capacity represents the maximum amount of a pollutant a waterbody can assimilate and still meet applicable water quality objectives. For the organochlorine compound TMDLs, sediment targets protective of the objectives were identified and formed the basis for the calculation of the loading capacity. The first step involved using the sediment targets and calculating particulate pollutant concentrations using information on the suspended sediment concentrations in the creek under three flow tiers. Daily flow records available at Campus Drive (USGS 1977-1997) were analyzed and categorized into the following flow tiers:

- Base and low flows: median (15 cfs) for 352 days
- Medium flows: median (365 cfs) for 10 days
- High flows: median (1,595 cfs) for 3 days

The suspended sediment concentration corresponding to each of the flow tiers was calculated based on the observation data and regression results from the Feasibility Report for Upper Newport Bay (RMA 1997). The values are 97, 1,730, and 5,011 mg/L for the base and small, medium, and high flow tiers, respectively. The following is the regression equation used in the analysis:

$$\log(y) = -0.09(\log(x)^2 + 2.24(\log(x)) - 1.96$$

where: x = flow (cfs)
y = sediment (tons/day)

Because the organochlorine compounds have a strong affinity for sediment, partition coefficients, which describe the ratio of a compound adsorbed to solids and in solution, were identified and used with the particulate concentrations to estimate the dissolved concentration. The sum of the particulate and dissolved concentrations represented the total concentration of the pollutant in the water column.

The total water column concentrations for each flow tier were than compared to either the acute (Criterion Maximum Concentration [CMC]) or the chronic (Criterion Continuous Concentration [CCC]) criterion. The concentrations for each flow tier that were most protective of water quality objectives were summed used with flow data to calculate the loading capacity. The base and low flow and medium flow concentrations were compared to the chronic criteria and the high flow concentrations were compared to the acute criteria. The acute and chronic values were obtained from the California Toxics Rule (USEPA 2000a) and are presented in Table F-3.

The following equations provide the approach for calculating the loading capacities presented in Table F-5.

$$\text{Load (g/yr)} = Cw \times Q \times 28.31 \times 86{,}400 \times Qd \times 0.000001$$

where: Cw = water concentration (µg/L)
Q = flow (cfs)

28.31	=	cubic feet to liter
86,400	=	conversion factor for days per year
Qd	=	number of days of flow (3, 10, or 362)
0.000001	=	conversion factor from μg to g

The values for Cw were calculated using the following equation:

$$Cw = Ct \times Cs \times 1/F_p \times CF$$

where:

Ct	=	pollutant target concentration in sediment (μg/kg)
Cs	=	sediment concentration (mg/L)
F_p	=	particulate fraction
CF	=	conversion factor from mg to kg

The values for F_p were calculated using the following equation:

$$F_p = 1 - F_d$$

$$F_d = \frac{1}{1 + K_d \cdot Cs}$$

where: K_d = pollutant-specific partition coefficient (m^3/g)

Table F-3. CCC (chronic) and CMC (acute) values.

Pollutant	CCC (chronic) (μg/L)	CMC (acute) (μg/L)
PCB	0.014	0.0140
DDT (total)	0.001	1.1000
Chlordane	0.0043	2.4000
Dieldrin	0.056	0.2400
Toxaphene	0.0002	0.7300

Source: EPA (2000a): California Toxics Rule

Existing Loads

The calculation of existing loads (see Figure F-1) was accomplished using the same general procedure outlined above for the loading capacity. The primary differences include:

- Recent fish tissue data were used with BCFs to back calculate the dissolved pollutant concentrations.
- Partition coefficients were used with the dissolved concentrations to estimate the particulate fraction.
- The total concentration and flow were used to calculate existing loads—no comparison to water quality criterion was conducted.

The analysis of existing loads was conducted using fish tissue (red shiner) data collected in June 1998 as part of the Toxic Substances Monitoring Program at the following three locations:

- San Diego Creek/Michelson Drive
- Peters Canyon Channel
- San Diego Creek/Barranca Parkway

The geometric mean of the fish tissue data (Appendix 1) from this source were used because they represented the best available recent data on the accumulation of the organochlorine compounds in aquatic biota.

The next step in the analysis required using the fish tissue concentrations with BCF values for each of the organochlorine compounds to calculate a dissolved pollutant concentration. The selection of appropriate BCF values, which have published values spanning several orders of magnitude, was conducted. Species-specific (i.e., Red Shiner) BCF values were not available therefore values for similar small bottom feeding fish such as the fat head minnow were used (Table F-4).

Table F-4. Bioconcentration factors used in the analysis of existing loadings.

Name	BCF	Reference
PCBs	270,000	EPA Ambient Water Quality Criteria - PCB (Aroclor 1260 - Fathead minnow (female) *Pimephales promeias*)
Dieldrin	2,993	EPA Ambient Water Quality Criteria - channel catfish (*ictalurus punctatus*)
DDT	363,000	EPA Ambient Water Quality Criteria - DDT (Common Shiner - *Notropis Cornutus*)
Toxaphene	52,000	EPA Bioaccumulation Testing And Interpretation For The Purpose of Sediment Quality Assessment Fathead minnow *Pimephales promeias*
Chlordane	37,800	EPA Ambient Water Quality Criteria - Chlordane (Fat Head Minnow - *Plmephales promelas*)

Once appropriate BCFs were determined, they were used with the fish tissue concentrations to calculate the dissolved pollutant concentration. In contrast to the approach used to calculate the loading capacity, partition coefficients were used to determine the pollutant concentration in the particulate fraction. The dissolved and particulate concentrations were then summed into a total concentration, which was used with flow data to calculate the existing loads for each pollutant. All of the equations presented above for the calculation of the loading capacity were also used to calculate existing loads. In addition, the following equation was used to calculate the dissolved concentration using the fish tissue concentrations and BCF values.

$$c_w = \frac{TC}{BCF}$$

where:

where:	TC	=	tissue Concentration in µg/kg
	BCF	=	EPA Bioconcentration Factor in L/kg
	c_w	=	dissolved concentration (estimated) in µg/L

Table F-5 presents the loading capacities and existing loadings of the organochlorine compounds for San Diego Creek.

Table F-5. Summary of San Diego Creek Existing Loads and Loading Capacities

	Existing Load (g/year)	Loading Capacity (g/year)
PCB	282.1	2,226.3
DDT	3,733.8	432.6
Chlordane	615.7	314.7
Dieldrin	381.8	261.5
Toxaphene	582.1	8.8

Calculation of Newport Bay Loading Capacity and Existing Loads

The major source of the organochlorine compounds into Newport Bay is upstream loadings from San Diego Creek (88 percent), local drainages, and redistribution of historically deposited sediments within the Bay system. Previous modeling studies, completed by RMA for the U.S. Army Corps of Engineers (USACE) have examined the circulation patterns, and transport and deposition of sediments in Newport Bay (RMA 1998). By examining model calibration results (RMA 1998) for Newport Bay from 1985-1997, the sediment deposition in each region of Newport Bay was estimated. Historic pollutant loads to the bottom sediment were estimated by using observed pollutant concentrations in bottom sediments and net sedimentation rates. Sediment volume was converted to dry weight using an estimated porosity of 0.65.

Figure F-2 presents a schematic of the approach used to calculate the loading capacity and existing loads for Newport Bay. The approach relies on the following key information:

- Sediment deposition rates (from the RMA (1997) model)
- Sediment deposition patterns (from the RMA (1997) model)
- Sediment pollutant targets (used for loading capacity) (see Table F-2)
- Sediment organochlorine concentrations from observation data (used for existing loads)

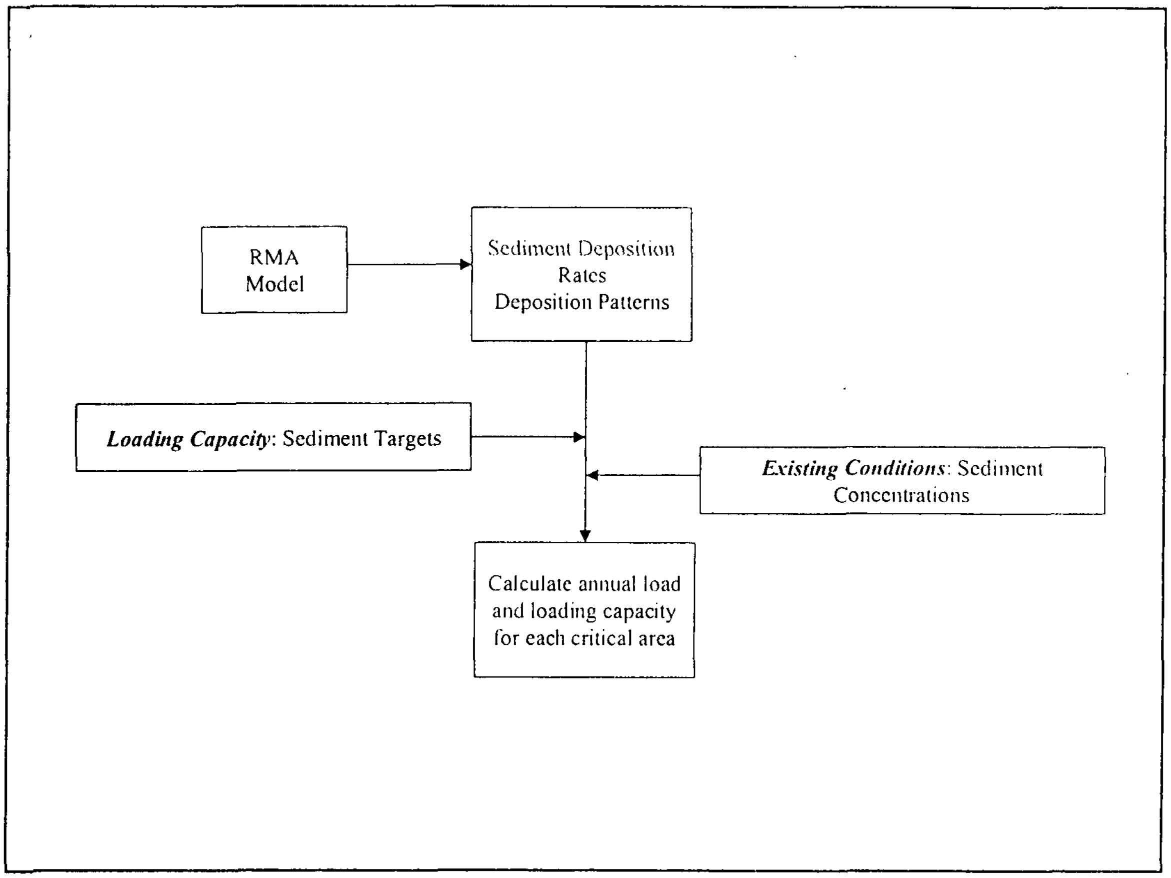

Figure F-2. Approach to Developing Loading Capacities and Existing Loads in Newport Bay

The remainder of this section presents the loading capacity calculations for each of the organochlorine compounds. For each compound, all equations, values applied, and references used in the calculation are included.

Summary of Approach for Calculating Loading Capacities and Existing Loads of Organochlorine Compounds for Newport Bay

The following equation was used with sediment target concentrations (Cs) (Table F-6) to calculate the loading capacities. For existing loadings, the same equation was used with concentrations from existing data substituted for the sediment targets.

$$\text{Load (g/yr)} = Cs \times Ds \times \rho s \times (1 - Ps) \times CF$$

where:

	Cs	=	sediment concentration (μg/kg dry)
	Ds	=	sediment deposition (m^3/yr)
	ρs	=	sediment density (kg/m^3)
	Ps	=	sediment porosity
	CF	=	conversion factor from μg to g

The values for all parameters used in the analysis for Newport Bay and Rhine Channel are presented in Table F-6.

Table F-6. Parameter values used in the Newport Bay TMDL Analysis.

	Sediment conc. (ug/kg dry)				ρs (kg/m^3)	Ps	CF
	Target Concentration	Observed Concentrations*					
		UNB	LNB	RC			
PCB	21.5	42.8	40.8	93.1	2,500	0.65	0.000001
DDT	3.89	58.7	74.5	7.45			
Chlordane	2.26	12.8	8.94	0.44			
Dieldrin	0.71	1.0	1.0	5.0			

*UNB: Upper Newport Bay; LNB: Lower Newport Bay; and RC: Rhine Channel
Ds (m^3/year): Upper Newport Bay: 81,233.95; Lower Newport Bay: 29,924.01; Rhine Channel: 859.23

Calculations

PCB

Loading Capacity

$$\text{Upper NB Loading Capacity (g/yr)} = 21.5 \times 81{,}234 \times 2{,}500 \times (1 - 0.65) \times 0.000001$$
$$\text{Lower NB Loading Capacity (g/yr)} = 21.5 \times 29{,}924 \times 2{,}500 \times (1 - 0.65) \times 0.000001$$
$$\text{Rhine Channel Loading Capacity (g/yr)} = 21.5 \times 859.23 \times 2{,}500 \times (1 - 0.65) \times 0.000001$$

Existing Loading

$$\text{Upper NB Existing Loading (g/yr)} = 42.8 \times 81{,}234 \times 2{,}500 \times (1 - 0.65) \times 0.000001$$
$$\text{Lower NB Existing Loading (g/yr)} = 40.8 \times 29{,}924 \times 2{,}500 \times (1 - 0.65) \times 0.000001$$
$$\text{Rhine Channel Existing Loading (g/yr)} = 93.1 \times 859.23 \times 2{,}500 \times (1 - 0.65) \times 0.000001$$

PCB	Existing Load (g/year)	Loading Capacity (g/year)
Upper Newport Bay	858.7	1528
Lower Newport Bay	409.8	563.0
Rhine Channel	70.02	16.16

DDT

Loading Capacity

$$\text{Upper NB Loading Capacity (g/yr)} = 3.89 \times 81{,}234 \times 2{,}500 \times (1 - 0.65) \times 0.000001$$
$$\text{Lower NB Loading Capacity (g/yr)} = 3.89 \times 29{,}924 \times 2{,}500 \times (1 - 0.65) \times 0.000001$$
$$\text{Rhine Channel Loading Capacity (g/yr)} = 3.89 \times 859.23 \times 2{,}500 \times (1 - 0.65) \times 0.000001$$

Existing Loading

$$\text{Upper NB Existing Loading (g/yr)} = 58.7 \times 81{,}234 \times 2{,}500 \times (1 - 0.65) \times 0.000001$$
$$\text{Lower NB Existing Loading (g/yr)} = 74.5 \times 29{,}924 \times 2{,}500 \times (1 - 0.65) \times 0.000001$$
$$\text{Rhine Channel Existing Loading (g/yr)} = 7.45 \times 859.23 \times 2{,}500 \times (1 - 0.65) \times 0.000001$$

DDT	Existing Load (g/year)	Loading Capacity (g/year)
Upper Newport Bay	1080	276.5
Lower Newport Bay	438.4	101.9
Rhine Channel	5.60	2.92

Chlordane

Loading Capacity

$$\text{Upper NB Loading Capacity (g/yr)} = 2.26 \times 81{,}234 \times 2{,}500 \times (1 - 0.65) \times 0.000001$$
$$\text{Lower NB Loading Capacity (g/yr)} = 2.26 \times 29{,}924 \times 2{,}500 \times (1 - 0.65) \times 0.000001$$
$$\text{Rhine Channel Loading Capacity (g/yr)} = 2.26 \times 859.23 \times 2{,}500 \times (1 - 0.65) \times 0.000001$$

Existing Loading

$$\text{Upper NB Existing Loading (g/yr)} = 12.8 \times 81{,}234 \times 2{,}500 \times (1 - 0.65) \times 0.000001$$
$$\text{Lower NB Existing Loading (g/yr)} = 8.94 \times 29{,}924 \times 2{,}500 \times (1 - 0.65) \times 0.000001$$
$$\text{Rhine Channel Existing Loading (g/yr)} = 0.44 \times 859.23 \times 2{,}500 \times (1 - 0.65) \times 0.000001$$

Chlordane	Existing Load (g/year)	Loading Capacity (g/year)
Upper Newport Bay	290.7	160.6
Lower Newport Bay	50.20	59.17
Rhine Channel	0.33	1.70

Dieldrin

Loading Capacity

$$\text{Lower NB Loading Capacity (g/yr)} = 0.71 \times 29{,}924 \times 2{,}500 \times (1 - 0.65) \times 0.000001$$
$$\text{Rhine Channel Loading Capacity (g/yr)} = 0.71 \times 859.23 \times 2{,}500 \times (1 - 0.65) \times 0.000001$$

Existing Loading

$$\text{Lower NB Existing Loading (g/yr)} = 1.0 \times 29{,}924 \times 2{,}500 \times (1 - 0.65) \times 0.000001$$
$$\text{Rhine Channel Existing Loading (g/yr)} = 5.0 \times 859.23 \times 2{,}500 \times (1 - 0.65) \times 0.000001$$

Dieldrin	Existing Load (g/year)	Loading Capacity (g/year)
Lower Newport Bay	5.93	18.59
Rhine Channel	3.76	0.53

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Appendix 1: Data Analysis and Assessment

This appendix presents the data available to characterize the level of contamination by organochlorine compounds in the Newport Bay watershed. Monitoring data are available for three media: water, sediment, and tissue. The following data summaries are organized by the source/agency.

Orange County Public Facilities and Resources Department (OCPFRD): Sediment data results were available for three DDT compounds and two PCB Aroclors; no data results were available for Chlordane, Dieldrin and Toxaphene. Data were available from 1999 to 2000 for some freshwater tributaries and several sites in Upper and Lower Bay. OCPFRD results (1999/00) for PCBs were used in the analysis of existing loads. Results reported below the MDL were assumed equal to half that value. No data for organics in the water column were available.

***Irvine Ranch Water District (IRWD)*:** Limited data were available for 1997 and 1998. All water monitoring data were reported as not detected. One sediment sample was reported as 1 µg/kg for p-p' DDE in October of 1998. This data was not used in the analysis.

Toxic Substance Monitoring Program(TSMP): Species specific fish tissue data was available for organic compounds from 1993 to 1998. The most recent fish tissue data (1998) from three locations in San Diego Creek (San Diego Creek/Michelson Drive, Peters Canyon Channel and San Diego Creek/Barranca Parkway) was used. Results were reported for all organochlorine pollutants in these TMDLs.

Bay Protection and Toxic Cleanup Program Data (BPTCP): This study reports sediment concentrations at various locations in the Newport Bay for PCB, DDT, Chlordane, Toxaphene, and Dieldrin. Sediment sample data in µg/kg was available from two sampling events that took place in 1994 and 1998. This data was used to supplement the most recent sediment sampling data when it was not available (i.e., Dieldrin in Newport Bay).

Newport Bay Sediment Toxicity Studies (SCCWRP 2001a): Sediment samples collected at 10 Newport Bay stations in May 2001 was available. Sediment data in µg/kg for PCB, DDT, Chlordane, and Dieldrin at selected locations was used to estimate the existing loading capacity.

Resource Management Associates report (USACE, 1997 - RMA model):
Estimates of the sediment distribution for the Upper Bay, Lower Bay and Rhine Channel were made using the results of sediment transport model developed by RMA. The model simulates wet and dry conditions as well as the largest storm event from 1985-1997. Because most sediment entering Upper Newport Bay occurs during the storm events, mean daily stream discharge records for San Diego Creek were used to develop a five-day hydrograph that were used to simulate storm event for RMA model. The peak flows for each model simulation years are shown in Table 2 below. A detailed description can be found in the RMA report (RMA, 1997). The sediment deposition rates for Newport Bay were derived from 12-year model simulation results. Although the mean values are used to estimate the sediment budget for the Newport Bay, the sediment deposition rates represents a net deposition over the years.

The following tables list data from different sources by the various sources used in the analysis.

The most recent sediment data (May 2001) was used from the Newport Bay Sediment Toxicity Studies Report, October 23, 2001 (Tables 8, 9 and 10). Where data were not available (dieldrin only), it was supplemented with sampling studies done in 9/19/1994 and from the Orange County Public Facilities and Research Department (OCPFRD 1991 – 2000). Supplemented data are footnoted.

Table 1 Sediment Chemistry Toxicity Data used in the TMDL

Location	Total DDT	Chlordane[a]	Total PCB	Dieldrin
	ug/kg dry	ug/kg dry	ug/kg dry	Ug/kg dry
Unit I basin (NB10)	17.43	3.52	18.00[b]	0.00
Unit II basin (NB9)	14.97	6.41	6.76[c]	1.00[d]
South of Unit II (NB7)	7.1	1.25	18.00[a]	0.00
Downstream to PCH Bridge(NB6)	19.18	1.6	0.00	0.00
Lower Bay (NB1)	1.91	0.00	18.00[b]	0.00
Turning Basin (NB4)	49.81	5.93	22.76	1.00[d]
Newport channel (NB2)	22.8	3.01	0.00	0.00
Rhine Channel (NB3)	7.45	0.44	93.13	5.00[d]

All non-detects were taken as zero
[a]sum of gamma-Chlordane, alpha-Chlordane, trans-Nonachlor, and cis-achlor reported in the Newport Bay Sediment Toxicity Studies Report, October 23, 2001 at each location.
[b]OCPFRD 1999 -- 2000 data.
[c]NB8 sediment concentration for Total PCB was used as NB9 was not available.
[d]9/19/1994 Bay Protection and Toxic Cleanup Program data (BPTCP)

Table 2. Peak storm flows USACE, 1997 (RMA model)

	Mean Daily Flow (cfs)					
Water Year	Day 0	Day1	Day2	Day3	Day4	Day5
1985-1986	18	268	530	1589	106	71
1986-1987	24	659	205	69	48	48
1987-1988	13	649	201	17	14	14
1988-1989	10	512	828	15	15	15
1989-1990	13	1772	175	38	18	18
1990-1991	10	1030	2370	1700	47	18
1991-1992	175	2020	2350	712	60	60
1992-1993	410	1950	2979	625	60	40
1993-1994	12	835	200	15	13	13
1994-1995	71	4509	437	397	70	53
1995-1996	24	1600	978	89	24	18
1996-1997	24	1600	978	89	24	18

Table 3. Sediment Deposition rates in Newport Bay – Estimated from the USACE 1997 (RMA model)

Location	Sediment Deposition (m3/year)
Unit I basin	31474.17
Unit II basin	30327.34
South of Unit II	11659.46
Downstream to PCH Bridge	7772.97
Upper Newport Bay Total	**81233.95**
Lower Bay	17444.29
Turning Basin	6782.52
Newport channel	5697.20
Lower Newport Bay Total	**29924.01**
Rhine Channel	859.23

Table 4. Fish Tissue Data in San Diego Creek – Toxic Substance Monitoring Plan (TSMP, 1983 –1998)

Station	Species	Date	Chlordane	Total DDT	Dieldrin	Total PCB	Toxaphene
San Diego Creek/Michelson Drive	Red Shiner	6/9/1998	8.1	203.5	5.7	ND	83.0
Peters Canyon Channel	Red Shiner	6/9/1998	54.8	2168.2	12.5	79.4	330.0
San Diego Creek/Barranca Parkway	Red Shiner	6/9/1998	13.8	458.8	3.2	60.7	91.6
Value used in calc.			**18.3**	**587.2**	**6.1**	**69.4**	**135.9**

Other information reviewed to identify potential sources and to characterize contributions is summarized blow.

Toxic Substance Control Act Facility Database—Federal

Congress enacted the Toxic Substances Control Act (TSCA) of 1976 to protect human health and the environment from the effects of chemicals and other substances that have not undergone appropriate risk screening. To implement its responsibilities under TSCA, EPA maintains the Toxic Substances Control Act database, which tracks the thousands of new chemicals developed by industries each year. A review of the TSCA facility database indicated that no facilities in the watershed handle DDT, Dieldrin, Toxaphene, Chlordane, or PCBs.

Resource Conservation and Recovery Act Information System—Federal

The Resource Conservation and Recovery Act of 1976 (RCRA) gave EPA the authority to control hazardous waste "cradle to grave." This control includes the generation, transportation, treatment, storage, and disposal of hazardous waste. The 1986 amendments to RCRA enabled EPA to address environmental problems that could result from underground tanks storing petroleum and other hazardous substances. RCRA focuses only on active and future facilities and does not address abandoned or historical sites.

According to the EPA RCRA Information System (RCRIS) records, the Newport Bay and San Diego Creek watersheds contain about 1,000 RCRA facilities. However, none of these facilities were found to be a possible source of DDT, Dieldrin, Toxaphene, Chlordane, or PCBs.

Comprehensive Environmental Response, Compensation, and Liability Act Information System—Federal

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) provides for a federal "Superfund" to clean up uncontrolled or abandoned hazardous waste sites, as well as accidents, spills, and other emergency releases of pollutants and contaminants into the environment. The Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) supports the identification and management of Superfund sites.

EPA Permit Compliance System and Industrial Facility Discharge

A review of the EPA Permit Compliance System (PCS) shows 14 permitted facilities in the watershed. None of these 14 facilities were permitted to discharge DDT, PCBs, Dieldrin, Toxaphene, or Chlordane. The Industrial Facility Discharge (IFD) database was also reviewed for facilities within the watershed. The facilities identified in IFD are permitted surface water discharges that have a small flow and are not expected to significantly affect the waters. No other potential point sources were identified based on review of the IFD database.

DTSC sites—State of California

Thirty-two facilities in the watershed were listed under the California Department of Toxic Substance Control (DTSC) CALSITE database (pers. commun. C. Mah). Only three of those facilities (Table F-2) were found to have the chemicals of concern for this TMDL. There is not enough information available to quantify pesticide loads from these three sites.

Table 4. DTSC Calsite facilities within Newport Bay watershed

Site ID number	Facility Name	City	Chemicals of concern	Comments (from database)	Comments (from OCHCA)
30970007	Tustin Parcel	Tustin	Pesticides near housing project;	Nfa for pesticides (1994);	No information
30280149	McKesson Chemical	Tustin	Pesticides and solvents in drums	Nfa by DTSC (1994); referred to County	No information, not a current site
30280073	Tibbetts Newport Company	Santa Ana	Pesticide containers, paint sludge	Referred to County (1987)	No information, not a current site

Source: DTSC database; Nfa = no further action; PEA = preliminary endangerment assessment; OCHCA=Orange County Health Care Agency

Part G— Chromium (Cr) and Mercury (Hg) TMDLs

This support document provides the technical details of the accompanying TMDL document and has been provided for readers interested in the approach, the assumptions, and the data used to develop the mercury and chromium TMDLs. The organization of this document is as follows:

Section I, Pollutant Properties, outlines the chemical and physical properties of mercury and chromium for which TMDLs have been developed. Because of the persistent nature of these pollutants and their known impact on the environment, there is a substantial body of literature available that describes their properties. This section also provides a summary of the possible sources of mercury and chromium to the Rhine Channel.

Section II, Calculation of Loading Capacities and Existing Loads, outlines the process and scientific rationale used to calculate the loading capacities and existing loads and presents the calculations for mercury and chromium. For each compound, all equations, input parameters, and assumptions have been included, along with text that describes how the information was used in the analysis.

Section III, References, includes complete citations for each of the references included in the document.

Appendix 1, Data Analysis and Source Assessment, includes the data used to support the mercury and chromium TMDL analysis.

I. Pollutant Properties

The mercury and chromium TMDLs have been presented in a single document because they are similar in physical and chemical properties and are identified as needing TMDLs in Rhine Channel only. Although these properties differ for the two compounds, they both exhibit an ability to associate with sediments or other solids, and to accumulate in the tissue of invertebrates, fish, and mammals.

The summaries have been developed by reviewing published reports and are focused on the properties that influence their behavior in the environment. This information provides a better understanding of these compounds and supports the TMDL analysis through the selection of values to represent environmental processes.

Mercury (Hg)

Mercury is naturally occurring metal that has several chemical forms: Hg(0), Hg(I) and Hg(II). It may enter the water or soil from natural mineral deposits and volcanic activity. Mercury combines with other elements, such as chlorine, sulfur or oxygen to form inorganic mercury salts, which are usually white powders or crystals. Metallic mercury is used to produce chlorine gas and caustic soda, and is sometimes used in thermometer, dental fillings, and batteries. Inorganic mercury enters the air from mining ore deposits, coal-fired power plants, chlor-alkali plants, cement manufacturing. Cinnabar (HgS) is the most common ore of mercury. Mercury is also used in seed dressings, fungicides, paints, and slimicides. Mercury laden soils or sediments may be a source of mercury in various chemical species.

Mercury also combines with carbon to make organic mercury compounds. Methylmercury (CH_3Hg^+) is produced primarily by microscopic organisms in the water or soil. The formation of methylmercury is the most significant transformation because methylmercury is far more toxic than any other form of mercury. Most scientists observe that anaerobic conditions are required for conversion of inorganic mercury to methylmercury. Organic forms of mercury build up in animal tissues; methylmercury is the prominent chemical species. Since mercury bioaccumulates in tissues, animals at higher trophic levels, such as larger and older fish or birds, tend to have the highest levels of mercury.

The human nervous system is very sensitive to all forms of mercury. Exposure to high levels of metallic, inorganic, or organic mercury can permanently damage the kidneys and brain. Effects on brain functioning may result in irritability, shyness, tremors, changes in vision or hearing, and memory problems. Short-term exposure to high levels of metallic mercury vapors may cause effects including lung damage, nausea, vomiting, diarrhea, increases in blood pressure or heart rate, skin rashes and eye irritation. Mercury's harmful effects may be passed from mother to nursing infant via breast milk. Developmental problems may result such as brain damage, mental retardation, incoordination, blindness, seizures, and inability to speak (ATSDR 2001).

Possible Mercury Sources

Most sources of mercury to the Rhine Channel are anthropogenic. Monitoring results suggest that existing sediments in Rhine Channel are the largest source of mercury. The Regional Board technical report (1998) defines the Rhine Channel as a toxic hot spot and states that historical uses of ship anti-fouling paints containing mercury and other metals may be responsible for elevated sediment levels. However, no investigation has been completed to explain the elevated (total) mercury sediment concentrations within Rhine Channel.

Orange County Coastkeeper (1999) measured mercury concentrations in one sediment core and the results provide a historical perspective. The highest concentrations of total mercury (11 mg/kg dry) were found at the bottom of the core and the lowest concentrations (3.4 mg/kg dry) were found at the top of the core. Other researchers have found similar sediment concentrations in Rhine Channel; the most recent data reported by SCCWRP (2001) reports 5.8 mg/kg dry and SARWQCB (1998) reports (8.7 mg/kg dry). However, these levels are still high enough to contribute to the degradation of benthic organisms. Mercury exceeds the Effects Range-Median (ERM) guidelines in the Rhine Channel (SARWQCB 1998). Table G-1 summarizes observations of mercury and chromium levels in the Rhine Channel sediments.

Table G-1. Chromium and Mercury Sediment Monitoring Results for Rhine Channel

Organization (cite)	Collection dates	Location	Cr conc. (mg/ kg dry)	Hg conc. (mg/ kg dry)	
SCCWRP (2001)	5/01	Boatyard launch	44.0	5.80	
	9/00	See above	26.0	5.30	
OCPFRD (2000)	4/96 -- 6/00	Rhine -- bend	13.3 – 60	N/a*	Mean = 24.4 Median = 17
BPTCP (1997)	1996	N/A	69.6	8.74	
	1994	N/A	51.5	7.62	
Coastkeeper (1999)	1999	Rhine -- middle	13	4.4	
Coastkeeper Sediment core (1999)	1999	Rhine -- bend Top	16	3.4	
	1999	Top-middle	15	7.6	
	1999	Mid-bottom	13	9.8	
	1999	Bottom	12	18	

*currently, OCPFRD does not monitor for mercury; mean and median values are for chromium.
N/A= not available

Mercury-containing sediments may also have been transported from the San Diego Creek watershed into the Rhine Channel. Historic records show mercury mining occurred at Red Hill mine between 1880 and 1939 (CA Division of Mines 1976). According to this report, 130 seventy-six pound flasks of mercury were produced between 1927 and 1929. Minor mercury production is also reported for 1932-33 and 1939. Insufficient information is available to accurately interpret sediment transport from this historic mining site.

