4-433

faxed Friday 6/11/04

(109)

TETRA TECH, INC.
1230 Columbia St., Suite 520
San Diego, CA 92101
Phone: 619-525-7014
Fax: 619-232-2392

3 total pages

FAX 916-341-5550

To: Melenee Emanuel

From: Amy King
Tel: 619-525-7017

MISC. Corresp
- previously faxed letters
- Letter from LADPW (we already talked about this)

Hi Melenee,

Here are letters from 2 dischargers in the LA Region indicating that their data are available via the Regional Board. I just want to make sure you all are aware of any loose ends, even if we do not pursue the data any further. I'll be in touch next week!

Have a great weekend!
-Amy

California Environmental
geologists & engineers

March 4, 2004

CE Job No. EP1000-2187

Amy King
Tetra Tech Inc.
420 West Broadway, Suite 400
San Diego, California 92101

Subject: Request for Electronic Data Submission

Dear Ms. King:

Attached, please find correspondence directed to our client, Mr. Mike Walline of SunCal Companies, relative to submittal of laboratory test data conducted as part of NPDES water quality monitoring. Electronically formatted data has already been sent to the Regional Water Quality Control Board (RWQCB). Ms. Cassandra Owens of the RWQCB-LA Region, has received all the electronic data for this project. The project is identified as Mandalay Bay Construction Dewatering, Wooley Road and East of the Reliance Energy Canal, Oxnard, California, NPDES CAG994001, Compliance File CI-8282. You may contact Ms. Cassandra Owens at the RWQCB at (213) 576-6750 or e-mail cowens@rb4.swrcb.ca.gov. Ms. Owens should have a completely compiled data set for our project.

Should you have any questions, please call me directly.

Respectfully submitted,

Charles I. Buckley
Certified Hydrogeologist No. 55
Registered Environmental Assessor II No. 20116

REGISTERED GEOLOGIST
CHARLES L. BUCKLEY
No. 55
CERTIFIED HYDROGEOLOGIST

Cc: Mr. Mike Walline, SunCal Companies; Mr. Jonathan Bishop, Chief, Regional Programs, LARWQCB

2187TT.LTR

1161 Calle Suerte, Suite G · Camarillo, CA 93012 · (805) 445-7117 · FAX (805) 445-8599 · Lic. #A732377

The Boeing Company
Rocketdyne Propulsion & Power
6633 Canoga Avenue
P.O. Box 7922
Canoga Park, CA 91309-7922

March 11, 2004
In reply refer to 2004RC0810

Regional Water Quality Control Board
Los Angeles Region
320 West 4th Street, Suite 200
Los Angeles, CA 90013

BOEING

Attention: Jonathan Bishop, Chief
Region Programs

Reference: Compliance File CI-6027 and NPDES No. CA0001309

Subject: Data Request

Gentlemen:

This letter is in response to your letter dated February 24, 2004 requesting that all readily available electronic data for surface water monitoring be submitted to EPA's contractor, Tetra Tech. Boeing is currently in the process of renewing the above referenced NPDES permit for the Santa Susana Field Laboratory. As such, Boeing has already submitted to your agency an extensive electronic data set of surface water data for our facility. We would request that your contractor use this data in support of their evaluation process as it is already in your database format. Ms. Cassandra Owens is the permitting engineer and is most familiar with the information already supplied.

If this data is not sufficient for your purposes, or you have questions regarding this transmittal, please do not hesitate to contact Mr. Bill McIlvaine at (818) 586-9228 for further assistance.

Sincerely,

Paul Costa, Manager
Environmental Protection

WM:dr

cc: Renee DeShazo- RWQCB
Amy King, Tetra Tech Inc. 402 W. Broadway, Suite 200 San Diego, CA 92101

SHEA-099422

713RC

COUNTY OF LOS ANGELES

DEPARTMENT OF PUBLIC WORKS

"Enriching Lives"

JAMES A. NOYES, Director

900 SOUTH FREMONT AVENUE
ALHAMBRA, CALIFORNIA 91803-1331
Telephone: (626) 458-5100
www.ladpw.org

ADDRESS ALL CORRESPONDENCE TO:
P.O. BOX 1460
ALHAMBRA, CALIFORNIA 91802-1460

March 4, 2004

IN REPLY PLEASE REFER TO FILE: WM-9
B-464

Mr. Jonathan Bishop, Chief
Regional Programs
Los Angeles Region
California Water Quality Control Board
320 West 4th Street, Suite 200
Los Angeles, CA 90013

Dear Mr. Bishop:

REQUEST TO SUBMIT MONITORING DATA TO ENVIRONMENTAL PROTECTION AGENCY CONTRACTOR, TETRA TECH, IN PREPARATION FOR CONDUCTING 2004 WATER QUALITY ASSESSMENT AND UPDATING CWA SECTION 303(d) LIST

As requested in your February 23, 2004, letter, Public Works will provide Tetra Tech, Environmental Protection Agency's contractor, with readily available electronic data for surface water monitoring and field data for the period July 1, 1997 through December 31, 2003. Public Works sent an e-mail to Ms. Amy King of Tetra Tech on February 26, 2004, providing instructions for downloading spreadsheets from our website that contain summary surface water monitoring data for the aforementioned time period. Public Works will also provide a copy of our Quality Assurance/Quality Control Plan to Ms. King along with any metadata associated with our surface water monitoring data.

If you have any questions regarding this matter, please call Mr. Fred Gonzalez at (626) 458-5948.

Very truly yours,

JAMES A. NOYES
Director of Public Works

FOR ROD H. KUBOMOTO
Assistant Deputy Director
Watershed Management Division

FG:sw
P:\wmpub\NPDES\Unit1\Gonzalez\B-464.doc

cc: Tetra Tech (Amy King)

Melenee has been in contact w/ Fred 6/4/04

pending

traded voicemails with Fred Gonzalez

4-435

Total Maximum Daily Loads for Contaminated Sediments for Ballona Creek and Ballona Creek Estuary

Prepared by

U.S. Environmental Protection Agency

Region 9

And

California Regional Water Quality Control Board

Los Angeles Region

Draft: January 5, 2005

LIST OF FIGURES

LIST OF ACRONYMS

µg/g	Micrograms per Gram
µg/kg	Micrograms per Kilogram
µg/L	Micrograms per Liter
ATSDR	Agency for Toxic Substances and Disease Registry
BAT	Best Available Technology
BCT	Best Conventional Pollutant Control Technology
BMPs	Best Management Practices
BPTCP	Bay Protection and Toxic Cleanup Program
Caltrans	California Department of Transportation
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
cfs	Cubic Feet per Second
COMM	Commercial and Sport Fishing
CSTF	Contaminated Sediments Task Force
CTR	California Toxics Rule
CWA	Clean Water Act
DL	Detection Limit
EMCs	Event Mean Concentrations
ERL	Effects Range-Low
ERM	Effects Range-Median
EST	Estuarine Habitat
FHWA	Federal Highway Administration
FR	Federal Register
HSPF	Hydrological Simulation Program FORTRAN
IPWP	Integrated Plan for the Wastewater Program
IRP	Integrated Resources Plan
kg	Kilograms
LACDPW	Los Angeles County Department of Public Works
LARWQCB	Los Angeles Regional Water Quality Control Board
M&N	Moffatt and Nichol Engineers
m^3	Cubic Meters
m^3/yr	Cubic Meters per Year
MAR	Marine Habitat
MCLs	Maximum Contaminant Levels
MdRH	Marina del Rey Harbor
MGD	Million Gallons per Day
mg/kg	Milligrams per Kilogram
MIGR	Migration of Aquatic Organisms
MS4	Municipal Separate Storm Sewer System
MTRL	Maximum Tissue Residue Level
MUN	Municipal and Domestic Water Supply
NAV	Navigation
ND	Non Detect

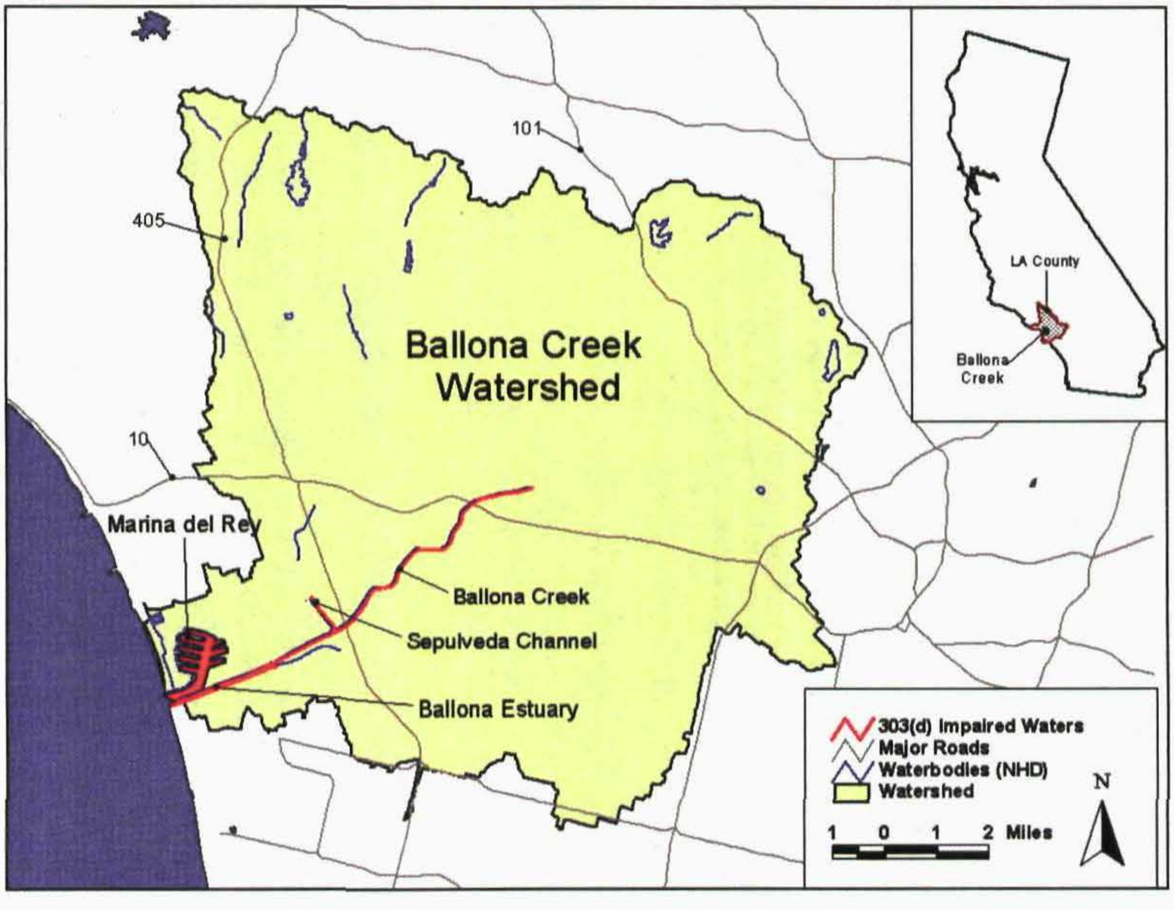
ng/L	Nanograms per Liter
NHD	National Hydrography Data Set
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPTN	National Pesticide Telecommunications Network
O&M	Operation and Maintenance
OEHHA	Office of Environmental Heath Hazard Assessment
PAHs	Polynuclear Aromatic Hydrocarbons
PCBs	Polychlorinated biphenyls
PEL	Probable Effects Level
pg/L	Picograms per Liter
ppb	Parts per Billion
ppt	Parts per Thousand
RARE	Rare, Threatened, or Endangered Species
REC1	Water Contact Recreation
REC2	Non-Contact Water Recreation
SCCWRP	Southern California Coastal Water Research Project
SHELL	Shellfish Harvesting
SMBRP	Santa Monica Bay Restoration Project
SPWN	Spawning, Reproduction, and/or Early Development
SQGs	Sediment Quality Guidelines
SQOs	Sediment Quality Objectives
SWPPP	Storm Water Pollution Prevention Plan
TEL	Threshold Effects Level
TMDL	Total Maximum Daily Load
TSMP	Toxic Substances Monitoring Program
US	United States
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds
WARM	Warm Freshwater Habitat
WDRs	Waste Discharge Requirements
WILD	Wildlife Habitat
WLAs	Waste Load Allocations
WQA	Water Quality Assessment
WQOs	Water Quality Objectives

1. INTRODUCTION

This report presents the required elements of the Total Maximum Daily Load (TMDL) for toxic pollutants in the sediments of Ballona Creek Estuary and summarizes the technical analyses performed by the United States Environmental Protection Agency, Region 9 (USEPA) and the California Regional Water Quality Control Board, Los Angeles Region (Regional Board or LARWQCB) to develop this TMDL.

Segments of Ballona Creek and Estuary are listed for a variety of toxic pollutants, including *metals, historic pesticides, and legacy organics, the analytical group of organic pesticides* referred to collectively as "ChemA", and sediment toxicity (Table 1-1). These segments (reaches) of Ballona Creek and Estuary were included on the 1996, 1998 and 2002 California 303(d) list of impaired waterbodies (LARWQCB, 1996, 1998, 2002). The Clean Water Act (CWA) requires a TMDL be developed to restore the impaired waterbodies to their full beneficial uses.

Figure 1. Impaired waterbodies in the Ballona Creek watershed



This TMDL complies with 40 CFR 130.2 and 130.7, Section 303(d) of the CWA and USEPA guidance for developing TMDLs in California (USEPA, 2000a). This document summarizes the information used by the USEPA and the Regional Board to develop TMDLs for toxic pollutants to the sediments of Ballona Creek Estuary.

1.1. REGULATORY BACKGROUND

Section 303(d) of the 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 objective applicable to such waters." The CWA also requires states to establish a priority ranking for waters on the 303(d) list of impaired waters and establish TMDLs for such waters.

The elements of a TMDL are described in 40 CFR 130.2 and 130.7 and Section 303(d) of the CWA, as well as in the USEPA guidance (USEPA, 2000a). 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 waterbody to assimilate pollutant loads (the loading capacity) is not exceeded. A TMDL is also required to account for seasonal variations and include a margin of safety to address uncertainty in the analysis (40 CFR 130.7).

As part of its 1996 and 1998 regional water quality assessments (WQAs), the Regional Board identified over 700 waterbody-pollutant combinations in the Los Angeles Region where TMDLs would be required (LARWQCB, 1996, 1998). These are referred to as "listed" or "303(d) listed" waterbodies or waterbody segments. A 13-year schedule for development of TMDLs in the Los Angeles Region was established in a consent decree approved on March 22, 1999 (Heal the Bay Inc., et al. v. Browner, et al. C 98-4825 SBA).

For the purpose of scheduling TMDL development, the consent decree combined the more than 700 waterbody-pollutant combinations into 92 TMDL analytical units. This TMDL addresses the impairments in Ballona Creek and Estuary associated with Analytical Unit 55 for organic pollutants (ChemA, chlordane, dieldrin, DDT, PCBs, PAHs, and sediment toxicity), and Analytical Unit 57 for metals (cadmium, lead, silver, and zinc) in sediments. The consent decree also prescribed schedules for certain TMDLs, and according to this schedule, a TMDL for Analytical Units 55 and 57 was to be adopted by the Regional Board by March 22, 2004. Under the terms of the consent decree, USEPA must either approve a state TMDL or establish its own, by March 22, 2005.

Table 1-1. Pollutants listed in the Consent Decree for Ballona Creek and Estuary

Pollutants in AU 55	**Ballona Creek**	**Ballona Creek Estuary**
PCBs	X	X
DDTs	X	X
Chem A	X	
Chlordane	X	X
Dieldrin	X	
Sediment Toxicity	X	
PAHs		X
Pollutants in AU 57	**Ballona Creek**	**Ballona Creek Estuary**

Arsenic	X	
Cadmium	X	
Copper	X	
Lead	X	X
Silver	X	
Zinc		X
Toxicity	X	

Paragraph 8 of the consent decree provides that TMDLs need not be completed for specific waterbody by pollutant combinations if the State or EPA determines that TMDLs are not needed for these combinations, consistent with the requirements of Section 303(d). The consent decree provides that this determination may be made either through a formal decision to remove a combination from the State Section 303(d) list or through a separate determination that the specific TMDLs are not needed. Pursuant to these provisions, EPA and the State have determined that the data used to list Ballona Creek for organic contaminants were from Ballona Creek Estuary. There is no data to suggest that Ballona Creek should be listed for the organic contaminants identified under Analytical Unit #55. We find that the Ballona Creek listings for organic were made in error and should be applied to the estuary. Furthermore, we find that the fish and shellfish tissue data used in by the Regional Board in 1996 and 1998 listing cycles is insufficient by itself for listing purposes under current listing procedures. Therefore we find that a TMDL is not required for dieldrin was found solely in fish tissue. Finally we find that the listing for Chem A (an analytical suite of pesticides) is redundant, since chlordane and dieldrin were the only Chem A pesticides detected in the data used by the Regional Board in the 1996 and 1998 listing cycles. The bases for these findings are discussed in Section 2 of this document. This constitutes the notice pursuant to paragraph 9 of the consent decree.

This TMDL addresses impairment of beneficial uses due to the concentration of toxic pollutants in sediments. The sediment toxicity listing will be addressed by the WLAs and LAs for the listed toxic pollutants. This TMDL was developed concurrently with the Ballona Creek Metals TMDL, which addresses impairments related to exceedances of water quality objectives for toxic metals in the water column. The TMDLs for nearby Marina del Rey Harbor required under Analytical Unit # 54 and 56 are not addressed in this document.

1.2. ENVIRONMENTAL SETTING

Ballona Creek flows as an open channel for just under 10 miles from Los Angeles (South of Hancock Park) through Culver City, reaching the Pacific Ocean at Playa del Rey. North of Hancock Park, the channel continues in a network of underground storm drains. Ballona Creek and its tributaries drain a watershed with an area of approximately 128 square miles. Approximately 60% of the land use can be categorized as residential, 17% as recreation/open space, 16% as commercial, 5% as industrial, and 2% as other. The Ballona Creek watershed is comprised of the Cities of Beverly Hills and West Hollywood, and portions of the cities of Culver City, Inglewood, Los Angeles, Santa Monica, and unincorporated areas of Los Angeles County.