Atmospheric deposition is believed to be an active source of mercury; however, compared to inputs from existing sediments and contributions from freshwater sediment deposition, atmospheric deposition of mercury is considered negligible. In addition, ambient seawater concentrations of mercury are extremely low, typically less than 1 ng/L, indicating that seawater is an insignificant source of mercury in the Rhine Channel.

Chromium (Cr)

Chromium is a naturally occurring element found in plants, rocks, soils, and volcanic dust and gases. Chromium is present in the environment in several different forms. The most common forms are chromium (0), chromium (III), chromium (VI). Metallic chromium (0) is used for making steel. Chromium (III) and (VI) are used for chrome plating, dyes and pigments, leather tanning, and wood preserving.

Chromium can strongly attach to soil and only a small amount can dissolve in water and move deeper in the soil to underground water. Fish do not accumulate much chromium in their tissues from water. Chromium (III) is an essential nutrient that helps humans metabolize sugar, protein and fat. Chromium (VI) is classified as human carcinogen by the World Health Organization. Ingesting large amounts of chromium (VI) can cause stomach upsets and ulcers, convulsions, kidney and liver damage, and even death. Skin contact with certain chromium (VI) compounds can cause skin ulcers. Some people are extremely sensitive to chromium (III) or chromium (VI). Allergic reactions consisting of severe redness and swelling of the skin have been noted (ATSDR 2001).

Possible Chromium Sources

A wide range of information was accessed to identify potential sources of chromium and mercury and to characterize contributions, including monitoring data, data from national, state and local databases, and scientific literature. The source analysis section focused on possible point, nonpoint, and tributary sources. Sources of chromium in the Rhine Channel include existing sediments in Newport Bay, historic deposits in the San Diego Creek watershed, and possibly atmospheric deposition. Sources of chromium may include paint chips, dust, and grit from shipyard operations, leaching of anti-fouling paints from boat hulls, and storm water runoff from industrial areas. Chromium may also be leaching from treated wood pylons in marine areas (Warner and Solomon 1990). Recently reported levels of chromium in Rhine Channel sediments are shown in Table G-1.

According to Regional Board records, a potential source of chromium inputs to the Rhine Channel is the former Newport Plating facility located at 2810 Villa Way in Newport Beach (see Figure A-7, TSD Part A). Chromium has been found at excessive levels both in soil samples (maximum concentrations of 8,160 mg/kg total chromium and 34.7 mg/kg Cr^6) and in groundwater (0.03 – 1.98 mg/L as total Cr) beneath the facility (Petroleum Industry Consultants, Inc., 1987; Remedial Action Corporation, 1988). (Other contaminants identified in borings and groundwater monitoring wells at the facility include cadmium, copper, nickel, and zinc.) On March 19, 1987, Orange County cited (Notice to Correct) the operator of the plating facility for leaking of finishing wastewater (OCHCA, 1987). The facility was the site of several spills during its period of operation (approximately 20 years) and many of the solutions used in the plating process were disposed to a floor drain that discharged directly to the soils beneath the facility (SARWQCB facility investigation reports, March 25 and April 7, 1987). A Cleanup and Abatement Order (CAO No. 87-83) was issued to the property owner and the operator of Newport Plating on May 18, 1997. On December 11, 1987, the operator discharged wastewater to City of Newport Beach surface drains in violation of the CAO (SARWQCB staff report, February 11, 1988). A storm drain that connects directly to the Rhine Channel is located at the southern end of the plating facility property (Figure A-7, TSD Part A).

The plating facility closed in March 1988 after the owner evicted the operator of the facility. In 1990 the case was referred to the Attorney General for collection of ACL assessments (Resolution No. 90-100). It appears that the site has not yet been remediated based on a visit to the facility on February 7, 2002, by Regional Board staff (the facility and property did not appear to have been disturbed). OCHCA staff indicated that the plating waste inside the facility was cleaned and disposed of on March 3, 1988, but they have no records indicating that the soils and groundwater beneath the facility were cleaned up or remediated (pers. comm., B. Pepki). Therefore, soils and groundwater beneath the facility are likely continuing to contribute to the pollutant loading in the Rhine Channel.

Currently, there is not sufficient information to estimate chromium atmospheric deposition rates in the Newport Bay watershed.

Review of Sediment Targets

As discussed in the TMDL document, two targets have been identified for each chemical, one for sediment and one for tissue levels. The primary target value (sediment) is for TMDL development, whereas the alternate target (tissue) is designed to provide another means of assessing desired water quality conditions of Rhine Channel.

There are several available screening values for mercury concentrations in sediment and fish tissue. For mercury in Rhine Channel, EPA applied the sediment numeric target, 0.13 mg/dry kg, as the most appropriate indicator of desired water quality. This threshold effect level (TEL) is associated with no observed effect on benthic organisms as part of a study by MacDonald et al. 1996 and cited in NOAA SQuiRTs (Buchman 1999). For comparison, the TEL value is much lower than the probable effects level (PEL = 0.696 mg/kg dry). The NOAA Effects Range-Low (ERL) value for mercury (ERL = 0.15 mg/kg dry) is close to the TEL target value.

EPA has also evaluated the available water quality criteria and levels for sediments and fish tissue to determine the appropriate numeric target for chromium TMDL in Rhine Channel. EPA selected the sediment target (52 mg/kg dry, Buchman 1999) as the best available target to protect both wildlife predators and benthic organisms.

Table G-2. Sediment Targets Used in the TMDL Analyses

	Mercury (mg/kg)*	**Chromium (mg/kg)***
Rhine Channel	0.13	52

* dry weight

II. Calculation of Loading Capacities and Estimate of Existing Loadings

General Conceptual Approach

The loading capacity for each pollutant represents the maximum loading that a waterbody can assimilate and still meet and maintain water quality standards. For the mercury and chromium addressed in these TMDLs, long-term loadings at or below the loading capacities should eventually result in reduction in concentrations of these compounds in bottom sediment to levels protective of the standards. A review of available data (see Appendix 1 for a summary of the data used in the TMDL analysis) indicates that bottom sediments currently exhibit elevated mercury and chromium concentrations. The higher the current concentrations in bottom sediments, the longer it will take to meet standards, even if external sources are reduced.

The approach to determining the loading capacities for mercury and chromium is similar to the approach used for the organochlorine compounds (TSD – Part F) and was based on an understanding of the sources of these compounds (past, present, and future) and the transport and ultimate fate of these compounds in various environmental media. Based on a review of literature sources, it was observed that mercury and chromium environmental persistence and affinity for adsorbing to sediment and accumulating in biota generally limits their presence in the water column, at least relative to sediment and biota. The loading capacities were determined by "back-calculating" the allowable load from the selected sediment target (Table G-2) and the associated estimates of sediment loads.

The calculation of existing mercury and chromium compound loads, which are not required components of the TMDLs, allows for a relative comparison the estimated current loading to the calculated loading capacity. In contrast to the calculation of the loading capacities, which was accomplished through back calculation from the sediment targets, the existing loadings were based on review and analysis of available sediment data.

Calculation of Newport Bay Loading Capacity and Existing Loads

Previous modeling studies, completed by RMA for the U.S. Army Corps of Engineers (USACE) have examined the circulation patterns, and transport and deposition of sediments in Newport Bay (RMA 1998, 1997). By examining model calibration results (RMA 1997) for Newport Bay from 1985-1997, the sediment deposition in Rhine Channel was estimated. Historic pollutant loads to the bottom sediment were estimated by using observed pollutant concentrations in bottom sediments and net sedimentation rates. Sediment volume was converted to dry weight using an estimated porosity of 0.65.

Figure G-1 presents a schematic of the approach used to calculate the loading capacity and existing loads for Mercury and Chromium for Rhine Channel.

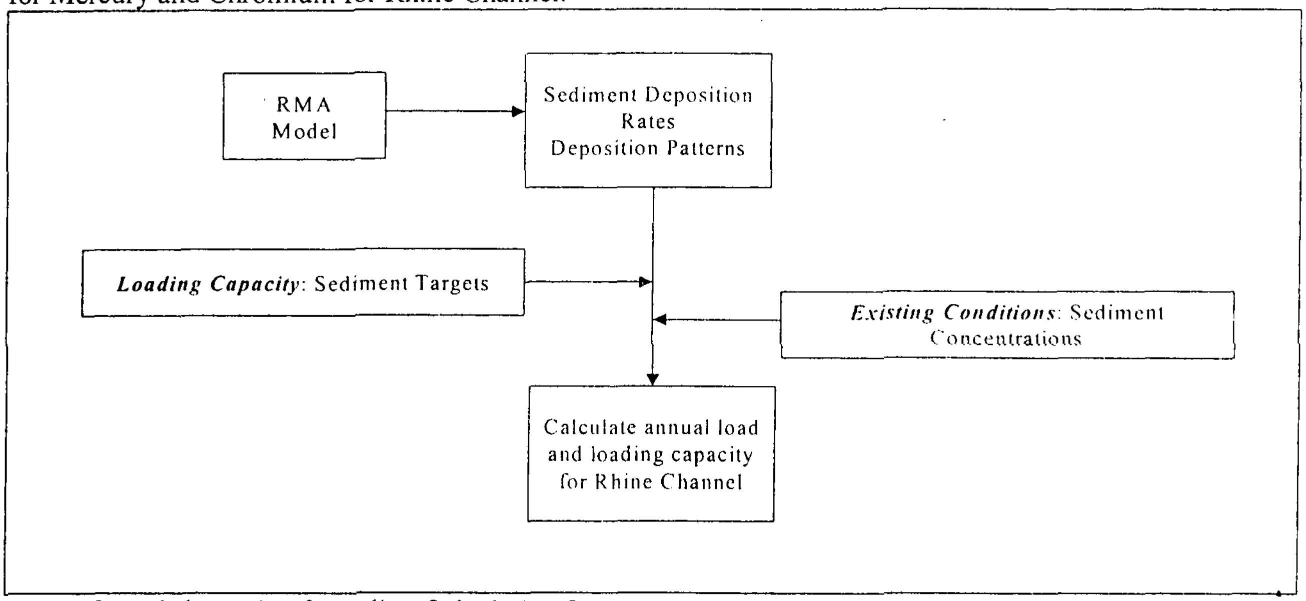

Figure G-1. Schematic of Loading Calculation Steps

The approach relies on the following key information:

- Sediment deposition rates (from the RMA (1997) model)
- Sediment deposition patterns (from the RMA (1997) model)
- Sediment pollutant targets (used for loading capacity) (see Table G-2)
- Sediment mercury and chromium concentrations from observation data (used for existing loads) (see Table G-1 and Appendix 1)

The remainder of this section presents the loading capacity calculations for mercury and chromium. For each compound, all equations, values applied, and references used in the calculations are included.

Summary of Approach for Calculating Loading Capacities and Existing Loads of Mercury and Chromium Compounds for Rhine Channel

The following equation was used with sediment target concentrations (Cs) (Table G-2) to calculate the loading capacities. For existing loadings, the same equation was used with concentrations from existing sediment data substituted for the sediment targets.

$$\text{Load (g/yr)} = \text{Cs} \times \text{Ds} \times \rho\text{s} \times (1 - \text{Ps}) \times \text{CF}$$

where:
- Cs = sediment concentration (mg/kg dry)
- Ds = sediment deposition (m^3/yr)
- ρs = sediment density (kg/m^3)
- Ps = sediment porosity
- CF = conversion factor from mg to kg

The values for all parameters used in the analysis for Newport Bay and Rhine Channel are presented in Table G-3.

Table G-3. Parameter values used in the Rhine Channel TMDL analysis.

	Sediment conc. (mg/kg dry)		**ρs (kg/m^3)**	**Ps**	**CF**
	Target Concentration	**Observed Concentrations***			
Mercury	0.13	5.8	2,500	0.65	0.000001
Chromium	52	44			

Ds (m^3/year): Rhine Channel: 859.23
*SCCWRP (2001), 2001 sampling data

Calculations

Mercury

Loading Capacity

$$\text{Rhine Channel Loading Capacity (kg/yr)} = 0.13 \times 859.23 \times 2{,}500 \times (1 - 0.65) \times 0.000001$$

Existing Loading

$$\text{Rhine Channel Existing Loading (kg/yr)} = 5.8 \times 859.23 \times 2{,}500 \times (1 - 0.65) \times 0.000001$$

Table G-4. Existing and Loading Capacity for Rhine Channel for Mercury

Mercury	**Existing Load (kg/year)**	**Loading Capacity (kg/year)**
Rhine Channel	4.39	0.10

Chromium

Loading Capacity

$$\text{Rhine Channel Loading Capacity (kg/yr)} = 52 \times 859.23 \times 2{,}500 \times (1 - 0.65) \times 0.000001$$

Existing Loading

$$\text{Rhine Channel Existing Loading (kg/yr)} = 44 \times 859.23 \times 2{,}500 \times (1 - 0.65) \times 0.000001$$

Table G-5. Existing Loading and Loading Capacity for Rhine Channel for Chromium

Chromium	Existing Load (kg/year)	Loading Capacity (kg/year)
Rhine Channel	33.1	39.10

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Appendix 1: Data Analysis and Assessment

This appendix presents the data available to characterize the level of contamination by chromium and mercury in Rhine Channel. Monitoring data are available for three media: water, sediment, and tissue. The following data summaries are organized by the source/agency.

Bay Protection and Toxic Cleanup Program Data (BPTCP): This study reports sediment concentrations at various locations in the Newport Bay for Mercury and Chromium. Sediment sample data in mg/kg was available from two sampling events that took place in 1994 and 1996. This data was not used in the analysis but is reported in Table G-1.

Newport Bay Sediment Toxicity Studies (SCCWRD, 2001): Sediment samples collected at 10 Newport Bay stations in May 2001 were available. Sediment data in mg/kg for Cr and Hg at selected locations in Rhine Channel was used to estimate the existing loading capacity.

Resource Management Associates report (RMA, 1997): Estimates of the sediment distribution for the Upper Bay, Lower Bay and Rhine Channel were made using the results of sediment transport model developed by RMA. The model simulates wet and dry conditions as well as the largest storm event from 1985-1997. Because most sediment entering Upper Newport Bay occurs during the storm events, mean daily stream discharge records for San Diego Creek were used to develop a five-day hydrograph which were used to simulate storm event for RMA model. The peak flows for each model simulation years are shown in Table 2 below. A detailed description can be found in the RMA report (RMA, 1997). The sediment deposition rates for Newport Bay were derived from 12-year model simulation results. Although the mean values are used to estimate the sediment budget for the Newport Bay, the sediment deposition rates represents a net deposition over the years.

The following tables list data from different sources by the various sources used in the analysis. The most recent sediment data (May 2001) was used from the Newport Bay Sediment Toxicity Studies Report, October 23, 2001 (Tables 8, 9 and 10) (SCCWRD, 2001).

Table 1. Sediment Chemistry Toxicity Data used in the TMDL

Location	Chromium mg/kg dry	Mercury mg/kg dry
Rhine Channel (NB3)	44	5.8

All non-detects were taken as zero

Table 2. Sediment Deposition rates in Newport Bay – Estimated from the RMA (1997)

Location	**Sediment Deposition (m3/year)**
Unit I basin	31474.17
Unit II basin	30327.34
South of Unit II	11659.46
Downstream to PCH Bridge	7772.97
Upper Newport Bay Total	81233.95
Lower Bay	17444.29
Turning Basin	6782.52
Newport channel	5697.20
Lower Newport Bay Total	29924.01
Rhine Channel*	859.23

*Rhine Channel deposition rates used for this analysis.

H. Decision Document of Water Quality Assessment for San Diego Creek and Newport Bay

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June 14, 2002

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I. TMDL Overview

EPA Region 9 is required by a consent decree to ensure completion of Total Maximum Daily Loads (TMDLs) for certain toxic pollutants in Newport Bay by June 2002. The chemicals of concern are specific to three water bodies and are identified in the consent decree. Although the consent decree included a list of chemicals for which TMDLs would be prepared, it specifically provided that EPA was under no obligation to establish TMDLs for any pollutants that EPA determined did not need TMDLs consistent with Clean Water Act Sec. 303(d). This document summarizes EPA's analysis supporting our determinations of which pollutants need TMDLs. This document was originally drafted in May 2001 but has been revised based on some additional data and analysis.

Santa Ana Regional Water Quality Control Board staff prepared a problem statement (Dec. 2000) that includes their determination of which chemicals warrant preparation of TMDLs based on their assessment of which chemicals appear to be creating toxicity in the water bodies at issue. This report recommends a significant number of chemicals identified in the consent decree not receive TMDLs. The report also recommends preparing TMDLs for some water body segments in the Newport Bay watershed and specific chemicals not identified in the consent decree.

EPA Region 9 independently evaluated all readily available data for San Diego Creek and Upper and Lower Newport Bay to determine which chemicals warrant TMDLs. We did not evaluate chemicals beyond those identified in the consent decree or by Santa Ana Regional Board. Column 1 of Table 1 lists specific chemicals for each affected water body identified in the consent decree. Column 2 of Table 1 identifies the specific chemicals for each affected water body for which EPA has determined that TMDLs need to be prepared. As part of our analysis, we determined the Rhine Channel should be treated as a separate water body. Therefore, Table 1 identifies chemicals for the three water bodies set forth in the consent decree, plus Rhine Channel.

EPA Region 9 has agreed to gather monitoring data for those constituents not determined to be appropriate for TMDL development, e.g., Endosulfan, Silver and other chemicals in Column 3 of Table 1. EPA Region 9 will compile analytical results of water column, sediment and fish tissue samples collected in 2001, 2002 and 2003. This monitoring report (and accompanying data) will be submitted to Santa Ana Regional Board in April 2003. This report will supply additional information to the Regional Board as part of future water quality assessment and planning activities.

Watershed description

Newport Bay is about 4 miles long by three to one-half mile wide with one ocean inlet. The watershed (150 sq. miles) consists of two regions of freshwater tributaries flowing into San Diego Creek, which flows into Upper Newport Bay. Santa Ana Regional Board has divided San Diego Creek (**SDC**) into two Reaches, upstream (Reach 1) and downstream (Reach 2) of Jeffrey Road. San Diego Creek has a mean base flow of about 8 cfs with significant increases (1000 to 4000 cfs) during storm events. SDC is influenced by slightly saline water table (less than 1 or 2% salinity) and approximate mean hardness of about 400 ppm. SDC is the primary tributary and flows into Upper Newport Bay.

Upper Newport Bay (**UNB**) is defined by Jamboree Road to the North and Pacific Coast Highway (PCH) Bridge to the south. There are two main freshwater inputs—San Diego Creek and Santa Ana/Delhi Channel—as well as tidal influxes, so salinity is about 15 ppt. It has estuarine wetlands and is designated a State Ecological reserve in the upper areas with more small boat marinas (including a boat painter's yard) near PCH Bridge. Periodically it has been dredged to remove trapped sediment. There is a storm drain just above PCH Bridge coming from the PCH Bridge overpass and immediate vicinity.

Lower Newport Bay (**LNB**) is defined as below PCH bridge to the outer harbor, so salinity is about 30--35 ppt. Surrounding shores and two islands are highly urbanized with nine boatyards and about 10,000 small boats. In the western area of Lower Newport Bay, two isolated areas have less tidal flushing: Turning Basin and Rhine Channel.

Santa Ana Regional Board has designated **Rhine** Channel as toxic hotspot. The land use history in the area immediately adjacent to Rhine Channel suggests that local pollutant source may be significantly different from the pollutant sources that have discharged to the rest of the watershed. Given the different levels of sediment contamination observed in Rhine Channel as compared to other areas of Newport Bay and the likely association of toxic hotspots in Rhine Channel with local pollutant sources, EPA has determined that is appropriate to develop separate TMDLs for that reach of Lower Newport Bay rather than simply addressing it as part of the TMDLs for Lower Newport Bay. We believe this approach will facilitate more effective planning and implementation of pollutant control strategies by the State.

Table 1.

Consent Decree	TMDL Development	More monitoring
San Diego Creek: Cd, Cr, Cu, Pb, Zn	**Cd, Cu, Pb, Zn, Se**	Cr
Endosulfan, DDT, PCBs, Toxaphene, Chlorpyrifos	**Chlordane, Dieldrin, DDT, PCBs, Toxaphene** **Chlorpyrifos, Diazinon**	Endosulfan
Upper Newport Bay: Cd, Cr, Cu, Pb, Hg, Ag, Zn	**Cd, Cu, Pb, Zn, Se, As**	Cr, Hg, Ag
Endosulfan, DDT	**Chlordane, DDT,** **PCBs,** **Chlorpyrifos**	Endosulfan
Lower Newport Bay: As, Cd, Cu, Pb, Se, Ag, Hg, Zn	**Cu, Pb, Zn, Se, As**	Ag, Cd, Hg
Chlorbenside, Chlordane, Chlorpyrifos, Dieldrin, Endosulfan, DDT, PCBs, Toxaphene,	**Chlordane, Dieldrin, DDT, PCBs**	Chlorbenside, Chlorpyrifos, Endosulfan, Toxaphene
Rhine Channel:	**Cu, Pb, Zn, Se, As, Cr, Hg**	Ag, Cd
	Chlordane, Dieldrin, DDT, PCBs	Chlorbenside Chlorpyrifos, Endosulfan, Toxaphene

III. Weight of Evidence Approach

EPA Region 9 assessed several types of available toxicity and chemical data to assess the need for TMDLs: water column data, sediment quality data, and fish/shellfish tissue data. We applied a two-tiered approach whereby data were analyzed to determine whether there is clear evidence of impairment with probable adverse effects (TIER 1) or incomplete evidence and/or evidence of possible adverse effects or potential for future impairment (TIER 2). Table 2 provides a diagram of EPA's assessment criteria for determining whether a constituent would be placed in TIER 1 or TIER 2 with respect to each data category.

If a chemical exceeded the screening criteria in TIER 1 with respect to any of the three categories, we determined that a TMDL would be completed for that chemical in the affected water body.

TIER 2 addresses the "gray area" where exceedences of standards or screening guidelines are less frequent or less extreme, where data sets are incomplete for particular categories, or where there is concern about potential water quality standards violations in a segment based on conditions in the adjacent segments. EPA developed two methods for determining whether TMDLs were needed based on TIER 2 considerations.

First, if a chemical exceeded the screening criteria in TIER 2 with respect to two or more data categories, we determined that a TMDL is needed. This determination was based on a conclusion that the weight of available evidence indicates applicable numeric and/or narrative water quality standards are being exceeded and that designated beneficial uses may not be fully supported.

Second, we also considered as part of the TIER 2 analysis whether a TMDL is warranted for an individual water segment based on the considerations that TMDLs were determined to be needed for adjoining water segments and that some evidence of impairment was present for the individual segment. All the water segments in the watershed are hydrologically connected, and in many cases pollutants may move freely between different segments. Therefore, EPA carefully evaluated situations where a specific water segment did not meet the criteria for a TMDL determination based on the data analysis criteria described above, but one or more adjoining segments did meet the data analysis criteria and were found to need TMDLs. If there was some evidence for the specific segment indicating potential impairment and the impairment evidence for the adjacent segment was very strong, we determined TMDLs may be needed for the specific water segments in order to ensure that TMDLs would be developed where needed despite uncertainties about the degree of local impairment. For the toxic pollutants of potential concern in the watershed, this approach was warranted because many of these pollutants remain in and move through the aquatic environment for long periods of time. Because Newport Bay is tidally influenced, water, sediments, and pollutants may move back and forth in the Bay over time. EPA concluded that it is appropriate to take a "watershed approach" to TMDL development for many pollutants rather than simply excluding individual segments from consideration because TIER 1 and TIER 2 data analysis thresholds were not fully met when adjacent segments did meet those thresholds. This watershed approach enabled EPA to look holistically at pollutant discharges and transport through the watershed in developing TMDL approaches. The sections below that present analysis for specific pollutants describe the basis for EPA's judgments in conducting the adjacent waters analysis.

In a few situations, however, EPA determined it was not appropriate to develop TMDLs for specific segments despite the fact that an adjacent segment was determined to need a TMDL. TMDL development is not appropriate in these situations because the evidence of impairment in the adjacent segment, or evidence of potential impairment in the specific segment, was not strong enough to support such a determination. The basis for these determinations is described below where the individual pollutant assessments are discussed.

We have applied this tiered system to assess water, sediment and tissue monitoring data in four water body segments: San Diego Creek, Upper Newport Bay, Lower Newport Bay and Rhine Channel (see Table 5 for data sources). To maximize the relevance of this analysis to present conditions of water quality and to ensure the analysis is based on reliable data, we concentrate on most recent results (since 1995) and apply quality control (QC) measures outlined in Section V.

Tier 1 Sufficient evidence in *one category* establishes impairment and triggers a TMDL

Water Column

Dissolved water column concentrations were compared to acute and chronic California Toxic Rule (CTR) water quality criteria (WQC). EPA 305(b) guidance (EPA, 1997) suggests that if greater than 10% of sample results exceed either acute or chronic values then the aquatic life beneficial uses of the water body are not fully supported. If water toxicity tests showed a chemical caused toxicity, then we concluded a TMDL was needed for this chemical. In our best professional judgment, we assumed that toxicant identification evaluations (TIE) should be completed for at least two organisms or three or more separate sampling events to clearly demonstrate impairment associated with water column toxicity tests. This frequency is based on the often-transient nature of water column contamination and associated toxicity.

Sediment

Sediment TIE studies and triad studies determine if one or more chemicals are present at levels which do not support beneficial uses. Triad studies require three measurements: sediment toxicity, infaunal analysis and sediment chemistry to evaluate sediment effects on aquatic life. If two of the three portions of triad study indicate benthic community degradation (e.g., defined as a negative value by Bay Protection Toxic Clean-up Program) then impairment was established but additional analysis was needed to clarify which pollutants were causing the degradation. To identify chemicals associated with impairment, we compared sediment concentrations to higher sediment quality guidelines (SQGs) or equilibrium partitioning guidelines (ESG) and if greater than 25% of sample results exceed higher SQGs then we concluded a TMDL was necessary.

Tissue

Two types of tests were applied. First, if a fish consumption advisory was posted *and* based on analysis of local data, then TMDL development was determined to be necessary. Second, sportfish and shellfish tissue concentrations were compared to screening values, primarily those established by EPA or California Office of Environmental Health Hazard Assessment (OEHHA). For chemicals for which neither EPA or OEHHA have established screening values, we also considered tissue screening values from other sources: maximum tissue residue levels (MTRLs), United Nations Median International Standards (MIS), and wildlife risk values (US Fish and Wildlife, 1998). We compared the lowest or most protective screening value to results of total tissue concentrations, except for arsenic as discussed in section IV below. If greater than 25% of sample results exceeded this screening value then we concluded a TMDL is necessary for this pollutant.

We determined that a minimum of ten samples were needed in order to make a TIER 1 determination of TMDL necessity. Because TIER 1 determinations were based on a single line of evidence, we concluded that it was reasonable to expect a minimum number of samples in order to increase the level of confidence in the determination. The EPA 305(b) guidance (EPA, 1997) recommends a minimum of 10 water samples in three years in assessing potential exceedences of water quality standards for toxic pollutants. We assumed that ten sediment or fish tissue sediments were required for clear evidence of impairment. For each pollutant and data category, if 10 samples do not exist then available data were considered through the TIER 2 assessment methods described below. We consider our reliance on a minimum of ten samples for an assessment based on a single data type to be reasonable and prudent given the variability and uncertainty associated with environmental monitoring. In addition, our reliance on a minimum sample size was reasonable for the Newport Bay watershed for which relatively plentiful data are available compared to most waters in the region.

Tier 2 Requires evidence in *two out of three categories* or information from adjacent segments to trigger a TMDL

Water Column

Dissolved water column concentrations were compared to applicable acute and chronic CTR values. EPA 305(b) guidance states if chemical results exceeded either acute or chronic values more than once in three years then the chemical partially supports beneficial uses of the water body. Limited toxicity tests were also considered reasonable indicators of possible adverse effects. Either case warranted further convincing evidence from other categories (sediment or tissue results). Prudent evaluation includes consideration of the frequency and magnitude of these exceedences as well as the analytical error for these results relative to the CTR values. (See Data QA/QC in section V.)

Sediment

Sediment concentrations were compared to low sediment quality guidelines (e.g., effects range low (ERL) and threshold effect levels (TELs)) and if greater than 10% sample results exceed *both* of those lower SQGs then the chemical was found to partially support aquatic life use. Whenever feasible specific freshwater SQGs were used for San Diego Creek sediment data. In sediment triad studies (as described above in Tier 1), when only two of three legs have been completed, at least one part must be for chemistry data in order to identify the pollutant(s) of concern. Again, evidence from water or tissue studies was also required to trigger TMDL development.

Tissue

Tissue concentrations were compared to the lowest or most protective screening values. Total concentrations were used except for arsenic as discussed in section IV below. If greater than 10% of sample results exceed the screening value, then we reviewed results of water and sediment assessments to determine additional evidence and possibly trigger TMDL. EPA or OEHHA values were preferred, yet if value for chemical was unavailable (e.g., Ag, Cd, Cr, Pb, Zn), then MTRLs, MIS, FDA, or wildlife risk values were used.

Adjacent Segments Analysis

As discussed above, we also considered as part of the TIER 2 analysis whether a TMDL is warranted for an individual water segment based on the considerations that:

- TMDLs were determined to be needed for adjacent water segments, and
- some evidence of impairment (e.g., one potential exceedence based on TIER 2 analysis) was present for the individual segment.

If there was some evidence for the specific segment indicating potential impairment and the impairment evidence for the adjacent segment was very strong, we determined TMDLs may be needed for the specific water segments in order to ensure that TMDLs would be developed where needed despite uncertainties about the degree of local impairment

Table 2.

Two–tiered approach to assessment of monitoring data for Newport Bay and its watershed

	Water Quality	Sediment Quality	Tissue Results
Tier 1 Impairment to Aquatic Life or Probable Adverse Human Health effects	>10% samples* exceed CTR values OR water TIEs clearly demonstrate toxicant	sediment triad or TIE studies clearly demonstrate toxicant OR >25% samples[#] exceed high SQGs (or ESG values)	posted consumption advisory[δ] OR >25% samples[#] above tissue screening values
Tier 2 Possible Effects to Aquatic Life or Human Health	two or more samples* exceed applicable CTR values within six years	>10% samples above *both* low SQGs OR toxicity evident and sediment chemistry results provided, but no TIEs	>10% samples above fish tissue OR Shellfish values
Comment TMDL can triggered by one category in Tier 1 but needs two categories in Tier 2	see CTR for full discussion of acute and chronic values; Freshwater metals values are hardness dependent	ESGs from EPA (draft 2001a) High SQGs = PELs/ERMs/AETs; low SQGs = ERLs/TELS	Use lowest value of EPA, OEHHA, US F&W, MTRL or MIS.

NOTE: For TIER 1 requires minimum number of 10 samples within each category. If insufficient data exist then assessment defaults into TIER 2 or inconclusive.
*10% and "two or more" from EPA 305(b) guidance (1997), section 3.2.4 on toxics in water samples.
[#]25% from Consolidated Assessment and Listing Methodology guidance (EPA draft report 2001b).
[δ]based on local data in comparison to criteria equal to or more stringent than water quality standard
Acronyms explained in text of Sections III & IV.

Trend Analysis

EPA guidance provides that threatened waters (waters currently meeting standards but expected to exceed standards within the next two years) should be considered for TMDL development (EPA, 1997). EPA regulations, as interpreted in EPA guidance (1997) also provides that TMDLs may not be needed for impaired waters if other control mechanisms will result in attainment of standards within the next two years. Therefore, EPA evaluated whether there appeared to be water quality trends in the different water segments in the watershed that would indicate either:

- waters currently meeting standards appear to have declining trends and may not meet standards in the future or
- waters currently exceeding standards appear to have improving trends and may meet standards in the future.

We plotted available water chemistry, sediment, and tissue data to evaluate whether chemical concentrations are decreasing or increasing relative to the numeric criteria or screening value in that category. Such graphs were generated *if* and *only if* there is sufficient data (using consistent sampling and analytical methods) covering more than five years of results; e.g., State Mussel Watch program. If trends were apparent based on visual observation of the graphs, we applied statistical methods (e.g. regression analysis and Mann-Kendall test (Gilbert, 1987) to evaluate the apparent trends were statistically significant.