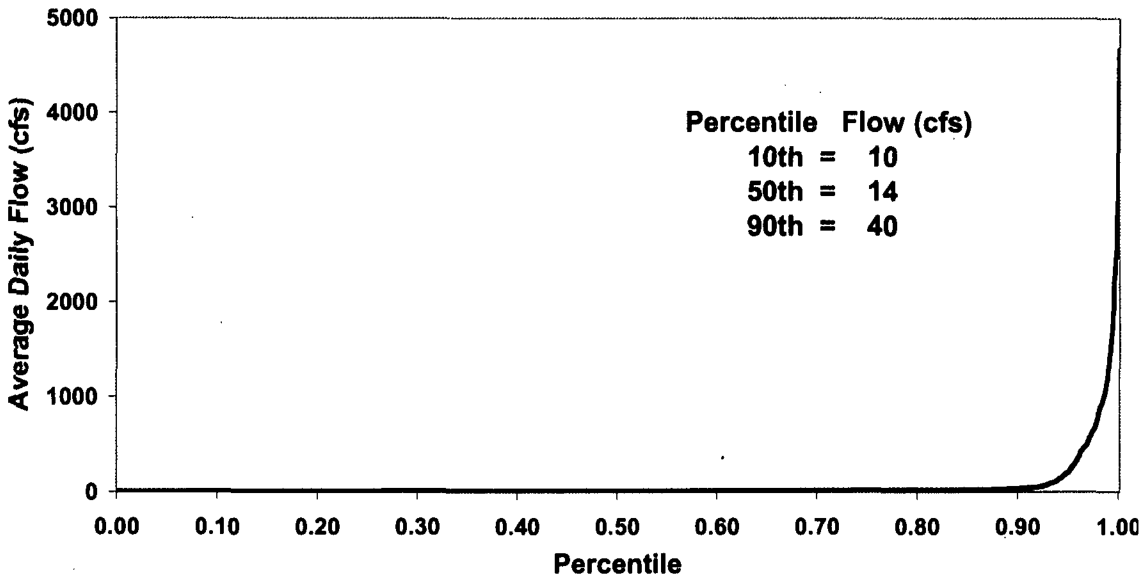
Channelization and construction of Marina del Rey Harbor altered the natural hydrology of Ballona Creek Estuary, Ballona Creek and its tributaries. Except for the estuarine section of the creek, which is composed of grouted rip-rap sloped sides and an earthen bottom, Ballona Creek is entirely lined in concrete and extends into a complex underground network of storm drains, which reaches north to Beverly Hills and West Hollywood. Tributaries of Ballona Creek include Centinela Creek, Sepulveda Canyon Channel, Benedict Canyon Channel, and numerous storm drains (Figure 1). All of these tributaries are concrete lined channels that lead to covered culverts upstream.

The Water Quality Control Plan for the Coastal Watersheds of Los Angeles and Ventura Counties (Basin Plan) defines three sections of the creek based on hydrologic units. The section referred to as "Ballona Creek" (Reach 1) is a 2-mile stretch from Cochran Avenue to National Boulevard. This area is characterized by vertical concrete walls, which line the creek from the point where it emerges from the underground network of drains at Cochran Avenue, in the City of Los Angeles, to National Boulevard in Culver City. "Ballona Creek to Estuary" (Reach 2) is the longest segment of the creek (approximately 4 miles) continuing on from National Boulevard and ending at Centinela Avenue where the estuary begins. Sepulveda Canyon Channel discharges into Ballona Creek Reach 2. "Ballona Creek Estuary" (Estuary) continues to the Pacific Ocean for 3.5 miles and its lower portion runs parallel to the main channel of Marina del Rey Harbor (Figure 1).

The bike path along the creek provides opportunities for recreation in the area. This path extends almost seven miles from Ballona Creek at National Boulevard in Culver City to the end of Ballona Creek Estuary in Marina del Rey. The bike path is connected to another path along Dockweiler Beach by the Pacific Bridge, which links Marina del Rey to Playa del Rey.

Dry-weather flows are estimated at 14 cubic feet per second (cfs) (Ackerman et al., 2003) and can be up to 36,000 cfs for a 100-year storm event (SMBRP, 1997). As shown in Figure 2 the average daily flows during dry weather in Ballona Creek are very consistent. The 90th percentile flow is considered the inflection point between dry and wet weather. Ballona Creek was channeled to quickly convey storm water to the ocean. Therefore, the relationship between rain events in the watershed and increased flow in the creek is strong and immediate (Ackerman and Weisberg, 2003).

Figure 2. Flow in Ballona Creek at Sawtelle Avenue (1987 to 1998)



1.3. ORGANIZATION OF THIS DOCUMENT

Guidance from USEPA (1991) identifies seven elements of a TMDL. Sections 2 through 7 of this document present these elements, with the analysis and findings of this TMDL for that element. The required elements are as follows:

- **Section 2: Problem Identification.** This section presents the data used to add the waterbody to the 303(d) list, and summarizes existing conditions using that evidence along with any new information acquired since the listing. This element identifies those reaches that fail to support all designated beneficial uses; the beneficial uses that are not supported for each reach; the WQOs designed to protect those beneficial uses; and, in summary, the evidence supporting the decision to list each reach, such as the number and severity of exceedences observed. This section also identifies the listed reaches and pollutants for which available data do not indicate water quality standards violations and for which TMDL development is not needed
- **Section 3: Numeric Targets.** This section identifies the numeric targets established for the TMDLs and representing attainment of WQOs and beneficial uses. For this TMDL, the numeric targets are based on narrative WQOs, interpreted through the use of sediment quality guidelines (SQGs).
- **Section 4: Source Assessment.** This section identifies the potential point sources and nonpoint sources of organic pollutants and metals to Ballona Creek and Estuary.
- **Section 5: Linkage Analysis, TMDL and Pollutant Allocations.** This section presents the analysis to evaluate the link between sources of toxic pollutants and the resulting conditions in the impaired waterbody. The pollutant loading capacity (i.e., assimilative

capacity) and associated TMDL for each pollutant are identified. Each identifiable source is allocated a quantitative load or waste load allocations for the listed pollutants, representing the load that it can discharge while still ensuring that the receiving water meets the WQOs. Allocations are designed to protect the waterbody from conditions that exceed the applicable numeric target. The allocations are based on critical conditions to ensure protection of the waterbody under all conditions.

- **Section 6: Implementation.** This section describes the regulatory tools, plans and other mechanisms available to achieve the WLAs.
- **Section 7: Monitoring.** This TMDL describes the monitoring to ensure that the WQOs are attained. If the monitoring results demonstrate the TMDL has not resulted in attainment of WQOs, then revised allocations will be developed.

2. PROBLEM IDENTIFICATION

The listings for Ballona Creek and Estuary are based on concentrations of chlordane, dieldrin, DDT and PCBs in fish tissue and concentrations of cadmium, lead, silver, zinc, chlordane, DDT, PCBs and PAHs in sediments. This section provides an overview of water quality criteria and guidelines applicable to Ballona Creek and Estuary and reviews the water quality data used in the 1998 water quality assessment, the 2002 303(d) listing, and additional data gathered in preparation of this TMDL.

As a result of the data review conducted to prepare this section, EPA and the State concluded that some of the 303(d) listing decisions were made in error. Section 2.2 describes the basis for this conclusion. Pursuant to the consent decree, TMDLs are not required to address these listings and are therefore not developed pursuant to the consent decree. This analysis should be considered by the State during its 2004-05 303(d) listing update.

2.1. WATER QUALITY STANDARDS

California state water quality standards consist of the following elements: 1) beneficial uses; 2) narrative and/or numeric WQOs; and 3) an antidegradation policy. In California, beneficial uses are defined by the Regional Boards in the Water Quality Control Plans (Basin Plans). Numeric and narrative objectives are specified in each region's Basin Plan. The objectives are set to be protective of the beneficial uses in each waterbody in the region and/or to protect against degradation. Numeric objectives for toxics can be found in the California Toxics Rule (40 CFR §131.38).

2.1.1. Beneficial Uses

The Basin Plan for the Los Angeles Regional Board (1994) defines 13 existing (E), potential (P), or intermittent (I) beneficial uses for Ballona Creek, Sepulveda Canyon Channel, and Ballona Creek Estuary (Table 2-1).

Table 2-1. Beneficial Uses of Ballona Creek and Ballona Creek Estuary (LARWQCB, 1994)

Ballona Creek Watershed	Hydro Unit #	MUN	NAV	REC1	REC2	COMM	WARM	EST	MAR	WILD	RARE	MIGR	SPWN	SHELL
Ballona Creek Estuary	405.13		E	E	E	E		E	E	E	Ee	Ef	Ef	E
Ballona Creek to Estuary	405.13	P*		Ps	E		P			P				
Ballona Creek	405.15	P*		Ps	E		P			E				

Beneficial use designations apply to all tributaries to the indicated waterbody, if not listed separately.
E: Existing beneficial use
P: Potential beneficial use
e: One or more rare species utilize all oceans, bays, estuaries, and wetlands for foraging and/or nesting.
f: Aquatic organisms utilize all bays, estuaries, lagoons, and coastal wetlands, to a certain extent, for spawning and early development. This may include migration into areas that are heavily influenced by freshwater inputs.
s: Access prohibited by Los Angeles County Department of Public Works
* Conditional designation

The municipal and domestic supply (MUN) use designation is conditional, as noted by the asterisk in Table 2-1. Conditional designations are not recognized under federal law and are not subject to water quality objectives requiring TMDL development at this time. (Letter from Alexis Strauss [USEPA] to Celeste Cantú [State Board], February 15, 2002.)

Discharges of toxic pollutants to these waterbodies may result in impairments of beneficial uses associated with aquatic life (WARM, EST, MAR, WILD, RARE, MIGR, and SPWN), human use of these resources (COMM and SHELL), and recreational uses (REC1 and REC2).

Ballona Creek Estuary has existing designated uses to protect aquatic life that use the estuarine, marine, and wildlife habitat (EST, MAR and WILD). The RARE use designation is designed to protect rare, threatened or endangered species that may utilize the estuary and adjacent wetlands for foraging or nesting habitat. There are existing uses to protect aquatic organisms utilizing the estuary for migration (MIGR) or for spawning, reproduction, and/or early development (SPWN). There are also beneficial uses associated with human use of the estuary including navigation (NAV), commercial and sport fishing (COMM), and shellfish harvesting (SHELL). In the creek, there are potential designated beneficial uses to protect warm freshwater habitat (WARM) and wildlife habitat (WILD). The recreational use for water contact (REC1) applies as an existing use for the estuary and a potential use in the creek. The secondary non-contact water recreation (REC2) applies as an existing use in both the estuary and creek.

2.1.2. Water Quality Objectives (WQOs)

As stated in the Basin Plan, water quality objectives (WQOs) are intended to protect the public health and welfare and to maintain or enhance water quality in relation to the designated existing and potential beneficial uses of the water. The Basin Plan specifies both narrative and numeric water quality objectives. The following narrative water quality objectives are the most pertinent to this TMDL. These narrative WQOs may be applied to both the water column and the sediments.

> Chemical Constituents: *Surface waters shall not contain concentrations of chemical constituents in amounts that adversely affect any designated beneficial use.*
>
> Bioaccumulation: *Toxic pollutants shall not be present at levels that will bioaccumulate in aquatic life to levels, which are harmful to aquatic life or human health.*
>
> Pesticides: *No individual pesticide or combination of pesticides shall be present in concentrations that adversely affect beneficial uses. There shall be no increase in pesticide concentrations found in bottom sediments or aquatic life.*
>
> Toxicity: *All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life.*

Numeric WQOs for pollutants addressed in these TMDLs were established in the California Toxics Rule (CTR), which was promulgated by USEPA in 2000 (USEPA, 2000b). The CTR establishes numeric aquatic life criteria for 23 priority toxic pollutants and numeric human health criteria for 92 priority toxic pollutants. These criteria are established to protect human health and the environment and are applicable to inland surface waters, enclosed bays and estuaries.

For the protection of aquatic life, the CTR establishes short-term (acute) and long-term (chronic) criteria in both freshwater and saltwater. The acute criterion equals the highest concentration of a pollutant to which aquatic life can be exposed for a short period of time without deleterious effects. The chronic criterion equals the highest concentration of a pollutant to which aquatic life can be exposed for an extended period of time (4 days) without deleterious effects. Freshwater criteria apply to waters in which the salinity is equal to or less than 1 part per thousand (ppt) 95 percent or more of the time. Saltwater criteria apply to waters in which salinity is equal to or greater than 10 ppt 95 percent or more of the time. For waters in which the salinity is between 1 and 10 ppt, the more stringent of the two criteria apply.

The human health criteria are established to protect the general population from priority toxic pollutants regulated as carcinogens (cancer-causing substances) and are based on the consumption of water and aquatic organisms or aquatic organisms only, assuming a typical consumption of 6.5 grams per day of fish and shellfish and drinking 2.0 liters per day of water. Table 2-2 summarizes the CTR aquatic life criteria (freshwater and saltwater) and human health criteria for organic constituents covered under this TMDL (chlordane, dieldrin, DDT, and PCBs.) The CTR criteria for metals are addressed in the Ballona Creek Metals TMDL.

Table 2-2. Water quality objectives established in the CTR for organochlorine compounds

Pollutant	Criteria for the Protection of Aquatic Life				Criteria for the Protection of Human Health	
	Freshwater		Saltwater			
	Acute (µg/L)	Chronic (µg/L)	Acute (µg/L)	Chronic (µg/L)	Water & Organisms (µg/L)	Organisms only (µg/L)
Chlordane	2.4	0.0043	0.09	0.004	0.00057	0.00059
Dieldrin	0.24	0.056	0.71	0.0019	0.00014	0.00014
4,4'-DDT[1]	1.1	0.001	0.13	0.001	0.00059	0.00059
Total PCBs[2]		0.014		0.03	0.00017	0.00017

[1] Based on a single isomer (4,4'-DDT).
[2] Based on total PCBs, the sum of all congener or isomer or homolog or aroclor analyses.

For PCBs, the Basin Plan states that, "*Pass-through or uncontrollable discharges to waters of the Region, or at locations where the waste can subsequently reach water of the Region, are limited to 70 picograms per liter (pg/L) measured as a 30 day average for protection of human health and 14 nanograms per liter (ng/L) measured as a daily average and 30 ng/L measured as a daily average to protect aquatic life in inland fresh water and estuarine waters, respectively.*" The aquatic life values in the Basin Plan are the same as in the CTR. The human health value in the Basin Plan of 70 pg/L is more stringent the CTR value of 170 pg/L.

There are no numeric standards for fish tissue in the Basin Plan. The human health criteria in the CTR were developed to ensure that bioaccumulative substances do not concentrate in fish tissue at levels that could impact human health.

There are no water quality objectives for sediment in the Basin Plan. The Regional Board applied best professional judgment to define elevated values for metals in sediment during the water quality assessments conducted in 1996, 1998, and 2002. The State Board is in the process of developing sediment quality objectives (SQOs) for enclosed bays and estuaries. Draft objectives are expected to be released for public review in August 2005, and State Board expects to adopt final sediment quality objectives and an implementation policy by March 2007. The final objectives and implementation policy would be subject to review by the Office of Administrative Law before becoming effective.

2.1.3. Antidegradation

State Board Resolution 68-16, "Statement of Policy with Respect to Maintaining High Quality Water" in California, known as the "Antidegradation Policy," protects surface and ground waters from degradation. Any actions that can adversely affect water quality in all surface and ground waters must be consistent with the maximum benefit to the people of the state, must not unreasonably affect present and anticipated beneficial use of such water, and must not result in water quality less than that prescribed in water quality plans and policies. Furthermore, any actions that can adversely affect surface waters are also subject to the federal Antidegradation Policy (40 CFR 131.12).

2.2. WATER QUALITY DATA REVIEW

This section summarizes the data for Ballona Creek and Estuary for the listed toxic pollutants in water, fish and sediments. The summary includes data considered by the Regional Board and USEPA in developing the 1998 and 2002 303(d) lists as well as subsequent data.

2.2.1. Water Column

There is very little information on the concentrations of organic constituents in the waters of Ballona Creek. Los Angeles County Department of Public Works (LACDPW) has conducts storm water sampling for PAHs, PCBs and organochlorine pesticides in Ballona Creek at Sawtelle Boulevard as part of their Municipal Stormwater Permit. The data for 1995 to 2000 are summarized in Table 2-3.

Table 2-3. Summary of LACDPW water quality monitoring data

Pollutant	Human Health Criteria Organisms only (μg/L)	Detection Limit (μg/L)	Total No. of Samples	Total No. of Non-detected Samples
Acenaphthene	2,700	0.05	16	16
Acenaphthylene	---	0.05	16	16
Anthracene	110,000	0.05	16	16
Benzo(a)anthracene	0.049	0.1	16	16
Benzo(a)pyrene	0.049	0.1	16	16
Benzo(b)fluoranthene	0.049	0.1	16	16
Benzo(k)fluoranthene	0.049	0.1	16	16
Chrysene	0.049	0.1	16	16
Dibenzo(a,h)anthracene	0.049	0.1	16	16
Fluoranthene	370	0.1	16	16
Fluorene	14,000	0.1	16	16
Indeno (1,2,3-cd)pyrene	0.049	0.1	16	16
Naphthalene	---	0.05	16	16
Phenanthrene	---	0.05	16	16
Pyrene	11,000	0.05	16	16
Organochlorine Pesticides & PCBs	0.00014-0.00059	0.05-1.0	13	13

None of the samples collected had concentrations above the analytical detection limit. However, it should be noted that the detection limits were greater than the CTR standards for PCBs, DDTs and several of the PAHs. No data were available for assessing water column concentrations of organic pollutants in Ballona Creek Estuary. Based on the limited data available, there is no indication that CTR standards are exceeded for any of the organic pollutants in the Creek or Estuary. See the Ballona Creek Metals TMDL for a discussion of metals data in the water column.

2.2.2. Fish and Shellfish Tissue

As discussed above, there is very little data on water column concentrations to address this potential for bioaccumulation in fish. Analysis of fish tissue for chemical contaminants provides a more direct means for assessing impacts.

Maximum tissue residue levels (MTRLs) were developed by State Board by multiplying the human health CTR water quality objectives by the bioconcentration factor for each substance. The MTRLs do not constitute enforceable regulatory limits and are no longer used by the State for 303(d) listing purposes. Indeed, the tissue listings for metals based on MTRLs in 1996 and 1998 assessments were removed in the 2002 assessment (LARWQCB, 2002).

Screening values have been developed by the Office of Environmental Health Hazard Assessment (OEHHA). These relate human health endpoints to contaminant concentrations in fish based on an average consumption rate for fish and shellfish.

To assess potential impairments associated with contaminant concentrations in fish and shellfish tissue, we reviewed the 1996 WQA worksheets, which formed the basis for the 1998 303(d) list. Tissue data used in the assessment were from the State Mussel Watch Program in the mid-1980s and data collected as part of the Toxic Substances Monitoring Program (TSMP) in 1993. A review of the original data sets revealed that both sets of data were from locations in Ballona Creek Estuary. There is no data on fish tissue or mussel tissue for Ballona Creek. We conclude that the Ballona Creek listings for PCBs, DDT, chlordane, and dieldrin were made in error and should have been applied more properly to Ballona Creek Estuary.

Table 2-4. Summary of tissue data from State Mussel Watch Program and Toxic Substances Monitoring Program (ppb, wet weight). Station locations are in Ballona Creek Estuary

Program	Mussel Watch			TSMP	SWRCB	OEHHA
Date	1985	1986	1988	1993	Maximum Tissue Residue Level (MTRL)	Screening Value
Species	Transplant California Mussel	Transplant California Mussel	Resident Bay Mussel	Striped Mullet		
Number of individuals	3	3	3	1	--	--
Total PCBs	28	32	39	890	5.3	20
Total DDT	16	18	16	119	8.3	30
Chlordane	17	13	15	26	0.7	2.6
Dieldrin	2	NA	ND	182	--	100

Both the Mussel Watch and the TSMP data indicate concentrations of PCBs, DDTs, chlordane and dieldrin that are above the MTRL or OEHHA screening values. The listing for the pesticide grouping known as ChemA is based entirely on chlordane and dieldrin. No other contaminants in the ChemA grouping were detected in either the TSMP or BPTCP samples. Therefore, we find that the ChemA listing is redundant.

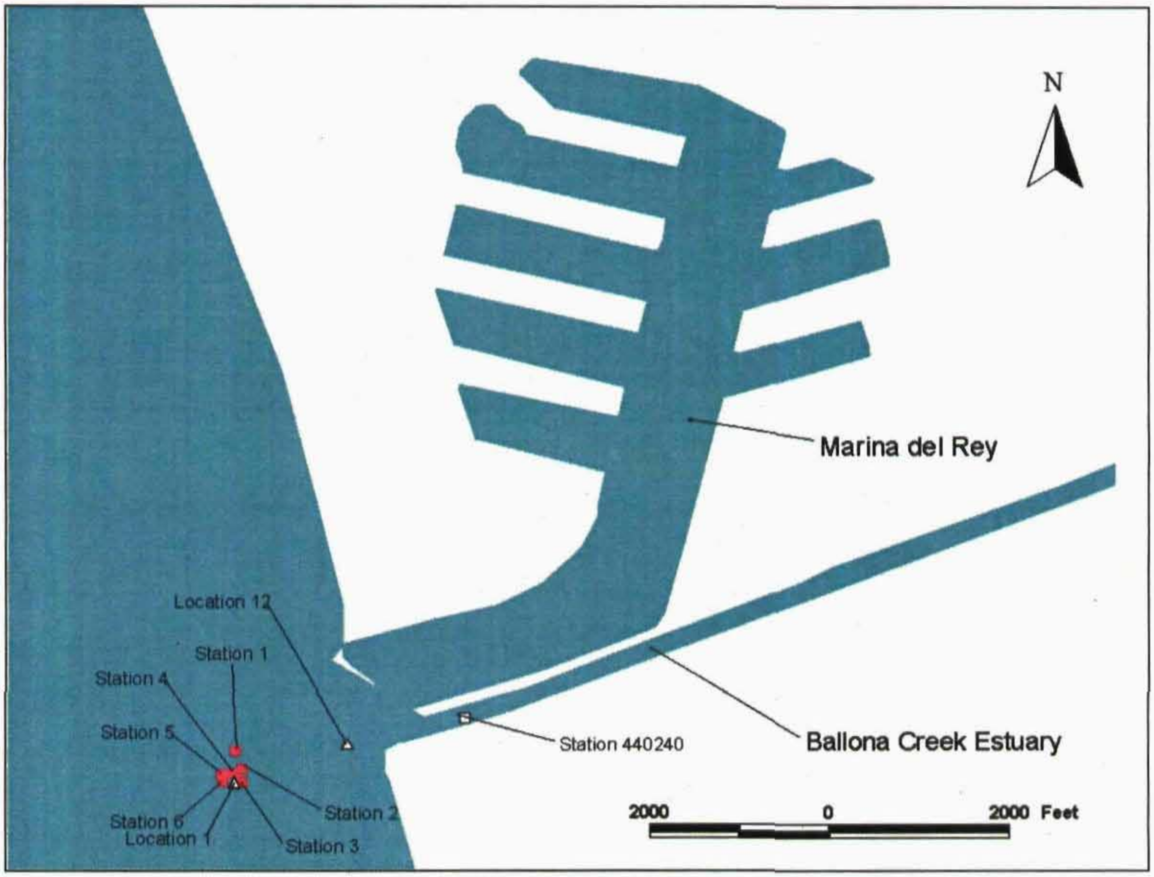
The Mussel Watch data represents three sampling events from a station labeled Marina del Rey/Ballona Creek located near the mouth of Ballona Creek Estuary. The TSMP data represents the results from a single fish (striped mullet) collected in Ballona Creek Estuary. These data sets are over 10-years old and may not reflect current conditions. Given the age of the data, the limited number of samples and the questions about the representativeness of the samples, we find that developing TMDLs based on fish or shellfish tissues is not warranted at this time.

2.2.3. Sediment

To assess impacts to sediments, we reviewed the 1996 WQA worksheets, additional data reviewed by the Regional Board in the 2002 listing cycle (Table 2-4) and data compiled through the Contaminated Sediments Task Force (CSTF). The 1996 WQA worksheets, which formed the basis for the 1998 303(d) list, provide only summary information on the chemical concentrations in sediments. The original data are longer available, so we cannot confirm the sample locations. This is important because there is a discrepancy in the nomenclature used to define Ballona Creek and the Estuary. In the Basin Plan, the transition between Creek and Estuary is at Centinela Blvd. Ballona Creek (above Centinela) is concrete-lined. Ballona Creek estuary (below Centinela) is soft-bottomed. Agencies unfamiliar with this regulatory distinction may have inadvertently attributed samples collected from Ballona Creek Estuary to Ballona Creek. Sediment data used in the 1996 WQA appear to have been collected from soft-bottomed estuary sediments as opposed to the concrete-lined channel. Therefore we believe that Ballona Creek was listed in error.

For Ballona Estuary, the sediment listings were based primarily on data collected as part of the Bay Protection and Toxic Cleanup Program (BPTCP), which collected samples from a single station (Station 440240) at the mouth of the estuary in January 1993 and February 1994. The CSTF database also contains sediment data from two studies in the bay near the mouth of the Ballona Creek Estuary. In one study, the US Army Corps of Engineers (USACE) analyzed chemical concentrations in sediments at six stations in March 1998. The other study performed by the LACDPW provides information on long-term trends (1990-1999) in sediment contaminant concentrations at two locations. Figure 3 presents the locations of the stations and the results of these studies are summarized in Table 2-4.

Figure 3. Sediment sampling locations in Ballona Estuary



In the 2002 listing cycle, the Regional Board evaluated sediment contaminants relative to sediment quality guidelines (SQGs), specifically the values for Effects Range-Low (ERL), Effects Range-Median (ERM) (Long et al., 1995), Threshold Effects Level (TEL), and Probable Effects Level (PEL) (MacDonald, 1994). These SQGs are based on empirical data compiled from numerous field and laboratory studies performed in North America.

The National Oceanic Atmospheric Administration (Long et al., 1995) assembled data from throughout the country that correlated chemical concentrations in sediments with effects. These data included spiked bioassay results and field data of matched biological effects and chemistry. The product of the analysis is the identification of two concentrations for each substance evaluated. One level, the ERL values, were set at the 10th percentile of the ranked data and represent the point below which adverse biological effects are not expected to occur. The ERM values were set at the 50th percentile and are interpreted as the point above which adverse effects are expected.

The TEL and PEL values were developed by the State of Florida and were based on a biological effects empirical approach similar to the ERLs/ERMs. The development of the TELs and PELs differ from the development of the ERLs and ERMs in that data showing no effects were incorporated into the analysis. In the Florida weight-of-evidence approach, two databases were assembled: a "no-effects" database and an "effects" database. The TEL values were generated by taking the geometric mean of the 15th percentile value in the effects database and the 50th percentile value of the no-effects database. The PEL values were generated by taking the geometric mean of the 50th percentile value in the effects database and the 85th percentile value of the no-effects database. By including the no-effect data in the analysis, a clearer picture of the chemical concentrations associated with the three ranges of concern (no effects, possible effects, and probable effects) can be established.

The ERLs and TELs are presumed to be non-toxic levels and pose with a high degree of confidence no potential threat. The ERMs and PELs identify pollutant concentrations that are more probably elevated to toxic levels. The SQGs used by the Regional Board during the 2002 WQA are summarized in Tables 2-5.

Table 2-5. Summary of marine sediment quality guidelines (mg/kg) used in WQAs for metals

Pollutant	ERL (mg/kg)	ERM (mg/kg)	TEL (mg/kg)	PEL (mg/kg)
Total PCBs	22.7	180	21.6	189
Total DDT	1.58	46.1	3.89	51.7
Chlordane	0.5	6	2.26	4.79
Dieldrin	0.02	8	0.715	4.3
Total PAHs	4,022	44,792	1,684	16,770
Cadmium	1.2	9.6	0.676	4.21
Lead	46.7	218	30.2	112
Silver	1	3.7	0.733	1.77
Zinc	150	410	124	271

The sediment data were compared to the SQGs to confirm and evaluate the impairment (Table 2-6). Several of the samples were non-detect, however, in some cases the detection limits were greater than the SQG. In Table 2-6, the detection limits were treated as the actual concentration when evaluating the sediment data. Figures 4 through 8 present the available sediment quality data for the listed pollutants in the Estuary compared with the SQGs.

Table 2-6. Evaluation of sediment data relative to detection limit (DL) and sediment quality guidelines

Chemical	Number of samples	# >DL	# > ERL	# > ERM	# > TEL	# > PEL
PCBs	28	10	20	10	20	10
DDTs	28	28	28	9	25	6
Chlordane	20	18	20	20	20	20
Dieldrin	22	5	22	3	20	3
PAHs	8	8	1	0	3	0
Cadmium	28	?	3	0	12	0
Chromium	28	?	1	0	2	0
Copper	28	?	10	0	15	1
Lead	28	?	23	3	26	12
Nickel	28	?	4	1	7	1
Silver	18	?	2	0	4	1
Zinc	28	?	9	2	11	3