Some potential trends were observed based on this analysis. Tissue levels of chromium, selenium, zinc in tissue samples appeared to be increasing over time in some segments of Newport Bay. On the other hand, tissue levels of organic chemical pollutants and sediment levels of copper and lead appeared to be declining over time in some segments of Newport Bay.

However the available data were too limited and the apparent trends insufficiently clear to conclude either that:

- waters which now exceed standards will meet standards within the next two years or
- waters that now meet standards will exceed standards within the next two years.

Therefore, EPA concluded that no adjustments to the determinations of TMDL necessity were warranted based on the trend analysis.

IV. Discussion of numeric screening values used in decision process

Table 3 provides a compilation of screening values used in our decision process. Here we provide further explanation on selection of these values.

Water

Water quality criteria values are from California Toxics Rule (CTR), promulgated by EPA (2000a). As appropriate for certain metals, we have adjusted freshwater values to assume hardness equals 400 ppm (average conc. in San Diego Creek). Monitoring data for chromium (Cr) results in water samples are reported in two different ways, depending upon whether the available data identified valence states of chromium. First, Irvine Ranch Water District (IRWD) and Orange County Public Facilities Resources Department (OCPFRD) report dissolved Chromium results, so we have combined chromium CTR values (added Cr (3+) and Cr (6+)) to make the appropriate comparison with the OCPFRD data. This is reasonable based upon the analytical method to determine dissolved chromium in aqueous samples. Second, Lee and Taylor (2001a) report chromium speciation results so separate Cr (3+) and Cr (6+) data were interpreted against those individual CTR values.

Sediments

There are no *promulgated* sediment quality criteria, so we have chosen to use values from National Oceanic Atmospheric Association (NOAA) Sediment Quality Reference Tables (September 1999). According to NOAA, these numeric values are "intended for preliminary screening purposes only...to initially identify substances which may threaten resources of concern. [These multiple SQGs]... help portray the entire spectrum of [environmental] concentrations which have been associated with various probabilities of adverse biological effects." We recognize these NOAA values have been derived by associating nationwide sediment chemistry data sets with benthic toxicity results and there is no direct cause and effect relationship. Nonetheless, we have concluded that these values provide reasonable evidence of potential adverse aquatic life effects and therefore apply them as sediment quality guidelines (SQGs) to provide comparison for trace metals and organic compounds. Low SQGs (e.g., threshold effect levels (TELs) and effects range low (ERLs)) are presumed to be non-toxic levels and pose with a high degree of confidence no potential threat. High SQGs (e.g., probable effects levels (PELs) and effects range median (ERMs)) identify pollutants that are more probably elevated to toxic levels. SQG values for some pollutants do not exist; e.g., silver (in freshwater) and toxaphene.

We use freshwater SQGs for comparison to San Diego Creek sediment results and saltwater SQGs for the three saline segments of Newport Bay. Based upon methods explained by Long, *et al.* (1998), we have opted to use low SQG levels (TELs and ERLs) as protective levels for aquatic life. In that study, the authors determined that if sediment concentrations did not exceed *both* TELs and ERLs then one could reasonably predict non-toxicity in those sediments. We believe it is appropriate to apply these lower threshold values in TIER 2, when evaluating "gray area" data. When evaluating heavily contaminated sediments, we use the higher SQGs to indicate probable impairment (TIER1) since adverse effects are (nearly) always expected when PELs or ERMs are exceeded. Adverse effect threshold (AET) values were used only if other SQGs do not exist, since these values were derived from site-specific studies in Puget Sound.

EPA has drafted (2001a) equilibrium partitioning sediment guidelines (ESGs) for a limited group of pollutants-- six metals and two organic compounds. These ESGs are based upon a different approach than NOAA's screening guidelines and ESGs rely on considerably more data than is typically generated in sediment studies. In short, measurements of total organic carbon (for organic compounds) and acid volatile sulfides (for metals) are required to calculate ESGs for those sediment sites. To date, only one study (Bight '98/SCCWRP) has sufficient data to use ESG values, and these results apply only to sediments in Lower Newport Bay. We have included assessment of acid volatile sulfide and simultaneously extracted metal results for five metals at ten Lower Newport Bay sites. We have also evaluated metal porewater concentrations relative to interstitial water guidelines for those same Lower Bay sties. We were unable to perform ESG assessments for organic compounds but Bight '98 results for organic compounds were incomplete.

Tissue

Both EPA (2000b,c) and OEHHA (1999) have issued guidance for issuing fish consumption advisories to protect human health via sportfish and shellfish consumption. Tissue screening values (SVs) were determined for noncarcinogens and some carcinogens using a risk-based approach, assuming a risk level of 1 in 100,000. This risk based approach included assumptions on human body weight, reference dose and daily consumption rates. EPA has evaluated numerous fish consumption surveys and recommended that risk assessments assume consumption values of 17.5 grams per day for the general adult population and recreational fishers and 142.2 grams/day for subsistence fishers (2000d). OEHHA assumes recreational fishers consume 21 grams per day. We have found no data that a large number of anglers are subsistence fishers in Newport Bay, thus we have utilized screening values from EPA and OEHHA for recreational fishers and the general adult population.

For some metals for which EPA or OEHHA tissue SVs do not exist, we have opted to use either MTRLs or MIS values. California State Water Board's Mussel Watch Program developed MTRLs using a different approach than EPA and OEHHA. MTRLs are calculated by multiplying the applicable water quality objective by a bioconcentration factor specific for each chemical. State Water Board applies MTRLs to fish and shellfish results for Enclosed Bays and Estuaries. Median International Standards (MIS) values arise from a survey of international standards and legal limits by Food and Agriculture Organization of United Nations (1983). We acknowledge that MIS values were not developed in the United States; however, we have used them because fore certain pollutants values (Ag, Cr, Pb, Se, and Zn) have not been established by EPA, OEHHA or the State Water Board. Separate MIS values exist for freshwater fish and shellfish, thus we have applied them with respect to fish tissue results in San Diego Creek and shellfish results throughout Newport Bay. Total concentrations were compared to the lowest (or most protective) screening value provided by EPA, OEHHA, State Water Board, or MIS.

For arsenic in tissue results we have formulated a side-by-side comparison to examine both total arsenic and inorganic arsenic concentrations. The goal was to evaluate the relative contribution from inorganic arsenic, the carcinogenic form of arsenic. We used updated EPA guidance (2000b) to provide an inorganic arsenic screening value, whereas OEHHA (1999) used total arsenic concentrations. Our comparison uses reported total arsenic results and calculated inorganic arsenic data (from the total results) using 4% in finfish and 60% in shellfish. These percentages arise from conclusions in scientific literature. Donohue and Abernathy (1996) completed a broad literature review of total and inorganic arsenic results in both types of tissue and Schoof, *et al.* (1999) performed a market basket survey of inorganic arsenic in food, including finfish. Estimates of inorganic arsenic results in shellfish are provided by Francesconi and Edmonds (1994) and Creed (pers. commun.).

To address protection of aquatic wildlife and aquatic dependent species as well as human health, we have reviewed available literature and selected the lowest screening value from several sources. (Again, there are no promulgated wildlife criteria fish tissue values.) For example, National Academy of Sciences *recommended* maximum concentrations of organic chemicals in animals in freshwater systems (NAS Blue Book 1973). These NAS values were designed to protect aquatic organisms themselves as well as wildlife predators. US Fish and Wildlife (1998) have compiled scientific information to provide guidelines for interpreting biological effects of some chemicals in biota, water and sediment. For most chemicals of concern, the EPA or OEHHA tissue screening values are both the most protective tissue value; copper is one exception (see Table 4). Moreover, EPA and OEHHA values are based upon the most recent scientific information.

Table 4. Fish tissue values: Human Health vs. Wildlife protection

	EPA (2000a) Human health	OEHHA (1999) Human health	NAS (1973) Aquatic Wildlife	U.S Fish & Wildlife (1998) Biological Effects
Arsenic (As)	1.2	1.0	--	0.25
Copper	--	--	--	15
Mercury	0.3*	0.3	--	0.3#
Chlordane	114	30	50	--
Dieldrin	2.5	2.0	5	--
DDT (total)	117	100	50¥	wide range
PCB (total)	20	20	500	--

all values expressed in wet weight: total metal in ppm; organic in ppb; -- means no data available)
*0.3 mg/kg wet wt. for methylmercury conc in fish tissue
#from Canadian study on bird reproduction
¥another DDT value is 150 ppb ww from EPA water quality criteria (1980)
[*EPA (1995) defined aquatic freshwater wildlife criteria for three analytes: DDT, PCBs and mercury based upon studies in Great Lakes Region. Those aquatic wildlife criteria apply only to water bodies within the Great Lakes Region, due to site-specific bioaccumulation factors, and were not used in this assessment of Newport Bay watershed.*]

Table 3. Overview of numeric screening values for METALS

	WATER (ppb)						**SEDIMENT** (ppm dry wt.)							**TISSUE** (ppm wet)		
	fresh acute	fresh chronic	salt acute	Salt Chronic	Water & org.	Org. only	Fresh TEL	Fresh PEL	Salt TEL	Salt ERL	Salt PEL	Salt ERM	Salt AET	EPA	OEHHA	MTRL or MIS
As	340	150	69	36			5.9	17	7.24	8.2	41.6	70	35	1.2	1.0	1.4
Cd	19	6.2	42	9.3			0.596	3.53	0.67	1.2	4.2	9.6	3.0	4.0	3.0	0.3/1
Cr-tot	1724	565	1100	50			37.3	90	52.3	81	160.4	370	260			1.0
Cr6+	16	11	1100	50												
Cu	50	29	4.8	3.1	1300		35.7	197	18.7	34	108	270	390			15[@]
Pb	281	11	210	8.1			35	91.3	30.2	46.7	112	218	400			2.0
Hg	1.4	0.77	1.8	0.94	0.050*	0.051*	0.174	0.486	0.13	0.15	0.696	0.71	0.41	0.3	0.3	0.37[#]
Ag	37		1.9						0.73	1	1.77	3.7	3.1			
Se	20	5	300	71									1	20	20	2/0.3
Zn	380	380	90	81	1.7	6.3	123.1	315	124	150	271	410	410			45/70

Blank space indicates no value available

Water values from CTR (EPA 2000a) , freshwater values calculated at 400 ppm hardness
*mercury CTR values (for human health consumption of water and/or organisms) do not reflect most current fish bioconcentration factor, thus EPA fish tissue value (0.3 ppm wet wt. MeHg as determined in 2000b) is most appropriate.

Sediment values from NOAA SQuiRTS (1999)
TEL = threshold effects level; PEL = probable effects level; ERL = effects range low; ERM = effects range median; AET = apparent effects threshold

Tissue values from EPA (2000b), OEHHA (1999)
[ʸ]most recent available inorganic arsenic value is 1.2 ppm (EPA 2000b)
[#]MTRL value from State Mussel Watch (2000), [@]Copper value from US Fish & Wildlife (1998)
MIS values from Median International Standards from United Nations survey (1983); first value presented for freshwater fish and second for shellfish

Table 3. (cont'd) Overview of numeric screening values for ORGANICS

	WATER (ppb)						**SEDIMENT** (ppb dry wt.)							**TISSUE** (ppb wet)		
	fresh acute	fresh chronic	salt acute	Salt chronic	Water & org.	Org. only	fresh TEL	fresh PEL	Salt TEL	Salt ERL	Salt PEL	Salt ERM	Salt AET	EPA	OEHHA	MTRL
C h																
Chlordane	2.4	0.0043	0.09	0.004	.00057	.00059	4.5	8.9	2.26	0.5	4.79	6	2.8	114	30	8.3
Dieldrin	0.24	0.056	0.71	0.0019	.00014	.00014	2.85	6.67	0.715	0.02	4.3	8	1.9	2.5	2.0	0.7
DDT-tot	1.1	0.001	0.13	0.001	.0059	.0059	6.98	572*	3.89	1.58	51.7	46.1	11	117	100	109
Endosulfan-tot#	0.44	0.112	0.068	0.0174	220	480								24 (ppm)	20 (ppm)	64.8 (ppm)
PCBs-tot	2	0.014	10	0.03	.00017	.00017	34.1#	277	21.5	22.7	189	180	130	20	20	5.3
Toxaphene	0.73	0.0002	0.21	0.0002	.00073	.00075								36.3	30	9.8

Blank space indicates no value available

Water values from CTR (EPA 2000a) ; #sum of endosulfan α & β values
"water & org." and "org. only" refer to human health criteria for consuming water and/or organisms from same waterbody

Sediment values from NOAA SQuiRTS (1999)
TEL = threshold effects level; PEL = probable effects level; ERL = effects range low; ERM = effects range median; AET = apparent effects threshold
*freshwater PEC (probable effects concentration) from Ingersoll, et al. (2000), range of values cited therein: SEL = 120, ERM = 350, PEL = 4450
#freshwater TEL from NOAA, MacDonald et al. (2000) have reviewed the range of total PCB values for freshwater and saltwater (see values cited therein) and provide threshold effects concentrations (TEC) determined by consensus: freshwater TEC = 35 ppb and saltwater TEC = 48 ppb

Tissue values from EPA (2000b), OEHHA (1999), MTRL values from State Mussel Watch (2000) for Enclosed Bays and Estuaries

V. Data QA/QC issues

Sound scientific practice calls for applying quality assurance and quality control measures when assessing sampling design and analytical results. Relevant issues are presented below. We applied QA/QC issues to monitoring data as part of the two-tier decision scheme. Best professional judgment was also required as each project and data set has unique nuances.

a. To determine present day water quality condition and support of aquatic uses, recent data (past 5 years) was given more significance than older data (past ten years). Data greater than 10 years old was not used in the evaluation process except to generate trend analyses.

b. Ideal monitoring studies supply robust data sets, which address spatial and temporal variability and include relevant speciation or congener data. However, robust data sets are not always available so we used the best of data available.

c. Only dissolved (<0.45 um filter) water data were used for comparison to CTR values, since the dissolved fraction best approximates bioavailable metals and organics. Metals are hardness dependent and CTR values were adjusted to appropriate water hardness measurements.

d. Results generated from best sampling and analysis protocols were preferred over those studies that use inappropriate or outdated practices. (Historical evidence has demonstrated that sampling, storage and analytical protocols have yielded contaminated water column samples and consequently high bias data for aqueous mercury and other priority pollutant metals.) Representative ambient water samples are best collected via trace metal clean techniques (EPA Method 1669), handled carefully to minimize contamination within the laboratory (Method 1669), and analyzed by optimal analytical methods (EPA 1600 series). Also, accurate detection of metals in seawater requires specific preparation methods to remove and account for salt matrix interferences (EPA Methods 1638, 1639 and 1640). Simple dilution of seawater samples is not sufficient for accurate detection of aqueous metals in comparison to marine CTR values.

e. Water--Four (consecutive) day composite samples were computed using OCPFRD data for San Diego Creek and tributaries and we made comparisons to CTR chronic water values (assuming mean hardness value of 400 ppm).

f. Tissue–Data from fish fillets were compared to human health screening values, whereas whole fish data were based against ecological criteria if they exist. Ideally, fish tissue data include arsenic speciation results; that is, inorganic values are measured directly and compared to EPA's inorganic arsenic tissue values. In this assessment, finfish inorganic values were calculated as 4% of total arsenic values. For shellfish, total arsenic data and inorganic data (60% of total) were compared to MTRL values.

g. If method detection limits were insufficiently low then we found it difficult to make definitive evaluations with data relative to water quality criteria, sediment guidelines or tissue screening values. If datum was stated "<x" or "-x" then datum was interpreted as "x/2" for numerical value in comparisons or statistical calculations.

h. If datum was reported "yy" then datum was not used in numerical comparisons or statistical calculations. Presumably this datum was considered suspect by laboratory or sampling staff and required further verification prior to use in comparisons or calculations.

i. Trend analyses were applied to program results using consistent sampling and analytical protocol; e.g., State Mussel Watch Program. If a change in protocol was made to comply with improved methods or techniques then trend analyses clearly identified the date(s) and the distinction.

j. "Hits" were defined as data above WQC, SQG or tissue screening levels. EPA Region 9 evaluated frequency of hits and magnitude of hits. Two important considerations were applied.

    a. Extreme magnitude exceedences were heavily weighted with regard to frequency of exceedence and minimum sample size. For example, if sample results were more than 20fold higher than the appropriate WQS, SQG or tissue screening value and sufficient samples existed (>five) then this was viewed as evidence of impairment similar to TIER 1 decisions. See mercury sediment concentrations in Rhine Channel.

    b. We also evaluated the magnitude of these exceedences by considering the analytical error for monitoring results relative to the screening criteria/values. For example, two "hits" at levels three times the CTR acute value were valid exceedences and deserved recognition of possible adverse effects. Whereas two "hits" at levels very close to the CTR value (within analytical error, ±20%) were considered borderline cases and warranted further convincing evidence from other categories. Both of these examples are TIER 2 type decisions.

Monitoring Data for San Diego Creek and Newport Bay

EPA has considered all readily available and most recent data (as of March 2002) in our assessment. Since Santa Ana Regional Board staff issued their Problem Statement (December 2000), we have added three new data sets (cited by name here): Lee report, City dredge report, and Bight '98. We have also updated three data sets: OCPFRD, Toxic Substances Monitoring Program (TSMP) and State Mussel Watch to include more recent (still preliminary) results. Two Southern California Coastal Research Water Project (SCCWRP) studies are still pending and results are currently unavailable.

Table 5. Overview of monitoring data

Attach-ment	Title/org.	Data dates	Type	Comments
J	**Lee & Taylor** / 319(h) report to Santa Ana RWQCB	'99-'00	Water chem. & tox test	Metals and OP pesticides in watershed, Draft report provided Feb. 2001
K	IRWD WWSP Report	'97-'99	Water & Sediment	metals and organics measured using APPROPRIATE sampling and analytical techniques, one day composites, year round, NO storm events
L	**OCPFRD** Stormwater	'95-'00	Water	seven metals, year round sampling, includes dry and wet weather events; four consecutive day sampling data can be used for chronic comparisons; most dissolved samples in 1996—'00 (one dissolved sample in 1995 for SDC)
M	OCPFRD	'91-'00	Sediment	semi-annual sediment data for same metals and some organics
N	**Ogden Environ.**/for City of Newport Beach	'99	Sediment	Metals and few organics in dredge studies of only four sites, most in LNB
O	BPTCP/ SWRCB/NOAA /EPA	'94 & '96	Sediment triad study	metals and organics measured, some porewater results, toxicity on six organisms, and benthic community index, APPROPRIATE sampling and analytical techniques, only two sites in '96
P	Bight '98/ Coordinated by SCCWRP	'98	Sediment chemistry	Metals and few organics at 11 LNB sites, AVS & SEM data, interstitial porewater data for SEM; no Rhine Channel site
Q	Orange County Coastkeeper / MEC Consultants	'99	Sediment chemistry	Metals at two Rhine sites and one in Turning Basin; two surface sediment samples and one sediment core sample
R	Calif. Fish Contam. Study (SWRCB & OEHHA)	'99–'00	Sport fish Tissue	Total As, Cd, Se, Hg and organics in fish fillets of UNB & LNB
S	**SMW**/SWCRB	'80-'00	Shellfish Tissue	Total metals and organics in resident or transplanted mussels, no recent data in SDC, useful for trends analysis
T	**TSMP**/SWRCB	'83–'98	Fish Tissue	Total metals and organics in whole fish
U	Fish Bioaccumulation /SCCWRP	pending	Tissue	sportfish samples for two seasons, some data available in Summer 2001
V	Sediment Toxicity/ SCCWRP	pending	sed & water Toxicity	sediments and water in UNB & LNB, some data available in Summer 2001

VII. Question sequence for weight of evidence approach:

- Does **water (dissolved) monitoring data** exist in past 5 years?
- Were appropriate sampling and analysis techniques used for ambient surface waters?
- Compare data to CTR values, using hardness adjustments for freshwater samples.
- Per chemical parameter, do data exceed CTR value (either chronic or acute) more than 10% frequency in 5 years?
- Are there at least 10 water samples? If yes, TIER 1 = develop TMDL (If less than ten samples then default into TIER 2.)

- Per chemical parameter, do four day composite data exceed chronic CTR value twice or more in 5 years? If yes, then TIER 2; i.e., examine sediment and tissue data for additional exceedances.
- Per chemical parameter, do grab sample data exceed acute CTR value twice or more in 5 years? If yes, then TIER 2.
- Any water TIE studies available for this waterbody in past 5 years? Were water TIE studies completed for more than one sampling event to evaluate "representative" conditions of waterbody? If yes, then develop TMDL for identified pollutants.

- Does **sediment monitoring data** exist in past 5 years?
- Were samples composited or individually analyzed in study? If composites were used then proceed. Whereas if grabs were analyzed, then consider use median (in lieu of mean) to evaluate data skewed by individual data.
- Compare chemistry data to NOAA sediment quality guidelines. (If AVS and SEM results exist, determine ESG values.)
- Per chemical parameter, do data exceed PEL or ERM or ESG values more than 25% frequency in 5 years?
- Are there at least ten samples? If yes, TIER 1 = develop TMDL (If less than ten samples then default into TIER 2.)

- Per chemical parameter, do data exceed *both* ERLs *and* TELs values more than 10% frequency in 5 years? If yes then TIER 2; i.e., examine water and tissue data for additional exceedances.
- Any sediment TIE studies for this waterbody in past five years? Do sediment triad studies establish impairment of benthic organisms? Are there chemistry results to make correlations with high or low SQGs?
- If porewater concentration results exist, convert them to interstitial water guideline units and compare them to (total) chronic saltwater CTR values (as in water data above).

- Do **finfish or shellfish tissue** monitoring data exist in past 5 years?
- Were samples composited or individually analyzed in study? If mixture of results provided then consider use median (in lieu of mean) to evaluate data skewed by individual data.
- Fish filet results are best compared to human health SVs; whole fish data to predator tissue values.
- Compare total concentrations to various tissue screening values. For arsenic, compare both total and inorganic arsenic concentrations to tissue screening values.
- Per chemical parameter, do data exceed lowest screening value more than 25%

frequency in 5 years?

- Are there at least ten samples? If yes, TIER 1 = develop TMDL (If less than ten samples then default into TIER 2.)

- Per chemical parameter, do data exceed lowest screening value more than 10% frequency in 5 years?
- If yes, then TIER 2; i.e., examine water and sediment data for additional exceedances.
- Use MTRL or MIS values only if no EPA or OEHHA value exists.

- Are **trends** evident in any of the above monitoring data? Be sure to compare "apples to apples" and create graphs from data collected over longer than five-year timeframe, preferably ten or twenty years at the same site. If graphs indicate expected impairment or "threatened water bodies" based upon increasing concentrations soon above screening values, then perform statistical tests to elucidate confidence in such a comparison. If graphs indicate improving water quality and presently below screening levels, then no TMDL is required.

- How does impairment information for subject segment related to impairment information for **adjacent segments?**
- Is evidence of potential impairment . available for the subject segment (e.g. exceeds one TIER 2 criterion or potential water quality threat indicated based on other data or studies) ? If yes, proceed to next question.
- Is there impairment evidence for one or more adjacent segments that is very strong e.g., very high frequency or magnitude exceedence of objectives or screening values)? If yes, TMDL development is warranted.

VIII. Assessment Summary

This section discusses how the weight of evidence decision rules were applied for individual pollutants and waterbody segments in the Newport Bay watershed. In general, TMDLs are warranted in cases where one TIER 1 criterion is met, two TIER 2 criteria are met, or where there is TIER 2 evidence in a segment and very strong evidence of impairment in an adjacent segment.

Arsenic (As)

San Diego Creek — Determination: no TMDL

No (0/62) water quality criteria exceedances
Sediment results (2/2) inconclusive vs. freshwater SQGs
7% (1/15) tissue exceedances vs. inorganic As screening value in past five years = TIER 2

Upper Newport Bay — Determination: no TMDL

No (0/6) water quality criteria exceedances
12% (1/8) sediment results above low SQGs = TIER 2
0% (0/9) tissue exceedances vs. inorganic As value (1.2 ppm) in past five years

Lower Newport Bay — Determination: no TMDL

no (0/3) water quality criteria exceedances
68% (17/25) sediment results above low SQGs. = TIER 2
0% (0/22) tissue exceedances vs. inorganic As value (1.2 ppm)in past five years

Rhine Channel — Determination: no TMDL

no water column data
(2/2) sediment results above low SQGs = TIER 2
0% (0/11) shellfish exceedances vs. inorganic As (0.026 ppm)in past five years

Cadmium (Cd)

San Diego Creek — Determination: yes TMDL

no water quality criteria exceedances -- (1/347 acute; 0/90 chronic) based on CTR std.
Many water quality criteria exceedances (6/347 acute; 23/23 chronic) based on more recent EPA criteria value; therefore threatened waterbody = TIER 2
46% (12/26) sediment results above low freshwater SQGs = TIER 2
No (0/15) tissue exceedances in past five years

Upper Newport Bay — Determination: yes TMDL

no (0/10) water quality criteria exceedances
21% (8/42) sediment results above low SQGs = TIER 2
No (0/15) tissue exceedances in past five years
Sediment data indicate potential threat to UNB, and substantial evidence of impairment in San Diego Creek, therefore TMDL warranted based on adjacent waters analysis.

Lower Newport Bay — Determination: no TMDL

no (0/6) water quality criteria exceedances
no porewater results above saltwater chronic CTR values
30% (8/27) sediment samples above low SQGs = TIER 2
acid volatile sulfide and porewater results indicate no problem
No (0/20) tissue exceedances in past five years

Rhine Channel Determination: no TMDL
no reliable water column data
15% (2/15) sediment results above low SQGs = TIER 2
acid volatile sulfide and porewater results indicate no problem
No (0/13) shellfish tissue exceedances in past five years

Chromium (Cr) **Assessment Summary**
San Diego Creek Determination: no TMDL
no water quality criteria exceedances—(0/269 for Cr-tot and 0/30 for Cr(VI) and Cr(III))
[OCPFRD field screening data of Cr(VI) in SDC tributaries showed false positives results (26%) due to interferences with analytical technique.]
1% (3/94) sediment results above freshwater SQGs
No (0/15) tissue exceedances in past five years

Upper Newport Bay Determination: no TMDL
no (0/10) water quality criteria exceedances
no (0/42) sediment results above low SQGs
10% (1/10) tissue exceedance in past five years = TIER 2

Lower Newport Bay Determination: no TMDL
no (0/6) water quality criteria exceedances
4% (1/27) sediment results above low SQGs
20% (2/10) tissue exceedances in past five years = TIER 2

Rhine Channel Determination: yes TMDL
no reliable water column data
8% (1/13) sediment results above low SQGs
31% (4/13) shellfish tissue exceedances in past five years = TIER 1

Potential increasing trends in tissue data since 1980s.

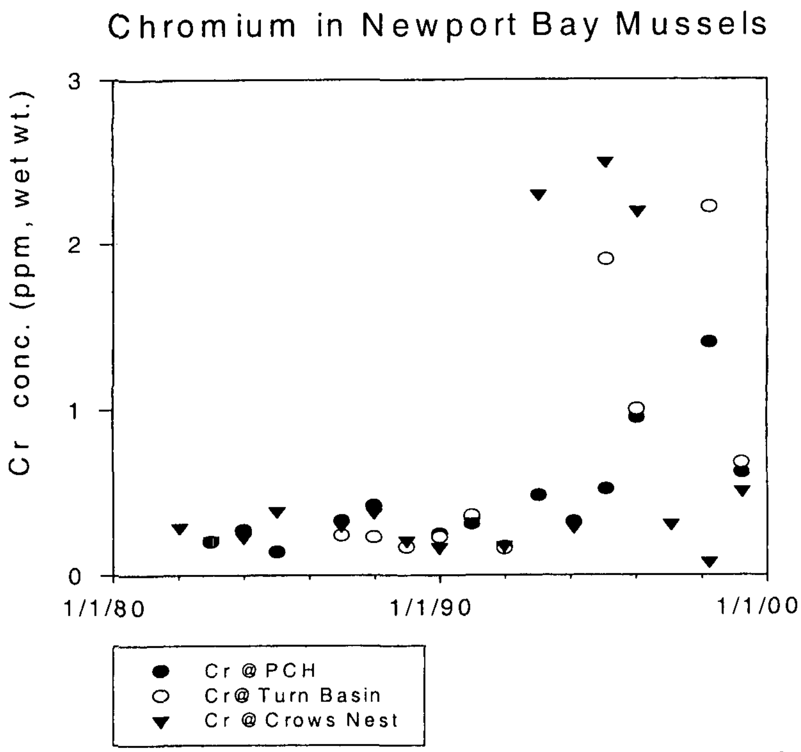


Figure H-1. Cr in Newport Bay Mussels (SMW database). Screening value is 1.0 ppm ww.

Copper (Cu) **Assessment Summary**

San Diego Creek Determination: yes TMDL

5.6% (21/347) acute water exceedances; 25% (7/28) chronic water exceedances based upon OCPFRD data = TIER 1

3% (1/30) acute water exceedances based on Lee (00-01) report, no exceedances in IRWD data

4% (4/92) sediment results above freshwater SQGs

No (0/15) tissue exceedances in past five years

Upper Newport Bay Determination: yes TMDL

Numerous water quality exceedances based on OCPFRD monitoring data = TIER 2

no (0/10) water quality criteria exceedances based on IRWD data

17% (7/42) sediment results above low SQGs = TIER 2

No (0/10) tissue exceedances in past five years

Lower Newport Bay Determination: yes TMDL

no (0/6) water column criteria exceedances, based on IRWD data but some values close to saltwater CTR std; many OCPFRD exceedances

33 (9/27) sediment results above low SQGs = TIER 2

acid volatile sulfide results indicate no problem

(5/10) sites have elevated Cu conc. in porewaters based on Bight '98 data = TIER 2

No (0/10) tissue exceedances in past five years

Rhine Channel Determination: yes TMDL

no reliable water column data

82% (9/11) sediment samples above *higher* SQGs = TIER 1

acid volatile sulfide and porewater results indicate problem =TIER 2

15% (2/13) shellfish tissue exceedances in past five years = TIER 2

Potentially increasing trends in mussel tissue in Newport Bay

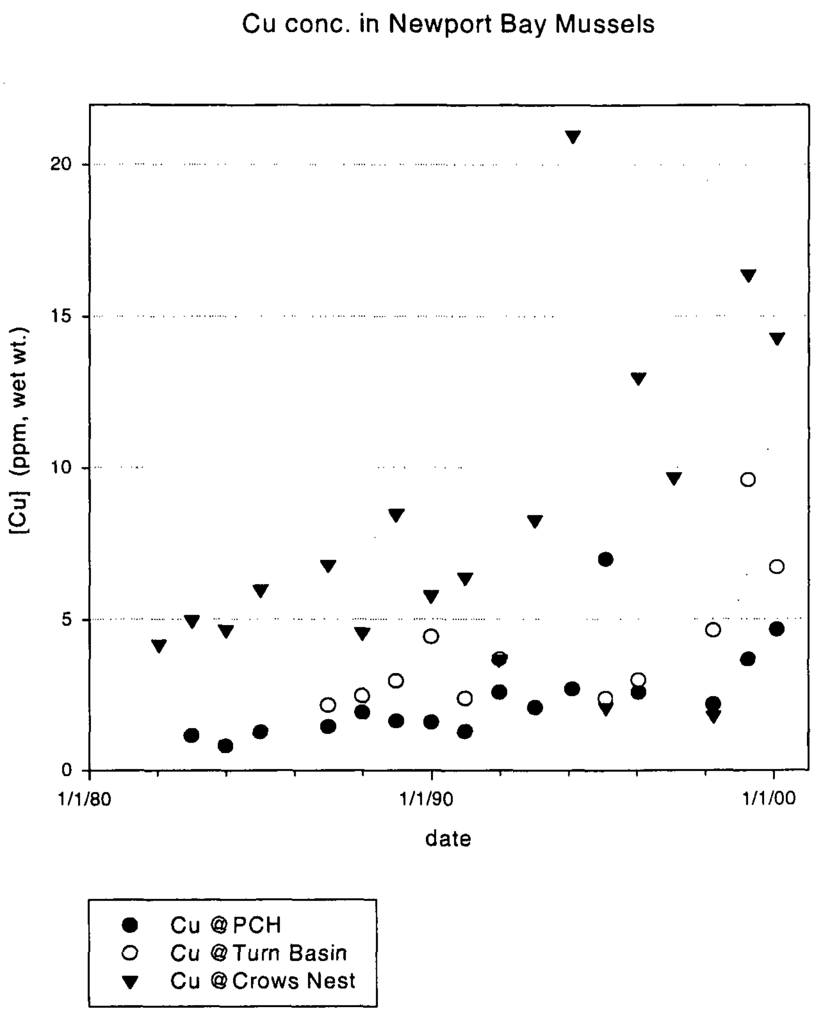


Figure H-2. Copper in Newport Bay mussels (SMW database). Screening value is 15 ppm

Lead (Pb) **Assessment Summary**

<u>San Diego Creek</u> Determination: yes TMDL

7% (2/28) chronic water exceedances based on OCPFRD data = TIER 2
no (0/371) acute water exceedances
6% (4/72) sediment results above low freshwater SQGs
No (0/15) tissue exceedances in past five years
Water column and sediment data indicate potential threat to SDC, and substantial evidence of impairment in Rhine Channel, therefore TMDL warranted based on adjacent waters analysis.