Figure 4. Available sediment quality data for Chlordane in Ballona Estuary*

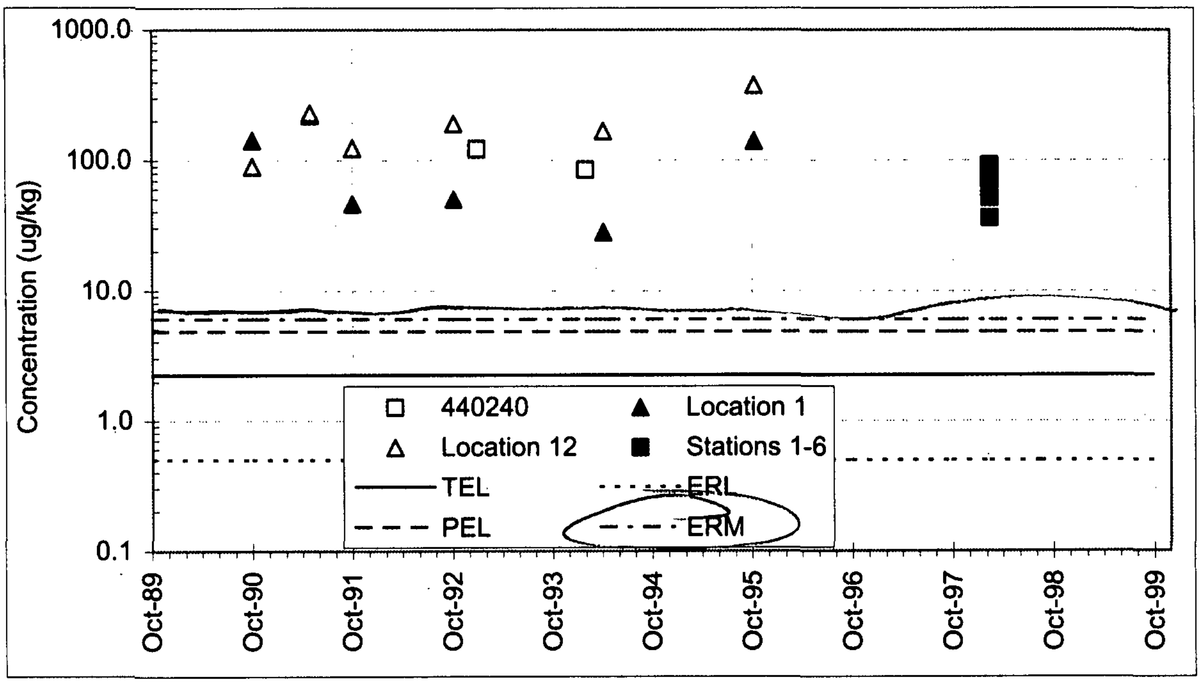


Figure 5. Available sediment quality data for Dieldrin in Ballona Estuary*

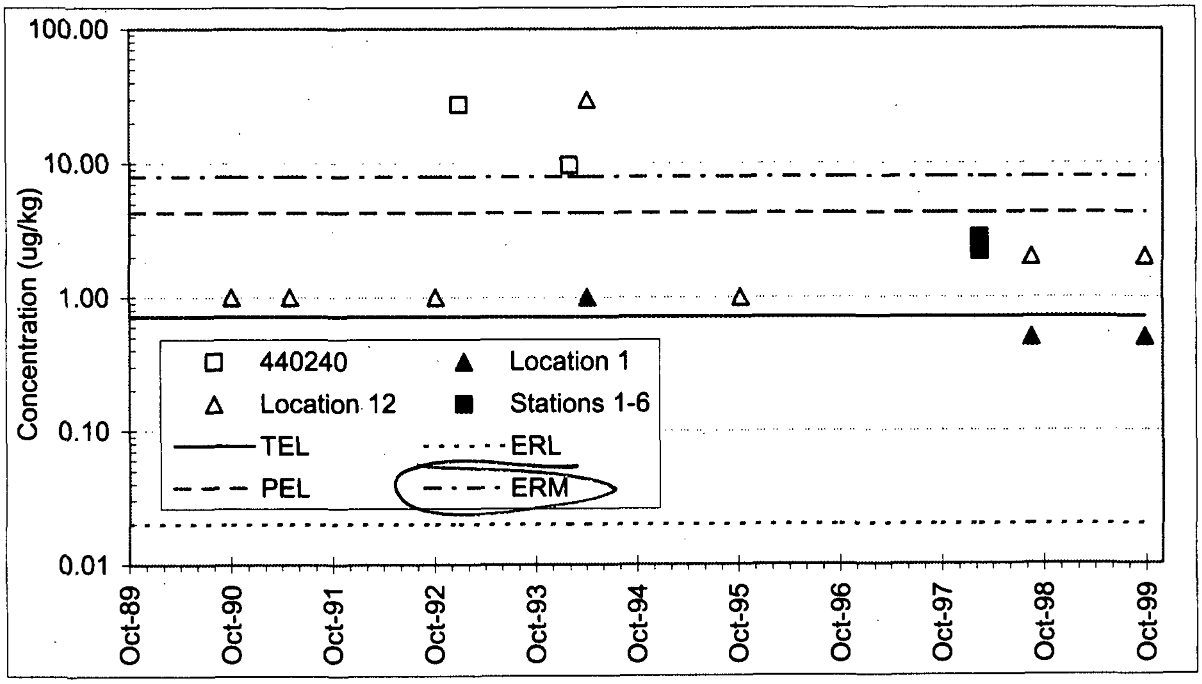


Figure 6. Available sediment quality data for DDTs in Ballona Estuary*

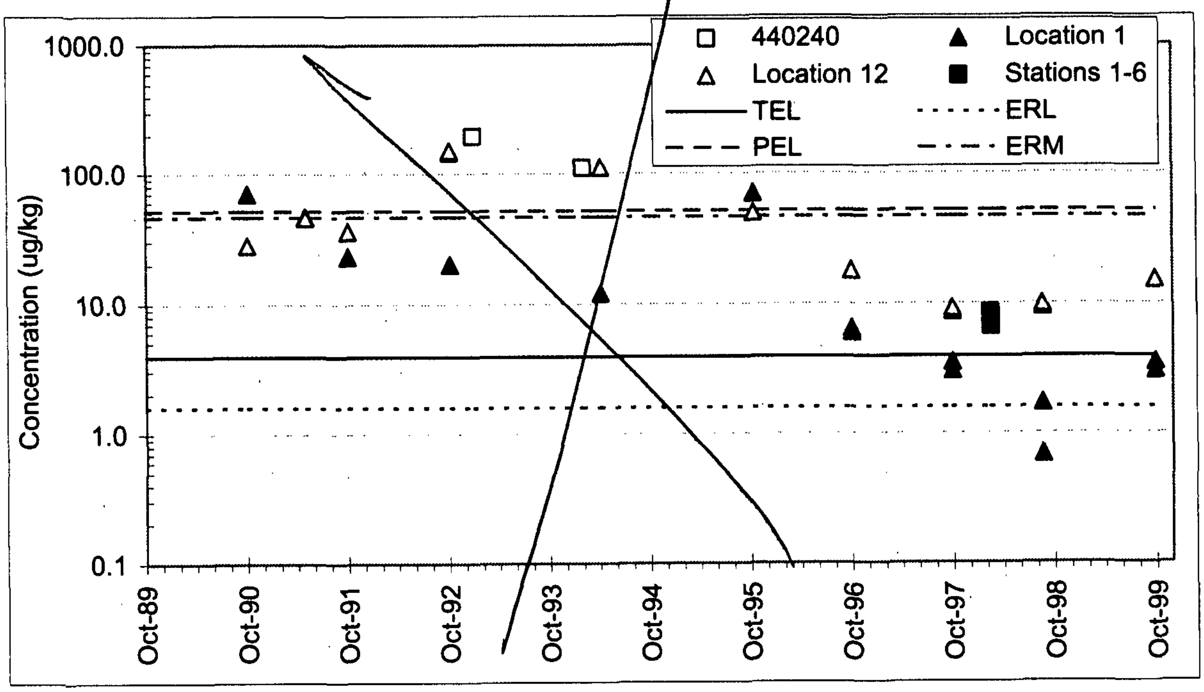
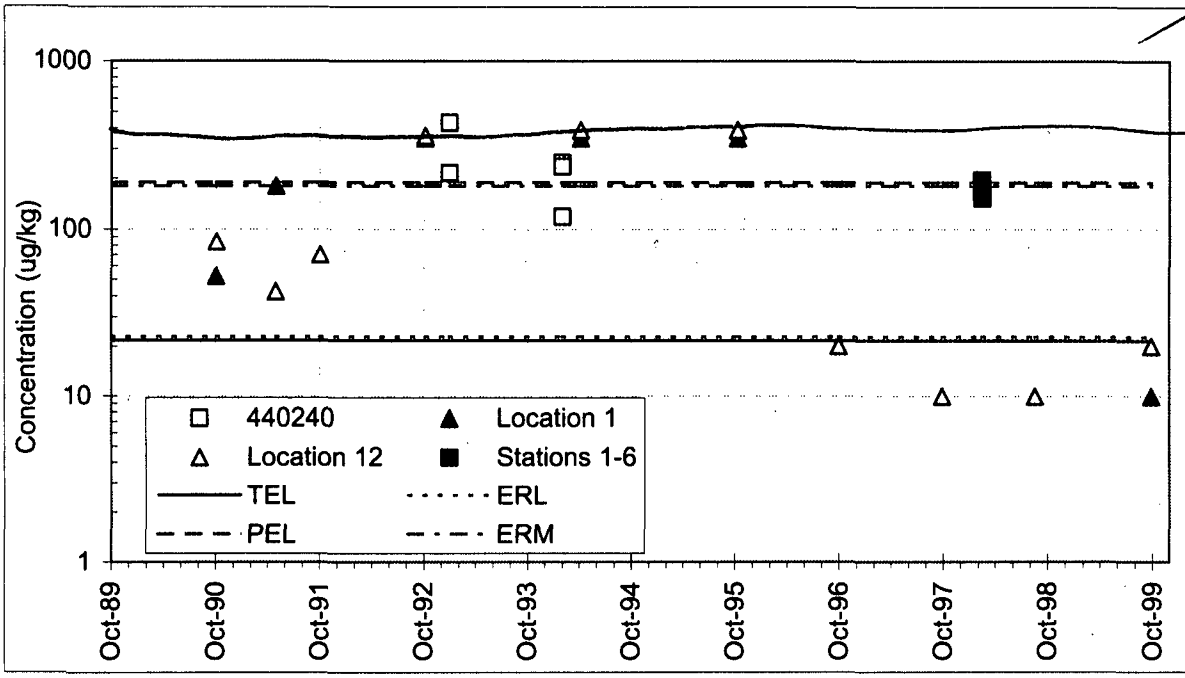
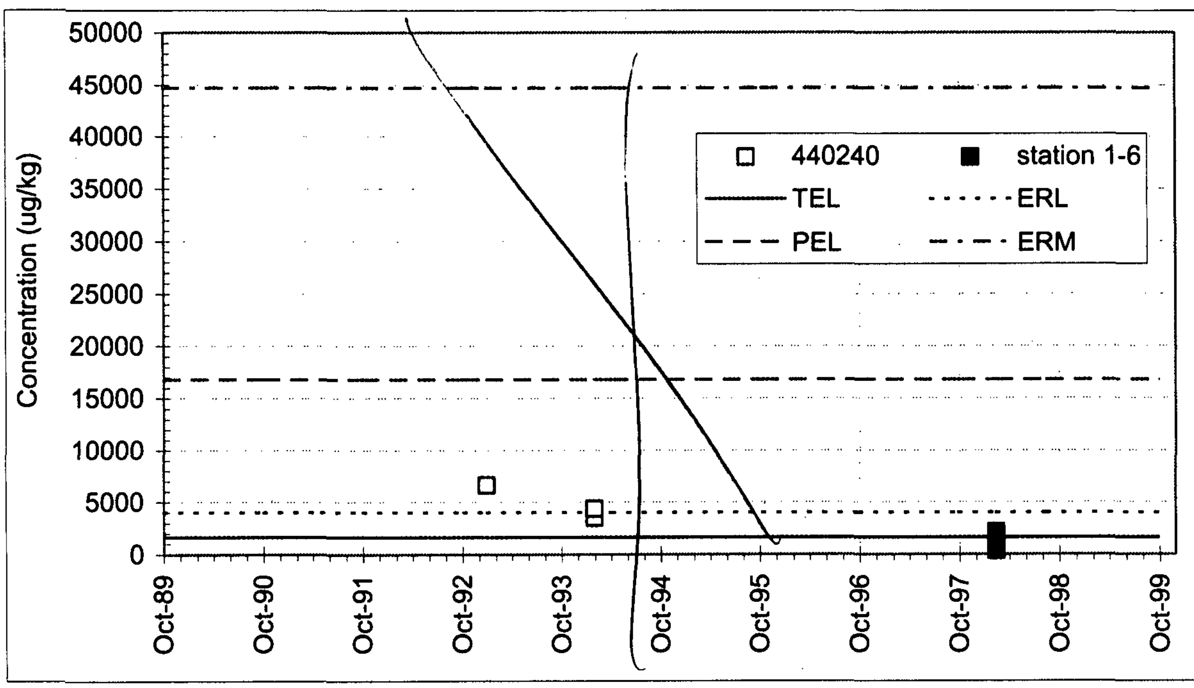


Figure 7. Available sediment quality data for PCBs in Ballona Estuary*



Low
check
450ng/g

Figure 8. Available sediment quality data for PAHs in Ballona Estuary*



Not enough to remove

Organics in sediments

Chlordane (Fig 4) was detected in 18 out of 20 samples in the CTSF database. In the two samples, that were non-detect, the detection limit was above the SQGs. Therefore, all 20 samples exceeded the ERL, ERM, TEL and PEL values based on the assumption that the detection limit is the actual concentration.

Dieldrin (Fig 5) was detected in 5 out of 22 sediment samples in the CSTF database. Three of the samples exceeded all of the SQGs. Concentrations at the BPTCP station 440240 ranged from 9.8 to 26.7 µg/kg. The maximum concentration of 30 µg/kg was detected at USACE location 12. Samples from the other locations were below detection levels.

DDT (Fig 6) was detected in 20 out of 28 sample records in the CSTF database. Sediment DDT concentrations ranged from below detection limits to 198 µg/kg. All samples were above the ERL and 8 samples were above the ERM. DDT appears to remain above concentrations of concern.

PCBs (Fig 7) were detected in 10 out 28 samples in the CTSF database. Total PCB concentrations from the BPTCP ranged from 236 to 431 µg/kg (calculated as the sum of the congeners). PCB concentrations measured by LACDPW and the USACE were calculated as aroclor mixtures. PCBs were largely undetected in these studies, but the detection limits associated with these studies were relatively high. Summing up the detection limits for each of the aroclors, the range of values runs from 10 to 390 µg/l. Treating detection limits as true values, 20 out of the 28 measurements in CSTF database were greater than the lower level SQGs (ERL or TEL) and 9 out of 28 were greater than the highest SQG (PEL = 189 µg/kg).

PAHs (Fig 8) were detected in 8 out of 8 samples in the CTSF database. The BPTCP data that indicated values ranging from 3,525 to 6,663 µg/kg. PAH values measured by the Army Corps ranged from 407 to 2,160 µg/kg. These concentrations are less than the ERM and PEL, but close to or greater than the ERL and TEL values.

In summary, the concentrations of legacy pollutants such as PCBs, DDTs, chlordane, and to a lesser extent dieldrin, remain at elevated concentration in sediments within the Ballona Creek Estuary. Concentrations of PAHs are also moderately elevated relative to sediment quality guidelines.

Metals in sediments

The Ballona Creek cadmium listing in 1998 was based on a sediment concentration of 30 µg/g reported in the 1996 WQA. The maximum concentration in the CTSF data base is 2.2 µg/g. Although, this value is lower, it is still greater than the low SQGs (ERL or TEL).

The original lead listing was based on a maximum sediment concentration of 306 µg/g report in the 1996 WQA. The maximum concentration in the CTSF database is 427 µg/g. These concentrations are higher than any of the SQGs.

Ballona Creek was listed for silver in the 1998 303(d) list based on a maximum silver concentration of 10 µg/g reported in the 1996 WQA. The maximum concentration in the CTSF database is 3.6 µg/g, which is lower than previously reported values, but still higher than the SQGs.

Ballona Creek Estuary was listed for zinc in the 1998 303(d) list based on a maximum sediment concentration of 1310 µg/g reported in the 1996 WQA. The maximum concentration in the CTSF database was 464 ug/g. These values are moderately elevated (i.e., lower than the high SQGs but higher than the low SQGs).

In summary, metals are moderately elevated in sediments of Ballona Creek estuary and generally confirm the sediment listings.

2.2.4. Summary and Findings concerning TMDLs Required

There is no evidence for water column impairment in Ballona Creek or Ballona Creek Estuary for any of the organic contaminants listed under Analytical Unit #55. The water column impairments for metals in Ballona Creek listed under Analytical Unit #57 are addressed in the Ballona Creek Metals TMDL.

There is no evidence of fish tissue problems in Ballona Creek. The fish tissue data and mussel watch data used in the listing was from Ballona Creek Estuary. Although these data indicate concentrations of PCBs, DDT, chlordane and dieldrin that are elevated relative to screening levels, both sets of tissue data are over 10-years old and represent relatively small data sets. They may not reflect current conditions.

The site locations of the data attributed to sediments in Ballona Creek is no longer available. However, we believe these data were from the soft-bottomed estuary rather than the concrete-lined portion of the creek. We find that the listings for PCBs, DDTs, chlordane, PAHs, cadmium and silver based on the sediment data applied to the Creek are more appropriately applied to the estuary. There is clear evidence of that these compounds are elevated in the sediments of Ballona Creek Estuary .

TMDLs will be developed to reduce sediment contamination in Ballona Creek Estuary for four metals (cadmium, lead, silver, zinc) and five organic pollutants (PCBs, DDTs, chlordane, dieldrin, PAHs).

Table 2-7. Pollutants listed in the Consent Decree for Ballona Creek and Estuary

Pollutants in AU 55	**Ballona Creek**	**Ballona Creek Estuary**
PCBs	N[1]	Y
DDTs	N[1]	Y
Chem A	N[1]	
Chlordane	N[1]	Y
Dieldrin	N[1]	
Sediment Toxicity	N[1]	Y[3,4]
PAHs		Y
Pollutants in AU 57	**Ballona Creek**	**Ballona Creek Estuary**
Arsenic	Y[2]	
Cadmium	Y[2]	Y[4]
Copper	Y[2]	
Lead	Y[2]	Y
Silver	Y[2]	Y[4]
Zinc		Y
Toxicity	Y[3]	

1. No TMDL required based on finding that fish tissue data inadequate for listing
2. TMDLs for these listings are covered under Ballona Creek Metals TMDL
3. Toxicity addressed indirectly through pollutant specific TMDLs
4. These are modifications of the listings. This is based on the finding that the original listings for Ballona Creek sediments were made in error and are more appropriately applied to the sediments of Ballona Creek Estuary

3. NUMERIC TARGETS

We develop numeric targets for metals, organochlorine compounds and PAHs in sediments that are protective of aquatic life beneficial uses. As discussed in Section 2, the Basin Plan provides narrative objectives that can be applied to sediments but does not provide numeric WQOs for sediment quality. To develop the TMDLs, it is necessary to translate the narrative objectives into numeric targets that identify the measurable endpoint or goal of the TMDL and represent attainment of applicable numeric and narrative water quality standards.

Sediment quality guidelines compiled by National Oceanic and Atmospheric Administration (NOAA) are used in evaluating waterbodies within the Los Angeles Region for development of the 303(d) list. The sediment quality guidelines are appropriate targets because the impairments and the 303(d) listings are primarily based on sediment quality data. In addition the pollutants being addressed have a high affinity for particles and the delivery of these pollutants is generally associated with the transport of suspended solids from the watershed or from sediments within the estuary.

The ERLs (Long et al., 1995) guidelines are established as the numeric targets for sediments in Ballona Creek and Estuary as summarized in Table 3-1. The SWRCB listing policy recommends the use of ERMs along with other lines of evidence as a threshold for listing. Use of the ERLs was as a target selected over the ERMs to provide a margin of safety.

Table 3-1. Numeric targets for sediment quality in Ballona Creek and Estuary

Pollutant	**Numeric Target for Sediment**
Cadmium	1.2 mg/kg
Lead	46.7 mg/kg
Silver	1.0 mg/kg
Zinc	150 mg/kg
Pollutant	**Numeric Target for Sediment**
Total DDT	1.58 µg/kg
Total PCBs	22.7 µg/kg
Chlordane	0.5 µg/kg
Total PAHs	4,022 µg/kg

4. SOURCE ASSESSMENT

This section identifies the potential sources of metals and organochlorine compounds to Ballona Creek and Estuary. The toxic pollutants can enter surface waters from both point and nonpoint sources. Point sources typically include discharges from a discrete human-engineered point. These types of discharges are regulated through the federal National Pollutant Discharge Elimination System (NPDES) program, which the Regional Boards have been delegated to implement through the issuance of Waste Discharge Requirements (WDRs). Nonpoint sources, by definition, include pollutants that reach surface waters from a number of diffuse land uses and activities. The Regional Board, under the authority of the Porter-Cologne Water Quality Control Act, issues WDRs for discharges to groundwater from nonpoint sources. The distinction between point and nonpoint sources is not always clear. In Los Angeles County urban runoff to Ballona Creek and Estuary is regulated under storm water NPDES permits, which are regulated as a point source discharge.

4.1. BACKGROUND ON TOXIC POLLUTANTS

The following sections provide background information on the toxic pollutants addressed in this TMDL, including their properties and uses.

4.1.1. Metals

Cadmium is a trace element used in a wide variety of applications, including, electroplating, the manufacture of pigments, storage batteries, telephone wires, photographic supplies, glass, ceramics, some biocides, and as a stabilizer in plastics. The main anthropogenic sources of cadmium appear to be metal smelting, industries involved in the manufacture of alloys, paints, batteries, and plastics, agricultural uses of sludge, fertilizers and pesticides that contain cadmium, and the burning of fossil fuels.

Lead and its compounds are used in electroplating, metallurgy, construction materials, coating and dyes, electronic equipment, plastics, veterinary medicines, fuels and radiation shielding. Lead is also used for ammunition, corrosive-liquid containers, paints, glassware, fabricating storage tank linings, transporting radioactive materials, solder, piping, cable sheathing, and roofing (MacDonald, 1994). Prior, to the phasing out of leaded gasoline, lead additives in gasoline was a significant source of lead in the environment. Since the phasing out of leaded gasoline, there has been a gradual decline of lead concentrations in the environment.

Silver is used extensively in photographic materials. Other uses of silver include the manufacture of sterling and planted ware, jewelry, coins and medallions, electrical and electronic products, brazing alloys and solders, catalysts, mirrors, fungicides, and dental and medical supplies. Potential sources of silver to surface waters include leachates from landfills, waste incineration, and effluents from the iron, steel and cement industries

Zinc is primarily used as a coating on iron and steel to protect against corrosion, in alloys for die casting, in brass, in dry batteries, in roofing and exterior fittings for buildings, and in some printing processes. The principal sources of zinc in the environment include smelting, and refining activities, wood combustion, waste incineration, iron and steel production and tire wear.

4.1.2. Organic pollutants

Chlordane was used as a pesticide to control insects on agricultural crops, residential lawns and gardens, and in buildings, particularly for termite control In 1988 all chlordane uses, except for fire ant control, were voluntarily canceled in the United States (NPTN, [undated]). Chlordane can still be legally manufactured in the United States for sale or use by foreign countries. Although it is no longer used in the US, chlordane persists in the environment, adhering strongly to soil particles. It is assumed that the only source of chlordane in the watershed is storm water runoff carrying historically deposited chlordane most likely attached to eroded sediment particles.

Dieldrin is an organochlorine insecticide that was used from 1950 to 1970 on crops, such as corn and cotton, and to control termites. USEPA banned all uses of dieldrin in 1974 except to control termites. In 1987, USEPA banned all uses. Although it is no longer used, dieldrin persists in the environment, adhering strongly to soil particles. It is assumed that the only source of dieldrin in the watershed is storm water runoff carrying historically deposited dieldrin most likely attached to eroded sediment.

DDT is an organochlorine insecticide that was widely used on agricultural crops and to control disease-carrying insects. The use of DDT was banned in the United States in 1972, except for public health emergencies involving insect diseases and control of body lice. From 1947 to 1982, the Montrose Chemical Corporation of California, Inc. (Montrose) manufactured DDT at its plant on Normandie Avenue in Los Angeles, California. Wastewater containing significant concentrations of DDT was discharged from the Montrose plant into the sewers, flowed through the Los Angeles County Sanitation Districts wastewater treatment plant and was discharged to the ocean waters of the Palos Verdes Shelf through subsurface outfalls. Montrose's discharge of DDT reportedly stopped in about 1971, and the Montrose plant was shut down and dismantled in 1983. Although DDT is no longer used, it persists in the environment, adhering strongly to soil particles and moving slowly to groundwater. It is assumed that the only source of DDT in the watershed is historically deposited DDT transported through storm water runoff most likely attached to eroded sediment.

Polychlorinated biphenyls (PCBs) are mixtures of up to 209 individual chlorinated compounds (known as congeners). They were used in a wide variety of applications, including dielectric fluids in transformers and capacitors, heat transfer fluids, and lubricants. In 1976, the manufacture of PCBs was prohibited because of evidence they build up in the environment and can cause harmful health effects. 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. Products made before 1977, which 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 (USEPA, 2002).

Polynuclear aromatic hydrocarbons (PAHs) are a group of over 200 different chemicals. They are found in nature in coal and crude oil and in emissions from forest fires and volcanoes. Most

PAHs entering the environment are formed unintentionally during burning (coal, oil, wood, gasoline, garbage, tobacco and other organic material) or in certain industrial processes. Important sources of PAHs in surface waters include deposition of airborne PAHs, municipal waste water discharge, urban storm water runoff particularly from roads, runoff from coal storage areas, effluents from wood treatment plants and other industries, oil spills, and petroleum pressing (ATSDR, 1995). It is assumed that the primary source of PAHs to Ballona Creek and Estuary is urban storm water runoff. Although airborne PAHs may be a significant source to surface waters, most of airborne PAH is deposited on the land (e.g., through precipitation or indirect atmospheric deposition) and are transported to Ballona Creek through storm water runoff.

4.2. POINT SOURCES

A point source, is defined in 40 CFR 122.3, as "any discernable, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel, or other floating craft from which pollutants are or may be discharged." The NPDES Program, under CWA sections 318, 402, and 405, requires permits for the discharge of pollutants from point sources.

The NPDES permits in the Ballona Creek Watershed include the MS4 and Caltrans Storm Water Permits, general industrial storm water permits and general construction storm water permits, minor NPDES permits, other general NPDES permits (Table 4-1).

Table 4-1. NPDES Permits in the Ballona Creek Watershed

Type of NPDES Permit	Number of Permits
Municipal Storm water	1
California Department of Transportation Storm water	1
General Construction Storm water	17
General Industrial Storm water	14
Individual NPDES Permits (minors)	16
Other General Permits:	
Construction and Project Dewatering	98
Petroleum Fuel Cleanup Sites	18
VOCs Cleanup Sites	7
Potable Water	6
Non-Process Wastewater	3
Hydrostatic Test Water	1
Total	**182**

4.2.1. Stormwater Permits

Stormwater runoff in the Ballona Creek watershed is regulated through a number of permits. The first is the municipal stormwater (MS4) permit. The second is a separate statewide storm water permit specifically for the California Department of Transportation (Caltrans). The third is the statewide Construction Activities Storm Water General and the fourth is the statewide Industrial Activities Storm Water General Permit.

There are fourteen general industrial storm water permits and seventeen general construction storm water permits within the watershed. The permitting process defines these discharges as point sources because the storm water discharges from the end of a storm water conveyance system. Since, the industrial and construction storm water discharges are enrolled under NPDES permits, these discharges are treated as point sources in this TMDL.

MS4 Storm Water Permits

In 1990, USEPA developed rules establishing Phase I of the NPDES storm water program, designed to prevent harmful pollutants from being washed by storm water runoff into MS4s (or from being dumped directly into the MS4s) and then discharged from the MS4 into local waterbodies. Phase I of the program required operators of medium and large MS4s (those generally serving populations of 100,000 or more) to implement a storm water management program as a means to control polluted discharges from MS4s. Approved storm water management programs for medium and large MS4s are required to address a variety of water quality-related issues, including roadway runoff management, municipally owned operations, and hazardous waste treatment. Large and medium operators are required to develop and implement Storm Water Management Plans that address, at a minimum, the following elements:

- Structural control maintenance
- Areas of significant development or redevelopment
- Roadway runoff management
- Flood control related to water quality issues
- Municipally owned operations such as landfills, wastewater treatment plants, etc.
- Hazardous waste treatment, storage, or disposal sites, etc.
- Application of pesticides, herbicides, and fertilizers
- Illicit discharge detection and elimination
- Regulation of sites classified as associated with industrial activity
- Construction site and post-construction site runoff control
- Public education and outreach

The County of Los Angeles Municipal Storm Water NPDES permit (MS4 Permit) was renewed in December 2001 (Regional Board Order No. 01-182) and is on a five-year renewal cycle. There are 85 co-permittees covered under this permit including 84 cities and the County of Los Angeles.

Caltrans Storm Water Permit

As stated previously, Caltrans is regulated by a statewide storm water discharge permit that covers all municipal storm water activities and construction activities (Order No. 99-06-DWQ). The Caltrans storm water permit authorizes storm water discharges from Caltrans properties such as the state highway system, park and ride facilities, and maintenance yards.

The storm water discharges from these Caltrans properties and facilities eventually ends up in either a city or county storm drain. The metals or pesticides loading specifically from Caltrans properties have not been determined in the Ballona Creek watershed. A conservative estimate of the percentage of the Ballona Creek watershed covered by state highways is 1% (approximately 970 acres). This percentage does not represent all the watershed area that Caltrans is responsible for under the storm water permit. The park and ride facilities and the maintenance yards were not included in the estimate. Although, the percentage is low the associated metals loading and sediment may be high especially for zinc since vehicles and tires may be a source of zinc loading.

General Stormwater Permits

Federal regulations for controlling pollutants in storm water discharges were issued by the USEPA on November 16, 1990 (40 Code of Federal Regulations [CFR] Parts 122, 123, and 124). The regulations require operators of specific categories of facilities where discharges of storm water associated with industrial activity occur to obtain an NPDES permit and to implement Best Available Technology Economically Achievable (BAT) and Best Conventional Pollutant Control Technology (BCT) to reduce or prevent pollutants associated with industrial activity in storm water discharges and authorized non-storm discharges. In addition, the regulations require discharges of storm water to surface waters associated with construction activity including clearing, grading, and excavation activities (except operations that result in disturbance of less than five acres) to obtain an NPDES permit and to implement BAT and BCT to reduce or eliminate storm water pollution. On December 8, 1999, federal regulations promulgated by USEPA (40CFR Parts 122, 123, and 124) expanded the NPDES storm water program to include storm water discharges from construction sites that resulted in land disturbances equal to or greater than one acre but less then five acres.

On April 17, 1997, State Board issued a statewide general NPDES permit for Discharges of Storm Water Associated with Industrial Activities Excluding Construction Activities Permit (Order No. 97-03-DWQ). This Order regulate storm water discharges and authorized non-storm water discharges from ten specific categories of industrial facilities, including but not limited to manufacturing facilities, oil and gas mining facilities, landfills, and transportation facilities. On August 19, 1999, State Board issued a statewide general NPDES permit for Discharges of Storm Water Runoff Associated with Construction Activities (Order No. 99-08-DQW). All dischargers covered under these general NPDES storm water permits are required to develop and implement an effective Storm Water Pollution Prevention Plan (SWPPP) and Monitoring Program. The SWPPP has two main objectives. One, to identify and evaluate sources of pollutants associated with industrial activities or construction activities that may affect the quality of storm water discharges. Two, to identify and implement site-specific BMPs to reduce or prevent pollutants associated with industrial activities in storm water discharges.

There are fourteen general industrial storm water permits and seventeen general construction storm water permits within the watershed. Potential pollutants from an industrial site will depend on the type of facility and operations that take place at that facility. In the Ballona Creek watershed there are sand and gravel, oil and natural gas, transportation, recycling and manufacturing facilities. In general, potential pollutants from manufacturing facilities may include metals, oils and grease, and organic chemicals. Potential pollutants from construction sites include sediment, which may contain historic pesticides or PCBs, and metals (e.g. lead and zinc) from construction materials and the heavy equipment used on construction sites. In addition, in the highly urbanized Ballona Creek watershed re-development of former industrial sites have a higher potential to discharge sediments laden with pollutants such as PCBs and PAHs.

4.2.2. Other Individual NPDES Permits

The individual NPDES permit is classified as either a major or a minor permit. The discharge flows associated with minor individual NPDES permits and general NPDES permits are typically less than 1 million gallons per day (MGD). General NPDES permits often regulate episodic discharges (e.g. dewatering operations) rather than continuous flows. The minor NPDES permits issued within the Ballona Creek watershed are also for episodic discharges.

Minor NPDES Permits

There are sixteen minor NPDES permits in the Ballona Creek watershed for a combined total design discharge flow of approximately 11 MGD. The City of Santa Monica's municipal/domestic water supply treatment plant (1.6 MGD) and the Inglewood Oil Field located in Baldwin Hills (7.55 MGD) account for approximately 9 MGD of flow; therefore, 2 MGD is discharged by the remaining fourteen dischargers. There are eleven minor NPDES permits issued to building complexes that discharge a combination of cooling tower bleed-off, groundwater seepage, pool or fountain filter backwash and drainage and water softener waste. Some of these permits contain effluent limits for metals (e.g. cadmium, copper, lead, silver, and zinc), however, these permits were issued in 1997 and the limits are not based on CTR. In addition, there are three minor NPDES permits issued to gasoline service stations for the cleanup of petroleum contaminated groundwater. Since these permits were issued in 1999, the effluent limitations (e.g. lead) are not based on CTR. Therefore, there is the potential for these minor NPDES permits to discharge metals in exceedance of the numeric targets.

The City of Santa Monica operated a municipal/domestic water supply plant that pumped groundwater containing high dissolved solids and organic compounds. The water was treated by softening and then disinfected and distributed. On August 22, 2000, the operation of the treatment plant was shut down because the waste discharged from the cation exchange softening process did not meet the waste discharge limits specific in the NPDES permit. The Inglewood Oil Field has an NPDES permit for the discharge of storm water from retention basins located on site. Therefore, the waste discharge is only permitted to occur during and immediately after rain events.

Other General NPDES Permits

Pursuant to 40 CFR parts 122 and 123, the State Board and the Regional Boards have the authority to issue general NPDES permits to regulate a category of point sources if the sources: involve the same or substantially similar types of operations; discharge the same type of waste; required the same type of effluent limitations; and require similar monitoring. The Regional Board has issued general NPDES permits for six categories of discharges: construction and project dewatering; petroleum fuel cleanup sites; volatile organic compounds (VOCs) cleanup sites; potable water; non-process wastewater; and hydrostatic test water.

The general NPDES permit for Discharges of Groundwater from Construction and Project Dewatering to Surface Waters (Order No. R4-2003-0111) covers wastewater discharges, including but not limited to, treated or untreated groundwater generated from permanent or temporary dewatering operations. Currently, there are approximately 98 dischargers enrolled under this Order in the Ballona Creek watershed for a combined total discharge flow of approximately 14 MGD.

The general NPDES permit for Discharges of Nonprocess Wastewater to Surface Waters (Order No. R4-2004-0058) covers waste discharges, including but not limited to, noncontact cooling water, boiler blowdown, air conditioning condensate, water treatment plant filter backwash, filter backwash, swimming pool drainage, and/or groundwater seepage. Currently, there are approximately three dischargers enrolled under this Order in the Ballona Creek watershed for a combined total discharge flow of 0.2 MGD.

Discharges from construction dewatering and nonprocess wastewater have a low potential to contribute to metals, pesticides, PCBs or PAHs loadings for two reasons. First, in order to be eligible to be covered under this Order, a discharger must perform an analysis using a representative sample of the groundwater or nonprocess wastewater to be discharged. The sample is analyzed and the data compared to the water quality screening criteria, which includes metals, pesticides, PCBs and PAHs based on the CTR criteria. Second, the permit includes effluent limitations for metals, pesticides, PCBs and PAHs, which are based on the CTR. For the hardness dependent metals, the effluent limitation is based on three ranges of hardness values up to 200 mg/L, 200 to 300 mg/L, and 300 mg/L and above. The hardness range selected is based on the site-specific hardness value.

The general NPDES permit for Treated Groundwater and Other Wastewaters from Investigation and/or Cleanup of Petroleum Fuel-Contaminated Sites to Surface Waters (Order No. R4-2002-0125) covers discharges, including but not limited to, treated groundwater and other wastewaters from the investigation, dewatering, or cleanup of petroleum contamination arising from current and former leaking underground storage tanks or similar petroleum contamination. Currently, there are approximately 18 dischargers enrolled under this Order in the Ballona Creek watershed for a combined total discharge flow of 1.6 MGD.

The general NPDES permit for Discharges of Treated Groundwater from Investigation and/or Cleanup of VOCs-Contaminated Sites to Surface Waters (Order No. R4-2002-0107) covers discharges, including but not limited to, treated groundwater and other wastewaters from the investigation, cleanup, or construction dewatering of VOCs only (or VOCs commingled with petroleum fuel hydrocarbons) contaminated groundwater. Currently, there are approximately seven dischargers enrolled under this Order in the Ballona Creek watershed for a combined total discharge flow of 0.5 MGD.

Discharges from site cleanup operations have a low potential to contribute to metals, pesticides, PCBs or PAHs loadings. In order to be eligible to be covered under these Orders, the discharger must demonstrate that a representative sample of the contaminated groundwater to be treated and discharged does not exceed the water quality screening criteria, which includes metals, pesticides, PCBs and PAHs based on the CTR criteria. In addition, the permit includes effluent limitations for lead and PCBs, since these pollutants may be found at gasoline service stations, and industrial facilities that use VOCs, cutting oils, heat transfer fluids, and lubricants. The effluent limitation for lead is based on the CTR default hardness value of 100 mg/L.

The general NPDES permit for Discharges of Groundwater from Potable Water Supply Wells to Surface Waters (Order No. R4-2003-0108) covers discharges of groundwater from potable supply wells generated during well purging, well rehabilitation and redevelopment, and well drilling, construction and development. Currently, there are approximately six dischargers enrolled under this Order in the Ballona Creek watershed for a combined total discharge flow of 1 MGD.

The general NPDES permit for Discharges of Low Threat Hydrostatic Test Water to Surface Waters (Order No. R4-2004-0109) covers waste discharges from hydrostatic testing of pipes, tanks, and storage vessels using domestic/potable water. Currently, there is one discharger, with a design flow of 0.72 MGD, enrolled under this Order in the Ballona Creek watershed.

Discharges of potable water from water supply wells and from hydrostatic testing have a low potential to contribute metals, pesticides, PCBs or PAHs loadings to Ballona Creek or its tributaries, since these pollutants are not expected to be in potable water. In order to be eligible to be covered under Order Nos. R4-2003-0108 or R4-2004-0109, the discharger must demonstrate that concentrations are not greater than the maximum contaminant levels (MCLs) for drinking water. However, there are no MCLs for the historic pesticides (chlordane, dieldrin, DDT), the MCL for PCBs is greater than the numeric target and the MCLs for the metals are also generally greater than the numeric targets.

Table 4.2 Summary of non-stormwater general permits in Ballona Creek Watershed

Type of NPDES Permit	Number of Permits	Permitted Volume (MGD)	Screening for pollutants?	Permit Limits for pollutants?	Potential for significant contribution?
Construction and Project Dewatering	98	14	Yes	Yes	Low
Petroleum Fuel Cleanup Sites	18	1.6	Yes	Yes	Low
VOCs Cleanup Sites	7	0.5	Yes	Yes	Low
Potable Water	6	1	Yes	Yes	Low
Non-Process Wastewater	3	0.2	Yes	Yes	Low
Hydrostatic Test Water	1	0.7	Yes	Yes	Low

4.2.3. Summary Point Sources

Urban storm water has been recognized as substantial source of metals (Characklis and Wiesner 1997, Davis et al. 2001, Buffleben et al. 2002) and organic pollutants such as PAHs and organochlorine compounds (Suffet and Stenstrom, 1997). This is reflected in routine stormwater monitoring performed by LADPW under the MS4 permit (LADPW, 2002). Studies have also shown that dry-weather pollutant loadings are not insignificant (McPherson et al., 2002). In drier year, the annual dry-weather load associated with urban runoff may be comparable to the annual wet-weather load (Stein et al., 2004).

The total loadings of metals and organic pollutants reflects sum of inputs from urban runoff and multiple NPDES permits within the watershed (see Table 4.1). In the Ballona Creek Watershed stormwater discharges are regulated under the MS4 permit, the Caltrans permit, the general industrial stormwater permit and the general construction stormwater permit. There are sixteen minor NPDES permits with the potential to contribute loadings to the system. There are also over 100 non stormwater general permits with low potential to contribute significant loadings to the system on an individual basis but may in the aggregate contribute significantly to the system

The most prevalent metals in urban storm water (i.e., copper, lead, zinc, and to a lesser degree cadmium) are consistently associated with the suspended solids (Sansalone and Buchberger 1997, Davis et al. 2001). These metals are typically associated with fine particles in storm water runoff (Characklis and Wiesner 1997, Liebens 2001), and have the potential to accumulate in estuarine sediments posing a risk of toxicity (Williamson and Morrisey, 2000). Locally, McPherson et al. (2002) have documented that the majority of storm water metals loading in Ballona Creek is associated with the particle phase.

The organic contaminants in storm water are also associated with suspended solids and the particulate fraction. Noblet et al. (2001) have shown that there is toxicity associated with suspended solids in urban runoff discharged from Ballona Creek, as well as with the receiving water sediments. This toxicity was likely attributed to metals and PAHs associated with the suspended sediments.

The major contributor of associated metals, organochlorine compounds, PCBs and PAHs loading to Ballona Creek and Estuary is assumed to be wet-weather runoff discharged from the storm water conveyance system.

While the loadings of metals (cadmium lead, silver, zinc) and PAHs are attributable to ongoing activities in the watershed, the loadings of PCBs, DDT, chlordane and dieldrin reflect historic uses. Although the uses of these compounds are banned, these legacy pollutants continue to remain elevated in sediments. DDT and PCB loadings appear to have declined over the last 30 years (Stein et al., 2003).

4.3. NONPOINT SOURCES

A nonpoint source is, by definition, runoff that is not covered under any of the storm water permits. An example of this would be the runoff from National Parks and State lands. In the Ballona Creek watershed National Park Service and State lands cover approximately 430 acres (0.5% of the watershed). While not subject to the MS4 Permit, the contribution of runoff from these exempted areas must be accounted for in the TMDL. This can be done through the development of pollutant allocations for the National Parks and State lands or by treating the runoff from these areas as natural background in the TMDL calculation.

Atmospheric deposition may be a potential source of metals and PAHs to the watershed, either through direct or indirect deposition. PAHs are released to the atmosphere through natural and synthetic sources of emissions. The largest sources of PAHs to the atmosphere are from synthetic sources, including wood burning in homes; automobile and truck emissions; and hazardous waste sites such as abandoned wood-treatment plants (sources of creosote) and former manufactured-gas sites (sources of coal tar).

Direct atmospheric deposition can be quantified by multiplying the surface area of the waterbody times the rate of atmospheric deposition. These numbers are generally small because the portion of Ballona Creek watershed that is covered by water is small, approximately 480 acres (0.6% of the watershed). Therefore, it is assumed that the amount of metals and PAHs that would be directly deposited to the waterbodies through atmospheric deposition is insignificant. Indirect atmospheric deposition reflects the process by which metals and PAHs deposited on the land surface may be washed off during storm events and delivered through storm water runoff to Ballona Creek and Estuary. The loading of metals and PAHs associated with indirect atmospheric deposition are accounted for as part of the point source loading from storm water runoff.