<u>Upper Newport Bay</u> Determination: yes TMDL

no (0/10) water quality criteria exceedances
5% (2/42) sediment results above low SQGs
No (0/10) tissue exceedances in past five years
Sediment data indicate potential threat to UNB, and substantial evidence of impairment in Rhine Channel, therefore TMDL warranted based on adjacent waters analysis.

Lower Newport Bay — Determination: yes TMDL

no (0/6) water quality criteria exceedances
12% (2/42) sediment results above low SQGs = TIER 2
acid volatile sulfide and porewater results indicate no problem
No (0/10) tissue exceedances in past five years
Sediment data indicate potential threat to LNB, and substantial evidence of impairment in Rhine Channel, therefore TMDL warranted based on adjacent waters analysis.

Rhine Channel — Determination: yes TMDL

no reliable water column data
54% (7/13) sediment results *above high* ERMs = TIER 1
acid volatile sulfide and porewater results indicate no problem
No (0/13) shellfish tissue exceedances in past five years; and trend analysis shows declining conc. below SV

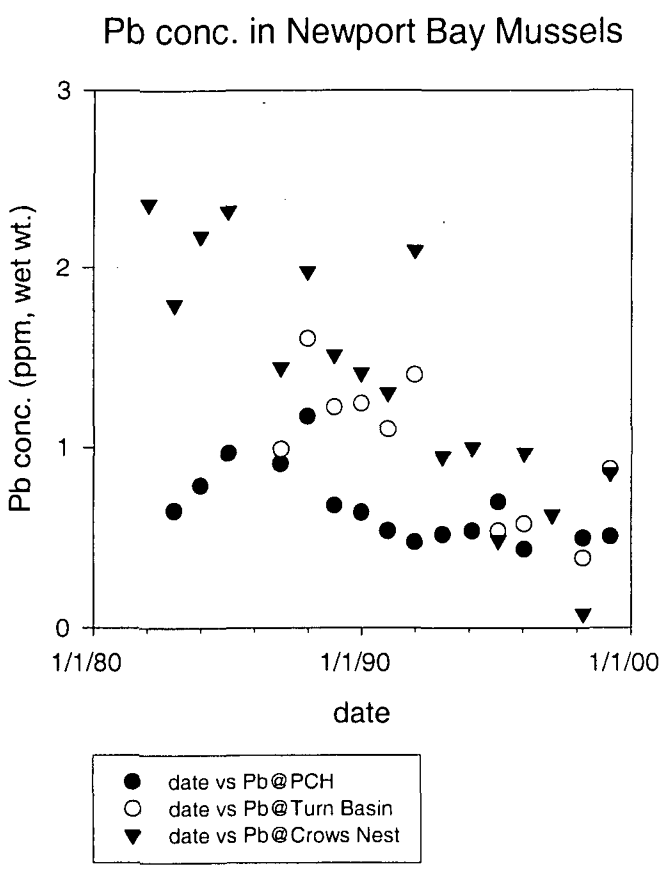


Figure H-3. Lead in Newport Bay mussels (SMW database) Screening value is 2.0 ppm ww.

Mercury (Hg) Assessment Summary

San Diego Creek — Determination: no TMDL

no (0/62) water quality criteria exceedances
no (0/2) sediment results above freshwater SQGs
No (0/15) tissue exceedances in past five years

Upper Newport Bay — Determination: no TMDL

no water column data available
no (0/2) sediment results above low SQGs
10% (1/10) tissue exceedances in past five years = TIER 2

Lower Newport Bay — Determination: no TMDL
no water column data available
36% (5/14) sediment exceedances above low SQGs = TIER 2
No (0/23) tissue exceedances in past five years

Rhine Channel — Determination: yes TMDL
no water column data available
(5/5) sediment results *above high* SQGs = TIER 2 or TIER 1 based on magnitude of exceedences
all values show very high exceedances (>3.4 ppm) vs. ERM value (0.71 ppm), indicating substantial threat. TMDL warranted based on observed magnitude of sediment levels which are at least 5 times higher than screening values
No (0/12) shellfish tissue exceedances in past five years

Selenium **Assessment Summary**

San Diego Creek — Determination: yes TMDL
97% (30/31) water quality criteria exceedances = TIER 1
(3) sediment results inconclusive since no freshwater SQG
no (0/15) tissue exceedances in past five years

Upper Newport Bay — Determination: yes TMDL
no water quality data
all sediment results were non-detect, but no saltwater SQG
no (0/9) tissue exceedances in past five years
Due to substantial evidence of exceedences in SDC, appearance of increasing Se trend in Newport Bay mussel tissue, and concerns about protection of aquatic and aquatic dependent species in Ecological Reserve in UNB, TMDL warranted based on adjacent waters analysis. Implementation of TMDLs for SDC should be sufficient to attain TMDLs for Newport Bay segments; establishment of the Bay TMDLs will assist in ensuring that aquatic life uses of concern in the Bay are fully maintained in the future.

Lower Newport Bay — Determination: yes TMDL
all (0/11) sediment results were detects, but no saltwater SQG
no (0/9) tissue exceedances in past five years, but trend analysis shows increase in mussels
Due to substantial evidence of exceedences in SDC, and increasing Se trend in Newport Bay mussel tissue, TMDL warranted based on adjacent waters analysis. Implementation of TMDLs for SDC should be sufficient to attain TMDLs for Newport Bay segments; establishment of the Bay TMDLs will assist in ensuring that aquatic life uses of concern in the Bay are fully maintained in the future.

Rhine Channel — Determination: yes TMDL
(2) sediment results were detects, but no saltwater SQG
no (0/10) tissue exceedances in past five years
Due to substantial evidence of exceedences in SDC, and increasing Se trend in Newport Bay mussel tissue, TMDL warranted based on adjacent waters analysis. Implementation of TMDLs for SDC should be sufficient to attain TMDLs for Newport Bay segments; establishment of the Bay TMDLs will assist in ensuring that aquatic life uses of concern in the Bay are fully maintained in the future.

Silver (Ag) **Assessment Summary**

San Diego Creek — Determination: no TMDL
(1/338) acute water exceedance but no chronic exceedences
Virtually all sediment results below detection limits and inconclusive since no freshwater SQG
No tissue screening value for comparison

<u>Upper Newport Bay</u> Determination: no TMDL
no (0/7) water quality criteria exceedances
9% (4/42) sediment result above low saltwater SQGs
No tissue screening value for comparison

<u>Lower Newport Bay</u> Determination: no TMDL
no (0/3) water quality criteria exceedances
no (0/27) sediment results above low saltwater SQGs
no acid volatile sulfide results for silver; porewater results show no problem
No tissue screening value for comparison

<u>Rhine Channel</u> Determination: no TMDL
no reliable water column data
31% (4/13) sediment results above low saltwater SQGs = TIER 2
no acid volatile sulfide results for silver; porewater results show no problem
No tissue screening value for comparison

Zinc (Zn) **Assessment Summary**
<u>San Diego Creek</u> Determination: yes TMDL
no (0/62) acute exceedances based on IRWD dataset and Lee report
1% (5/370) acute water quality criteria exceedances based upon OCPFRD data = TIER 2
4% (4/94) sediment results above low freshwater SQGs
20% (3/15) tissue exceedances in past five years = TIER 2

<u>Upper Newport Bay</u> Determination: yes TMDL
no (0/25) water quality criteria exceedances based solely on IRWD data, but many exceedences found if OCPFRD data are considered= probably TIER 2
17% (8/48) sediment results above low SQGs = TIER 2
10% (1/10) tissue exceedances in past five years =TIER 2

<u>Lower Newport Bay</u> Determination: yes TMDL
no (0/15) water quality criteria exceedances exceedances based solely on IRWD data, but many exceedences found if OCPFRD data are considered= probably TIER 2
37% (14/38) sediment results above low SQGs = TIER 2
acid volatile sulfide and porewater results indicate no problem
No (0/10) tissue exceedances in past five years

<u>Rhine Channel</u> Determination: yes TMDL
no reliable water column data
38% (5/13) sediment results above low SQGs; 15% results above high SQGs = TIER 2
acid volatile sulfide and porewater results indicate no problem
69% (9/13) shellfish tissue exceedances in past five years = TIER 1

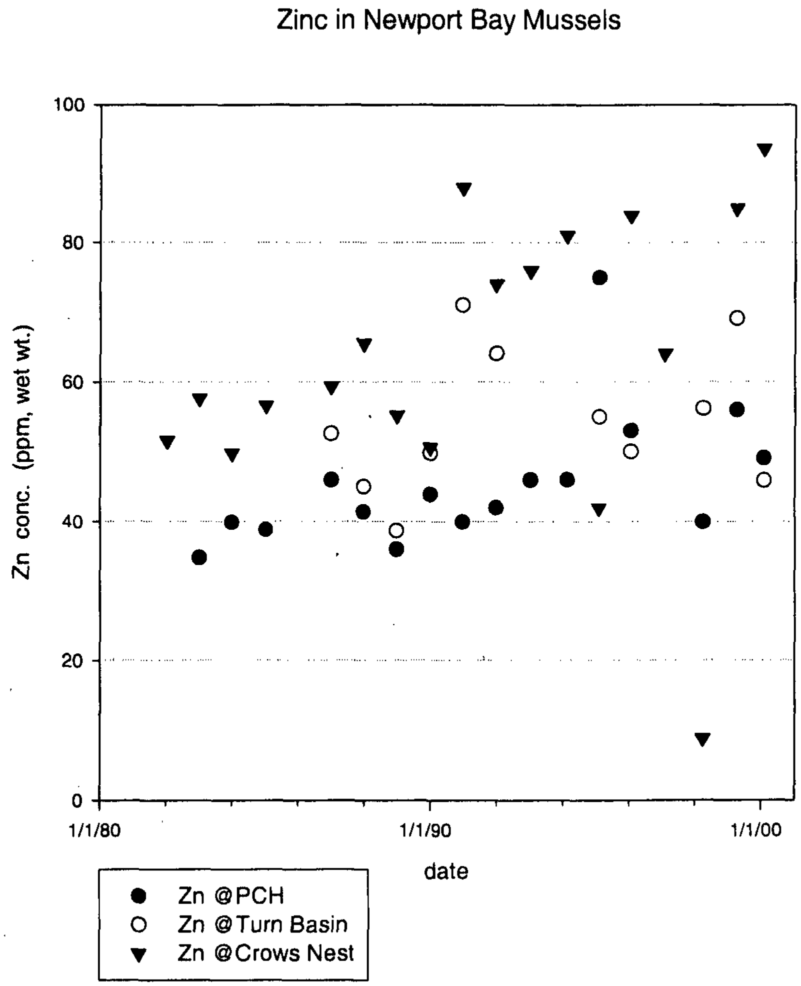


Figure H-4. Zinc in Newport Bay Mussels (SMW database) Screening value is 70 ppm ww.

Chlorbenside **Assessment Summary**

San Diego Creek Determination: no TMDL
no water quality data
no sediment data
no shellfish tissue detections in 1983—'93

Upper Newport Bay Determination: no TMDL
no water quality data
no sediment data
no tissue detections in 1982—'94

Lower Newport Bay Determination: no TMDL
no water quality data
no sediment data
two shellfish tissue detections in 1982 & 1983; no detections in 1984—'90

Rhine Channel Determination: no TMDL
no water quality data
no sediment data
one shellfish tissue detections in 1982; no detections in 1983—'94

Chlorpyrifos **Assessment Summary**

San Diego Creek Determination: yes TMDL
Water Quality: 44% (34/78) exceed acute freshwater numeric target of 20 ng/L = TIER 1
(this includes some non-detects with MDL = 40 ng/L) (2/2) detections but results inconclusive, no sediment criteria guidelines available
no (0/34) tissue exceedances of OEHHA screening value (10,000 ppb)

Upper Newport Bay Determination: yes TMDL
Water Quality: 92% (22/24) exceed acute saltwater numeric target of 11 ng/L = TIER 1
No sediment data
Tissue: (0/14) tissue exceedance of OEHHA screening value (10,000 ppb)

Lower Newport Bay Determination: no TMDL
no data

Rhine Channel Determination: no TMDL
no data

Diazinon **Assessment Summary**

San Diego Creek Determination: yes TMDL

Water Quality: 87% (68/78) exceed acute freshwater numeric target of 80 ng/L = TIER 1
(Seventy-eight water samples from San Diego Creek)
(2/98) sediment detections, but no sediment criteria guidelines available
3% (1/34) tissue exceedances of OEHHA screening value (300 ppb)

Upper Newport Bay Determination: no TMDL

Water Quality: 0% (0/26) exceed *Americamysis bahia* LC-50 of 4,500 ng/L
(lowest LC50 available in literature for diazinon in saltwater; no other numeric targets available)
(2/64) sediment detections, no sediment criteria guidelines available
no (0/14) tissue exceedance of OEHHA screening value (300 ppb)

Lower Newport Bay Determination: no TMDL

no data

Rhine Channel Determination: no TMDL

no data

Chlordane (total) **Assessment Summary**

San Diego Creek Determination: yes TMDL

no (0/6) water quality criteria exceedances
sediment results (2) inconclusive vs. freshwater SQG
40% (6/15) tissue exceedances in past five years = TIER 1

Upper Newport Bay Determination: yes TMDL

no water column data
56% (13/23) above high SQGs = TIER 1
(see Masters and Inman data)
No (0/6) tissue exceedances in past five years

Lower Newport Bay Determination: yes TMDL

no water column data
36% (8/22) sediment results *above high* SQGs = TIER 1
no (0/19) tissue exceedances in past five years

Rhine Channel Determination: yes TMDL

no water quality data
2/2 sediment results above low SQGs = TIER 2
no (0/10) shellfish tissue exceedances in past five years
Sediment data indicate potential threat to Rhine Channel, and substantial evidence of impairment in LNB, therefore TMDL warranted based on adjacent waters analysis.
Potentially declining tissue trends in San Diego Creek but still above screening values.

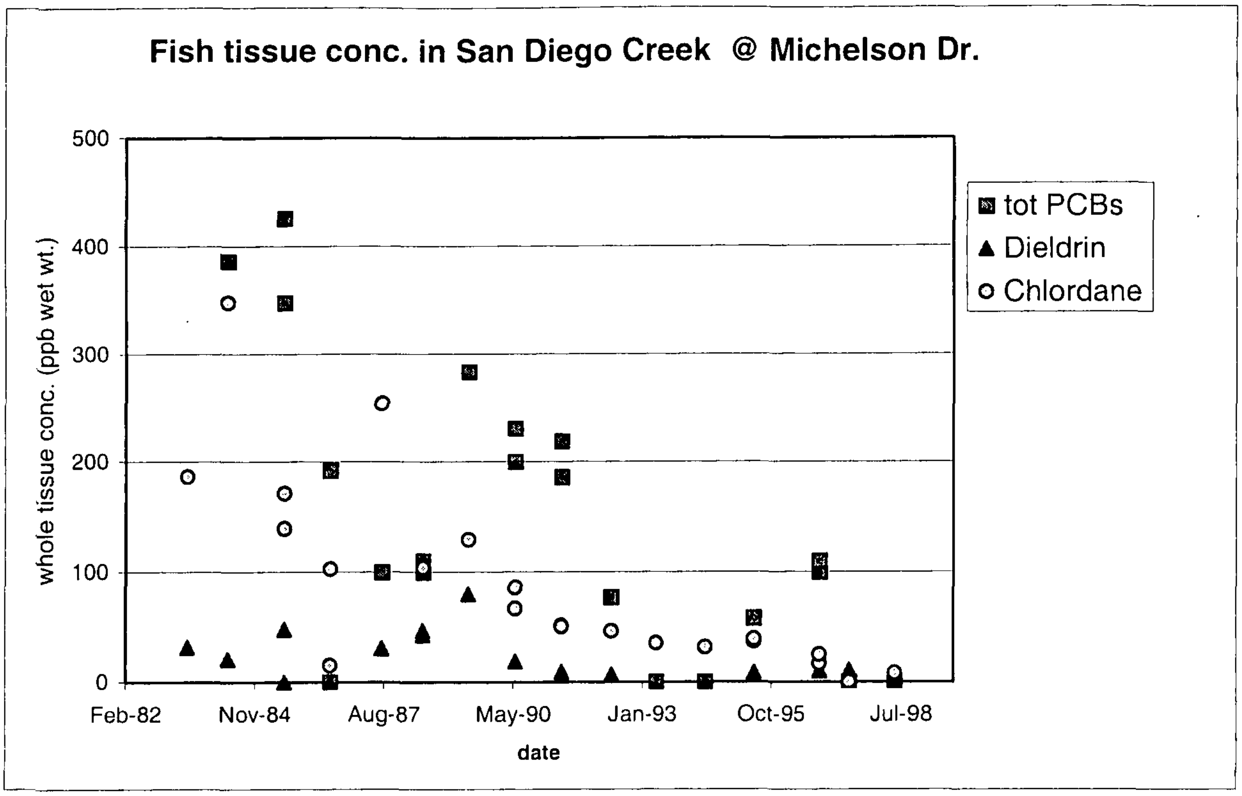


Figure H-5. Chlordane, Dieldrin and total PCBs in fish tissue at San Diego Creek. (TSMP database) Chlordane screening value is 30 ppb; Dieldrin value is 2.0 ppb; total PCBs value is 20 ppb wet wt.

Dieldrin **Assessment Summary**

San Diego Creek Determination: yes TMDL
no water quality criteria exceedances
no (0/2) sediment results above freshwater SQG
93% (13/14) tissue exceedances in past five years = TIER 1

Upper Newport Bay Determination: no TMDL
no water quality data
37% (3/8) sediment results above low SQGs = TIER 2
(see Masters and Inman for additional data of non-detects for Dieldrin)
No (0/6) tissue exceedances in past five years
EPA concluded that the evidence of impacts in the adjacent segments was not strong enough to warrant a conclusion that a TMDL is needed for Upper Newport Bay.

Lower Newport Bay Determination: yes TMDL

no water quality data
27% (3/11) sediment results above low SQGs = TIER 2
5% (1/21) tissue exceedances in past five years
Sediment data indicate potential threat to LNB, and substantial evidence of impairment in Rhine Channel, therefore TMDL warranted based on adjacent waters analysis.

Rhine Channel Determination: yes TMDL
no water quality data
(1/2) sediment result *above high* SQG = TIER 2
60% (6/10) shellfish tissue exceedances in past five years= TIER 1
trend analysis shows decline in mussels but not below screening value as of 1999

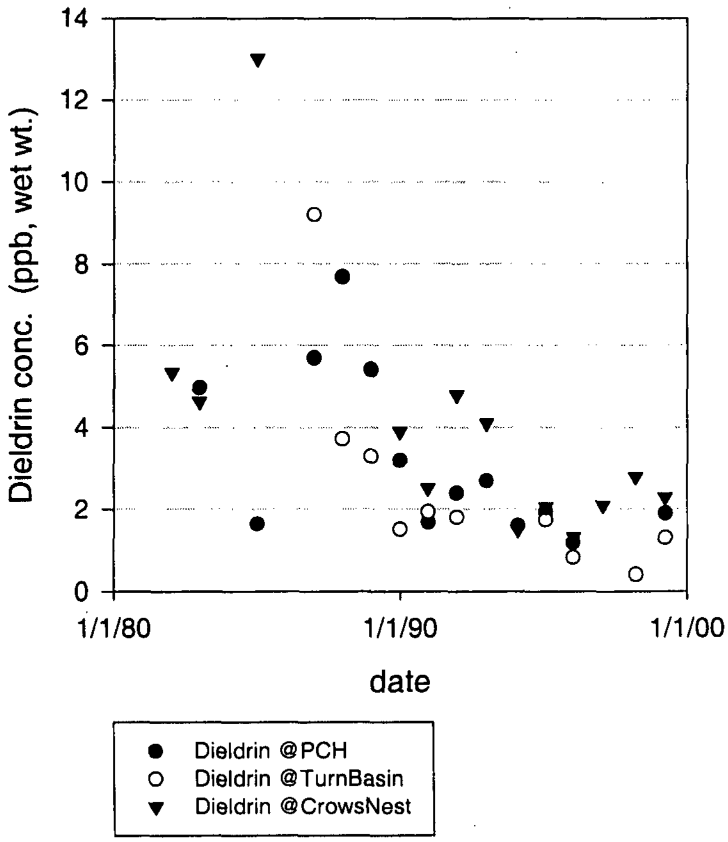


Figure H-6. Dieldrin in Newport Bay mussels. (SMW database) Tissue screening value is 2.0 ppb.

DDT (total) **Assessment Summary**

San Diego Creek Determination: yes TMDL
no water quality criteria exceedances
(0/2) sediment results above freshwater SQG
93% (14/15) tissue exceedances in past five years = TIER 1

Upper Newport Bay Determination: yes TMDL
no water quality data
37% (20/21) sediment results *above low* saltwater SQGs = TIER 2
50% (3/6) tissue exceedances in past five years = TIER 2

Lower Newport Bay Determination: yes TMDL
no water quality data
91% (10/11) sediment results *above high* saltwater SQGs = TIER 1
14% (3/21) tissue exceedances in past five years = TIER 2

Rhine Channel Determination: yes TMDL
no water data
(2/2) sediment results *above high* saltwater SQGs = TIER 2
10% (1/10) tissue exceedances in past five years = TIER 2

trend analysis shows decline in mussels but not below screening value as of 1999

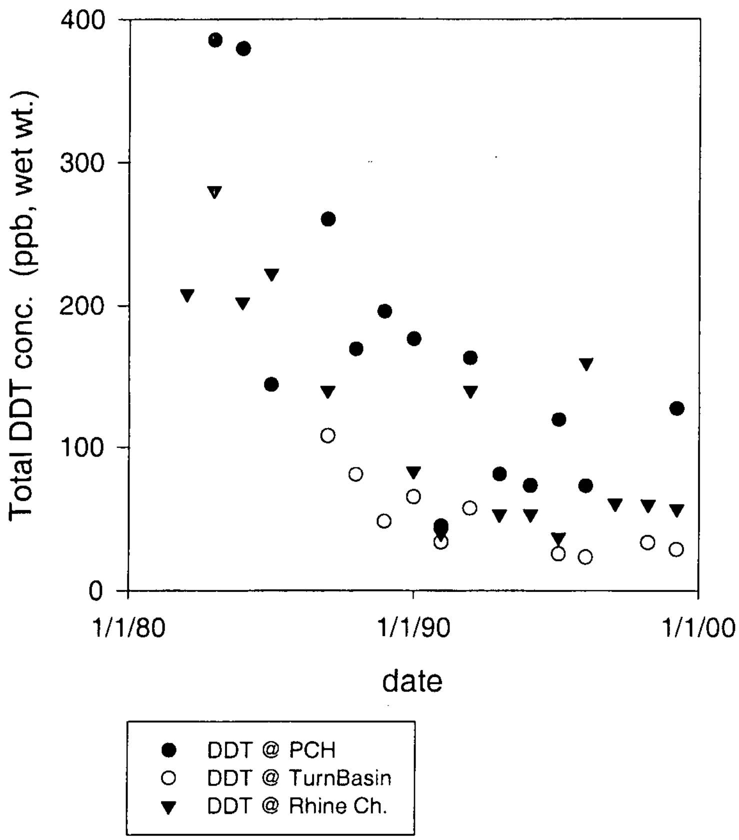


Figure H-7a. DDT in Newport Bay Mussels (SMW database). Tissue screening value is 100 ppb.

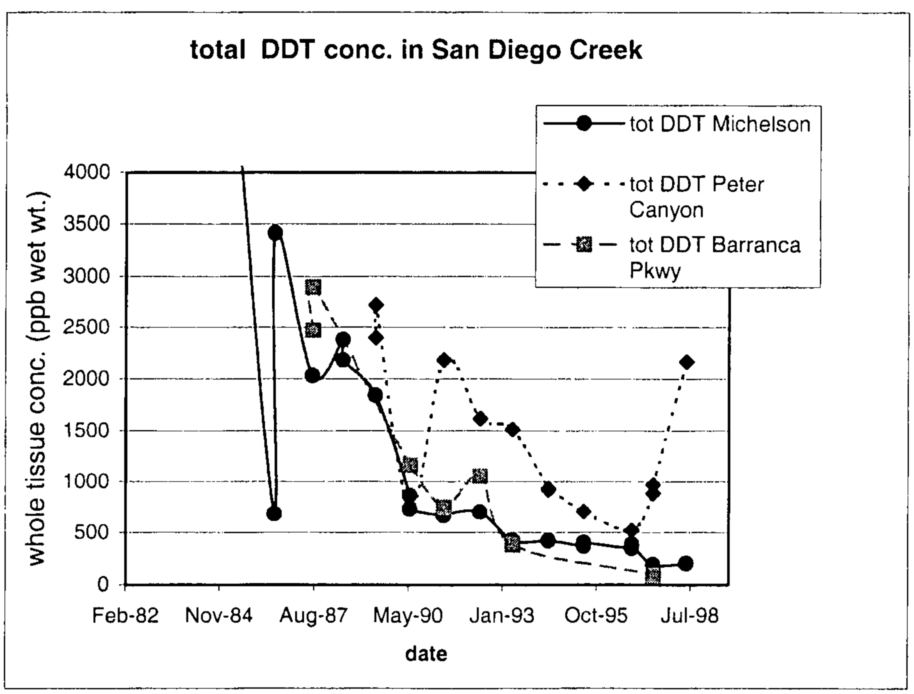


Figure H-7b. Total DDT fish tissue conc. in San Diego Creek (TSMP database). Total DDT screening value is 100 ppb wet wt.

Endosulfan (total) **Assessment Summary**

<u>San Diego Creek</u> Determination: no TMDL

no water quality criteria exceedances of endosulfan α and β, nor endosulfate
6% (5/84) sediment results <u>maybe</u> detection, yet inconclusive since no freshwater SQG
no (0/15) tissue exceedances in past five years

<u>Upper Newport Bay</u> Determination: no TMDL

no water quality data
(3/36) sediment results <u>maybe</u> detection, yet inconclusive since no saltwater SQG
No (0/6) tissue exceedances in past five years

<u>Lower Newport Bay</u> Determination: no TMDL

no water quality data
no (0/12) sediment results above detection limit and inconclusive since no saltwater SQG
no (0/19) tissue exceedances in past five years

<u>Rhine Channel</u> Determination: no TMDL

no water data
no (0/10) sediment results above detection limit and inconclusive since no saltwater SQG
no (0/10) tissue exceedances in past five years

PCBs (total) **Assessment Summary**

<u>San Diego Creek</u> Determination: yes TMDL

no water quality data
(1/2) sediment results non-detect vs. freshwater SQG, inconclusive
67% (10/15) tissue exceedances in past five years = TIER 1

<u>Upper Newport Bay</u> Determination: yes TMDL

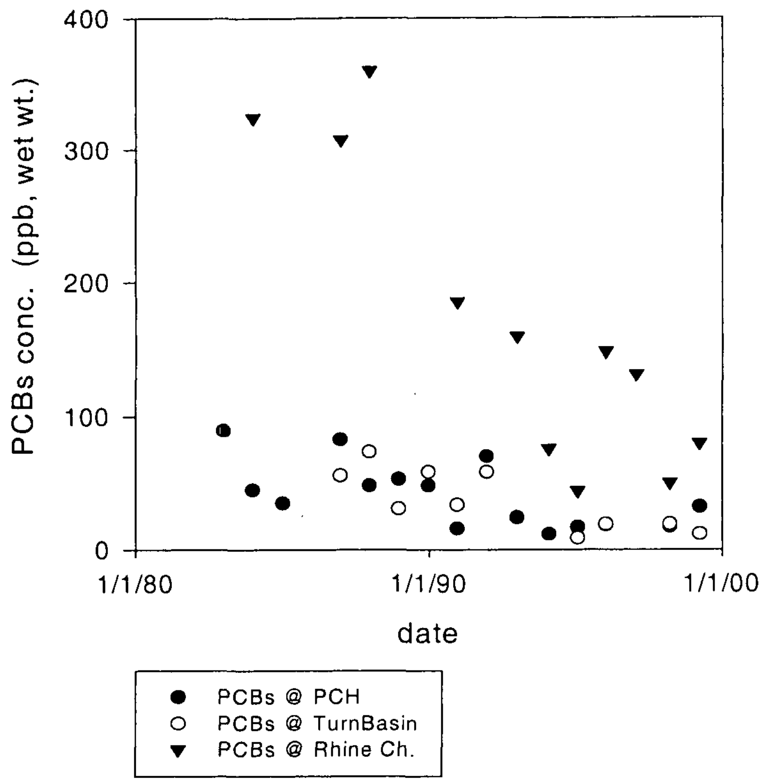
no water quality data
no (0/8) sediment results above low SQGs, (max = 530 ppb in 1995)
17% (1/6) tissue exceedances in past five years = TIER 2
Tissue data indicate potential threat to UNB, and substantial evidence of impairment in SCD and LNB, therefore TMDL warranted based on adjacent waters analysis.

<u>Lower Newport Bay</u> Determination: yes TMDL

no water quality data
14% (2/14) sediment results above low SQGs = TIER 2
33% (7/21) tissue exceedances in past five years = TIER 1

<u>Rhine Channel</u> Determination: yes TMDL

no water quality data
(2/2) sediment results were above low SQGs; one sample above high SQG = TIER 2
100% (13/13) shellfish tissue exceedances in past five years = TIER 1
trend analysis shows decline in mussels but not below screening value in 1999



FigureH-8. PCBs in Newport Bay mussels (SMW database). Tissue screening value is 20 ppb.

Toxaphene **Assessment Summary**

San Diego Creek — Determination: yes TMDL

no water quality criteria exceedances
(2/2) sediment results inconclusive vs. freshwater SQG
87% (13/15) tissue exceedances in past five years = TIER 1

Upper Newport Bay — Determination: no TMDL

no water quality data
all (0/6) sediment results were non-detect, but no saltwater SQG
17% (1/6) tissue exceedances in past five years = TIER 2

Lower Newport Bay — Determination: no TMDL

no water quality data
all (0/10) sediment results were non-detect, but no saltwater SQG
no (0/23) tissue exceedances in past five years

Rhine Channel — Determination: no TMDL

no water quality data
(0/2) sediment results were non-detect, but no saltwater SQG
20% (2/10) tissue exceedances in past five years = TIER 2

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I. RESPONSIVENESS SUMMARY

NEWPORT BAY & SAN DIEGO CREEK TMDLS FOR TOXIC POLLUTANTS

Prepared by USEPA, Region 9

June 14, 2002

INTRODUCTION

This document summarizes the comments that were submitted, identifies the commentor, and responds to those comments. They are arranged by topic wherever possible. When multiple comments were received on a single topic, the multiple commentors are grouped under one comment number. Changes to the TMDLs made in response to a comment are generally summarized in the response to that comment.