5. LINKAGE ANALYSIS, TMDL AND POLLUTANT ALLOCATION

The linkage analysis is used to identify the assimilative capacity of the receiving water for the pollutant of concern by linking the source loading information to the water quality target. The TMDL is then divided among existing pollutant sources through the calculation of load and waste load allocations. This section discusses the linkage analysis used for Ballona Creek and Estuary and identifies the resulting pollutant allocations.

The goal of the contaminated sediment TMDLs is to reduce pollutant loads of cadmium, lead, silver, zinc, chlordane, dieldrin, DDT, PCBs and PAHs from the Ballona Creek watershed to the sediments of estuary. These contaminants which are associated with fine-grained particles are delivered to the sediments through the deposition of these fine-grained particles. It is expected that reductions in loadings of these pollutants will lead to reductions in sediment concentrations over time. The existing contaminants in surface sediments will be removed over time as sediments are scoured during storms or removed in dredging operations. For the legacy pollutants (PCBs, DDT, chlordane and dieldrin), some loss will also occur through the slow decay and breakdown of these organic compounds. Concentrations in surface sediments will be reduced through mixing with cleaner sediments.

The loading capacity of the sediments was estimated from the annual average net deposition of fine-grained material at the mouth of the Ballona Creek Estuary. This was translated into pollutant specific numbers using the sediment targets and an estimate of bulk sediment density of the fine-grained deposits. This provides a pollutant-specific estimate of the maximum load that can be deposited to the sediments on an annual basis. The pollutant-specific loading capacities were then divided into load and waste load allocations using information provided in Section 4 (Source identification).

5.1. LOADING CAPACITY

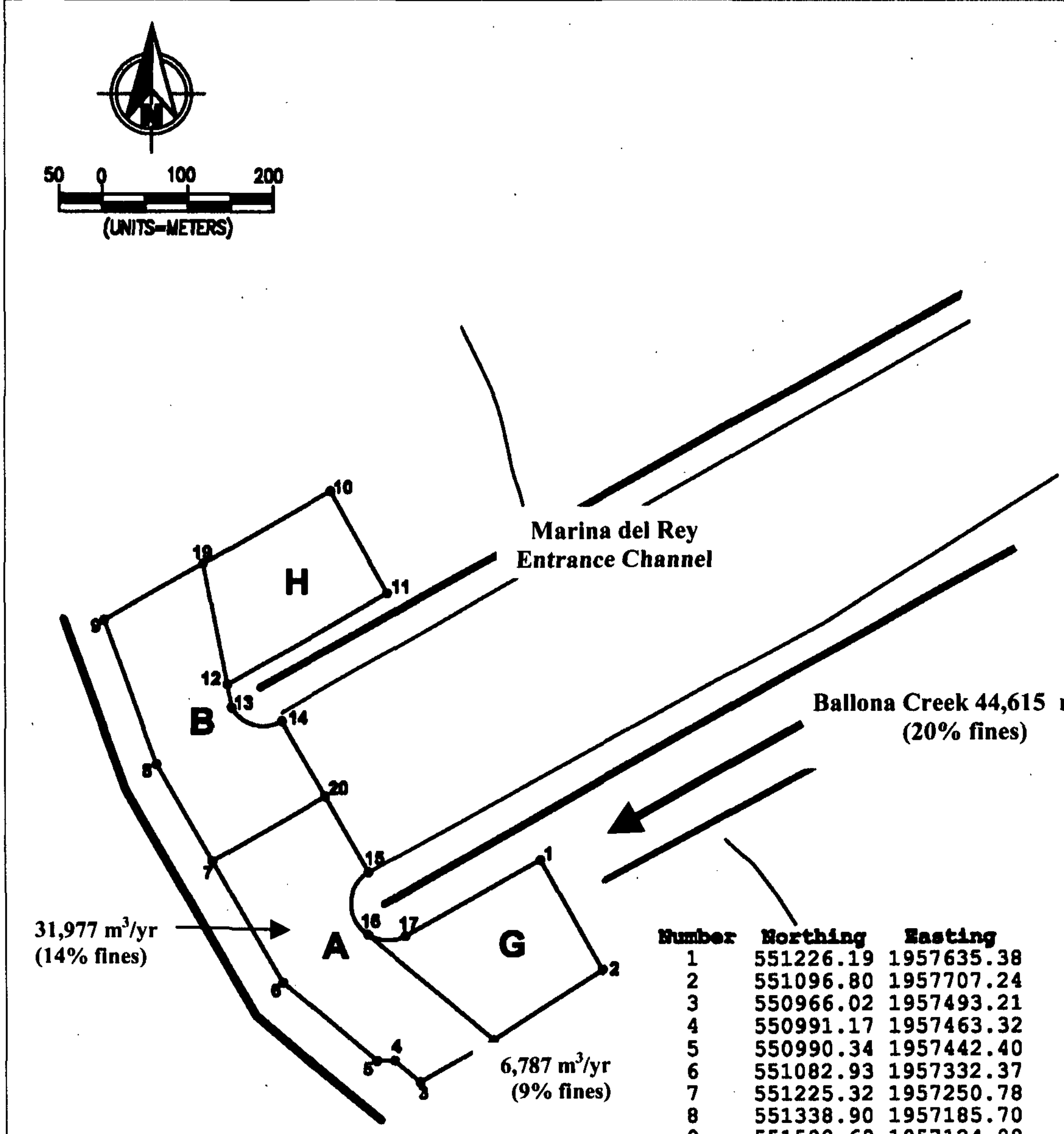
In order to maintain navigability, the USACE needs to dredge the harbor entrance regularly. On average the USACE dredges the entrance to Marina del Rey Harbor every two years. Estimates of the sediment loading capacity were obtained from these historical dredging records. Hydrographic condition, pre-dredge and post-dredge bathymetric surveys of Marina del Rey Harbor were obtained by the USACE for the period between July 1991 and February 2001. Sequential combinations of surveys were then examined to determine shoal volumes within the entrance channel of Marina del Rey Harbor (M&N, 1999, USACE, 2003). The entrance channel was divided into sub-areas to help quantify the spatial distribution of shoaling rates and patterns (Figure 9). Area A and Area B cover the south and north entrance channel, respectively. Area G represents the dredging area at the mouth of Ballona Creek and Area H is the north jetty fillet, which traps sand at the north entrance. Sediment yield from Ballona Creek has been shown to be the main contributor to shoaling in Areas A and G (M&N, 1999, USACE, 2003). The shoal volumes were calculated by overlaying the successive pairs of survey and calculating relative changes in bottom elevation (Table 5-1).

Shoaling volume changes were calculated between sequential bathymetric surveys for periods during which natural processes of shoaling and erosion occurred (i.e. not for periods that included dredging). The shoal volume was then divided by the time period in fraction of years between surveys to give an annual shoaling rate for that period. Annual shoaling rates were then averaged to provide an average annual shoaling rate (Table 5-1). A sufficient number of surveys are desirable to smooth seasonal and annual variations. This calculation provides information on the spatial variation of shoaling rates within each sub-area of the entrance. The average annual sediment discharge from Ballona Creek was estimated to be 44,615 m^3/year. The estimated sedimentation rate at area A was 31,977 m^3/year. The estimated sedimentation rate at Area G was 5,851 m^3/year. Approximately 6,787 m^3/year of sediment is discharged beyond the harbor entrance. The finer material is deposited offshore while the coarser sand material replenishes the down coast beaches. Approximately 5,004 m^3/year of fine sediments are deposited in areas A and G.

Table 5-1. Shoal Volume Change and Annual Shoaling Rate by Sub-Area (USACE, 2003)

Time Period	Yrs.	Area A		Area B		Area G		Area H	
		Δ Vol (m^3)	Rate (m^3/yr)	Δ Vol (m^3)	Rate (m^3/yr)	Δ Vol (m^3)	Rate (m^3/yr)	Δ Vol (m^3)	Rate (m^3/yr)
July 91 – May 92	0.86	20,483	23,734	11,031	12,782	50,548	58,571		
May 92 – Oct 92	0.40	-3,391	-9,448	-1,967	-5,481	-1,751	-4,879		
Dec 92 – Dec 93	1.00	26,297	26,297	18,785	18,785	-13,748	-13,748		
Dec 93 – June 94	0.56	1,005	1,807	1,504	2,704	4,353	7,827		
June 94 – Oct 94	0.50	-9,943	-20,051	-3,629	-7,318	-12,132	-24,465		
Dec 94 – Jan 95	0.10	23,569	238,963	11,987	121,535	1,260	12,775	25,153	250,023
Jan 95 – June 95	0.46	19,291	53,750	17,490	48,732	7,102	19,788		
June 95 – Dec 95	0.50	-8,103	-16,206	-4,983	-9,966	-6,440	-12,880	3,820	3,445
Dec 95 – Mar 96	0.25	14,071	56,284	18,405	73,620	1,862	7,448		
Apr 96 – Sept 96	0.47	4,909	10,540	4,851	10,415	-1,208	-2,594	5,580	11,981
Sept 96 – Aug 97	0.90	8,065	8,975	9,626	10,712	2,515	2,799	38,853	43,236
Aug 97 – Feb 98	0.50	18,554	37,210	25,750	51,641	1,591	3,191	51,732	96,388
Feb 98 – Mar 98	0.04	6,219	162,138	1,952	50,891	2,469	64,370		
Apr 98 – Jun 98	0.14	-1,316	-9,418	-48,269	-77,957	-2,111	-15,108	-36,634	-59,166
Jun 98 – Nov 98	0.48	4,204	8,768			336	701		
Nov 98 – May 99	0.48	310	647	14,280	29,784	-879	-1,833	32,293	67,354
May 99 – Oct 99	0.44	-3,171	-7,145	-357	-804	-3,344	-7,534	-7,100	-15,997
Mar 00 –Feb 01	0.96	8,373	8,732	9,637	10,050	10,439	10,886	56,390	58,807
Average annual shoal rate by area			**31,977**		**20,007**		**5,851**		**51,225**

Figure 9. Marina del Rey Harbor, Entrance Channel Sub-



Number	Northing	Easting
1	551226.19	1957635.38
2	551096.80	1957707.24
3	550966.02	1957493.21
4	550991.17	1957463.32
5	550990.34	1957442.40
6	551082.93	1957332.37
7	551225.32	1957250.78
8	551338.90	1957185.70
9	551508.69	1957124.88
10	551659.69	1957389.72
11	551539.28	1957456.59
12	551432.03	1957268.48
13	551405.28	1957273.63
14	551389.56	1957332.21
15	551211.75	1957433.59
16	551138.41	1957432.47
17	551137.60	1957475.87
18	551015.01	1957579.12
19	551574.89	1957240.99
20	551300.65	1957382.90

NOTE:
1. COORDINATES ARE CALIFORNIA STATE PLAN ZONE V IN METERS (NAD 1983)
2. VERTICAL DATUM BASED ON MEAN LOWER LOW WATER (MLLW).

Aeas

Source: U.S. Army Corps of Engineers, Los Angeles District

The translation to pollutant specific loading capacity was calculated by multiplying the estimated 5,004 m^3/year of fine sediment deposited by the numeric sediment targets (Table 3-1). The bulk sediment density of the deposit was assumed to be 1.42 mt/m^3 (Steinberger et al., 2003). This resultant numbers are presented in Table 5-2. The TMDL is set equal to the loading capacity.

Table 5-2. Relationship between numeric targets and the loading capacity expressed as mass loadings per year

Pollutant	Numeric Target based on ER-L (ug/g)	TMDL Mass loading (kg/year)
Cadmium	1.2	9
Lead	46.7	332
Silver	1	7
Zinc	150	1,066
Chlordane	0.0005	0.004
Dieldrin	0.000023	0.0002
DDT	0.00158	0.011
PCBs	0.0227	0.161
PAHs	4.022	29

Calculations based on net deposit of 37,828 m3/yr, fines 5,004 m3/yr, bulk density of 1.42 mt/m3

5.1.1. Critical Conditions

There is a high degree of inter and intra-annual variability in sediments deposited at the mouth of Ballona Creek. This is a function of the storms which are highly variable between years. Studies by the Corps of Engineers have shown that sediment delivery in Ballona Creek is related to the size of the storm (USACE, 2003). The TMDL is based on a long-term average deposition patterns over a 10-year period from 1991 to 2001. This time period contains a wide range of storm conditions and flows in the Ballona Creek watershed. Use of the average condition for the TMDL is appropriate because issues of sediment effects on benthic communities and potential to for bioaccumulation to higher trophic levels occurs over long time periods.

5.1.2. Margin of Safety

TMDLs must include a margin of safety to account for any uncertainty concerning the relationships between sources and sediment quality. A margin of safety is applied through the use of more protective SQGs values (ERLs) were selected over the higher SQGs (ERMs) as the numeric targets.

5.2. WASTE LOAD ALLOCATIONS

Most contaminants of concern generated in the watershed are transported to the estuary through the stormwater conveyance system. These are regulated directly in the NPDES process through stormwater permits or indirectly through the issuance of NPDES permits for discharges to the stormwater system. Mass-based allocations are developed for the stormwater permittees using the information presented in Table 5-2. Loadings from other point sources are thought to be insignificant (Table 4-2). However to ensure that these sources do not contribute significant loadings, concentration-based allocations are developed for all other NPDES dischargers based on the water quality standards in the CTR.

USEPA requires that waste load allocations be developed for NPDES-regulated storm water discharges. Allocations for NPDES-regulated storm water discharges from multiple point sources may be expressed as a single categorical waste load allocation when data and information are insufficient to assign each source or outfall individual allocations. The WLAs consist of pollutant loadings of metal and organics must be less than the numeric targets as listed in Table 5-2. The WLAs were partitioned among the four stormwater permitees (MS4 storm water permittees, Caltrans storm water permit, the general industrial stormwater and the general construction stormwater permittees) based on an estimate of the percentage of land area covered under each permit (Table 5-3). Estimates of the areas covered under the general industrial stormwater and general construction stormwater permits were made assuming an average of 20 permits in any given year and a maximum size of 5 acres (which is the size limit for coverage under the general permits). Both assumptions are conservative. The contributions of pollutants from area covered under the permit such as park areas or direct atmospheric deposition were estimated in a similar manner and assigned as load allocations for nonpoint sources.

Table 5-3. Areal extent of watershed and percent area covered under stormwater permits

Category	Area in acres	Percent area
MS4 Permit	79,840	97.50%
Caltrans Stormwater Permit	970	1.10%
General Industrial Stormwater Permit	100	0.10%
General Construction Stormwater Permit	100	0.10%
Parks (LA for non-permitted runoff)	430	0.50%
Water (LA for direct atmospheric dep)	480	0.60%
Total	**81,920**	**99.90%**

The WLAs for the stormwater permitees are presented in Table 5-4 and 5-5. In the storm water permits, permit writers may translate the numeric waste load allocations to BMPs, based on BMP performance data. It is anticipated that reductions will be achieved through either pollutant control measures or sediment control measures.

Table 5.4. Mass-based waste load allocations and load allocations for metals (kg/year)

Waste Load Allocations	Cadmium	Lead	Silver	Zinc
MS4 Permit	8.775	323.700	6.825	1039.350
Caltrans Stormwater Permit	0.099	3.652	0.077	11.726
General Industrial Stormwater	0.009	0.332	0.007	1.066
General Construction Stormwater	0.009	0.332	0.007	1.066
Load Allocations	Cadmium	Lead	Silver	Zinc
Parks (LA for non-permitted runoff)	0.045	1.660	0.035	5.330
Water (LA for direct atmospheric dep)	0.054	1.992	0.042	6.396
Total	9.000	332.000	7.000	1066.000

Table 5.5. Mass-based waste load allocations and load allocations for organic pollutants (kg/year)

Waste Load Allocations	Chlordane	Dieldrin	DDT	PCBs	PAHs
MS4	0.003900	0.000195	0.010725	0.156975	28.275
Caltrans	0.000044	0.000002	0.000121	0.001771	0.319
General Industrial Stormwater	0.000004	0.000000	0.000011	0.000161	0.029
General Construction Stormwater	0.000004	0.000000	0.000011	0.000161	0.029
Load Allocations	Chlordane	Dieldrin	DDT	PCBs	PAHs
Parks (LA for non-permitted runoff)	0.000020	0.000001	0.000055	0.000805	0.145
Water (LA for direct atmospheric dep)	0.000024	0.000001	0.000066	0.000966	0.174
Total	0.004000	0.000200	0.011000	0.161000	28.971

Concentration-based WLAs are established for minor NPDES permits and general NPDES permits (other than stormwater permitees) that discharge to Ballona Creek or its tributaries to ensure that these do not contribute significant loadings to the system. The concentration-based WLAs will be based on CTR. The WLAs for metals were developed as part of the Ballona Creek Metals TMDL for both dry and wet-weather conditions. These are incorporated by reference. The freshwater WLAs apply to permits within the watershed which discharge either directly Ballona Creek or indirectly to Ballona Creek or Ballona Creek Estuary. The Saltwater WLAs apply to discharges within the watershed which discharge directly to Ballona Creek Estuary. The WLAs for organics are based on the CTR values human health criteria values (expressed as an annual average). Monitoring requirements will be placed on these discharges as appropriate in their respective NPDES permits. Any future minor NPDES permits or enrolees under a general NPDES permit, general industrial storm water permit or general construction storm water permit will also be subject to the concentration-based WLAs.

Table 5-6. Concentration-based waste load allocations for metals expressed in terms of total recoverable metals (from Ballona Creek Metals TMDL).

Metal	Freshwater Dry WLAs* (µg/L)	Freshwater Wet WLAs* (µg/L)	Saltwater Dry WLAs (µg/L)	Saltwater Wet WLAs (µg/L)
Cadmium	5.8	3.4	9.4	42
Copper	24	11	3.7	5.8
Lead	13	59	8.5	220
Selenium	5.0	5.0	71	290
Silver	27	2.6	2.2	2.2
Zinc	300	96	86	95

* Freshwater targets for dry weather are based on a hardness of 300 mg/L. Freshwater targets for wet targets are based on a hardness value of 77 mg/l.

Table 5-7. Concentration-based waste load allocations for organic pollutants

Organic Pollutant	Concentrations ((µg/L)
Chlordane	0.00057
Dieldrin	0.00014
4'4'-DDT	0.00059
Total PCBs	0.00017

5.3. LOAD ALLOCATIONS

The only expected significant source of sediments to Ballona Creek and Estuary is from storm water runoff. The storm water in the Ballona Creek watershed is covered under the MS4 permit, Caltrans permit, and the general industrial and general construction stormwater permits. There is very little area in the watershed. Approximately 99.5% of the land area of watershed is covered under these permits. The land area belonging to the National Park Service and State Lands in the Ballona Creek Watershed is about 0.5% of the total area. The area of surface water subject to loadings from direct atmospheric deposition is about 0.5% of the total area. The loadings of pollutants from these areas are small. The cumulative load from these sources is about 1% of the total load. The mass-based load allocations from these two sources for metals and organic pollutants are presented in Tables 5-4 and 5-5. These load allocations may change if it is determined through future studies that the contributions from natural sources or atmospheric deposition are significant.