Comments were received from the following organizations and individuals:

- The Irvine Co./Latham & Watkins
- California Dept. of Pesticide Regulation
- Bordier's Nursery
- Irvine Ranch Water District (IRWD)
- California Farm Bureau Federation
- Orange County Integrated Waste Management Department/GeoSyntec Consultant
- California Regional Water Quality Control Board, Santa Ana Region
- National Resources Defense Council/Defend the Bay/Limmo-Tech, Inc.
- City of Irvine Public Works Department
- City of Costa Mesa
- City of Irvine
- Orange County PFRD
- MANA (Makhteshim-Agan of North America, Inc.)
- Dr. John Skinner

GENERAL LEGAL COMMENTS

L1. *Comment:* TMDLs should not be based on narrative standards when there are numeric standards which have been subject to notice and comment rulemaking. It is arbitrary and capricious to ignore the specific CTR numerical standards that are just two years old, and instead base the TMDLs on outdated, vague, ambiguous, less reliable narrative criteria. EPA oversteps its authority by establishing numeric targets that are more restrictive than the adopted numeric WQS.

Commentor(s): Irvine Co./Latham&Watkins, California Farm Bureau Federation

Comment: One source of uncertainty concerns interpretation of the narrative Basin Plan objectives pertaining to toxic substances when numeric objectives are either not available or there may be debate about their relevance, given the nature of the impairment. We support the application of appropriate data, including sediment and tissue data (fish or other organisms), to interpret and implement the narrative objectives. *Commentor:* Santa Ana Regional Water Quality Control Board.

Response: EPA regulations provide that TMDLs shall be established "at levels necessary to attain and maintain the applicable narrative and numerical WQS...." 40 C.F.R. 130.7(c)(1). It is incorrect to say that in developing these TMDLs, EPA ignored any CTR numeric standards. Rather, EPA took into consideration, and developed TMDLs designed to achieve, both the CTR numeric criteria (for those pollutants having CTR numeric criteria) and also the narrative bioaccumulation and toxicity criteria.

As discussed in the TMDLs, the metals and selenium TMDLs are based explicitly on the CTR numeric criteria or equations, and for the OP pesticides there are no promulgated numeric criteria. The comment that EPA ignored the CTR criteria, therefore, appears to be addressing the TMDLs for the OC compounds, mercury and chromium. EPA did in fact calculate the numeric targets for the OC, mercury and chromium TMDLs based on tissue or sediment screening criteria which we considered the best indicators of achieving the narrative criteria; however, we emphasize, as noted above, that our analysis indicated that attaining the sediment or tissue targets would also result in attainment of the CTR water column numeric criteria.

EPA regulations provide that in developing TMDLs, site-specific information should be used whenever possible. 40 C.F.R. 130.7(c)(1)(i). For the OC compounds, mercury and chromium, the available data were primarily sediment and tissue data. When we compared this data with screening criteria developed by various organizations, it appeared that these pollutants are having an adverse impact on the environment in this particular watershed such that the beneficial uses, e.g. RARE and WILD, and the narrative standards designed to protect those beneficial uses, were not being achieved. As discussed in the Overview section of the TMDLs, the narrative objectives considered for these TMDLs are (1) toxic substances shall not be discharged at levels that will bioaccumulate in aquatic resources to levels which are harmful to human health, and (b) the concentrations of toxic substances in the water column, sediments or biota shall not adversely affect beneficial uses. As discussed in the TMDL, all the water bodies in this watershed are designated for wildlife habitat and recreational beneficial uses, and other beneficial uses (e.g. uses related to fishing and preservation of biological habitats) apply to specific portions of the watershed.

Based on our analysis of the available data along with relevant screening criteria (discussed generally in the Overview section of the TMDLs and more particularly in the TMDL for each group of pollutants), we determined that it was necessary to develop sediment and fish tissue targets to protect the beneficial uses and to achieve the narrative criteria designed to protect those beneficial uses – in general, to protect against pollutant bioaccumulation in the food chain and resultant human health or aquatic life impacts from consumption of contaminated organisms. Additionally, EPA determined that these pollutants, as present in this particular watershed, are more likely to be associated with particulate matter sorbed to bottom sediments, rather than occurring in the dissolved phase in the water column; therefore, setting sediment and tissue targets most closely relates to the actual way in which the pollutants exist in the environment in this particular watershed. EPA determined that developing such targets was more appropriate than simply applying the CTR criteria, which apply to the water column.

We acknowledge that the CTR numeric criteria would generally be the applicable target, and, as noted above, we are in fact basing the metals and selenium targets on the CTR criteria and equations. EPA's decision regarding the appropriate targets for the OC, mercury and chromium TMDLs in this particular watershed does not reflect a determination that the statewide CTR numeric criteria are no longer applicable. Rather, based on the our review of site-specific data for those specific pollutants, we determined that establishing the TMDLs based on the statewide CTR numeric criteria alone would not be sufficient to protect the designated uses and attain the narrative criteria in this particular watershed. In order to protect the applicable uses and meet the narrative criteria, the most appropriate approach, for these particular pollutants in this particular watershed, was to develop TMDLs designed to meet narrative as well as numeric criteria.

L2. *Comment:* EPA's inclusion of numeric targets into any TMDL is unacceptable because the statute and regulations don't mention numeric targets. Establishing numeric targets is tantamount to creating a new water quality standard.

Commentor: California Farm Bureau Federation

Response: EPA disagrees. Since a TMDL is an inherently quantitative analysis, it is necessary to develop appropriate quantitative indicators of any applicable narrative criteria in order to calculate the pollutant level that can be present in the water and attain the applicable criteria, and the appropriate loads (see EPA Region 9, 2000). The TMDL process provides a mechanism for identifying quantitative targets as necessary to interpret and apply existing, applicable numeric or narrative water quality standards for different pollutants. Establishing numeric targets, or a numeric interpretation of a narrative criterion, is not establishing a water quality standard but rather is a necessary step in the implementation of a narrative criterion.

L3. *Comment:* EPA cannot base TMDLs for priority toxic pollutants listed pursuant to CWA 307(a) on narrative criteria. CWA 303(c)(2)(B) provides that water quality criteria for these pollutants "shall be specific numerical criteria." It is contrary to law to rely instead on the less reliable narrative criteria. The commentor cites the case of *City of Los Angeles v. U.S. EPA*, No. CV-00-08919 (C.D. Cal. 2001).

Commentor: Irvine Co./Latham&Watkins

Response: See response to comment L1. CWA 303(c)(2)(B) requires that states adopt numeric water quality criteria for certain toxic pollutants. EPA satisfied this requirement with promulgation of the California Toxics Rule (CTR). Neither the Clean Water Act nor the *City of Los Angeles* decision precludes the State from also adopting narrative criteria as well as numeric criteria for toxic pollutants. EPA developed these TMDLs to meet both numeric and narrative water quality criteria.

L4. *Comment:* The narrative criteria upon which EPA is relying are without specific procedures to translate them into numerical criteria and therefore cannot be used as the basis of a TMDL. EPA's Dec. 12, 1988 guidance on water quality standards under CWA 303(c)(2)(B) provides that narrative standards for toxic pollutants must include a procedure to translate the narrative standards into numerical standards. Because California has not adopted such a translation procedure, EPA cannot apply narrative standards to toxic pollutants and cannot base a TMDL on the State's narrative standards.

Commentor: Irvine Co./Latham&Watkins

Response: EPA's 1988 guidance was designed to identify options a State could follow in meeting the requirement of CWA 303(c)(2)(B) that there be numeric criteria for toxic pollutants. Under EPA's guidance, if a state does not adopt numeric criteria for toxic pollutants, the state is allowed to satisfy Sec. 303(c)(2)(B) by adopting a translator procedure to translate narrative criteria for priority toxic pollutants. The EPA guidance does not preclude a State from adopting narrative criteria in addition to numerical criteria, and does not invalidate the narrative criteria at issue in these TMDLs. As noted in response to Comment L3, CWA 303(c)(2)(B) has been complied with through the California Toxics Rule. (CWA 303(c)(2)(B) does not apply to chlorpyrifos and diazinon because they are not listed pursuant to CWA 307(a); see 40 C.F.R. 401.15.)

L5. *Comment:* EPA cannot rely on non-regulatory sediment or fish tissue values to establish a TMDL for priority toxic pollutants unless those values have been the subject of notice and comment rulemaking. EPA is trying to perform an "end-run" around the requirement that numerical criteria or a "translator" procedure for priority toxic pollutants go through notice-and-comment rulemaking. This is especially a problem when there are numeric criteria which are not being used and which have gone through rulemaking. EPA cannot promulgate a regulation establishing sediment and biota criteria through the establishment of a TMDL.

Commentor: Irvine Co./Latham&Watkins

Response: See response to Comment L4. In these TMDLs, EPA is using sediment and fish tissue values in interpreting the State's narrative criteria. EPA's interpretation is included in the TMDLs, which have been subject to a 45-day public review and comment period. Thus, commentors have had full opportunity to comment on EPA's interpretation of the narrative criteria. In these TMDLs, EPA is not establishing sediment and biota criteria. Rather, EPA is using the best information available to set TMDLs which meet both the numeric water quality criteria and also the narrative bioaccumulation and toxicity criteria.

L6. *Comment:* EPA cannot base TMDLs on narrative criteria that give the public no explanation as to how they will be applied. EPA regulations at 40 C.F.R. 131.11(a)(2) provide that when a state adopts narrative criteria for toxic pollutants, it must provide information identifying the method by which it intends to regulate point sources. The Basin Plan does not contain such information.

Commentor: Irvine Co./Latham&Watkins

Response: 40 C.F.R. 131.11(a)(2) requires the State to provide information identifying the method by which the State intends to regulate point source discharges of toxic pollutants on water quality-limited segments based on the State's narrative criteria. Thus, this requirement becomes an issue when the State takes regulatory action. EPA's action in establishing these TMDLs does not directly regulate point source discharges. No NPDES permittee must directly comply with this TMDL. Pursuant to 40 CFR 122.44(d)(1)(vii)(B), when permits are issued, the permits must include conditions consistent with wasteload allocations in TMDLs. That is not to say, however, that TMDLs themselves are a permit or a regulation of point sources, nor that their only function is permit-related. TMDLs are used by States in a variety of ways, including addressing nonpoint source pollution, and general watershed planning.

The State has been closely involved in the development of these TMDLs and supports EPA's interpretation of the State's narrative criteria and use of site-specific data. Some of the screening values which EPA used in developing the numeric targets were values established by the State, e.g. the OEHHA tissue concentration screening values and the Department of Fish and Game aquatic life criteria values for chlorpyrifos and diazinon. Additionally, these TMDLs themselves provide abundant information that the State may use in implementing its narrative criteria. The State may consider the methods used to derive the acceptable pollutant loads in these TMDLs as a method (or a major component of a method) for regulating point source discharges based on the narrative criteria in this particular watershed.

The State intends to revisit these TMDLs and develop implementation plans for them as part of their Basin Plan amendment process. In developing the implementation plans, the State will be determining how to regulate point source discharges which may need to be reduced based on the calculations and wasteload allocations in these TMDLs. If the State identifies additional methods pursuant to 40 C.F.R. 131.11(a)(2), in addition to those set forth in these TMDLs, those will be identified during the Basin Plan amendment process. Additionally, if the State obtains new information which it can use in interpreting the narrative standards through numeric targets, or if the methods ultimately identified by the State lead to a different interpretation of the State's narrative, the State may revise the TMDLs as appropriate and submit the revised TMDLs to EPA for approval.

L7. *Comment:* EPA cannot establish a TMDL for any pollutant without first demonstrating that the watershed at issue is in violation of an applicable water quality standard for that pollutant. EPA has not demonstrated through monitoring data that any of the watersheds are in violation of applicable numeric standards for many of the pollutants in these TMDLs.

Commentor: Irvine Co./Latham&Watkins

Response: The commentor's assertions concerning the limits on when a TMDL may be developed are not correct. TMDLs are developed for "water quality limited segments," and EPA defines "water quality limited segments" as including both waters which are not meeting water quality standards, and also waters which are not expected to meet standards. 40 C.F.R. 130.2(j). Additionally, in determining which segments are water quality-limited, States consider whether narrative criteria as well as numeric criteria are being achieved In determining which segments in this watershed needed TMDLs for which pollutants, EPA assessed available toxicity and chemical data in three water-quality categories–water column quality, sediment quality, and tissue levels. EPA used a two-tiered weight-of-evidence approach, set forth in detail in EPA's *Decision Document of Water Quality Assessment for San Diego Creek and Newport Bay* ("Decision Document") (2002), to determine which TMDLs were appropriate.

L8. *Comment:* EPA cannot establish a TMDL for any pollutant without first demonstrating that the TMDL will render the watershed in compliance with an applicable water quality standards. For several of the pollutants, EPA has not demonstrated that implementation of the TMDL will bring the watersheds in compliance. [Comments regarding specific TMDLs are discussed separately in the sections on those TMDLs.]

Commentor: Irvine Co./Latham&Watkins

Response: EPA agrees that under Clean Water Act 303(d), TMDLs are to be established at levels necessary to implement the applicable water quality standards. However, if a TMDL is not stringent enough to meet a water quality standard, then the remedy is not to determine that no TMDL is appropriate, as the commentor seems to be suggesting, but instead to make the TMDL more stringent. EPA has calculated these TMDLs at levels necessary to meet all applicable water quality standards, as is discussed in the specific TMDLs. However, we acknowledge that there are many uncertainties in these analyses, and we strongly support the Regional Board's plans to monitor implementation of these TMDLs and, if warranted, revise the TMDLs.

L9. *Comment:* The toxics TMDL is invalid to the extent it proposes to regulate nonpoint source pollutant. Because the TMDLs propose allocations for nonpoint sources, they exceed EPA jurisdiction. Pollutants only deal with discharge from point sources.

Commentor: Irvine Co./Latham&Watkins

Response: The TMDL program applies to both point source and nonpoint source pollution. This was recently reaffirmed by the Federal Court of Appeals for the Ninth Circuit. See *Pronsolino v. Marcus*, 91 F.Supp. 2d 1337 (N.D. Cal. 2000), affirmed by *Pronsolino v. Nastri*, No. 00-16026 (9^{th} Cir. May 31, 2002).

L10. *Comment:* U.S. EPA's resort to a narrative toxicity standard which does not itself identify a single compound is a concern.

Commentor: Irvine Co.

Response: These TMDLs are intended to meet all applicable water quality standards, narrative or numeric. Because all the pollutants at issue in these TMDLs are considered to be toxic substances, EPA considers the toxicity and bioaccumulation narrative standards to be applicable.

L11. *Comment:* None of the compounds which are the subjects of these TMDLs are included in the 1998 303(d) list, even though the consent decree requiring establishment of these TMDLs was signed in 1997. The List specifies broad categories of compounds and "unknown toxicity, but does not identify specific compounds. EPA should not deny the public the opportunity to participate in the process of determining which specific pollutants are responsible for the impairment. EPA knew the pollutants of concern in 1997 when it entered into the consent decree, but did not require California to notify the public of these pollutants in the 1998 List.

Commentor: Irvine Co./Latham&Watkins

Response: While EPA prefers that States identify specific pollutants in their 303(d) Lists, we recognize that sometimes States are only able to identify general classes of pollutants or broader problems such as "unknown toxicity." The pollutants identified in the 1997 consent decree were EPA's best understanding of the probable pollutants for which TMDLs needed to be developed. The consent decree itself, however, specifically noted that the list of pollutants was subject to change by the State, and that EPA could also determine that TMDLs were not needed. In fact, the TMDLs being established by EPA in this action differ somewhat from the list in the consent decree, as explained in EPA's *Decision Document* (2002). Given the uncertainties regarding the specific pollutants, EPA determined that the State's identification of general categories in its 1998 303(d) list was adequate to meet the requirements of the Clean Water Act and its implementing regulations

L12. *Comment:* The technical work is arbitrary and capricious because it is based on compound assumptions and extrapolations and "black box" science. There is too much uncertainty, subjectivity, and error. The materials are too hard to understand, do not satisfy minimum scientific standards, and do not give the public a meaningful opportunity to comment. Affected parties have not been afforded due process because they have not been given a full and fair opportunity to participate in TMDL development.
Commentor(s): Irvine Co./Latham & Watkins

Comment: The conclusions in the proposed toxics TMDLs are presented without detailed backup data. Potential concerns relating to data validation, sampling procedures, sample preparation, use of appropriate laboratory procedures, establishment of dose-response, seasonal variability, biological population evaluation, etc., could not be evaluated. *Commentor:* Orange Integrated Waste Management Department/GeoSyntec Consultant

Response: EPA acknowledges that the scientific issues involved in these TMDLs are complicated, and for that reason we included the Technical Support Documents (TSDs) in the materials available for public review and afforded the public a 45-day public comment period. There were also opportunities for public input at EPA and State workshops and meetings, as discussed under "Public Participation" in the TMDL document. The fact that there is uncertainty does not preclude development of a TMDL. Indeed, Congress fully anticipated that there would be uncertainty, and for that reason incorporated the margin of safety requirement in the TMDL statute. EPA acknowledges that there were some errors in the draft analysis and appreciates the complete review provided by commentors. The final TMDLs have been revised to correct errors which EPA and others found during the public review period. These revisions are discussed in the final TMDLs and/or in responses to specific comments.

With respect to the comment that "potential concerns" about the technical basis for the TMDLs could not be evaluated, the comment did not identify any specific concerns about the approaches used to calculate the TMDLs. As noted above, the TSDs, as well as the TMDLs, were available for public review during the comment period. Although EPA is not required to include every aspect of a TMDL analysis in the decision document, EPA did attempt to fully explain the analytical basis for the TMDL decisions in the TMDL summary document and TSDs. Many commentors did review and comment in detail on the technical approaches used for these TMDLs. The general comment about "potential concerns" does not provide a basis for modifying any specific aspect of the TMDL decisions or underlying technical analysis.

L13. *Comment:* The promulgation of a new TMDL is a rulemaking, as it will have a future binding effect and limit administrative discretion. EPA should publish the draft TMDL it in the Federal Register or give actual notice to "persons subject to the rule" to allow for public comment, citing 5 U.S.C. 553(b)(3) (Administrative Procedure Act). The supporting data for the TMDL should also be available for public comment. Among other things, the partitioning information is missing from the chemical description, the water values used are unavailable, the model used to calculate loading capacity is not comprehensible, and the basis for water column concentrations is not sufficiently explained to assess the accuracy of the approach.

Commentor: Irvine Co./Latham & Watkins

Response: EPA disagrees with the commentor's assertion that establishment of TMDLs constitutes "rulemaking" under the Administrative Procedure Act. These TMDLs are specific factual determinations - calculations of the loads these particular water bodies can receive and still achieve the water quality standards applicable to the water bodies. They have no application nationwide, nor even statewide. Furthermore, we submit that if Congress had intended to require EPA to use rulemaking procedures, it would have given EPA more than the 30 days in which EPA is expected to establish TMDLs after disapproving State TMDLs under CWA 303(d)(2). Indeed, the fact that Congress explicitly established a rulemaking procedure for other actions, e.g. establishing water quality standards in CWA 303(c), indicates that such a procedure is not required for actions such as TMDL establishment under CWA 303(d), where the statute does not specify any type of public participation at all, much less rulemaking procedures.

Although the CWA does not require any type of public notice prior to establishment of TMDLs by either EPA or the State, EPA regulations do require some public review when TMDLs are established under certain circumstances; for example, 40 C.F.R. 130.7 provides that when EPA establishes a TMDL after disapproving a State TMDL, EPA must "issue a public notice seeking comment" and consider the public comments received. There is no requirement, however, for publication in the Federal Register.

For the toxics TMDLs, EPA determined that the most effective way of providing notice and soliciting public comment was through the local newspaper of general circulation. Thus, EPA public-noticed the draft TMDLs in the Orange County Register. Copies of the public notice were mailed to the Basin Plan distribution list provided by the Regional Board and posted on the EPA Region 9 TMDL website. Public meetings and workshops were also held, as discussed in the "Public Participation" section of the TMDL document. Copies of the TMDLs and TSDs were available at the public meetings, on the EPA REgion 9 TMDL workshop, and in the EPA and Regional Board offices.

As noted previously, EPA acknowledges that the scientific issues in these TMDLs are quite complicated, and for that reason made the more detailed TSDs available in the website postings, at the Regional Board and EPA offices, through mailings, and at the public meeting held during the comment period. EPA staff, EPA's technical consultant, and all supporting data and information used to develop the TMDLs were also available to commentors via email, conference calls, and in person during the public comment period. The TMDLs were revised in several places in response to technical issues raised by commentors, as is discussed in responses to specific comments and/or in the final TMDLs. As sufficient level of detail was provided in the draft TMDLs and administrative record to facilitate a technical review of the TMDLs by interested commentors. The commentor's consultants submitted extensive technical comments which express the commentor's views concerning the technical approaches used in the TMDLs. Therefore, we disagree that insufficient information was provided in the TMDL documents and supporting information to enable the commenter to assess the TMDL methods.

L14. *Comment:* EPA used unreliable scientific methodologies to establish the TMDLs. EPA translated narrative standards into numeric standards using techniques that have not been subject to peer or public review, ignored well-established numerical data for the watersheds at issue, and produced a largely unintelligible explanatory document. (Commentor includes specific examples, which are addressed separately in this Response to Comments in the Technical Comments section.)

Commentor: Irvine Co./Latham&Watkins

Response: EPA based this TMDL on the best scientific data and methods which were available to us. In some cases, it was necessary to devise new methods of analysis specifically for these TMDLs. EPA's reasons for considering narrative as well as numeric water quality criteria and data are set forth in our Response to Comment L1. While these TMDLs have not been subject to a formal peer review process, they have been subject to comprehensive public review, including workshops during and after development of the draft TMDL and the formal public comment period. EPA also worked closely with scientists at the Regional Board and with EPA's consultant, Tetra Tech. We acknowledge that there were some errors in our original analysis, which have been corrected in the final TMDLs and are discussed in response to specific comments and/or in the final TMDLs.

L15. *Comment:* EPA must ensure that allocations for all point and non-point sources are included in the TMDLs. In some cases, EPA either does not include a potential source in the allocations or does not set an adequate allocation for that source. (Commentor includes several examples, which are addressed separately in this Response to Comments in the sections regarding the individual TMDLs.) Each individual point source should be assigned its own individual wasteload allocation, not grouped together under a catch-all loading (specifically noting the metals TMDLs) so that the WLAs may be implemented through the individual NPDES permits. All of the allocations should be transparent when reading the TMDL so that everyone is fully informed of what is being covered and so that dischargers are aware of which allocations apply to them.

Commentor: Natural Resources Defense Fund (NRDC)

Response: As noted above, comments regarding allocations in specific TMDLs are addressed in the specific TMDL sections of this Response to Comments. EPA agrees that TMDLs should if possible establish individual wasteload allocations for individual point sources. Given time constraints and the data available, however, we were not able to do this for some point sources in some of the TMDLs. We have identified the specific permitted discharges to which the grouped allocations apply and specified how these allocations should apply to individual dischargers in the future. For metals, we established concentration based wasteload allocations which apply to each NPDES permitted facility. More specific allocations within the general allocations will be determined by the Regional Board when it develops implementation measures for these TMDLs and revises permits consistent with these TMDLs.

L16. *Comment:* Where there is significant uncertainty and/or lack of data to support the source analysis, we believe a larger explicit margin of safety must be provided. EPA should clarify which loadings, if any, are encompassed by the explicit margin of safety.

Commentor: NRDC

Response: The explicit margin of safety was included to account for uncertainties in the analysis but was generally not intended to comprise an unallocated reserve or account for loadings not addressed in the source analysis. We do consider the MOS for the selenium TMDLs to encompass loading from atmospheric deposition, although this source is not considered to be significant. EPA considers the 20% explicit margin of safety for metals and the 10% MOS for the other pollutants, combined with conservative assumptions used throughout development of the TMDLs, to provide an adequate margin of safety. See also response to comments OP17, M11, and OC 37.

L17. *Comment:* The Regional Board has adopted a phased approach in establishing TMDLs for other pollutants (nutrients, sediments) in this watershed. The phased approach includes a schedule whereby final compliance with the TMDLs is to be achieved, and also includes interim implementation steps, including additional monitoring and investigation, and revision/refinement of the TMDLs if warranted. We expect the Board will take a similar approach in the adoption of the toxics TMDLs, given limited data and the difficulties anticipated in achieving compliance. We would welcome a discussion of EPA's implementation recommendations for these TMDLs. The implementation recommendations section might be the appropriate vehicle to express EPA's position that no discharge rights or obligations are changed directly by TMDL promulgation. Rather, any such changes would occur in the process of implementing the TMDL through NPDES permit/WDR modifications and other implementation actions identified by the Regional Board in the implementation plan in the basin plan. This is a position with which we agree, as reflected in the recently reissued Orange County MS4 permit. The Regional Board's TMDL implementation approach to date has been to request that the responsible parties submit plans and schedules for achieving compliance with the requirements of the TMDLs. We urge EPA to endorse this approach.

Commentor: Santa Ana Regional Water Quality Control Board

Response: EPA supports the Regional Board's phased approach. Additionally, the Regional Board's interpretation of EPA's position concerning the obligations of dischargers is correct. As recommended by the Regional Board, we are including an implementation recommendations section in the final TMDLs.

L18. *Comment:* The ambiguities in the TMDL preclude clear notice to the City of its obligations. Compliance with the TMDLs is unrealistic and an undue burden on the City. The City is not a major contributor of the pollutants and should not have to undergo tremendous cost to prove this.

Commentor: City of Costa Mesa.

Response: The commentor did not provide specifics concerning the cost which it envisions incurring, nor is the comment clear with regard to ambiguities and the City's obligations. As discussed in Comment L17, the City's discharge rights and obligations are not changed directly by the TMDL. Rather, such changes will occur, if necessary, in the process of implementing the TMDL by the Regional Board through permits or possibly other means.

L19. *Comment:* There are no time-for-compliance provisions in the TMDL. The TMDL will immediately place many stakeholders in a position of violating the TMDL. The TMDL should contain provisions for a phased-in approach for eventual compliance.

Commentor: City of Costa Mesa

Response: See Comments L17 and L18.

L20. *Comment:* A re-opener clause should be incorporated into the TMDL that allows the load allocations to be re-evaluated and revised. This will provide the ability to take into account any new scientific data that is developed or to revise the proposed load allocations in the event that stakeholders are unable to meet the load allocations as currently proposed.

Commentor: City of Costa Mesa

Response: EPA declines to include a mandatory reopener clause in the TMDLs; however, we note that the State is always free to revise a TMDL and submit the revised TMDL to EPA for approval, and we encourage States to do this when new information becomes available. In this regard, we note the Regional Board's intent to develop a phased implementation approach, including additional monitoring, investigation, and revisions of the TMDLs if warranted. If commentors are concerned with implementability of the TMDLs, we urge them to submit comments and recommendations to the Regional Board when it develops implementation measures for the TMDLs.

L21. *Comment:* The TMDLs may result in regulatory requirements that are unattainable and subject stakeholders to third party lawsuits and possible criminal proceedings by regulatory agencies.

Commentor: Irvine Public Works Dept.

Comment: I believe that a forced TMDL for toxics will be counter productive and logistically unenforceable. How can the EPA hold liable the vast majority of permit holders and those businesses that have demonstrated continuous support and improvements of this watershed's water quality? My hope is that EPA will not actively enforce these TMDLs and instead work with the Regional Board to develop an implementation plan that will satisfy the consent decree and reward stakeholders for their continued efforts to protect this watershed's water quality. *Commentor:* Bordier's Nursery.

Response: See Response to Comments L17-20. As discussed in Comment L17, discharge rights and obligations are not changed directly by the TMDL. Rather, such changes will occur, if necessary, in the process of implementing the TMDL by the Regional Board through permits or possibly other means. If commentors are concerned with implementability of the TMDLs, we urge them to submit comments and recommendations to the Regional Board when it develops implementation measures for the TMDLs.

L22. *Comment:* Further monitoring and analysis has been, and will continue to be, an important part of our TMDL implementation efforts, both to assess the effectiveness of control measures and to assist us in refining the TMDLs. In addition to implementation of a routine monitoring program, which will be coordinated with the local stakeholders, a number of special investigations are being conducted to forward the TMDL work. These include studies in the Rhine Channel area, an identified Toxic Hot Spot. The Regional Board has already approved a general cleanup plan for that area and the studies underway will help us to refine it. We expect that implementation of a detailed cleanup plan will be the key remediation vehicle for the Rhine Channel.

Commentor: Santa Ana Regional Water Quality Control Board.

Response: EPA applauds the Regional Board's commitment to future monitoring, analysis, and refinement of these TMDLs, and the Regional Board's efforts to coordinate this work with local stakeholders. We also commend the Regional Board for its work on the general Rhine Channel cleanup plan, and note that this is an positive example of combining the results of TMDL analyses with overall watershed planning.

L23. *Comment:* In order to manage the Irvine Groundwater Basin, IRWD will need to construct, operate and maintain water wells and desalters. These activities will require discharge to surface waters, because they will discharge large quantifies of water for short periods of time. IRWD requests that discharges associated with the management of the Irvine Groundwater Basin be included in any waste load allocations included in the TMDL.

Commentor: Irvine Ranch Water District (IRWD).

Response: The grouped wasteload allocation for groundwater dewatering and groundwater treatment operations is designed to apply to the type of discharge described by the commenter. As discussed in the implementation section, we will urge the State to work with dischargers to collect data and conduct analysis necessary to support more specific delineation of wasteload allocations for individual dischargers of pumped groundwater. Meanwhile, the grouped allocation is intended to ensure that the sum of all discharges from this class of discharge does not contribute to TMDL exceedences.

L24. *Comment:* We request that EPA stay the promulgation and implementation of the proposed TMDLs pending further investigation, and allow further opportunity for public comment. *Commentor:* Latham & Watkins.

Comment: We suggest extending the deadline for comments by 90 days. *Commentor:* City of Irvine Public Works Department.

Comment: We encourage EPA to defer approval of the TMDLs in question until they can be revised and subjected to additional public review. *Commentor:* California Farm Bureau Federation.

Response: EPA has already negotiated an extension of the consent decree deadline for establishing these TMDLs (to June 15, 2002), has provided for a 45-day public comment period, and does not consider an additional extension to be appropriate. We agree that the issues are technically very complicated, and applaud the Regional Board's commitment to including monitoring and further analysis as it implements these TMDLs (see Comment L17, 20). As the Regional Board develops implementation measures for these TMDLs, there will be additional opportunity to both submit formal comments to the Regional Board, and also to work with Regional Board staff in developing the implementation measures.

L25. *Comment:* It is stated that TMDLs are required for toxic substances that are shown to cause probable adverse effects. However, it is not clearly stated how "adverse effects" are defined. The TMDL states, "Evidence of adverse impacts to aquatic life as a result of direct or indirect exposures to these toxic pollutants is limited." This lack of evidence is significant. It appears that based on these statements and the lack of definition of a problem statement that further study and data gathering may be required before a determination of "adverse effect" can be made.

Commentor: Orange County IWMD/GeoSyntec Consultant

Response: The Commentor is referred to EPA's 2002 *Decision Document*, in which we document our criteria for determining which TMDLs needed to be developed. We have revised the language in the TMDL to indicate that although water quality standards have been exceeded for the subject pollutants, the degree to which beneficial uses have actually experienced adverse effects is unknown. Water quality standards and TMDLs are designed to be protective, and the TMDLs are intended to identify maximum allowable pollutant loads and concentrations that can be discharged without exceeding water quality standards and harming beneficial uses.

EPA agrees that further study and data gathering is desirable for the implementation phase of these TMDLs, and concurs with the Regional Board's plans to increase data gathering and analysis and, if necessary, revise these TMDLs.

L26: *Comment:* It is difficult to comment on a draft TMDL that has no implementation plan.
Commentor: Irvine Co.

Response: EPA is not establishing implementation plans for these TMDLs as it is the State, not EPA, which is responsible for developing implementation measures necessary to attain TMDLs, In its comments concerning the EPA TMDLs, the Regional Board signaled its commitment to adopt TMDLs and implementation plans for these toxic pollutants in a timely manner. The Regional Board will do this through the Basin Plan amendment process, which involves extensive public participation. At the request of the Regional Board, EPA has included general recommendations of implementation actions in a new section of the TMDL summary document ("Implementation Recommendations"). As discussed in that section, these implementation and monitoring recommendations are not required and are not part of the TMDL decisions being made by EPA at this time; rather, they are included with the TMDLs to assist followup planning and implementation work by the State and local stakeholders.