5.4. SUMMARY OF TMDL.

The TMDL is based on pollutant loadings to the sediments of Ballona Creek Estuary. The loading capacity is based on an estimate of the annual pollutant loads that can be delivered to the sediments and still meet the sediment targets. A margin of safety is provided through the use of ER-Ls. A grouped waste load allocation has been developed for the stormwater permitees (MS4, CalTrans, general industrial and construction stormwater permittees). Concentration-based WLAs will also be applied to all other NPDES permittees. It is anticipated that implementation will be based on BMPs which address pollution prevention and/or sediment reduction. Compliance with the TMDL will be determined through sediment monitoring program.

6. Implementation

As required by the federal Clean Water Act, discharges of pollutants to Ballona Creek and its tributaries from municipal storm water conveyances are prohibited, unless the discharges are in compliance with a NPDES permit. The Los Angeles County Municipal Storm Water NPDES Permit, the State of California Department of Transportation (Caltrans) Storm Water Permit and the State issued general industrial and general construction storm water permits will be the key implementation tools for this TMDL. In addition, the individual NPDES permits and general NPDES permits issued by the Regional Board will also be used to implement this TMDL. Future NPDES permits will be modified in order to address implementation and monitoring of this TMDL and to be consistent with the waste load allocations of this TMDL.

The administrative record and the fact sheets for the MS4 permit, Caltrans permit and the general storm water permits must provide reasonable assurance that the BMPs selected will be sufficient to implement the waste load allocations in the TMDL. We expect that reductions to be achieved by each BMP will be documented and that sufficient monitoring will be put in place to verify that the desired reductions are achieved. The permits should also provide a mechanism to make adjustments to the required BMPs as necessary to ensure their adequate performance. If non-structural BMPs alone adequately implement the waste load allocations then additional controls are not necessary. Alternatively, if the non-structural BMPs selected prove to be inadequate then structural BMPs or additional controls may be required.

The Regional Board has signaled that it will allow seven years for the stormwater permittees to achieve the mass-based WLAs. The individual and general NPDES permits shall incorporate the concentration-based water quality WLAs upon permit issuance or renewal.

Each municipality and permittee will be required to meet the WLAs at the designated assessment locations as defined in the TMDL effectiveness monitoring plan. Flexibility will be allowed in determining how to reduce these toxic pollutants as long as the WLAs are achieved. It is anticipated that implementation strategies will be integrated with other TMDLs in the watershed and the City of Los Angeles' Integrated Wastewater Program.

7. MONITORING

The monitoring program has three objectives. The first is to collect additional water and sediment quality data (e.g., metals and organochlorine concentrations) to evaluate assumptions made in the TMDL, including the loading and extent of exceedances. The second is to assess the effectiveness of the TMDL and ultimately achieving the waste load allocations. The third is to conduct special studies to address the uncertainties in the TMDL and to assist in the design and sizing of BMPs.

7.1. AMBIENT MONITORING

An ambient monitoring program is required to assess water quality throughout Ballona Creek and its tributaries and to assess sediment quality in Ballona Creek Estuary. Data on background water quality for organics and sediments will help refine the numeric targets and waste load allocations and assist in the effective placement of BMPs.

Samples shall be analyzed for chlordane, dieldrin, DDT, total PCBs and total PAHs at detection limits that are at or below the minimum levels. The minimum levels are those published by the State Water Resources Control Board in Appendix 4 of the Policy for the Implementation of Toxic Standards for Inland Surface Water, Enclosed Bays, and Estuaries of California, March 2, 2000. Initial test should focus on estimates of water quality to determine if there are water quality impacts. Special emphasis should be placed on achieving detection limits that will allow evaluation relative to the CTR standards. If these can not be achieved with conventional techniques, then a special study should be proposed to evaluate concentrations of organics.

Stormwater monitoring should continue to provide assessment of water quality during wet-weather conditions and load estimates from the watershed to the estuary. However, special emphasis should be placed on achieving lower detection limits for DDTs, PCBs.

Representative sediment sampling locations shall be randomly selected within the Estuary and analyzed for cadmium, lead, silver, zinc, chlordane, dieldrin, DDT, total PCBs and total PAHs at detection limits that are lower than the ERLs. Sediment samples shall be analyzed for total organic carbon, grain size and sediment toxicity. Initial sediment monitoring should be done in the first year of the TMDL to refine the baseline and during the fifth year of the TMDL to evaluate effectiveness and regularly every five years.

7.2. EFFECTIVENESS MONITORING

Permittees will be asked to develop an effectiveness monitoring program. This should include a plan to provide 1) annual estimates of mass loadings, 2) an evaluation of sediment concentrations in the estuary at five year intervals and 3) an evaluation of effectiveness of proposed BMPs to reduce loadings to the system.

7.3. SPECIAL STUDIES

Special studies are recommended to refine source assessments, to provide better estimates of loading capacity, to optimize implementation efforts. The Regional Board will re-consider the TMDL in the sixth year after the effective date in light of the findings of these studies. Special studies may include:

Evaluation and use of low detection level techniques to evaluate water quality concentrations for those contaminants were standard detection limits cannot be used to assess compliance for CTR standards or are not sufficient for estimating source loadings from tributaries and stormwater

Evaluation and use of sediment TIEs to evaluate causes of any recurring sediment toxicity

Studies to refine relationship between pollutants and suspended solids aimed at better understanding of the delivery pollutants to the watershed.

Studies to understand transport of sediments to the estuary, including the relationship between storm flows, sediment loadings to the estuary, and sediment deposition patterns within the estuary

Studies to evaluate effectiveness of BMPs to address pollutants and/or sediments

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1.1 MONITORING PROGRAM OBJECTIVES

The major objectives of the Monitoring Program outlined in the Municipal Storm Water Permit are to:

- Assess compliance with the Los Angeles County Municipal Storm Water Permit No. CAS004001;
- Measure and improve the effectiveness of the Stormwater Quality Management Plans (SQMPs);
- Assess the chemical, physical, and biological impacts of receiving waters resulting from urban runoff;
- Characterize storm water discharges;
- Identify sources of pollutants; and
- Assess the overall health and evaluate long-term trends in receiving water quality.

The Monitoring Program, developed to address these objectives, has several elements: core monitoring, which includes mass emission monitoring, water column toxicity monitoring, tributary monitoring, shoreline monitoring, and trash monitoring; regional monitoring, which includes estuary sampling and bioassessment; and three special studies, which include the new development impacts study in the Santa Clara Watershed, the peak discharge impact study, and the Best Management Practice (BMP) effectiveness study.

1.2 MONITORING PROGRAM STATUS

The 1994-95 storm season was the first for which storm water monitoring was required under the 1990 Los Angeles County National Pollutant Discharge Elimination System (NPDES) Municipal Storm Water Permit (No. CA0061654). During the 1994-95 and 1995-96 seasons, automated and manual sampling was conducted to characterize storm water quality and quantity in accordance with the 1990 Municipal Storm Water Permit.

The 1996-97 season was the first storm season in which storm water monitoring was conducted under the 1996 Municipal Storm Water Permit (No. CAS614001). Under the 1996 Municipal Storm Water Permit, the scope of the Monitoring Program was expanded to incorporate further data collection through the Mass Emission, Land Use, and Critical Source Monitoring Programs, and new pilot studies, such as "Wide Channel" and "Low Flow" analyses.

Under the 2001 Municipal Storm Water Permit (No. CAS004001) adopted on December 13, 2001, the Monitoring Program eliminated Land Use and Critical Source elements and focused on core monitoring, regional monitoring, and three special studies. Due to varying compliance dates for each element, only mass emission, water column toxicity, and shoreline monitoring under the core monitoring program were addressed in the 2001-2002 Monitoring Report. The 2002-2003 Monitoring Report addresses mass emission monitoring, tributary monitoring, water column toxicity monitoring, shoreline monitoring, and trash monitoring under the core monitoring program, estuary sampling and bioassessment under the regional monitoring program, and the progress of the three special studies.

1.2.1 Core Monitoring

1.2.1.1 Mass Emission Monitoring

The objectives of mass emission monitoring are to estimate the mass emissions from the Municipal Separate Storm Sewer System (MS4), assess trends in the mass emissions over time, and determine if the MS4 is contributing to exceedances of water quality standards by comparing results to applicable standards in the Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties (Basin Plan), the California Ocean Plan (Ocean Plan), or the California Toxics Rule (CTR), and with emissions from other discharges.

Seven mass emission monitoring sites, Ballona Creek, Malibu Creek, Los Angeles River, Coyote Creek, San Gabriel River, Dominguez Channel, and Santa Clara River, were utilized to achieve the objectives outlined above during the 2002-2003 reporting period. Mass emission stations capture runoff from major Los Angeles County watersheds that generally have heterogeneous land use. All mass emission sites, except the Santa Clara River site, are equipped with automated samplers with integral flow meters for collecting flow-composite samples. Sampling at the Santa Clara River began during the 2002-2003 storm season. Although sample collections at the Santa Clara River station are performed manually, composite samples are achieved using the flow measurements by a United States Geological Survey (USGS) stream gage on-site. Four storm events and two dry weather events were sampled at each mass emission site. Total Suspended Solids (TSS) were collected from five storm events at the Santa Clara mass emission site, six storm events at Malibu Creek, San Gabriel River, and Dominguez Channel mass emission sites, seven storm events at Ballona Creek and Coyote Creek mass emission sites, and from eight storm events at the Los Angeles River mass emission site.

1.2.1.2 Water Column Toxicity Monitoring

The objectives of water column toxicity monitoring are to evaluate the extent and causes of toxicity in receiving waters and to modify and utilize the SQMP to implement practices that eliminate or reduce sources of toxicity in storm water.
Composite samples were taken at the mass emission monitoring stations. Two storm events and two dry weather events were sampled at each mass emission site during the 2002-2003 season. The sea urchin fertilization test could not be performed on the October 9, 2002 wet weather sample because the purple sea urchin did not spawn due to seasonal variability.

1.2.1.3 Tributary Monitoring

The objectives of tributary monitoring are to identify sub-watersheds where storm water discharges are causing or contributing to exceedances of water quality standards, and to prioritize drainage and sub-drainage areas that need management actions.

Sampling for the 2002-2003 season was conducted at six tributary monitoring stations in the Los Angeles River Watershed. The tributaries monitored included Aliso Creek, Bull Creek, Burbank

Western System Channel, Verdugo Wash, Arroyo Seco Channel, and Rio Hondo Channel. Automatic flow weighted composite samples were taken from each tributary location. Grab samples were also taken at these locations. Five storm events and one dry event were sampled at each tributary monitoring site.

1.2.1.4 Shoreline Monitoring

The City of Los Angeles is required to monitor shoreline stations to evaluate the impacts to coastal receiving waters and the loss of recreational beneficial uses resulting from storm water/urban runoff. Also, the Municipal Storm Water Permit requires the City of Los Angeles to annually assess shoreline water quality data and submit it to the Principal Permittee for inclusion in the monitoring report. Therefore, the City of Los Angeles' assessment is included in Appendix D of this monitoring report.

1.2.1.5 Trash Monitoring

The objectives of trash monitoring are to assess the quantities of trash in receiving waters after storm events and to identify areas impaired for trash. Visual observations of trash were made and a minimum of one photograph at each mass emission station was taken after four storm events including the first storm event.

In addition, a minimum of ten representative sites for each land use monitored were sampled. On average, each sampling site contained a minimum of five catch basins fitted with inserts with a total of 256 inserts within the Los Angeles Watershed Management Area (WMA) and 309 inserts within the Ballona Creek WMA. Three structural full capture devices were installed downstream of three separate sampling sites within the Ballona Creek WMA. All of the upstream catch basins were fitted with inserts. Each insert and the full capture devices were emptied within 72 hours of every rain event of 0.25 inches or greater.

1.2.2 Regional Monitoring

Los Angeles County Department of Public Works (LACDPW), representing the Flood Control District, is participating in regional monitoring programs that address public health concerns, monitor trends in natural resources and near shore habitats, and assess regional impacts from storm water pollutant sources. Those regional programs include the following:

1.2.2.1 Estuary Sampling

In compliance with Section II.F of the storm water monitoring requirements, LACDPW is participating in the coastal ecology committee of the Bight 2003 project coordinated by the Southern California Coastal Waters Research Project (SCCWRP). The two primary objectives of Bight '03 are to estimate the extent and magnitude of ecological change in the Southern California Bight (SCB) and to determine the mass balance of pollutants that currently reside within the SCB. The goal of the estuary monitoring program is to sample estuaries for sediment chemistry, sediment toxicity, and benthic macroinvertebrate diversity to determine the spatial extent of sediment fate from storm water, and the magnitudes of its effects. In Los Angeles County, the estuaries being sampled are those of: Malibu Creek, Ballona Creek, Los Angeles River, San Gabriel River, and Dominguez Channel.

Since the beginning of 2003, LACDPW staff has been involved in the design of the sampling program through regular attendance of the Bight '03 Coastline Ecology Committee meetings. To date, SCCWRP and the Committee have developed a work plan, which includes the following schedule:

- Collect samples by September 2003
- Submit data by September 2004
- Submit reports to SCCWRP by September 2006
- SCCWRP to complete executive summary no later than December 2006

1.2.2.2 Bioassessment

Section II.G of the storm water monitoring requirements requires LACDPW to perform annual bioassessments on streams in Los Angeles County beginning in October 2003. On May 22, 2003, a list of 20 stream sampling sites was approved by the Los Angeles Regional Water Quality Control Board (RWQCB). The sampling sites are located in each of the six major watersheds throughout Los Angeles County. Table 1-1 lists the sampling station locations and Figure 1-1 is a map showing the geographical location of the sampling stations.

1.2.3 Special Studies

As required by the 2001 Municipal Storm Water Permit, LACDPW, representing the Flood Control District, is conducting special monitoring programs, including the following:

1.2.3.1 New Development Impacts Study in the Santa Clara Watershed

The objective of the New Development Impacts Study in the Santa Clara Watershed is to evaluate the effectiveness of the Standard Urban Storm Water Mitigation Plan (SUSMP) Best Management Practices at reducing pollutants in storm water runoff. This evaluation will be accomplished by comparing the water quality of runoff from a new development constructed in accordance with SUSMP requirements to a development similar in size and land use constructed prior to the adoption of SUSMP requirements.

On August 1, 2002, with the assistance of the City of Santa Clarita, LACDPW submitted a work plan for the study to the Los Angeles RWQCB for approval. Following discussions and revisions to the proposal, the RWQCB accepted a revised work plan on April 10, 2003. Sampling will begin in the 2003-04 storm season, and results will be included in the 2003-2004 storm water monitoring report.

1.2.3.2 Peak Discharge Impact Study

The goal of this study is to assess the potential cause and effect relationships between stream erosion and urbanization in watersheds in Los Angeles County and to create, if possible, an Index of Biological Indicators with data from surrounding counties. The Southern California Coastal Waters Research Project (SCCWRP) is managing the project on behalf of the County and Flood Control District. A committee comprised of members of the Southern California Stormwater Monitoring Coalition is overseeing progress of the study.

In March, 2003, the contractor developed a set of site-selection criteria in coordination with the Stormwater Monitoring Coalition. As of July 2003, the contractor reported having tentatively selected three out of the ten required test sites. A draft work plan is scheduled for submission to the Stormwater Monitoring Coalition in September 2003. Final report submittal is scheduled for Spring 2004.

1.2.3.3 BMP Effectiveness Study

The Flood Control District is participating in the Santa Monica Bay Restoration Commission's (SMBRC) "Performance Evaluation of Structural BMPs for Stormwater Pollution Control in the Santa Monica Bay Watershed" study to fulfill this requirement. The SMBRC's study is in the site selection stage.

To characterize the runoff quality in Los Angeles County, mass emission sites have been selected for monitoring. To evaluate the runoff quality of various subwatersheds, tributary sites were established in the Los Angeles River watershed.

2.1 MASS EMISSION SITE SELECTION

The LACDPW monitored at seven mass emission stations, Ballona Creek, Malibu Creek, Los Angeles River, Coyote Creek, San Gabriel River, Dominguez Channel, and Santa Clara River. Four of the mass emission monitoring stations installed under the original 1990 Permit were retained under the 1996 and the 2001 Municipal Storm Water Permit; specifically Ballona Creek, Malibu Creek, Los Angeles River, and San Gabriel River. The Coyote Creek monitoring station was monitored under the 1990, 1996, and 2001 Municipal Storm Water Permit, though monitoring was not required under the 1996 Municipal Storm Water Permit. Monitoring began at Dominguez Channel mass emission station during the 2001-2002 season. Sampling at the Santa Clara mass emission station began during the 2002-2003 season. The seven mass emission monitoring stations were used to collect water quality data from 2060 square miles.

2.2 MASS EMISSION MONITORING LOCATIONS AND DRAINAGE AREAS

Figure 2-1 is an overview of the study area with all mass emission monitoring sites shown. Table 2-1 also indicates the dominant land use associated with each monitoring site and the total drainage area.

Provided below is a description of the seven mass emission stations, Ballona Creek, Malibu Creek, Los Angeles River, San Gabriel River, Coyote Creek, Dominguez Channel, and Santa Clara River, required by the Municipal Storm Water Permit for the 2002-2003 monitoring period. Figures 2-2 through 2-8 show the location of each monitoring station along with a description of its land use.

Ballona Creek Monitoring Station (S01)

The Ballona Creek monitoring station is located at the existing stream gage station (Stream Gage No. F38C-R) between Sawtelle Boulevard and Sepulveda Boulevard in the City of Los Angeles. At this location, which was chosen to avoid tidal influences, the upstream tributary watershed of Ballona Creek is 88.8 square miles. The entire Ballona Creek Watershed is 127.1 square miles. At the gauging station, Ballona Creek is a concrete lined trapezoidal channel.

Malibu Creek Monitoring Station (S02)

The Malibu Creek monitoring station is located at the existing stream gage station (Stream Gage No. F130-9-R) near Malibu Canyon Road, south of Piuma Road. At this location, the tributary watershed to Malibu Creek is 104.9 square miles. The entire Malibu Creek Watershed is 109.9 square miles.