Organophosphate (OP) TMDLs

OP1. *Comment:* I am concerned that the banning of diazinon and chlorpyrifos from products available to the general public may not be enough to reduce the levels of the organophosphates in the waters of San Diego Creek to an acceptable level in a reasonable length of time. It may be necessary to also restrict commercial use of these compounds in order to protect the biota in creek water.
Commentor(s): John F. Skinner MD

Response: The EPA re-registration agreements phase out various diazinon and chlorpyrifos uses over a five-year period. The uses that will be discontinued include many of the commercial applications as well. Overall, it is our best estimate that more than ninety percent of diazinon and chlorpyrifos use (as of 1999-2000) will be discontinued over the next five years. The implementation recommendations in the final TMDL suggest that if reductions associated with the phase-out of these pesticides are insufficient to implement the TMDL, then additional actions to reduce discharges of these pesticides may be necessary.

OP2. *Comment:* Overall, the draft OP pesticide TMDL and the interpretation of supporting data are reasonable. Instead of specific technical comments, DPR would like to inform you of the recent availability of documents addressing urban pesticide use and water quality.
Commentor(s): California Department of Pesticide Regulation (CDPR)

Response: Three of the documents listed were reviewed during development of the TMDL. The additional studies will be reviewed and may be used by the Regional Board for developing the implementation plan for the TMDL.

OP3. *Comment:* The TMDL is worded to include all Organophosphate products not just the currently identified products Diazinon and chlorpyrifos.
Commentor(s): George Gutman, Bordiers Nursery

Response: The TMDL is for chlorpyrifos and diazinon only. TMDLs for other organophosphates are not being developed at this time. The term "organophosphates" is used to distinguish these two pesticides from the organochlorine pesticides.

OP4. *Comment:* (A) There are state and federal regulations that require nurseries to maintain our stock and our facilities in "commercially clean" condition all the time. This requires pesticides. We are also in some case to be "free from" pests. This is the case for the federal quarantine on the Red Imported Fire Ant (RIFA). How will EPA work this issue out with USDA? (B) Ironically, to comply with protocols for protecting against the transport of red imported fire ants, the nurseries are directed to use diazinon on the nursery stock before it can be shipped from the nursery.

Commentor(s): (A) George Gutman, Bordiers Nursery, (B) Kathy Nakase, California Farm Bureau

Response: We are informed by the Regional Board that the implementation plan will address the issue of diazinon and chlorpyrifos use for the RIFA plan. Strategies to achieve the TMDL goals while taking into account the requirements of the RIFA program will be developed. In this regard, the Regional Board anticipates working with the stakeholders and building on the cooperative work being undertaken by the DPR, USDA, and UC Cooperative Extension to address potential water quality impacts from the RIFA program.

We also note that the USDA requires mitigation measures to minimize impact of quarantine treatment on the environment and human health. See, e.g. USDA *Imported Fire Ant Quarantine Treatments for Nursery Stock and Other Regulated Articles*, Program Aid No. 1653 (1999).

OP5. *Comment:* The OP pesticide TMDL creates a number of concerns for the agricultural community of Orange County. First, the OP pesticides, diazinon and chlorpyrifos, are important broad-spectrum pesticides for California agriculture. In reality, the ability of OPs to control a number of pests results in less pesticide use by the industry. When a farmer is forced to forego using OP, the farmer is usually forced to use two or more other pesticides that are designed to address a single pest. We state these concerns because of the statement on page 28, which indicates that additional measures will be necessary to achieve the reductions set forth in the TMDL. We are concerned that the allocations established by the TMDL will not be able to be implemented in an economically effective manner by the state and the Regional Board. If the set allocation is not implementable the impact to the Orange County agricultural community could be devastating.

Commentor(s): Kathy Nakase, California Farm Bureau

Response: Additional measures may be necessary to achieve the reductions in OP concentrations in San Diego Creek.. However, this does not mean that additional usage reductions are necessarily needed. Less than one percent of the applied diazinon and chlorpyrifos mass reaches San Diego Creek on an annual basis. Physical and chemical processes breakdown the pesticides before they reach the drainage channels. The Regional Board anticipates that the TMDL implementation plan will include a component focused on development and application of effective management practices that reduce pesticide concentrations in runoff.

OP6. *Comment:* Proposed application of the CDFG numeric targets is inconsistent with the NRC approach. EPA admitted that the methodology underlying the CDFG numeric targets would have to be updated when it was created seventeen years ago. The CDFG targets are excessively conservative. If the targets are to be used, they should reflect the results of PERA and Mesocosm/Microcosm studies. MANA recommends that EPA discontinue use of the numeric targets developed by the CDFG and revise the TMDL for diazinon and chlorpyrifos.

Commentor(s): Makhtashim Agan of North America Inc (MANA)

Response: The validity of the USEPA methodology ("Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and their Uses") was affirmed recently with the promulgation of the California Toxics Rule (CTR) in May 2000 (40 CFR Part 131, page 31689). This is the methodology used by the California Department of Fish and Game (CDFG). The NRC approach, while it appears worthwhile to consider, is not yet reflected in relevant TMDL regulations.

OP7. *Comment:* The saltwater chronic numeric target for chlorpyrifos in Upper Newport Bay is based on the National water chronic criterion of 5.6 pptr (EPA 1986). The criterion is based on 8 chronic bioassays in marine organisms. One of these bioassays was done by Chuck Mckenney at the EPA Gulf Breeze Laboratory and reported in 1981. The bioassay was a 28 day study in *Mysidopsis bahia.*

I discussed the study with Chuck Mckenney. He said the 42,000 pptr data point was in error in the National water criterion document and should be 42 pptr. He said 4 pptr and 10 pptr concentrations were estimated and not analyzed. The National water criteria are guidance and not standards unless adopted by local agencies for specific watersheds. Considering the lack of analytical verification and a questionable technique for assessing growth inhibition for the 4 pptr and 10 pptr concentrations, the effect level of 42 pptr is the lowest concentration verified by analysis and having effects on survival, reproduction, and growth. Adoption of this effect level would raise the chronic criterion above the California freshwater chronic criterion of 14 pptr.

Using a freshwater chronic criterion for chlorpyrifos in Upper Newport Bay seems appropriate since the period of concern is the during storm flows when the Upper Bay is dominated by freshwater. Therefore, whether the standard is considered to be a reinterpretation of the National chronic saltwater criterion (corrected from 5.6 pptr to 14 pptr or higher) or a CDFG recommended freshwater chronic guideline, the TMDL for chlorpyrifos in the Upper Newport Bay should be based on a maximum chronic concentration of 14 pptr.

Commentor(s): James Byard, (Irvine Co)

Response: Chuck Mckenny, the scientist who performed the study has expressed his confidence in the results, and that effects were present at the 4 pptr level (personal communication with EPA). The typographical error in the reporting of the bioassay did not affect calculation of the chronic criterion.

However, the numeric targets in the TMDL have been revised to use the recommended CDFG (2000) criteria, 9 ng/L(chronic) and 20 ng/L (acute), as these represent the latest scientific evaluation of available data. The study performed by Chuck Mckenny was reviewed by the CDFG and included in the data set used to derive the chronic numeric target.

OP8. *Comment:* There is no evidence of real-world, field toxicity in the waters that are subject of TMDLs.

Commentor(s): Latham & Watkins (Irvine Co)

Response: Numerous toxicity tests have demonstrated the occurrence of toxicity in the watershed. Cited references in the TMDL include:

Bailey, HC DiGiorgia, C and DE Hinton. 1993. *Newport Bay Watershed Toxicity Study*

Lee, GF and S Taylor. 2001a. Results of Aquatic Life Toxicity Testing Conducted During 1999-2000 in the Upper Newport Bay Watersheds.

Lee, GF and S Taylor. 2001a. Results of Aquatic Life Toxicity Testing Conducted During 1997-1999 in the Upper Newport Bay Watershed and Review of Existing Water Quality Characteristics of Upper Newport Bay and its Watershed.

CDPR 1999-2000. Preliminary Results of Pesticide Analysis and Acute Toxicity Testing of Monthly Surface Water Monitoring for RIFA Project in Orange County. (Monthly monitoring memos)

OP9. *Comment:* A simple mixing calculation indicates that if San Diego Creek contributes more than 40 percent of the volume in the Bay, Upper Newport Bay will not meet its target. Please provide an analysis of the relative proportion of the volume that San Diego Creek can contribute to the Upper Bay under storm conditions that demonstrates that the numeric targets for Upper Newport Bay will be met under the range of storm conditions.

Commentor(s): Limno-Tech (NRDC/Defend the Bay)

Response: The concentration-based TMDLs apply under all flow conditions to San Diego Creek and Upper Newport Bay and are sufficient to ensure that the numeric targets will be met under storm conditions. The Regional Board anticipates that the implementation plan will include a task to evaluate the degree of mixing and proportion of San Diego Creek flow volumes in Upper Newport Bay during storm conditions, and that the TMDL will be refined/revised as necessary.

OP10. *Comment:* The typical detection limit for chlorpyrifos water samples appears to be between 40-50 ng/L. Please provide guidance on how non-detect data for chlorpyrifos will be interpreted with respect to the numeric targets. Discuss the availability and use of sampling and analytical methods that will result in detection limits less than or near the numeric targets. This issue should be incorporated into the implementation plan.

Commentor(s): Limno-Tech (NRDC/Defend the Bay)

Response: Some of the data summarized in the TMDL were collected using sampling and analytical methods with detection limits below the numeric targets. The Regional Board anticipates that the implementation plan for the TMDL will include a monitoring and reporting program that specifies appropriate detection/reporting limits for chlorpyrifos and diazinon.

OP11. *Comment:* Source Analysis: The TMDL provides text describing how the available data compare to the chronic numeric criteria for each waterbody and compound. Please provide the same information with respect to the acute criteria.

Commentor(s): Limno-Tech (NRDC/Defend the Bay)

Response: Additional discussion of the data with respect to the acute criteria has been included in the TMDL and the TSD.

OP12. *Comment:* We cannot evaluate the current loadings in the analysis presented in the TSD. Please clarify how the mean base and storm flow concentration used in Tables C-14 and C-16 were determined. The concentrations in these tables are not consistent with the base and storm flow concentrations presented in Tables C-8 and C-11.

Commentor(s): Limno-Tech (NRDC/Defend the Bay); (B) James H. Eldridge, City of Irvine

Response: Tables C-8 and C-11 are data summaries for all 398 diazinon and chlorpyrifos samples collected from the various drainage channels in the watershed. Tables C-14 and C-16 refer to 28 samples collected at the San Diego Creek at Campus station (SDC-Campus). For purposes of estimating loads, the data from the SDC-Campus station are appropriate as the station is representative of flow from over 95% of the watershed (Tables C-14 and C-16).

The loads on page 25 of the Summary Document were determined using median concentrations from the data at the SDC-Campus station. The loads in Tables C-14 and C-16 of the TSD were determined using the mean concentrations. For consistency, the loads on page 25 have been edited to reflect the loads determined based on the mean concentrations as in the TSD.

It should be noted that the estimated loads are provided in the TMDL for information purposes only, as the TMDL is concentration based.

OP13. *Comment:* Please reconcile the various existing load estimates.
Commentor(s): Limno-Tech (NRDC/Defend the Bay)

Response: The load estimates in the TMDL were made using median concentrations from the SDC-Campus station while the load estimates in the TSD were made using mean concentrations. These concentrations were multiplied with mean annual base and storm flow rates. The text has now been revised to use mean concentrations in both the summary and the TSD, and the mean annual base and storm flow rates are based on the flow analysis from the TSD Part B.

OP14. *Comment:* The calculation of the percent contribution of indirect deposition from rainfall appears to be incorrect on page 17 of the TSD.
Commentor(s): Limno-Tech (NRDC/Defend the Bay)

Response: The atmospheric deposition percentage calculations have been redone using the new loads calculated as described above (OP13).

OP15. *Comment:* The language in the TMDL contradicts the analysis of loadings from atmospheric deposition presented in the TSD. We recommend that the TMDL be changed to more accurately reflect the analysis presented in the TSD by rephrasing the second full paragraph on page 25. We suggest the following language be inserted into the TMDL. "Loadings from atmospheric deposition are potentially significant, though not well-quantified. Because the origin and magnitude of these loadings are not well understood, their potential contribution is factored into the margin of safety."
Commentor(s): Limno-Tech (NRDC/Defend the Bay)

Response: The text has been modified to include the language similar to the suggested text. See also response to OP17 concerning margin of safety.

OP16. *Comment:* (A) Why are there two calculations for Reach 1 in Table C-16? (B) Please correct the following errata:

- On page 24 of the TMDL there is a reference to Table 3.2,which does not appear in the document with the content described in the paragraph.
- The last paragraph in the chlorpyrifos section on page 24 lists the saltwater chronic numeric target as 9 ng/L. This should be changed to 5.6 ng/L.
- In Table C-16 in the TSD, "SD Creek Reach 1" is listed twice. The second entry was likely meant to be "Upper Newport Bay."

Commentor(s): (A) James H. Eldridge, City of Irvine; (B) Limno-Tech (NRDC/Defend the Bay);

Response: The sentence referring to Table 3.2 has been removed. The saltwater numeric targets have been changed to reflect the latest scientific evaluation published by the CDFG in 2000. The saltwater chronic numeric target has thus been revised from 5.6 ng/L to 9 ng/L. See also the response to comment OP7. Table C-16 has been revised to simply provide the estimated load at the San Diego Creek-Campus station.

OP17. *Comment:* Given the uncertainty regarding the origin and magnitude of loadings from atmospheric deposition, we suggest increasing the margin of safety to 20 percent for chlorpyrifos for both water bodies to encompass this uncertainty.
Commentor(s): Limno-Tech (NRDC/Defend the Bay)

Response: As the TMDL is concentration-based, the uncertainty in the contribution from the atmosphere will not affect establishment of the TMDLs and allocations. Regional Board staff have indicated that the uncertainty may require targeted actions during the implementation period to ensure that the criteria are met in the watershed. These actions could include additional monitoring to better assess the significance of rainfall as a separate source, and a thorough investigation of potential sources and transport pathways to the watershed.

OP18. *Comment:* We suggest adding language to the text in the Allocations section that specifically states what sources are covered in each allocation.
Commentor(s): Limno-Tech (NRDC/Defend the Bay)

Response: The TMDL has been revised to include the suggested information.

OP19. *Comment:* The storm average concentrations presented in Table 3-4 are not consistent with the mean concentrations presented in Tables C-8, C-11, C-14, and C-16. Please explain how the values in Table 3-4 were derived.
Commentor(s): Limno-Tech (NRDC/Defend the Bay)

Response: Multiple samples are available from five separate storm events in the watershed from 1997-2000. The storm average concentrations in Table 3-4 are the maximum single storm averages at the SDC-Campus station. These are the best data available for comparison to the chronic criterion (4-day average). For chlorpyrifos the data are six samples from January 25-26, 2000. For diazinon, the data are four samples from January 25-27, 1999.

The averages in Tables C-8, C-11, C-14, and C-15, are for all sampled storms from 1996-2000. The diazinon and chlorpyrifos averages for the entire watershed are presented in Tables C-8 and C-11 respectively (data summary), while the averages for the SDC-Campus station are used in Tables C-14 and C-16 (load calculation).

OP20. *Comment:* On pages 22 and 23 of the document it states that there is no evidence of bioaccumulation. Yet further down, the TMDL concludes by saying that adverse impacts may be affecting fish survival and reproduction. There does not appear to be any evidence to support the claim of adverse impacts to fish survival. Without supporting evidence, the statement should be stricken and the conclusion of acute and chronic toxicity should be reexamined.

Commentor(s): Kathy Nakase (California Farm Bureau Federation)

Response: The sentence concerning potential impacts on fish survival and reproduction has been deleted. However, the document notes that the presence of acute and chronic toxicity has been well documented using the standard test species *Ceriodaphnia dubia.*

The commentor is referred to EPA's 2002 *Decision Document* for a discussion of EPA's method for determining which TMDLs are needed. As indicated in that document, there is sufficient water-column evidence of toxicity that EPA has concluded that a TMDL is warranted.

OP21. *Comment:* As mentioned above, on page 28 the document discusses the phase out agreements and then concludes that additional measures will be necessary to achieve reductions. The document fails to provide information on why the phase-outs will not be protective and why additional measures will be necessary. Based upon the small percentage of land use related to agriculture in this highly urban environment, it is hard to believe that additional agricultural reductions will be necessary once the phase-outs are implemented.

Commentor(s): Kathy Nakase (California Farm Bureau Federation)

Response: The TSD describes the estimated load contribution from agriculture as around 10 percent. However, the re-registration agreements, which target urban uses to a greater extent than agricultural uses, may result in a higher proportion of agriculture use remaining. Only a miniscule fraction (<1%) of the annually applied diazinon and chlorpyrifos mass reaches San Diego Creek. Regional Board staff expect that the TMDL implementation plan will not be focused on further reducing the remaining diazinon and chlorpyrifos uses in the watershed. Instead, the implementation plan will address development and application of BMPs to ensure that runoff to San Diego Creek meets the numeric targets.

OP22. *Comment:* The allocation of 20 percent of Orange County pesticide usage to the Newport Bay watershed because it represents 20 percent of Orange County land may not be appropriate. If the ratio of agricultural to nonagricultural uses is used for analysis differences in the ratio between the Newport Bay watershed and Orange County as a whole may affect the apportionment of use for the watershed.

Commentor(s): James H. Eldridge, City of Irvine

Response: Estimation of pesticide usage in the watershed from records kept on a county-wide basis can be performed several different ways. As noted by the comment, pesticide usage patterns may not be uniform across Orange County; thus a simple approach using proportion of total area may result in some degree of inaccuracy. Pesticide usage rates are also affected by a large number of factors such as income, landscaping, lot sizes, population, and the presence or absence of pest infestations. Detailed evaluation of all these factors was not necessary given that the usage rates were only used to estimate the general magnitude (>90 percent) of the decline in usage expected from the EPA re-registration agreements.

OP23. *Comment:* There should be a description of the analysis of the impacts associated with expected reductions in loadings from the re-registration of both pesticides.

Commentor(s): James H. Eldridge, City of Irvine

Response: The Regional Board indicates that this analysis will be performed for the TMDL implementation plan. The TMDL analysis discusses the prospective reductions in loads associated with scheduled phase-outs of these pesticides in urban uses.

OP24. *Comment:* There is an inconsistency between the TMDL and the TSD. The conclusions of the TSD state that re-registration agreements with EPA will result in a 90 percent decline in use in Newport Bay and if there are corresponding declines in runoff concentrations, chronic numeric targets should be met for both substances. However, the conclusion in the draft TMDL states that "While these agreements should result in significant decreases in OP pesticide use and the resulting discharge concentrations to the water bodies, additional measures appear to be necessary to achieve the reductions set forth above." Since there is no analysis presented, no conclusions should be drawn.

Commentor(s): James H. Eldridge, City of Irvine

Response: The text has been revised to state "additional measures may be necessary" rather than "additional measures appear to be necessary."

Achievement of the numeric targets through the re-registration agreements is dependent on the assumption of a linear relationship between usage and pesticide concentrations in runoff. While this might be the case, there is also some evidence that certain pesticide use practices may be responsible for a large part of the runoff load. Thus additional measures may be necessary.

OP25. *Comment:* There are no water quality standards for chlorpyrifos and diazinon. It is inappropriate to translate the narrative toxicity standard into numeric TMDLs using non-regulatory guidance values.

Commentor: Latham&Watkins.

Response: While at present there are no promulgated numeric water quality criteria for chlorpyrifos and diazinon, the narrative criteria for toxicity and bioaccumulation apply. See Responses to comments L1, L2 and L4.

OP26. *Comment:* We fully support EPA's commitment to promulgate a TMDL for diazinon, even though this TMDL is not required by the consent decree. Available data demonstrates that diazinon is a source of water column toxicity in San Diego Creek. This toxicity is appropriately addressed by the development and implementation of a TMDL.

Commentor: Santa Ana Regional Water Quality Control Board.

Response: EPA appreciates the comment.

Selenium TMDLs

S1. *Comment:* The Regional Board concluded (RB 2000 Problem Statement) that there are no data for selenium indicating any water quality toxicity in Newport Bay and no evidence that concentrations of selenium are impairing beneficial uses or exceeding water quality standards in the Bay. Selenium concentrations in the Bay do not exceed the CTR saltwater criterion of 71 ppb.

Commentor: Irvine Co./Latham&Watkins

Response: Though there have been no measurements to date of dissolved selenium concentrations in Newport Bay that exceed the CTR saltwater criterion (71 ug/L), recent tissue data indicate that selenium is bioaccumulating to levels that pose a concern about potential toxicological/reproductive effects. Thus, there is evidence that the concentrations of toxic substances in the biota may be adversely affecting wildlife-related beneficial uses, in violation of the Regional Board's narrative toxics objective. Combined with substantial evidence of water quality standards violations in San Diego Creek, Upper Newport Bay satisfies the decision criteria utilized in EPA's Decision Document for identifying waters needing TMDL development.

Regional Board staff indicates that implementation of this TMDL is expected to be accomplished largely through the implementation of the selenium TMDL for San Diego Creek and other tributaries to the Bay, and that additional monitoring of selenium bioaccumulation in fish and mussels in Newport Bay will be conducted as part of the selenium TMDL implementation plan.

S2. *Comment:* Regulating selenium is not appropriate because selenium is naturally occurring in the watershed and there is little anthropogenic selenium. The Clean Water Act does not require cleanup of naturally occurring conditions. EPA can only regulate pollution, which is defined in the CWA as man-made alterations to water. The TMDL acknowledged that selenium loadings come largely from natural runoff and discharges of shallow groundwater, and that it would be difficult to estimate naturally occurring selenium discharge levels. While acknowledging the selenium is present naturally, EPA is proposing to regulate *all* selenium, without distinguishing natural from anthropogenic. This approach will require a cleanup that will never end, as nature will keep producing selenium. EPA should look at other TMDLs in the region where natural conditions are used as a benchmark, at which TMDL compliance is achieved.

Commentor: Irvine Co./Latham&Watkins; IRWD

Response: TMDLs need to analyze all sources of a pollutant, natural and anthropogenic. The commentors did not provide specific examples of TMDLs where natural conditions are used as a benchmark and how those TMDLs provide a useful model for the selenium TMDLs, so it is not possible to ascertain exactly what the commentors are proposing.

Moreover, EPA disagrees with the commentors' premise that the selenium in the surface water bodies of Newport Bay and its watershed is naturally occurring. Though selenium in the groundwater is naturally occurring, the selenium in the San Diego Creek watershed and Newport Bay is primarily the result of anthropogenic processes. Agricultural practices conducted in the early 20th century resulted in the rerouting of the drainage patterns in the San Diego Creek and Newport Bay watersheds. Swamps and marshes were drained (most notably the historical Swamp of the Frogs [La Cienega de las Ranas]), irrigation channels were constructed, and the drainage net was artificially extended downstream to Newport Bay (Trimble 1998). Prior to these changes, the San Diego Creek watershed did not have integrated drainage and did not regularly drain to the Bay. Large storm flows from the watershed ponded in the Swamp of the Frogs and an ephemeral lake located along the southwestern margin of the swamp between Upper Newport Bay and the present route of the Santa Ana River (Trimble 1998). Though seleniferous water and sediments may have existed in the Swamp of the Frogs and the ephemeral lake, that selenium has now been re-mobilized and artificially rerouted into the watershed tributaries via groundwater discharge. As a result, the high selenium flows in San Diego Creek and its tributaries, which at one time did not except on very rare occasions reach Newport Bay, now flow directly to the Bay. It may be noted also that according to Trimble (1998), on those rare occasions when storm water overflowed from the ephemeral lake, it flowed westward into the Santa Ana River and directly into the Lower Bay, thereby completely bypassing the Upper Bay. The historical basis for selenium concentrations in the San Diego Creek Watershed has been described briefly by Dr. James Byard in his comments on the selenium TMDL

(Irvine Co.). Dr. Byard notes that though seleniferous water and sediments may have accumulated in the inland lentic water bodies that existed on the Tustin Plain, selenium associated with these swamp and lake deposits has now been re-mobilized in the shallow groundwater. The shallow (perched) groundwater discharges through springs, seeps and weepholes to San Diego Creek, which has been artificially extended to Upper Newport Bay.

S3. *Comment:* Although natural in origin, selenium is an undesirable contaminant, and communities may as a result of selenium removal show some improvement. Because of the widespread presence of selenium in the surface and subsurface environment, it will be necessary to disturb the environment in order to remove the selenium. Consequently, programs instituted to remove selenium may cause some short term increases in selenium in the surface environment. The USEPA and other regulatory agencies need to recognize that minor excursions of the adopted selenium standard do not constitute a violation of the standard. Since selenium is neither created or destroyed, the only alternative to lessen selenium toxicity is to move excessively high concentrations of selenium to an environment which is less susceptible to selenium toxicity. IRWD recommends that selenium removal implementation plans require as a goal the net export of selenium from the Irvine Basin to ocean waters which would not be affected by minor increases in their selenium load.

Commentor: IRWD

Response: Many of the comments on these TMDLs concern implementation issues. All comments will be forwarded to the Regional Board for its consideration in implementing these TMDLs. The Regional Board has indicated that in developing the implementation plan for the selenium TMDL, a variety of remedial options for treating or removing the selenium in the surface flows and/or groundwater in the watershed will be considered.

S4. *Comment:* The naturally-occurring selenium in the creek exceeds the CTR criteria; thus, the Creek is likely to be well adapted to this naturally-occurring substance. The environment has adapted well to the natural selenium. EPA erroneously assumed that naturally-occurring selenium is toxic, when the local ecosystem is adapted to background levels exceeding the regulatory standard.

Commentor: Irvine Co/Latham&Watkins; Byard, IRWD

Response: Though selenium in the groundwater is naturally occurring, the presence of selenium in San Diego Creek as it now exists is the result of anthropogenic processes. See Response to Comment S2.

Additionally, the commentors have not produced any evidence to support the argument that the ecosystem is likely well adapted to existing selenium concentrations, which, as discussed above, are not naturally occurring. Selenium concentrations in San Diego Creek at Campus Drive consistently exceed the CTR criterion for fresh waters (5 ug/L). These concentrations are well above the level that Engberg et al (1998) characterized as certain to cause toxicological and reproductive effects. Selenium concentrations in fish tissues collected from San Diego Creek fall in the range of levels of concern for fish. This suggests that selenium is likely to cause ecological impacts in San Diego Creek.

Since selenium biomagnifies up the food chain, toxicological impacts from selenium in primary producers such as birds may not show up immediately. Toxicological effects of selenium on wildlife include lowered reproduction rates, shortened life spans, and stunted growth. Many of these effects are not readily observable and detailed biological studies will be needed to determine whether or not selenium is negatively impacting biota in the watershed and the Bay. We understand that several extensive investigations of selenium and its role in the San Diego Creek watershed are planned or are in the data collection stage. While these investigations may yield data on which the Regional Board may base a determination that revisions to the TMDLs are warranted, at this time EPA does not consider it prudent to postpone this TMDL analysis until a time when these toxicological and reproductive effects are more apparent or when additional data is gathered.

S5. *Comment:* EPA cannot establish a TMDL for any pollutant without first demonstrating that the TMDL will render the watershed in compliance with applicable water quality standards. EPA can't show this for selenium because naturally occurring selenium exceeds the CTR criteria, so reducing anthropogenic selenium will not achieve water quality standards.

Commentor: Irvine Co./Latham&Watkins

Response: It appears that this comment is directed to the freshwater selenium TMDLs. Regarding compliance with applicable water quality standards, see our general response to comment L8. Regarding the commentor's inference that "natural" sources of selenium are causing the observed exceedences of water quality standards in San Diego Creek, see response to comment S2.

The selenium TMDLs and allocations do not specifically distinguish between apparently natural and anthropogenic sources of selenium discharge associated with rising or pumped groundwater because, as discussed above, basin land uses and hydrology have been substantially altered over time. We have set allocations which, upon implementation, would result in attainment of water quality standards for selenium. If the State later determines that it is infeasible to reduce selenium loadings to levels which result in attainment of standards, potentially because it finds that a significant portion of selenium loadings are truly natural in origin, the State may be able to carry out a use attainability analysis and revise the water quality standards accordingly.

S6. *Comment:* The agencies should take into consideration the unique characteristics of San Diego Creek watershed prior to implementing a TMDL based on the national standard for selenium of 5 ppb. The national standard is based on studies of a lake in North Carolina. Selenium in San Diego Creek is less likely to bioaccumulate.

Commentor: Irvine Co., Latham& Watkins; California Farm Bureau Federation.

Response: The 5 ppb standard has been adopted for California through the CTR and is considered the applicable standard in this watershed; therefore, it is necessary for these TMDLs to meet that standard.

Regarding the commentor's technical concerns, bioaccumulation of selenium has been found in both lotic (running water) and lentic (standing water) systems. High instream selenium levels will also affect offstream linkages such as backwaters, marshes, reservoirs, and estuaries (Hamilton and Lemly, 1999). In addition, given the low flow regime that predominates in San Diego Creek (mean flow rate = 13 cfs), the presence of small pools, stagnant ponds, and in-stream sedimentation basins likely results in localized reducing conditions that could cause accumulation of the more bioavailable forms of selenium.

Though some data suggests that selenite is more toxic than selenate, selenate toxicity data are scant (Nagpal and Howell, 2001). Some organisms appear to be sensitive to selenate. A decrease in cell division and growth rates of some species of algae exposed to selenate have been shown by several studies (Davis et al., 1988; Dobbs et al., 1996; Richter, 1982). Selenate is also readily taken up and accumulated by plants and enters the food chain via this route (Dr. Lemly, USFS, personal communication, June 10, 2002). Since all forms of selenium may interconvert, they should all be considered toxicologically important (Drs. Teresa Fan and Gregory Cutter, comments at EPA Peer Consultation Workshop on Selenium Aquatic Toxicity and Bioaccumulation, EPA, 1998).

Studies of selenium have been conducted in various watersheds throughout the United States, including the western states. Chronic toxicological effects associated with selenium range from less than 2 ug/L (Skorupa and Ohlendorf, 1991) to 6.8 ug/L (Adams et al. 1998) depending on which endpoint is chosen to be protected and the models used by the investigators (Nagpal and Howell, 2001). Though the 5 ug/L CTR standard was based predominantly on a study of Belews Lake in North Carolina it falls within this range of values. Additionally, Skorupa (1998) reviewed 12 examples of selenium poisoning. Five of the sites (42%) were in California (Kesterson Reservoir, Richmond Chevron Marsh, Tulare Basin, Salton Sea, and Red Rock Ranch) and concluded that a national water-based criterion of less than 5ug/L was easily justified (Hamilton and Lemly, 1999). EPA is currently engaged in the process of reviewing its national criteria for selenium. Until this process is complete, it is appropriate to base the selenium TMDLs on the established CTR objectives. If these objectives are revised, or if a site-specific objective for selenium is developed and approved for the Newport Bay watershed, the TMDL must be revised accordingly.

S7. *Comment:* Regional Board staff had proposed that the selenium TMDL be based on 2 ppb, based on the recommendations of US Fish & Wildlife Service. However, we recognize that the law requires the TMDL to meet the established CTR objective, and support basing the selenium freshwater TMDLs on the CTR objective. *Commentor:* Santa Ana Regional Water Quality Control Board.

Comment: Defend the Bay and NRDC believe that the chronic CTR criterion of 5 ug/l is not adequately protective. Rather, we believe that a 2 ug/l target for all flow conditions is required. A recent USGS study on the effects and fate of selenium in the San Francisco Bay and Delta found that a target of 5 ug/l is not adequately protective. In addition, US Fish & Wildlife Service has also suggested that a 2 ug/l target for selenium is necessary for adequate protection of fish and wildlife. If EPA does not use the 2 ug/l criterion, then a much larger margin of safety is required. *Commentor:* NRDC.

Comment: Targets for selenium must mirror the currently adopted water quality objectives, not objectives that may be adopted in the future. *Commentor:* California Farm Bureau Federation.

Response: EPA agrees with the Regional Board that the target should be based on the CTR criterion of 5 ppb. Commentors noted information from various studies which could support selenium targets which are either higher or lower than the currently applicable CTR standard. No evidence of current selenium bioaccumulation effects in San Diego Creek or Newport Bay biota was identified during the TMDL development process. Sufficient water column data were available to develop the initial TMDLs and allocations. In light of the uncertainty over, and disagreements about, the appropriate levels of protection from selenium exposures, the fact that criteria revision is currently underway, and the fact that we had sufficient water column data to develop TMDLs based on ambient criteria, EPA determined that it is most prudent to establish the TMDLs based on the existing CTR standard. However, we note that if the CTR in fact is altered and a lower criterion is adopted, the Regional Board will very probably need to revise the TMDL to ensure that the revised CTR criteria can be achieved.

As discussed in responses for other pollutants and in the general response to comment L1, EPA determined that in some other cases it is most appropriate to establish TMDLs for the watershed based on narrative standards due to the availability of data for sediment and/or fish tissue, the behavior of the pollutants following discharge, and the processes through which they potentially cause adverse effects to human or ecological health. However, those considerations were not applicable to the selenium TMDLs.

S8. *Comment:* A phased approach is recommended for the selenium TMDLs. We believe that a phased TMDL approach is particularly appropriate in dealing with selenium, given that the challenge of meeting the TMDL will be very significant, and given that we have relatively limited data on which to base management decisions. A number of studies are or will be underway shortly to assist us in filling those data gaps. One basic question is whether selenium is posing the ecological threat suggested by the findings of freshwater concentrations in excess of the CTR objective. Implementation of the selenium TMDL will also be difficult given that native groundwater is the major source.

Commentor: Santa Ana Regional Water Quality Control Board.

Response: EPA has not specifically developed these TMDLs as phased TMDLs. However, we acknowledge the problems noted by the Regional Board, and fully support the Regional Board's plan to develop a phased implementation program for these TMDLs. As noted in comments and responses no. L17 and L18, no discharge rights or obligations are changed directly by promulgation of these TMDLs. Rather, such changes will occur, if necessary, in the process of implementing the TMDL by the Regional Board through permits or possibly other means.

S9. *Comment:* TMDLs are proposed even though existing loads are not well understood. For example, in the analysis of selenium, a total of 408 pounds per year is estimated to be from "undefined sources." Leaving the source "undefined" makes subsequent implementation phases of the TMDL process unmanageable. Establishing a TMDL for this compound without better defining the sources in inappropriate.

Commentor: Orange County IWMD/GeoSyntec Consultant

Response: EPA acknowledges the uncertainties and supports the Regional Board's phased approach as described in the previous comment. Uncertainties in TMDL development are not uncommon, and for that reason both the Clean Water Act and EPA's implementing regulations specifically require a margin of safety.

S10. *Comment:* The Watershed is a flowing creek that terminates in an estuary. The flow-through nature of the Watershed limits the ability of selenium in the water column to equilibrate with sediments and the aquatic food chain

Commentor(s): Irvine Co./Byard

Response: Bioaccumulation of selenium has been found in both lotic (running water) and lentic (standing water) systems. High instream selenium levels will also effect offstream linkages such as backwaters, marshes, reservoirs, detention/sedimentation basins, and estuaries (Hamilton and Lemly, 1998). In addition, the low flow conditions (0-20 cfs) that predominates in San Diego Creek much of the year results in the presence of small pools and stagnant ponds. In-channel sedimentation basins are located in the creek directly above Newport Bay. These areas may result in localized reducing conditions that could provide conditions for accumulation of selenium in plants, sediment, and detritus and therefore, increase the concentrations of selenium in the food web.

S11. *Comment:* Other factors reducing the impact of selenium in the San Diego Creek are the predominance of selenate as the chemical form of selenium and the presence of high sulfate. Selenate is not as readily taken up by sediments and the aquatic food chain as selenite. Sulfate competes for the uptake of selenate into phytoplankton, reducing the bioaccumulation process.

Commentor(s): Irvine Co./Byard

Response: Since all forms of selenium may interconvert, they should all be considered toxicologically important. Though some data suggests that selenite is more toxic than selenate, selenate toxicity data are scant (Nagpal and Howell, 2001). Some organisms appear to be sensitive to selenate. A decrease in cell division and growth rates of some species of algae exposed to selenate have been shown by several studies (Davis et al., 1988; Dobbs et al., 1996; Richter, 1982). In addition, selenate is readily taken up and accumulated by plants, thereby entering the food chain (Dr. Lemly, USFS, personal communication, June 10, 2002). Sulfate does not appear to be important in terms of the expression of chronic toxicity except potentially for primary producers (USEPA, 1998).

S12. *Comment:* The EPA is considering lowering the selenium standard to 2 ppb. The high selenate, high sulfate, and flow-through characteristics of the San Diego Creek Watershed indicate that a 2 ppb standard would be unnecessarily overprotective. Even 5 ppb would likely be overprotective. A level of 10 ppb would most likely result in fish residue levels below 4 ppm. A reasonable approach would be a several year period at a watershed specific standard of 10 ppb_In the unlikely event that the levels of selenium in biota did not regress sufficiently to be below levels of concern, then a lower standard could be put in place. This titration approach to establishing a selenium standard for the Watershed would be the most efficient way to achieve protection of wildlife.

Commentor(s): Irvine Co./Byard

Response: The 5 ppb standard is the applicable numeric standard based on the CTR. This comment addresses potential revision of the selenium standards and is therefore beyond the scope of the TMDL establishment action.

S13. *Comment:* [T]he potential impacts to the Creek from high loads associated with storm events are much less than the smaller loads associated with dry flows. For this reason, an acute standard for selenium should be applied to storm flows_resulting from major storm events.

Commentor(s): Irvine Co./Byard

Response: Based on revision of the flow data (see revised TSD Part B), an acute standard of 20 ug/L for storm events exceeding 814 cfs (new flow tier 4), has been applied and the loads calculated accordingly.

S14. *Comment:* Selenium is present not only in surface soils but is also present to a substantial depth in the Irvine Basin. Based on the results of water analysis performed by the Orange County Water District, selenium is present at 32 ug/L at a depth of 100 feet and present at 5 ug/L to a depth of 360 feet.

Commentor(s): IRWD

Response: We are aware that selenium in the deeper groundwater aquifers often exceeds the levels in San Diego Creek., There appears to be little connectivity of these deeper aquifers with the surface flow in San Diego Creek, except as the result of man's activities. The aquifer located at 100 feet is a confined aquifer and the communication between this aquifer and the shallow perched aquifer has not been investigated. Regional Board anticipates that the selenium TMDL implementation plan will include studies to investigate the connection between these aquifers.

Selenium from these aquifers can enter surface flows in San Diego Creek through construction dewatering, well construction, purging, and maintenance, and groundwater remediation (pump and treat) operations. Regional Board anticipates that as part of the implementation plan, these inputs will be evaluated and considered prior to revising existing NPDES discharge limits.

S15. *Comment:* I believe the major threat of selenium is coming from dry weather flows originating from groundwater sources that are purposefully drained from shallow aquifers in central Irvine_I believe that selenium reduction efforts should target dry weather flows in San Diego Creek instead of wet weather flows.

Commentor(s): Dr. Jack Skinner

Response: We agree. This has been discussed with Dr. Barry Hibbs, who is of the opinion that as much as 70% of the selenium in San Diego Creek is likely coming from the shallow groundwater aquifer (personal communication, June 10, 2002). However, though construction dewatering, well construction, maintenance and purging, and groundwater remediation operations may periodically contribute to the surface flows in San Diego Creek, perched groundwater is predominantly getting into the creek via seeps, springs, and weepholes, as a result of the hydraulic gradient, not due to purposeful drainage. Ongoing studies by Dr. Hibbs, and Dr. Tom Meixner of UCR, are investigating the sources of the selenium in the San Diego Creek watershed.

Because of their relative infrequency, large volume of water, and high flow velocities, large storm events likely do not contribute to selenium in San Diego Creek itself, except for sediment that may be deposited in the creek in the inline sedimentation basins located just above Upper Newport Bay. The role these storm events play in contributing selenium to the Bay has not yet been determined. However, since the dry weather flows in San Diego Creek are currently dominated by groundwater inputs, treatment of these flows (and/or the shallow groundwater) will be an important step in removing a major source of selenium from the watershed.

S16. *Comment:* It is important to do the remediation of the groundwater selenium inputs near the source rather than just prior to entering Newport Bay.

Commentor(s): Dr. Jack Skinner

Response: We concur. Regional Board informs us that any remediation of selenium sources will be located as close to the sources as possible and upgradient of the Bay and tidally-influenced areas of the creek to ensure that the selenium is removed before it can reach sensitive estuarine habitats.

S17. *Comment:* _[W]ith regard to selenium, a 10% margin of safety will not be adequate if the TMDL is set at 5 ug/L instead of 2ug/L_As EPA has noted, there is considerable uncertainty and a lack of data to quantify loadings from various sources_For this reason, we recommend a larger margin of safety_In addition, the uncertainty regarding selenium sources to Newport Bay requires an additional MOS unless a thorough analysis indicates that compliance with the freshwater TMDLs will also ensure compliance with objectives in Newport Bay.

Commentor(s): Defend the Bay/NRDC/Limno-Tech

Response: There are ongoing investigations of the sources of selenium in the San Diego Creek/Newport Bay watershed. However, as much as 70% of the selenium in San Diego Creek is likely coming from the shallow groundwater aquifer (Dr. Barry Hibbs, personal communication, June 10, 2002). Since San Diego Creek is by far the largest freshwater contributor (>95%) to Upper Newport Bay and it drains over three-quarters of the entire Newport Bay watershed, reductions of selenium in the creek should also result in reductions in the Bay. Therefore, the level of uncertainty about selenium sources does not warrant an additional margin of safety.

As noted previously, EPA is reviewing the 5 ppb selenium criterion, and investigations of selenium in this watershed are on going. If warranted by this review or site-specific studies, the TMDL, including the margin of safety, can be modified as appropriate.

S18. *Comment:* The Regional Board's suggested approach of using different criteria for the base/small flows (2 ug/L) and medium/high flows (10 ug/L) is not sufficiently protective. Using a criterion of 10 ug/L is likely to cause toxicity to organisms in San Diego Creek.

Commentor(s): Defend the Bay/NRDC/Limno-Tech

Response: Based on revised flow data (see Revised TSD Part B), the chronic CTR criterion of 5 ug/L will be applied to all flow tiers that exceed an annual average of 4 days (see Table 2, TSD Part B). This includes base flows ($Q = \leq 20$cfs), small flows ($20>Q\leq 181$cfs), and medium flows ($181>Q\leq 814$cfs). The national acute criterion of 20 ug/L will only be applied to the large flows ($Q>814$cfs) which did not exceed 3 days in duration during the period of record examined for the TMDLs (Table 2, TSD Part B). The NTR value for acute conditions has been applied, as the CTR does not specify an acute criterion for selenium.

The selenium numeric targets in these TMDLs are expected to be protective of the wildlife in San Diego Creek and Upper Newport Bay. Site specific studies of the role selenium plays in the watershed are currently being planned or conducted. Regional Board anticipates that the results of these studies will be used to refine or revise the selenium TMDL during the implementation process.

S19. *Comment:* We are concerned that the numeric target selected for Newport Bay (the CTR saltwater criterion) will not be sufficiently protective of wildlife.

Commentor(s): Defend the Bay/NRDC/Limno-Tech

Response: The USFWS concurred with this saltwater value (71 ug/L) in its review of the CTR. This target is expected to result in protection of all designated uses in Newport Bay. Also, since San Diego Creek is the major contributor of freshwater flows to Newport Bay, reductions of selenium in the creek should also result in reductions in the Bay. Regional Board anticipates that additional monitoring of selenium bioaccumulation in fish and mussels in Newport Bay will be conducted as part of the selenium TMDL implementation plan.

S20. *Comment:* We recommend using a longer, more representative period to determine flow volumes for the loading capacity calculations, to ensure that the resulting calculated loading capacities are representative of actual conditions.

Commentor(s): Defend the Bay/NRDC/Limno-Tech

Response: The TMDL now reflects evaluation of daily flow records for 19 water years at San Diego Creek at Campus. These data have been used to determine the flow tiers for developing selenium (and metals) TMDLs. The rainfall-runoff information outlined by OCPFRD (in their comments on the proposed TMDLs) has been used and the analysis has been extended to include all available complete water year records; i.e., water years 1977/78, 1983/1984, 1984/85 and so on up to

2000/01. Flow volumes associated with each tier were calculated by summation of daily flow rates with each tier for all 19 water years. (See Table B-2 in the TSD Part B).

S21. *Comment:* Allocations were combined for all of the Newport Bay water bodies_we recommend that the San Diego Creek TMDL Allocation be separate from allocation for Santa Ana-Delhi Channel...

Commentor(s): Defend the Bay/NRDC/Limno-Tech

Response: This has been done. See revised tables in TSD Part D.

S22. *Comment:* We are concerned that the allocations for San Diego Creek and Santa Ana-Delhi Channel might not result in compliance with targets for Newport Bay.

Commentor(s): Defend the Bay/NRDC/Limno-Tech

Response: Since San Diego Creek is the major contributor of freshwater flows to Newport Bay (>95%), reductions of selenium in the creek should also result in reductions in the Bay. Regional Board anticipates that additional monitoring of selenium water column concentrations and bioaccumulation in fish and mussels in Newport Bay will be conducted as part of the selenium TMDL implementation plan.

S23. *Comment:* We are concerned that it will be difficult to implement the tiered allocations. Therefore, implementation of the TMDLs should be closely monitored by the EPA.

Commentor(s): Defend the Bay/NRDC/Limno-Tech

Response: We agree that implementation of these TMDLs will be challenging; the EPA will be providing feedback to Regional Board staff on all of the Toxics TMDL implementation plans.

S24. *Comment:* There are a great number of qualifiers describing loading pathways_If there is no methodology for quantifying existing loads by source, then that should be stated.

Commentor(s): City of Irvine

Response: Comment noted. The TSD explains the source analysis method used. We acknowledge that insufficient data and information were available to precisely characterize all loading sources. An investigation into potential sources of selenium in the San Diego Creek watershed is currently in progress. This study should help to quantify the unidentified sources of selenium in the watershed, and the Regional Board can revise the TMDL if necessary.

S25. *Comment:* For selenium, Figure 4-1 in the summary document (Figure D-9 in the TSD) is useful_, but should be expanded to give estimates of the existing loads from each source is these are available or is there a methodology to calculate them?

Commentor(s): City of Irvine

Response: A table has been added to the TSD (Table D-4) illustrating how the waste load and load allocations for selenium were calculated using the revised flow tiers.

S26. *Comment:* Additional explanation is needed for how the source allocations were made. If they are based on existing loads, the absence of source data in Table 4-5 should be rectified. If they are based on

land use, the analysis should be explained. As it stands, it us unclear how the allocations are derived.
Commentor(s): City of Irvine

Response: Please see Table D-4 which has been added in response to the previous comment. Table D-4 presents a more detailed breakdown of the estimated waste load and load allocations.

S27. *Comment:* Page D-3 – Source Analysis - The report does not reference historical selenium data collected by the County prior to the NPDES program. From 1973 to 1987, the Orange County Environmental Management Agency (now PFRD) collected samples for selenium analyses from San Diego Creek at Campus Drive. In all, 26 samples were collected including three influenced by stormwater runoff. Although the data are limited, they show that levels above the CTR chronic freshwater criterion and proposed TMDL numeric target of 5 micro g/L, were present in San Diego Creek 20-30 years ago.
Commentor(s): County of Orange, Public Facilities and Resource Department

Response: We appreciate the submittal of the additional data but do not believe it supports revisions to the TMDLs.

S28. *Comment:* Page D-18 – Tables D-2 and D-3 – The daily average discharges (cfs) shown in Table D-2 are incorrect. This has resulted in substantial inaccuracies in the daily load calculations. The total flows (cfs) in Table D-3 for both dry and wet weather events for the periods 4-98 thru 9-98 and 10-98 thru 3-99, respectively are incorrect.
Commentor(s): County of Orange, Public Facilities and Resource Department

Response: We have revised Tables D-2 and D-3 accordingly, and recalculated the total flow volumes for the wet and dry seasons.

S29. *Comment:* Appendix A - The title references Table D-5. This should be changed to Table D-2 as there is no Table D-5 found in the text.
Commentor(s): County of Orange, Public Facilities and Resource Department

Response: Correction made.

Metals TMDLs

M1. *Comment:* It is not necessary to reduce metals loading through a TMDL because most of the metals, on average, are below the CTR standards. According to the Regional Board (Problem Statement 2000), dissolved cadmium, chromium, lead, nickel, silver and zinc "are probably not causing, or contributing to, toxicity to aquatic life in Newport Bay and San Diego Creek." It appears that EPA has inflated the exceedences by assuming that the heavy metals readily dissolve in water, contrary to reality and common knowledge.
Commentor: Irvine Co./Latham&Watkins

Response: In preparing these TMDLs, EPA independently evaluated all readily available data for this watershed, including new and updated data since the Regional Board issued its 2000 Problem Statement, to determine which of the chemicals identified in the consent decree and by the Regional Board warranted TMDLs. The reasons EPA has determined that specific TMDLs should be prepared are discussed for each chemical in EPA's *Decision Document* (2002). As discussed in that document, EPA assessed not only water column data, but also sediment quality data and fish/shellfish tissue data.

See response to comment L1 regarding our use of narrative as well as numeric criteria in developing these TMDLs. We disagree that the methods used in these TMDLs inflate water body exceedences and we did not assume that heavy metals readily dissolve in water. EPA's methods for associating total and dissolved metals in the analysis are discussed in the TSD. On average, we found that dissolved metal and total metals concentrations were relatively close to each other.

M2. *Comment:* The TMDL does not contain a proposed methodology for allocating responsibility for any exceedence. For example, the copper TMDL includes allocations for urban runoff and for "other NPDES permittees". There are no provisions for distributing loads among the various stakeholders. What criteria will be used to assign limits?

Commentor: City of Costa Mesa

Response: EPA has provided additional information in final TMDLs to explain allocations. Section II of the Summary Document lists the NPDES discharge sources covered by the "other NPDES permittees" category. According to Regional Board staff, little monitoring data exists for these facilities and therefore it is not feasible to precisely estimate metals inputs from these sources. EPA has utilized best professional judgment to make an allocation to this source, rather than provide an allocation equal to zero.

M3. *Comment:* The summary tables E-10 and E-11 in the TSD need to be clarified. The totals for Pb and Zn do not reflect the sum of the sources. There is no explanation of whether the unknowns are significant.

Commentor: City of Costa Mesa

Response: EPA has reviewed and rectified summary tables E-10 and E-11 in TSD Part E. Insufficient data were available to support a precise assessment of the significance of the unknown sources. For example, groundwater inputs of these dissolved metals to could be significant in localized areas of San Diego Creek. In Newport Bay, zinc anodes are used on recreational boats, although they do not cover large surface areas as compared to wetted boat hulls, and are not likely to be nearly as significant a source of Zn as boat hulls are for Cu. Our review of available data and information yielded no evidence that Cd and Pb loads from unknown sources are significant.

M4. *Comment:* Explain the allocations for loading capacity. The correlation of allocations to existing loads is unclear except for ambient levels and air deposition.

Commentor: City of Costa Mesa

Response: EPA has included an explanation of allocations in the final summary document.

Comment: Clarify allocation categories for metals.

Response: EPA categories are defined by either known inputs to water bodies, such as urban stormwater and NPDES permittees (e.g, CalTrans) or non-point sources such as agricultural runoff from nurseries or open fields. Undefined includes natural runoff and possible inputs (very small) from contaminated sediments existing in the waterbody. Boats refers to all wetted surfaces of recreational boat hulls in Newport Bay.

M5. *Comment:* It is unclear which OCPFRD data were used to calculate metals translator values. EPA's translator average was 1.2, but analysis of SDC data from 1996-2000 yielded a translator closer to 3.0. It appears EPA included many pairs of data that were at the detection limit, which would yield translators of 1.0. Translators should be calculated for each metal on a site specific basis. Natural channels transporting greater sediment loads would have greater translators compared to concrete lined channels.

Commentor: County of Orange

Comment: The 80% dissolved to total metals ratio used for the TMDLs is a good estimate for nonstorm flows but the dissolved fraction in stormwater is about 40%. Use of the 80% translator could overestimate metals loads during storm flows.

Commentor: Irvine Company/Geosyntec

Response: EPA has used stormwater data (provided by OCPFRD) to estimate the ratio of dissolved to total metals. EPA concluded that it was reasonable to use a single translator based on average metals conditions since the mass-based TMDLs are expressed on an annual average basis and the concentration based TMDLs are expressed on an acute and chronic basis, but are not dependent upon the translator value(s) selected to be implemented.

M6. *Comment:* There is a large range of data shown in the TSD tables and the confidence interval brackets the CTR values for all parameters. The extreme values likely radically skew the data. Dry and wet weather data should be evaluated separately.

Commentor: Irvine Company/Geosyntec

Response: EPA synthesized considerable data collected by several groups in the TSD tables. The goal was to provide an overview of results from all data sources. Extreme results may skew the data, and it would be helpful to define dry vs. wet weather separately. However, there is no evidence that apparent outlier data are unreliable, and EPA guidance cautions against excluding apparent outliers without a sound rationale. We note that CTR values are not based on comparisons with means data values. Instead, most toxic pollutant standards are based on the assumptions that they are to be exceeded very rarely (i.e. once in 3 years on average). If the commenter intends to infer that the data indicate that the CTR standards are being met, we disagree.

M7. *Comment:* The margin of safety may be unreasonably stringent because (1) there are safety factors inherent to the CTR values, (2) unnecessarily conservative hardness values were applied, and (2) chronic standards were inappropriately applied. Expressing a margin of safety as a percent of the average concentration in the runoff has no scientific basis. The safety factor should be expressed as an upper or lower limit based on research on the pollutant of concern.

Commentor: Irvine Company/Geosyntec

Response: EPA applied the margin of safety based on uncertainty in several aspects of the source analysis; e.g., the dissolved to total metals ratio and the flow based approach.

TMDLs are required to be set at levels necessary to meet applicable water quality standards with a margin of safety. This does not mean that a TMDL can simply rely upon a margin of safety considered in establishing the water quality standards. The commenter provided no evidence that the hardness values applied are "unnecessarily conservative." The hardness values applied are consistent with the CTR assumptions and are based on moderate hardness values for each flow tier. The commenter provides no basis for concluding that chronic standards were inappropriately applied. EPA carefully evaluated the recurrence frequencies of flows in different flow tiers in comparison with the flow recurrence frequencies assumed in the CTR. Finally, the commenter provides no analysis supporting the assertion that expressing a margin of safety as a percentage of the concentration or mass based TMDLs is scientifically invalid. This approach is commonly used in TMDL calculations.

M8. *Comment:* The metals TMDLs are based on relatively wet years, which could result in an overestimate of loading capacities.

Commentor: NRDC

Response: EPA and Regional Board staff have revised flow records pertinent to these TMDLs. Analysis of nearly 20 water year records will provide more representative conditions in San Diego Creek; consequently this will yield more realistic estimates of loading capacities.

M9: *Comment:* Metals TMDLs for San Diego Creek should be concentration based and for Newport Bay should be mass based.

Commentor: NRDC

Response: EPA has revised the final TMDLs to include concentration-based TMDLs for San Diego Creek and mass-based TMDLs for Newport Bay, as discussed in the TMDLs. Concentration based targets for Newport Bay have also been included to assure compliance with CTR standards, should the mass based allocations require verification of compliance.

M10. *Comment:* EPA does not include several potential sources in the metals allocations, including sediment porewater (for copper), "undefined natural sources", and nurseries (for copper).

Commentor: NRDC

Response: EPA has identified that dissolved copper concentrations in porewaters exceed chronic saltwater targets; however, this data was produced in 1998 and only for Lower Bay (not including Rhine Channel). Further monitoring results, preferably from Rhine Channel and maybe from Upper Bay, would be useful to assist with defining the contributions of dissolved copper from sediments. For now, "undefined natural sources" may represent porewater inputs. Allocations for nurseries were included in "ag runoff" in allocations for Newport Bay.

M11. *Comment:* The metals TMDL implicit margins of safety are insufficient to account for uncertainty and should be increased another 5-10%.

Commentor: NRDC

Response: EPA has defined the margin of safety for both San Diego Creek and Newport Bay as 20%. This value arises from dissolved to totals metals ratios determined for copper in stormwaters. It is also consistent with the copper translator value defined for saltwaters in CTR (USEPA 2000a). No additional increase in margin of safety is warranted at this time.

M12. *Comment*: The hardness assumptions for high flow conditions are not stringent enough and are inconsistent with observed hardness levels under high flows. A low range hardness, perhaps at the 10^{th} percentile for the flow tier, should be used in determining the numeric targets.

Commentor: NRDC

Response: EPA has reviewed both high flow and low flow conditions to develop an indirect relationship between flow and hardness. Given that flow conditions vary widely as well as the individual hardness values, this was the best approach. The commentor does not provide convincing rationale for selecting the 10^{th} percentile.

M13. *Comment:* We disagree that chronic targets will always be protective due to variability during a 4 day averaging period. The acute targets should also apply.

Commentor: NRDC

Response: EPA has modified the metals TMDLs to include acute and chronic concentration based targets for base, small and medium flows. During large flows, and to be consistent with the short term duration of these elevated flow rate, only acute concentration targets apply.

M14. *Comment:* It is unclear whether EPA has verified that water column targets will be protective of sediments, which is a concern because the primary problem in Newport Bay is sediment toxicity.

Commentor: NRDC

Response: EPA has considered this problem and defined both water column targets and sediment targets (Table 5-3) to define desired water quality conditions. Sediment targets are designed to protect benthic organisms and alleviate toxicity attributable to these metals.

M15. *Comment:* We would like to review any revised flows used to calculate the TMDLs. The calculations must be based on actual flow data covering a representative period.

Commentor: NRDC

Response: EPA and Regional Board staff have revised flow records pertinent to these TMDLs. Analysis of nearly 20 water year records will provide more representative conditions in San Diego Creek; consequently calculations from this revised analysis yield more realistic estimates of loading capacities.

M16. *Comment:* EPA should correct several errors in the loading capacity calculation method, which appears technically appropriate, and clarify the procedures and values used in the calculations.

Commentor: NRDC

Response: EPA has corrected the errors in Newport Bay loading capacity. See TSD Part E - Metals.

17. *Comment:* The allocations for copper show poor correspondence between San Diego Creek and Newport Bay for sources including CalTrans and nurseries. Allocations for Newport Bay should account for upstream loads and allocations from San Diego Creek, and allocations for other sources to the Bay need to be reduced accordingly.

Commentor: NRDC

Response: EPA has revised the mass-based allocations for Newport Bay to account for the considerations raised in this comment. San Diego Creek allocations are now concentration based and therefore they are not defined in mass per year. The allocations for Newport Bay are expressed as net allowable loads for each segment, not cumulative allowable loads for each source. Total allocations for individual sources can be calculated by summing individual allocations for individual water segments.

M18. *Comment:* Undefined (natural) LAs are much lower than source assessment indicates is contributed by natural sources. The natural source LAs should be increase to reflect this discrepancy, and the other allocations decreased accordingly.

Commentor: NRDC

Response: Values for undefined natural sources in Table 5-6a are consistent with contributions defined by natural sources as outlined in Table E-10 in TSD.

M19. *Comment:* The TMDLs do not adequately address seasonality and critical conditions because they do not carry through the flow tier approach to the mass-based allocations. The TMDLs and allocations should be adjusted to avoid lumping allowable loads for each flow tier into a single annual number.

Commentor: NRDC

Response: EPA has revised the allocations in San Diego Creek to be concentration based for each flow tier. Three out of four of those flow tiers have chronic targets; this amount to 362 days of the year. In Newport Bay, mass-based allocations are still defined as a single annual number. Given that sediment toxicity is the major impairment in this waterbody, a single annual number is reasonable to address the long term loading of metals which may contribute to sediment toxicity.

M20. *Comment:* We support the 20% margin of safety, but believe a larger margin of safety is warranted to reflect uncertainty about whether the water column target concentrations will be protective of sediment toxicity. Commenter disagrees that some factors characterized by EPA as providing an implicit margin of safety actually do so.

Commentor: NRDC

Response: EPA has defined a 20% margin of safety as described above. Commenter does not provide sufficient rationale to support a larger margin of safety. See also responses to Comments M11 and L16.

Organochlorine Compound TMDLs

OC1. *Comment:* EPA is proposing TMDLs for DDT, chlordane, dieldrin, toxaphene, and PCBs despite the fact that none of these compounds have been detected at all in the waters of Newport Bay and San Diego Creek. A TMDL is inappropriate because EPA has not demonstrated through monitoring data that any of the watersheds are in violations of applicable numeric standards. Also, DDT is not bioaccumulating in the watersheds to a level that is harmful to human health or the environment. Concentrations of DDT are declining. Current concentrations are not causing harm to human health or the environment. There is no indication that wildlife or humans are being harmed.

Commentors: Irvine Co.,/Latham&Watkins; City of Costa Mesa; Irvine Ranch Water District

Response: See response to comment L1 regarding use of narrative criteria and data. EPA determined that TMDLs should be prepared for these pollutants based on exceedences of tissue and/or sediment data, as set forth in EPA's *Decision Document* (2002). The *Decision Document* explains EPA's general approach to determining whether there were probable adverse effects to beneficial uses (and thus nonattainment of the narrative criteria), including EPA's consideration of impairment in adjoining water segments. The basis for developing a TMDL for each specific segment and each specific pollutant is set forth in the Assessment Summary portion of the *Decision Document.* With regard to the comment that there is no indication that wildlife or humans are being harmed, we note that the Basin Plan provides that "an adverse effect or impact on a beneficial use occurs where there is an actual or threatened loss or impairment of that beneficial use." EPA considers current data to warrant preparation of TMDLs, and does not consider it prudent to postpone TMDL analysis until a time when adverse effects on wildlife or humans may be more apparent.

OC2: *Comment:* EPA cannot rely on non-regulatory sediment or fish tissue values to establish a TMDL unless those values have been the subject of notice and comment rulemaking. EPA has proposed sediment quality criteria for dieldrin and other compounds but has not finalized them. EPA cannot promulgate a regulation establishing sediment and biota criteria through the establishment of a TMDL.
Commentor: Irvine Co./Latham&Watkins

Response: EPA is not establishing water quality criteria in this TMDL. See response to Comment L2 regarding numeric targets.

OC3: *Comment:* Studies show that legacy pesticide levels are decreasing naturally.
Commentor: Bordier's Nursery.

Response: EPA's determination that these TMDLs are warranted is based on sediment and tissue exceedences and is documented in the *Decision Document* (2002). We agree that levels of the OC pollutants appear to be decreasing over time; however, the best recent data indicate that the sediment and tissue screening levels continue to be exceeded.

OC4. *Comment:* EPA cannot establish a TMDL for any pollutant without first demonstrating that the TMDL will render the watershed in compliance with applicable water quality standards. EPA can't show this for organochlorines because of the legacy residues. There is no nexus between the loadings for DDT and the achievement of any applicable water quality standards. In light of the 37 kilograms of DDT already present in Newport Bay sediments, it is not plausible to expect to be able to even detect any change in the concentration that might be associated with an annual reduction of 0.23 kilograms entering the Bay. Achieving the proposed TMDL for DDT, and probably the other legacy pollutants, is unlikely to make any difference in Newport Bay.
Commentor: Irvine Co./Latham&Watkins

Response: See response to Comment L7. We agree that legacy pollutants present serious challenges in TMDL development and implementation, but these challenges in no way lead to the conclusion that TMDLs should not be developed. The Clean Water Act does not specify timeframes for restoration of impaired waters. We acknowledge that improvement of the situation in the Bay will be incremental and not immediate; however, reducing the input of legacy pollutants to the Bay will keep the problems from worsening, and will accelerate the pace of recovery. Moreover, given ample evidence that organochlorine pollutants can cause significant adverse effects even at very low levels, we believe it is reasonable and necessary to establish TMDLs that address the ongoing estimated loadings of these pollutants.

If the State determines, based on followup monitoring, that the pace of recovery is too slow or that the TMDLs are ineffective, they may consider tightening allocations and controls and/or investigate the feasibility of remediating contaminated sediment sources in the Bay.

OC5. *Comment:* Legacy pesticides should not be included in the TMDL because they don't have a source nor are they background. Fixing this problem should happen outside the TMDL process. There is no purpose served by setting discharge limits on discharges that no longer occur. *Commentor:* City of Costa Mesa, IRWD

Comment: TMDLs for legacy pollutants create confusion and uncertainty since there is no responsible party for control or clean up of the legacy problem. *Commentor:* California Farm Bureau Federation.

Response: TMDLs must consider all sources of a pollutant in a waterbody, including natural background and legacy pollution. We disagree that there are no ongoing discharges of these pollutants. Ongoing loadings are associated with erosion of sediments to which OC pollutants may adhered, transport of sediments already in watercourses, and (potentially) discharges from localized hot spots or spill events. TMDLs can help determine whether additional pollutant source control or remedial actions are needed. TMDLs are but one tool available to the Regional Board, other agencies, and private entities for use in dealing with these problems, and EPA supports efforts in addition to the TMDL process to solve these problems. We hope, moreover, that the calculations and analyses in these TMDLs will assist planning agencies and entities in addressing these problems in a variety of ways.

OC6. *Comment:* Agricultural soils are more friable than urban soils and therefore more subject to erosion and mobilization of DDT into the aquatic environment. Therefore, the current process of converting land from agricultural use to urban use will reduce erosion and the transport of DDT into the aquatic environment. The Irvine Basin has in place extensive controls or Best Management Practices (BMPs) to minimize erosion of land under conversion to urban development. Rather than implement a standard that would be beyond current abilities to measure and then develop implementation strategies and BMPs to achieve the unmeasurable, IRWD feels that DDT control would be more successful by improving BMPs for contaminated soils than to set an unachievable numerical standard. *Commentor:* IRWD

Comment: The levels as outlined are too low for compliance at this time. There is no available technology for use in compliance. *Commentor:* Bordier's Nursery.

Response: TMDLs are inherently quantitative, and it is necessary to set numeric loads. However, EPA acknowledges the challenges of implementing these TMDLs. All comments are being forwarded to the Regional Board for their use in developing implementation strategies for these TMDLs, and commentors are encouraged to work with the Regional Board in developing implementation measures. EPA's implementation recommendations suggest that sediment control plans currently in place may result in sufficient OC pollutant reductions and that additional controls may not even be necessary. We note, however, that no commenter provided evidence to support assertions that TMDL compliance is infeasible in this case.

OC7. *Comment:* We urge you to specifically endorse, as the first phase of implementation for the organochlorine TMDLs, full implementation of the sediment TMDL reductions, coupled with monitoring to determine whether sediment TMDL implementation is sufficient to meet the organochlorine allocations.

Commentor: Santa Ana Regional Water Quality Control Board

Response: EPA recognizes the link between sediment and OC contamination, and fully supports full implementation of the Newport Bay sediment TMDL as the first step in the implementation of the OC TMDLs.

OC8. *Comment:* Partition coefficients used in Draft TMDLs were not identified. Kow and Koc values for DDT were too low and based on out-dated information in ATSDR.

Commentor: Irvine Co/R.Tjeerdema/J. Byard/S. Paulsen

Response: EPA has reviewed the Koc values used in the organochlorine TMDL analysis and has revised the numbers to reflect more recent values published in the literature. The values used in the analysis have been included and referenced in the revised Technical Support Document.

OC9. *Comment:* BCF values are inappropriate; there is no such thing as general BCF factor. BCFs should be [biological] species specific.

Commentor: Irvine Co/R.Tjeerdema

Response: EPA has reviewed the relevant literature on available BCF values and has determined that the BCF values used in the original analysis did not appropriately reflect values expected in the indicator species. Because tissue data were available for several fish species, updated BCF values that are more representative of a family of fish, for which data are available, have been used in the analysis. The BCF values are included and referenced in the Technical Support Document.

OC10. *Comment:* Use of mean values of mussel data is potentially inaccurate especially for San Diego Creek which has old data from 1984 to 1993.

Commentor: Irvine Co/R.Tjeerdema

Response: EPA agrees that the use of mussel data that does not coincide with available sediment data should be revised with a different approach to better represent existing conditions. The analysis has been modified to take advantage of more recently collected fish tissue data that are available for San Diego Creek. The revised analysis uses the available fish tissue data along with appropriate BCF values to support the calculation of existing loadings.

OC11. *Comment:* There is confusion about the DDT sediment target...if it pertains to 4,4'-DDT or total DDT, which is sum of DDT, DDE and DDE. Per conversations with EPA staff, new freshwater sediment targets for organochlorine compounds were identified. The new target would be 6.89 ug/kg dry for total DDT.

Commentor: Irvine Co/R.Tjeerdema/J. Byard/S. Paulsen

Response: EPA agrees that the sediment criteria used in the original TMDL analysis was incorrect for total DDT. The revised analysis uses the Total DDT sediment targets of 6.98 ug/kg for San Diego Creek and 3.89 ug/kg for Newport Bay.

OC12. *Comment:* Error in Tables F-5 and F-6 regarding units for fish tissue concentrations. The units should be ppb and not ppt. The fish data for Newport Bay in part F are in error and when corrected from ppt to ppb were still below the fish level that is the basis for the national water quality criteria and below the fish target level in the TMDL. Therefore, a TMDL for DDT is not needed.
Commentor: Irvine Co/R.Tjeerdema/J. Byard/S. Paulsen

Response: EPA has confirmed that the units in the original reference were incorrect and has made the corrections to the tables. Regarding the need for DDT TMDLs, see responses to comments L1 regarding narrative criteria, OC1 regarding the OC TMDLs in general, and OC15 regarding the DDT TMDLs. As noted in the response to Comment OC15 and in EPA's 2002 *Decision Document*, we have determined that a TMDL for the Upper Bay is warranted based on both tissue and sediment exceedences, and that a TMDL for Lower Bay is warranted based on sediment exceedences. This remains true following adjustment of some methods and values applied in the final TMDL analysis.

OC13. *Comment:* Modeling approach used by EPA/Tetra Tech should recognize the <u>declining trend</u> in DDT concentrations in mussel tissue.
Commentor: Irvine Co/R.Tjeerdema/J. Byard/S. Paulsen

Response: EPA has acknowledged that available mussel data indicate a decreasing trend in DDT concentrations.

OC14. *Comment:* Model should more accurately capture DDT loading during wet and dry periods.
Commentor: Irvine Co/ S. Paulsen

Response: EPA has revised the flow regimes used to calculate DDT loading in the final TMDL.

OC15. *Comment:* Draft TMDL shows the revised DDT sediment target (6.98 ug/kg dry) is being met, therefore no TMDL is required.
Commentor: Irvine Co/ S. Paulsen

Response: EPA has determined that the sediment criteria used in the original TMDL analysis was incorrect for total DDT. The revised analysis uses the correct sediment targets of 6.98 ug/kg for San Diego Creek and 3.89 ug/kg for Newport Bay (based in part on comments from commentors), and the analysis conducted using these targets does not indicate that DDT is meeting the criteria in either San Diego Creek or Newport Bay. EPA's decision to develop DDT TMDLs is set forth in the *Decision Document* (2002). We have concluded that a TMDL is warranted for San Diego Creek based on tissue exceedences; for Lower Newport Bay based on sediment exceedences, and for Rhine Channel and Upper Newport Bay based on both tissue and sediment exceedences, as set forth in more detail in the *Decision Document.* See response to comment OC11.

OC16. *Comment:* Table 6-5 must contain typo errors. For DDT, the table states that the existing load already meets the numeric target, when the numeric values show otherwise. This table has similar inconsistencies for other constituents.
Commentor: Irvine Co/ S. Paulsen

Response: EPA appreciates the identification of the errors in Table 6-5, which are corrected in the final TMDLs.

OC17. *Comment:* The lack of accuracy, abundance of errors and absence of rationales in the TMDL modeling (for DDT) is frustrating. The technical analysis was not adequately explained, continually changed during the comment period, and it was never clear on what proposal one was commenting. Despite your efforts to facilitate our understanding, there have been too many major errors, too many changes in approach and explanation, poor technical analysis and poor technical writing. The TMDL conclusions are not based on a solid scientific foundation. This does not provide a fair and full opportunity to comment on the organochlorine TMDL. EPA is encouraged to allow a longer time for TMDL development and review. The commentor requests the opportunity to provide comments on any revised analysis.

Commentor: Irvine Co/R.Tjeerdema/J. Byard/S. Paulsen

Response: EPA appreciates the time and effort put forth to review and comment on these TMDLs. EPA has made every effort to improve the clarity of the document and has strived to ensure all pertinent details and references are included in the current version of the TMDL and technical support document. See responses to Comments L11 and L12 regarding the public review process.

We disagree with the characterization that the draft TMDL was not based on a sound scientific foundation, While some errors were identified and corrected in the final TMDLs, the basic methods used were sound. Several commentors indicated their endorsement of the technical methods used to calculate the TMDLs.

During the comment period, we attempted to address technical questions posed by commentors and participated in several meetings and telephone calls to explain our approaches. We did not change our proposal during the comment period, but several staff at EPA and our contractors were involved in these meetings and calls, which may have contributed to delivery of inconsistent oral answers to technical questions. We regret any confusion that may have occurred as a result. However, several commentors provided detailed technical comments, which EPA carefully considered in our final decisions. We believe the public was afforded a sufficient opportunity to review the decision documents and calculation methods.

OC18. *Comment:* Comment: A fundamental concern is with the modeled estimates of DDT in sediment in the future. It is incorrect to hold c-s and c-w constant, given that the mass of DDT must decline over time.

Commentor: Irvine Co.

Response: We note the comment concerning future declines in DDT concentrations, but do not believe it would affect the definition of the current DDT loading capacity, which provides the basis for the TMDL calculations.

OC19. *Comment:* Given that the draft TMDL shows that the sediment target of 6.98 ug/kg is likely being met, even considering the flaws in the modeling approach which overestimate future concentrations, it is unclear that a TMDL is required for DDT.

Commentor: Irvine Co.

Response: See response to comment OC15.

OC20: *Comment:* There is a related liability question of what would happen if the load allocations are being met and yet the target sediment and/or biota concentrations remain above levels deemed appropriate by EPA.

Commentor: Irvine Co.

Response: As discussed in the final TMDL summary document, load allocations are not self-implementing and do not create any direct liability for allocation holders. See response to comment OC4.

OC21: *Comment:* I was quickly struck by what seemed to be unusually low sediment targets for DDT and other organochlorines.

Commentor: Irvine Co.

Response: See response to comment OC15.

OC22: *Comment:* The commentor reports much confusion regarding the use of a MacDonald South Florida reference. The commentor points out several problems with using the South Florida reference: 1) a recent workshop concluded the approach is not adequate, alone, for setting regulatory targets, 2) MacDonald uses different sediment targets for sum DDT versus the TMDL report refers to DDT (the parent compound.) 3) MacDonald southern California approach of using bioassay data could be used and result in effects levels higher than the Canadian approach; 4) The log K-oc used by MacDonald could result in a sediment TMDL of 53 ppb, this can be compared to the highest level of DDT reported in sediment of 15 ppb (Masters and Inman.)

Commentor: Irvine Co.

Response: See responses to comments OC1, 12, and 15.

OC23: *Comment:* Fish data from the Creek is higher than the Bay, however the creek is a small and infrequent source of dietary fish.

Commentor: Irvine Co.

Response: The commenter provides no evidence to support this assertion. In any event, fish consumption is a protected beneficial use of San Diego Creek, and it would not be reasonable to ignore evidence of OC pollutant bioaccumulation in San Diego Creek fish.

OC24: *Comment*: The 1.9 ppb for total DDT used is actually the TEL for DDT alone. "The real total TEL for marine systems is 3.89 ppb." The commentor also states that a freshwater total DDT value of 6.98 ppb was discussed.

Commentor: Irvine Co.

Response: See response to comment OC15.

OC25: *Comment:* The commentor states that using different sediment target values would result in target water concentration values (now 6 pptr and 3 pptr) and indicate that a TMDL is not necessary.

Commentor: Irvine Co.

Response: See response to comments OC12 and 15.

OC26: *Comment:* Arguing against the need to develop a total DDT TMDL, the commentor refers to graphs in Figure F-4. "For San Diego Creek, raising the sediment standard to 3.89 - 6.98 ppb would

indicate that current projected total DDT concentrations are currently below it.
Commentor: Irvine Co.

Response: See response to comment OC 15.

OC27: *Comment:* The commentor states that using a regression approach with the mussel watch data " would have better estimated current total DDT loads as well as what they would likely be at the time of predicted TMDL implementation. This would have further supported the contention the total DDT in sediments and water is currently below concentrations requiring the development of a TMDL."
Commentor: Irvine Co.

Response: EPA is not required to extrapolate the data as suggested by the commenter. Instead, we relied upon actual data results, based on relatively extensive monitoring, to identify the need to complete TMDLs for DDT. We did not detect statistically significant trends indicating that total DDT levels are currently below the screening levels.

OC28: *Comment:* Information regarding DDT in agricultural and nursery effluents in outdated and reflective of singular events, not long-term monitoring... total DDT are described as relatively high when they are clearly in the low ppb range.
Commentor: Irvine Co.

Response: EPA used all available data in the analysis. We have clarified our characterization of local DDT levels in the text to reflect the comment; however, we note that DDT levels in the low ppb range may contribute to adverse ecological effects over time.

OC30: *Comment:* The assumption that DDT (in dicofol) is present at 0.015% is clearly unsupported speculation.
Commentor: Irvine Co.

Response: The text was modified to clarify the basis for the concern about potential DDT content in dicofol. The registered formulation of dicofol indicates that DDT may be present in the formulation as an impurity.

OC 31: *Comment:* The commentor disagrees that atmospheric deposition or trace impurities of DDT in other registered pesticides are likely. The draft TMDL provides no local information in support of these sources.
Commentor: Irvine Co.

Response: The text was modified to reflect this comment.
OC32: *Comment:* The commentor provides a citation for DDT in sediment in Upper Newport Bay which shows that concentrations of chlorinated hydrocarbons are declining to near detection limits.
Commentor: Irvine Co.

Response: See response to comment OC15.

OC33: *Comment:* Information on pesticide... clean-up sites is presented for the period 1988-94, but the ... pesticide involved is absent. It is unlikely that DDT or related chlorinated organics were involved, as their

use was discontinued prior to 1988.
Commentor: Irvine Co.

Response: The comment is noted. Although DDT and most other OC pollutants addressed in these TMDLs were banned prior to 1988, this does not mean that their use from existing pesticide stocks or discharge from spills could not have occurred during the 1988-94 period. EPA was attempting to present all potentially useful information about potential OC pollutant sources in the analysis.

OC34: *Comment:* Sediment data for total DDT and 2 PCB arochlors are reported... the report describes the MDL as "relatively high" without either the specific analyte or actual value.
Commentor: Irvine Co.

Response: The comment is noted. Text in the final TMDLs was edited to clarify our analysis.

OC 35: *Comment:* The commentor states that the method for specifying water column concentrations (based on available monitoring data and best professional judgment) is not explained sufficiently to provide an assessment of the accuracy of the approach.
Commentor: Irvine Co.

Response: The text was clarified to address this comment.

OC36: *Comment:* Targets selected are not fully protective of designated uses. Targets should be revised as per Limmo-Tech (NRDC/Defend the Bay consultant) comments.
Commentor: NRDC

Response: EPA considers the targets to be protective, based on the analysis presented in the TMDL. Specific technical comments are responded to below.

OC37: *Comment:* There should be a margin of safety of 20%. There is a lack of detail in the source analysis, and where there is a lack of data to support the source analysis there should be a larger explicit margin of safety. Additionally, the TMDL should recognize the cumulative degree of uncertainty in the estimation of numerous parameters of the model, which is another reason for a larger margin of safety.
Commentor: NRDC

Response: Regarding the source analysis, EPA has developed the TMDL using the available source characterization data to support the analysis. Although the data to quantify existing sources is limited, we believe that the TMDLs provide the means to identify allowable loadings for the water bodies of concern. Further data gathering during the implementation of the TMDL will help to target restoration efforts.

EPA does not believe that any increase in the MOS is warranted at this time. EPA recognizes the range of values available for several of the key variables used in the analysis including Koc, partition coefficients, and estimates of sediment concentrations. EPA believes that 10% represents a reasonable margin of safety for the TMDLs in combination with the implicit margin of safety provided by the conservative analytical assumptions used in EPA's calculation approach. Since the reduction of the loading of OC compounds will rely largely on natural attenuation, and current trends identify a decline in loading over time, a larger margin of safety is currently not supported. Should future monitoring and implementation suggest that the allocation is not sufficiently protective, the State may consider appropriate revisions.

OC38: *Comment:* Flow analysis used by EPA is based on relative wet (higher flow) years. This may not represent actual conditions and result in an overestimation of loading capacity.
Commentor: NRDC

Response: The final TMDLs were modified based on a longer, more representative flow record.

OC39: *Comment:* The commenter recommends additional detail and specific allocations to potential sources in the allocations.
Commentor: NRDC

Response: EPA believes the current level of allocations is consistent with the available information for the pollutants evaluated in these TMDLs. Additional source specific information can be addressed in the implementation phase of the TMDL.

OC40: *Comment:* The use of flow tiers is proposed by EPA to address seasonality and critical conditions. However, the use of flow tiers will be adequate only if those tiers carry through to the wasteload and load allocations.
Commentor: NRDC

Response: The environmental mechanisms through which OC pollutants cause ecological hard operate over relatively long timeframes; therefore, EPA concluded that it was unnecessary to develop the TMDLs based on short term pollutant loading and control timeframes. We found no evidence of seasonal variability in loading capacities that would warrant setting TMDLs based on shorter timeframes.

OC41: *Comment:* The numeric targets presented in Table 6-1 should be normalized to organic carbon rather than being solids-based. Organic carbon content varies significantly within and across media. Since these compounds will preferentially adsorb to organic carbon, these targets will be more meaningful if they are based on that fraction within each media (sediments and tissue). This may change the media that is most restrictive. The loading capacity calculations should be repeated to reflect these changes in the selected endpoints.
Commentor: Limno Tech/NRDC/Defend the Bay

Response: The comment provides an insufficient rationale to warrant changes in the TMDL.

OC42: *Comment:* We suggest that if alternative sediment target values are considered for any compounds (e.g. Swartz et al., *Environ. Toxicol. Chem.* 13:949-962 for DDT), they be compared to the numeric targets proposed in the Draft TMDL and the lower of the two values be used to be most protective. Both values need to be based on the same media in order to be compared. We concur with EPA's approach for developing numeric targets. Given the high historical loadings, the toxicity associated with these compounds, and their tendency to accumulate in sediment and tissue, setting sediment and tissue targets will be more protective than water column numeric targets.
Commentor: Limno Tech/NRDC/Defend the Bay

Response: EPA verified that sediment and water column targets are the most protective available indicators.

OC43: *Comment:* The Source Analysis introduction in the TMDL is poorly worded when it suggests that DDT and PCB are the only chemicals still being discharged in the watershed. This wording should be changed or supplemented with text explaining that the basis for this statement is that these are the only compounds in this TMDL that are still detected at quantifiable levels in soil samples collected in the watershed.

Commentor: Limno Tech/NRDC/Defend the Bay

Response: EPA has revised to wording in the final TMDL report to clarify that other sources might be present but data are available to support the presence of DDT and PCBs.

OC44: *Comment:* Adding flow charts or decision trees explaining the process used for the analysis of San Diego Creek and Upper Newport Bay loadings and allocations would be very helpful in understanding the analyses.

Commentor: Limno Tech/NRDC/Defend the Bay

Response: The revised TMDL includes additional flowcharts describing the analyses performed for San Diego Creek and Newport Bay.

OC45: *Comment:* Neither the TMDL nor the TSD explains why the odd choice of flow tiers used in the San Diego Creek analysis can represent annual loads in the creek. The four tier approach used in the Metals TMDL provides a better characterization of annual flow conditions in the Creek and should be used in this TMDL for calculating the existing load and the loading capacity.

Commentor: Limno Tech/NRDC/Defend the Bay

Response: The flow tiers used in the final TMDLs were modified based on a longer, more representative flow record.

OC46: *Comment:* The Total Suspended Solids (TSS) concentrations associated with each flow tier presented in Tables F-7 and F-8 for San Diego Creek seem to be at least an order of magnitude higher than what one might reasonably expect. Are there any characteristics in the watershed that would lead one to expect such high concentrations? Use of these concentrations allows a finite amount pollutant mass to be "spread" over a larger mass of solids, essentially diluting the chemical concentration when measured on a solids basis. The net result is an increase, likely an overestimate, of the loading capacity of San Diego Creek. No information is provided in the TMDL or TSD regarding the source and analyses that were performed to determine these TSS concentrations. No information is provided on the source and analyses that were performed on the TSS concentrations. Analysis of the tiered TSS data should be performed to select an appropriate concentration for each tier used in the loading analysis. Details should be included in the TSD.

Commentor: Limno Tech/NRDC/Defend the Bay

Response: Additional information is provided in the TSD to describe the TSS analysis and sources of supporting information. The TSS concentration is derived based on a regression of RMA data for the flow tiers.

OC47: The fraction of organic carbon in the sediments is typically much different that the fraction of organic carbon in the solids entering the water column. The EPA approach appears to assume that they are

the same. The analysis should be refined to account for differences in organic carbon content between the in-stream sediments and solids in the water column.
Commentor: Limno Tech/NRDC/Defend the Bay

Response: Insufficient monitoring information and literature values are available to distinguish from in-stream and water column solids for this analysis.

OC48: *Comment:* The amount of DDT in dicofol can be a significant source to Newport Bay. The relative use of dicofol by land use should be factored into the allocations of load and wasteload categories. Control of the use of dicofol should be addressed in the implementation plan.
Commentor: Limno Tech/NRDC/Defend the Bay

Response: Dicofol as a source of DDT is cited in the source analysis of the TSD and in the TMDL document. The source allocation includes sources with potential for dicofol application.
Implementation measures for this TMDL will be developed by the Regional Board. Many of the comments submitted on these TMDLs raise implementation issues and will be forwarded to the Regional Board for its use in developing implementation measures.

OC49: *Comment:* To clarify the TMDL the following items should be added. 1. Description of total suspended solids, fraction organic carbon for each media (water, sediment and tissue) and lipid content data sources. 2. The BCFs and partition coefficients (and their units) used to compute water column concentrations in Tables F-7, F-8, F-10, F-11 and F-17. 3. Equations, assumptions and input data used to compute values presented in Tables F-7, F-8, F-10, F-11, and F-17. 4. Units for the partition coefficient column presented in Table F-8.
Commentor: Limno Tech/NRDC/Defend the Bay.

Response: Revisions have been made to the TSD to include flowcharts, more detailed descriptions of approach, and updated tables and references of supporting materials.

OC50: *Comment:* The commenter requests confirmation of the use of net sedimentation rates in the analysis. They recommend that the analysis be redone using burial rates.
Commentor: Limno Tech/NRDC/Defend the Bay

Response: The final TMDL TSD clarifies the sediment model approach.

OC51. *Comment:* Page 17 of TMDL provides summary of allocation strategy. More detail is requested.
Commentor: Limno Tech/NRDC/Defend the Bay

Response: EPA believes that the current level of allocation is consistent with the available information for development of this TMDL. The basis for the allocations is described in greater detail in the final TMDLs.

OC52: *Comment:* EPA should adjust scenario of allocation to make sure that sources outside San Diego Creek cannot increase from current load levels.
Commentor: Limno Tech/NRDC/Defend the Bay

Response: The allocation and TMDL loading capacities are designed to ensure protection of water quality standards. The TMDL allocation process selects existing loading if less than loading capacity to ensure that no additional discharges are allowed for the OC compounds. The final allocation was checked for San Diego Creek and Newport Bay to ensure that they are separately and collectively protective for all the water bodies of concern.

OC53: *Comment:* Clarify steps in section 6 of the TSD. Clarify which steps were applied to Newport Bay.

Commentor: Limno Tech/NRDC/Defend the Bay

Response: The revised TSD provides clarification of the approach taken for San Diego Creek and Newport Bay. The analysis and decision process have been further described using flowcharts.

OC54: *Comment:* Change equation 5 to equation 6 in Section 6 of the TSD.

Commentor: Limno Tech/NRDC/Defend the Bay

Response: The revised TSD correctly references the equations used and associated steps.

OC55. *Comment:* How was the RMA model used for San Diego Creek?

Commentor: Limno Tech/NRDC/Defend the Bay

Response: RMA modeling data was only used to derive suspended sediment concentrations for the flow tiers used in the San Diego Creek TMDL.

OC56: *Comment:* The "undefined" category of the Load Allocation in vague. The reviewer request that text be added to the TMDL describing the sources covered under "undefined".

Commentor: Limno Tech/NRDC/Defend the Bay

Response: EPA believes that the current source allocation is consistent with the available information for development of the TMDL. This category is intended to include sediment resuspension, atmospheric deposition, localized hot spots that have not been identified, and other uncharacterized sources. Further specific source information can be provided as part of the implementation process.

OC57: *Comment:* Presuming the "undefined" includes sediments and atmospheric deposition, the reviewer recommends that the undefined category remain unchanged and remaining sources be reduced sufficient to meet a 30% MOS.

Commentor: Limno Tech/NRDC/Defend the Bay

Response: For reasons discussed in previous comments, EPA does not consider a larger margin of safety to be warranted.

Chromium and Mercury TMDLs

CM1. *Comment:* According to the Regional Board (Problem Statement 2000), the data show that concentrations of chromium do not exceed CTR water quality objectives, and thus this chemical is "probably not causing, or contributing to, toxicity to aquatic life in Newport Bay and San Diego Creek."

Commentor: Latham&Watkins

Response: EPA determined that a chromium TMDL was warranted for the Rhine Channel based on shellfish tissue exceedences, as set forth in EPA's *Decision Document* (2002). The draft Problem Statement prepared by Regional Board staff recommended Cr TMDL in Rhine based on shellfish tissue exceedences.

CM2. *Comment:* The rationale for using the two tier flow system for chromium and mercury is not adequately explained.

Commenter: County of Orange

Response: EPA used a two tier flow system for chromium and mercury to define inputs of metal laden sediment from San Diego Creek. Two tiers represent dry and wet weather inputs as described in the TSD.

CM3. *Comment:* Explain why the chromium and mercury TMDLs are based on 15 years of runoff data when the report previously states that conditions have changed significantly during this time period.

Commenter: County of Orange

Response: EPA has explained in TSD Part B that flow conditions for San Diego Creek have changed over the past 15 years due to significant changes in land use (urbanization and loss of agricultural lands). The final TMDL is based on nearly 20 years of daily flow records for San Diego Creek to provide a more representative data set for these TMDLs. This decision recognizes the changes in land use as well as widely varying annual precipitation.

CM4. *Comment:* Mercury contamination may be a naturally occurring artifact rather than occurring from human causes based on the fact that mercury was mined in the Red Hill area. Mercury contamination in Rhine Channel could be from use of mercury-containing boat paints which are no longer used. Because this mercury pollution was episodic and is unlikely to reoccur, a mercury TMDL is not warranted.

Commenter: IRWD

Response: When developing TMDLs, EPA needs to consider all sources of the pollutant-- natural historical, as well as anthropogenic. As noted in the final TMDL, we considered the Red Hill site but do not believe it is likely to be a significant historical source of mercury loads to Rhine Channel. See response to comment OC4.

CM5. *Comment*: The use of modeling approaches for the mercury and chromium TMDLs introduces substantial uncertainty into the TMDL results, necessitating a higher margin of safety than provided in the draft TMDLs.

Commenter: NRDC

Response: EPA does not find sufficient rationale in the comment to increase the margin of safety. On-going studies, conducted under review by EPA and Regional Board staff, will supply more relevant data to provide better interpretation of current conditions of these and many other toxic pollutants in the Rhine.

CM6. *Comment:* EPA should translate sediment and tissue target concentrations to values that can be directly compared, and use the most stringent of the resulting targets.

Commentor: NRDC

Response: EPA acknowledges the value of comment although this "translation" is much like comparing apples to oranges. EPA believes the sediment target will also be protective of bioaccumulation of mercury and minimize build up of chromium in shellfish tissue.

CM7. *Comment:* Estimated loads from San Diego Creek are inconsistent between the Summary Document and TSD.
Commentor: NRDC

Response: EPA has rectified this inconsistency.

CM8. *Comment:* The fact that chromium levels in tissue are elevated but less so in sediment indicates there are likely sources besides existing sediment.
Commentor: NRDC

Response: EPA and Regional Board have included information pertaining to Newport Plating facility in vicinity of Rhine Channel. Two investigations of this facility in 1986 showed extremely high values of chromium and other metals in soil boring samples and groundwater. Regional Board have no indication that remediation has occurred at this facility (not operating for nearly 20 years). See TSD Part G.

CM9. *Comment:* Atmospheric deposition and mining operations have not been adequately considered as potential sources.
Commentor: NRDC

Response: EPA recognizes that atmospheric deposition could be contributing mercury to Rhine Channel although this waterbody has an extremely small surface area as to suggest negligible inputs. Any assessment to address inputs from mining operations would require further monitoring data from upstream non-point sources.

CM10. *Comment:* Partitioning coefficients are acknowledged as not well documented, and it is unclear which partition coefficients were selected for TMDL calculation. EPA must use the most conservative available value.
Commentor: NRDC

Response: EPA has provided more information in the TSD for mercury and chromium to define partitioning coefficient and other values used.

CM11. *Comment:* Additional information must be provided describing the BCFs, partition coefficients, and other methods used to estimate loads and calculate loading capacities.
Commentor: NRDC

Response: EPA has provided more information in the TSD for mercury and chromium to define partitioning coefficient and other values used.

CM12. *Comment:* There is insufficient description of how the loading capacities for Rhine Channel were determined.

Commentor: NRDC

Response: EPA has included additional information to describe determination of allocations in the final TMDL.

CM13. *Comment:* There are many potential sources of chromium (e.g. atmospheric deposition and mining) discussed but not specifically allocated in the TMDL. These sources should be properly assessed and allocations identified. Failure to allocate to these sources may result in other allocations being too high.

Commentor: NRDC

Response: EPA believes the sources of chromium are best defined by the categories outlined in the TMDL. Atmospheric deposition and mining would be included in the category of "other sources".

Arsenic

A1. *Comment:* There should be a TMDL for arsenic because EPA agreed to do so under the consent decree.

Commentor: NRDC

Response: The pollutants identified in the 1997 consent decree were EPA's best understanding of the probable pollutants for which TMDLs needed to be developed. However, the consent decree specifically noted that the list of pollutants was subject to change by the State, and that EPA could also determine that TMDLs were not needed. EPA has concluded that the most recent information does not justify establishing a TMDL for arsenic, as summarized in EPA's 2002 *Decision Document* and in the Arsenic Analysis in the TMDL summary document.

A2. *Comment:* The new EPA screening value is not protective enough because it does not consider carcinogenic effects.

Commentor: NRDC/LTI

Response: EPA utilized the most reliable screening factor available for inorganic arsenic. Due to EPA's concerns about the scientific validity of previously proposed screening values for assessment of potential carcinogenic effects, EPA believes it is inappropriate to apply it for TMDL screening purposes. The commentors provided no evidence to persuade EPA to reconsider this decision.

A3. *Comment:* EPA should account for weaknesses in its selected screening value by increasing the assumed fish consumption rate and redoing its risk analysis based on a higher fish consumption rate.

Commentor: NRDC/LTI

Response: The commentor provided no evidence of higher than average fish consumption rates by a significant portion of anglers in the Newport Bay area; therefore, EPA has no basis for reanalyzing arsenic-related risk based on a higher fish consumption value. EPA believes that absent evidence to the contrary, it is reasonable to apply national fish consumption rates recommended for criteria development in applying toxic pollutant screening values.

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