Los Angeles River Monitoring Station (S10)

The Los Angeles River Monitoring Station is located at the existing stream gage station (Stream Gage No. F319-R) between Willow Street and Wardlow Road in the City of Long Beach. At this location, which was chosen to avoid tidal influences, the total upstream tributary drainage area for the Los Angeles River is 825 square miles. This river is the largest watershed outlet to the Pacific Ocean in Los Angeles County. At the site, the river is a concrete lined trapezoidal channel.

Coyote Creek Monitoring Station (S13)

The Coyote Creek Monitoring Station is located at the existing ACOE stream gage station (Stream Gage No. F354-R) below Spring Street in the lower San Gabriel River watershed. The site assists in determining mass loading for the San Gabriel River watershed. At this location, the upstream tributary area is 150 square miles (extending into Orange County). The sampling site was chosen to avoid backwater effects from the San Gabriel River. Coyote Creek, at the gauging station, is a concrete lined trapezoidal channel. The Coyote Creek sampling location has been an active stream gauging station since 1963.

San Gabriel River Monitoring Station (S14)

The San Gabriel River Monitoring Station is located at an historic stream gage station (Stream Gage No. F263C-R), below San Gabriel River Parkway in Pico Rivera. At this location the upstream tributary area is 450 square miles. The San Gabriel River, at the gauging station, is a grouted rock-concrete stabilizer along the western levee and a natural section on the eastern side. Flow measurement and water sampling are conducted in the grouted rock area along the western levee of the river. The length of the concrete stabilizer is nearly 70 feet. The San Gabriel River sampling location has been an active stream gauging station since 1968.

Dominguez Channel Monitoring Station (S28)

The Dominguez Channel Monitoring Station is located at Dominguez Channel and Artesia Boulevard in the City of Torrance. At this location, which was chosen to avoid tidal influence, the upstream tributary area is 33 square miles. The portion of the river where the monitoring site is located is a concrete-lined rectangular channel.

Santa Clara River Monitoring Station (S29)

The Santa Clara monitoring station is located at the Santa Clara River and The Old Road in Santa Clara. The Santa Clara River has a soft bottom for the most part, which makes flow monitoring extremely difficult. This location was chosen because flow monitoring was possible from the existing USGS 11108000 Santa Clara River near Saugus California stream gauging station. The upstream tributary area is 411 square miles.

2.3 TRIBUTARY SITE SELECTION

All six of the tributary monitoring stations, Aliso Creek, Bull Creek, Burbank Western System, Verdugo Wash, Arroyo Seco Channel, and Rio Hondo Channel, were established under the 2001 Municipal Storm Water Permit. Monitoring began during the 2002-2003 season. The six tributary monitoring stations were used to collect water quality data from subwatersheds in the Los Angeles River WMA.

2.4 TRIBUTARY MONITORING LOCATIONS AND DRAINAGE AREAS

Figure 2-9 is an overview of the study area showing all the tributary monitoring sites. Figure 2-1 shows the location of the tributary monitoring sites in relation to the mass emission monitoring sites.

Provided below is a description of the six tributary monitoring stations required by the Municipal Storm Water Permit for the 2002-2003 monitoring period. The tributary stations include Aliso Creek, Bull Creek, Burbank Western System Channel, Verdugo Wash, Arroyo Seco Channel, and Rio Hondo Channel. Figures 2-10 through 2-15 show the location of each monitoring station.

Aliso Creek Tributary Monitoring Station (TS01)

Aliso Creek monitoring station is located at the southeast corner of the bridge on Saticoy over Aliso Creek Channel, in Reseda, California. The upstream tributary watershed area of Aliso Creek is approximately 21 square miles.

Bull Creek Tributary Monitoring Station (TS02)

Bull Creek monitoring station is located at the northeast corner of the bridge on Victory Boulevard over Bull Creek Channel, in Lake Balboa, California. The upstream tributary watershed area of Bull Creek is approximately 23 square miles.

Burbank Western System Monitoring Station (TS03)

Burbank Western monitoring station is located at the northwest corner of the bridge on Riverside Drive over the Burbank – Western Channel in Glendale, California. This is the same location as the Department's stream gaging station (E285-R). The upstream tributary watershed of the Burbank Western Channel is approximately 26 square miles.

Verdugo Wash Tributary Monitoring Station (TS04)

Verdugo Wash monitoring station is located at the south bank of Verdugo Wash, approximately 100 feet west of the bridge on Jackson Street, in the City of Glendale, California. The upstream tributary watershed area of the Verdugo Wash is approximately 30 square miles.

Arroyo Seco Channel Tributary Monitoring Station (TS05)

Arroyo Seco monitoring station is located on the east bank of the Arroyo Seco Channel, approximately ¼ mile south of the bridge on Avenue 52, and around the ramped entrance to the Arroyo Seco Channel at the Ernest Debs Regional Park, in the Montecito Heights area of Los Angeles City. The upstream tributary watershed area of the Arroyo Seco is approximately 47 square miles.

Rio Hondo Channel Tributary Monitoring Station (TS06)

Rio Hondo Channel monitoring station is located on Beverly Boulevard, downstream of Whitter Narrows dam, at the USGS – U.S. Army Corps of Engineers (ACOE) Stream gage No. 1102300 or E327-R. The upstream tributary watershed area is approximately 142 square miles.

This section describes the field and laboratory methods used to implement the Monitoring Program, which includes precipitation and flow monitoring, storm water sampling, and laboratory analyses.

3.1 PRECIPITATION AND FLOW MEASUREMENT

3.1.1 Precipitation Monitoring

For every monitoring station, a minimum of one automatic tipping bucket (intensity measuring) rain gage is located nearby or within the tributary watershed. Large watersheds may require multiple rain gages to accurately characterize the rainfall. The LACDPW operates various automatic rain gages throughout the county. Existing gages near the monitored watersheds are also utilized in calculating storm water runoff and are essential to develop runoff characteristics for these watersheds.

3.1.2 Flow Monitoring

Flow monitoring equipment is needed to trigger the automated samplers because the Monitoring Program requires flow-weighted composites for many constituents. Flows are determined from measurements of water elevation as described below.

The water elevation in a storm drain is measured by the stage monitoring equipment, and the flow rate is derived from a previously established rating table for the site or calculated with an equation such as Manning's. The LACDPW uses rating tables generated from analysis of storm drain cross sections and upstream/downstream flow characteristics. The rating tables are modified if it is demonstrated in the field through stream velocity measurements that calculated table values are incorrect. Previous storm water flow measurement efforts indicates that all stations will require multiple storm events to gather the data necessary for calibration of the measurement devices.

The automatic samplers utilize pressure transducers as the stage measurement device. However, pressure transducers are only accurate as flow measurement devices in open channel flow regimes. Therefore, for stations monitoring flows in underground storm drains, efforts were made to select drains that do not surcharge (flow under pressure) during events smaller than a 10-year storm event.

3.2 STORM WATER SAMPLING

3.2.1 Sample Collection Methods

Grab and composite sample collection methods, defined below, were used during the 2002-2003 storm season.

- **Grab Sample** - a discrete, individual sample taken within a short period of time, usually less than 15 minutes. This method is used to collect samples for constituents that have very short holding times and specific collection or preservation needs. For example, samples for coliforms are taken directly into a sterile container to avoid non-resident bacterial contamination.

- **Composite Sample** - a mixed or combined sample created by combining a series of discrete samples (aliquots) of specific volume, collected at specific flow-volume intervals. Composite sampling is ideally conducted over the duration of the storm event.

During a storm event, grab samples were collected during the initial portion of the storm (on the rising limb of the hydrograph) and taken directly to the laboratory.

Flow composite storm samples were obtained using an automated sampler to collect samples at flow-paced intervals. Samples collected at each station were combined in the laboratory to create a single flow-weighted sample for analysis.

During the storm season, the sampler was programmed to start automatically when the water level in the channel or storm drain exceeded the maximum annual dry weather stage. A sample was collected each time a set volume of water had passed the monitoring point (this volume is referred to as the pacing volume or trigger volume). The sample was stored in glass containers within the refrigerated sampler. A minimum of eight liters of sample was required to conduct the necessary laboratory analyses for all the constituents. The automated sampler was deactivated by field personnel when the water level in the channel or storm drain fell to about 120 percent of the observed maximum annual dry weather flow stage.

Samples were retrieved from the automated samplers as soon as possible to meet laboratory analysis holding time requirements. As samples were collected, rainfall and runoff data were logged and stored for transfer to the office.

3.2.2 Field Quality Assurance/Quality Control Plan

Properly performed monitoring station set up, water sample collection, sample transport, and laboratory analyses are vital to the collection of accurate data. Quality Assurance/Quality Control (QA/QC) is an essential component of the monitoring program.

Evaluation of Analytes and QA/QC Specifications for Monitoring Program (Woodward-Clyde, 1996a) describes the procedures used for bottle labeling, chain-of-custody tracking, sampler equipment checkout and setup, sample collection, field blanks to assess field contamination, field duplicate samples, and transportation to the laboratory.

An important part of the QA/QC Plan is the continued education of all field personnel. Field personnel were adequately trained from the onset and informed about new information on storm water sampling techniques on a continuing basis. Field personnel also evaluate the field activities required by the QA/QC Plan, and the Plan is updated if necessary.

Bottle Preparation

For each monitoring station, a minimum of three sets of bottles was available so that up to two complete bottle change-outs could be made for each storm event. Bottle labels contained the following information:

- LACDPW Sample ID Number

Travel Blanks and Field Duplicates

Potential field contamination was assessed through analysis of travel blanks and duplicate grab samples. Field travel blanks were collected for each monitoring station during every sampling event to quantify post sampling contamination. The monitoring program also included field duplicates to assess the precision of laboratory results. A field duplicate, the origin of which was unknown to the laboratory, was collected for each sampling event. This methodology for assessing post sampling contamination and laboratory testing procedures provided data to measure the precision and accuracy of the laboratory results.

3.3 LABORATORY ANALYSES

The Department of Agricultural Commissioner/Weights and Measures (ACWM) Environmental Toxicology Laboratory provides water quality laboratory and related services to the LACDPW. The ACWM lab is state certified to perform the water quality analyses contracted by LACDPW. The ACWM Lab maintains a laboratory analysis program that includes Quality Assurance and Quality Control protocols consistent with the objectives of the monitoring program required by the Permit.

3.3.1 Chemical and Biological Analysis

The suite of analyses and associated minimum levels (MLs) for samples collected at mass emission stations are specified in the Municipal Storm Water Permit. All the laboratory methods used for analysis of the storm water samples are approved by the California Department of Health Services and are in conformance with U.S. Environmental Protection Agency (USEPA) approved methods.

Table 3-1 shows all the constituents monitored during the 2002-2003 reporting period, including constituents analyzed with composite or grab samples. The table lists the method number, the PQL (which is the same as ML as defined in the Municipal Storm Water Permit), the method detection limit (MDL), and other relevant information for each constituent.

The Municipal Storm Water Permit defines MDL and ML (i.e. PQL) as follows:

MDL means the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero. ML means the concentration at which the entire analytical system must give a recognizable signal and acceptable calibration point. The ML is the concentration in a sample that is equivalent to the concentration of the lowest calibration standard analyzed by a specific analytical procedure, assuming that all the method specified sample weights, volumes, and processing steps have been followed. Throughout this report, "0" for sample results indicates the analyte concentration is less than the ML.

The primary objective of the laboratory QA/QC program is to ensure that the analyses are scientifically valid, defensible, and of known precision and accuracy. The ACWM laboratory maintains QA/QC procedures (as described in their Quality Assurance Manual) in accordance with requirements of the California Department of Health Services. The ACWM laboratory standard operation procedures include method validation, equipment calibration, preventive maintenance, data validation procedures, assessment of accuracy and precision, corrective actions, and performance and system audits. ACWM Lab conducted the QA/QC review and data validation for the 2002-2003 monitoring data, and the QA/QC documentation is available within

- Station Number
- Station Name
- Sample Type (Grab or Composite)
- Laboratory Analysis Requested
- Date
- Time
- Preservative
- Temperature
- Sampler's Name

Bottles were cleaned at the laboratory prior to use, then they were labeled and stored in sets. Each station was provided with the same number, types, and volumes of bottles for each rotation unless special grab samples were required. Clean composite sample bottles were placed in the automated sampler when samples were collected. This practice ensured readiness for the next storm event. All bottles currently not in use were stored and later transported in plastic ice chests. Composite sample bottles were limited to a maximum of 2-1/2 gallons each, to ensure ease of handling.

Chain-of-Custody Procedure

Chain-of-custody forms were completed to ensure and document sample integrity. These procedures establish a written record which tracks sample possession from collection through analysis.

Field Setup Procedures

All field sampling locations were fixed sites, with the sampler placed on a public road or flood control right-of-way. After sample collection, field staff prepared the sampler for collection of the next set of samples either in storm mode or in dry weather mode. Inspection of visible hoses and cables was performed to ensure proper working conditions according to the site design. Inspection of the strainer, pressure transducer, and auxiliary pump was performed during daylight hours in non-storm conditions.

The automated sampler was checked at the beginning of the storm (during grab sample collection) to ensure proper working condition and to see if flow composite samples were being collected properly. Dry weather collection techniques were similar, with grab and 24-hour composite samples being collected.

Bottles were collected after each event and packed with ice and foam insulation inside individually marked ice chests. Chain-of-custody forms were completed by field staff before transportation of the samples to the laboratory. Under no circumstance were samples removed from the ice chest during transportation from the field to the laboratory.

the ACWM Lab files. The validated data as provided by the ACWM Lab were used for data analysis and interpretation with no further QA/QC review.

3.3.2 Toxicity Analysis

The samples were subjected to the Ceriodaphnia dubia 7-day survival and reproduction tests in addition to the Strongylocentrotus purpuratus (sea urchin) fertilization test as a measure of toxicity. Performed as multi-concentration tests, sample concentrations of 100%, 56%, 32%, 18%, 10% and 0% (N-control) were used to determine the level of toxicity. These tests were conducted under guidelines prescribed in *Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to West Coast Marine and Estuarine Organisms* (US EPA, 1995).

Water quality measurements (temperature, pH, dissolved oxygen, hardness, conductivity, and alkalinity) were made for each sample at the beginning and throughout each test. These measurements were performed to ensure there were no large variations in water quality, which can affect the accuracy of the toxicity tests.

This section describes the results, data analysis, and recommendations for the 2002-2003 Monitoring Program.

4.1 HYDROLOGY: PRECIPITATION AND FLOW

The monthly rainfall during the 2002-2003 storm season was compared to the long-term pattern of rainfall in Figure 4-1. During this storm season, the total rainfall was about 15.45 inches, which is about three times more than the rainfall recorded during the 2001-2002 storm season. Figure 4-2 shows that the total annual rainfall of 15.45 inches during the 2002-2003 storm season in Los Angeles County was very close and just below the average annual rainfall. The average annual rainfall over 130 years at Station # 716, Ducommun Street in downtown Los Angeles is about 15.51 inches.

Table 4-1 summarizes the hydrologic and meteorologic conditions of each station-event monitored during this storm season. A collection of 2002-2003 season hydrographs for each storm event from the monitored sites is included in Appendix A. Each hydrograph includes the time of the first and last composite sample aliquot collection, the number of aliquots per composite, the sample volume interval, and the percent of storm sampled.

4.2 STORM WATER QUALITY

An inventory of the composite and grab samples taken for the chemical and biological analysis and toxicity analysis during the 2002-2003 monitoring season is included in Tables 4-2, 4-2a, and 4-3.

4.2.1 Mass Emission Analysis

This section provides a description of wet weather and dry weather mass emission results generated during the 2002-2003 monitoring season.

The County analyzes for an extensive number of individual water quality constituents, the results of which are included in Appendix B. A comparison was made between mass emission water quality results and the water quality objectives outlined in the Ocean Plan, the Basin Plan, and the CTR. The freshwater final acute criteria set by the California Department of Fish and Game was also used to provide water quality standards for chlorpyrifos and diazinon. The Municipal Storm Water Permit specifically requires the County to assess the pollutant loading for the sampling events that are analyzed for the complete list of constituents following the 2002-2003 storm season. In addition, the Municipal Storm Water Permit requires the identification and analysis of any long-term trends in storm water or receiving water runoff. An analysis of the correlation between pollutants of concern (metals and PAHs) and TSS loadings for the sampling events was also performed.

4.2.1.1 Comparison Study

As required by the Municipal Storm Water Permit, a comparison to the applicable water quality standards from the Basin Plan, the Ocean Plan, or the CTR for mass emission monitoring was conducted. The lowest possible standard of the three documents was used for the comparison study. The California Department of Fish and Game provided freshwater final acute criteria water quality standards for chlorpyrifos and diazinon. The Basin Plan is designed to enhance water quality and protect the beneficial uses of all regional waters. The Ocean Plan is applicable to point source discharges to the ocean. The CTR promulgates criteria for priority toxic pollutants in the State of California for inland surface waters and enclosed bays and estuaries. Constituents that exceeded the applicable water quality standards are highlighted in Appendix B and Table 4-4. Table 4-4 and Figure 4-3 summarize this comparison analysis.

The following conclusions were drawn from the mass emission comparison study:

Wet Weather

- The monitoring program has identified the nearly ubiquitous existence of bacteria in wet weather for all seven of the mass emission monitoring stations. Densities of total coliform, fecal coliform, and fecal enterococcus exceeded the public health criteria of the Basin Plan for each storm at each monitoring station 100% of the time, with the exception of Malibu Creek, which only exceeded the total coliform objective half of the time. As during the 2001-2002 storm season, the Malibu Creek station shows generally lower indicator bacteria counts than the other mass emission stations.
- The ratio of fecal coliform to total coliform Basin Plan standard was exceeded 75% of the time in all watersheds, except in Ballona Creek and Dominguez Channel where it was exceeded 100% of the time.
- For all monitoring stations, there was no clear trend between bacteria densities and storm events. However, Ballona Creek, Malibu Creek, San Gabriel River, Dominguez Channel, and Santa Clara River monitoring stations each had the highest total coliform density during the March 15, 2003 storm.
- For all monitoring stations except Malibu Creek, 50-100% of the total copper samples exceeded the Ocean Plan water quality standard.
- Coyote Creek, San Gabriel River, and Santa Clara River exceeded the California Department of Fish and Game's water quality criteria for diazinon 50% of the time.
- 50% of the dissolved copper samples taken at the Los Angeles River and Coyote Creek monitoring stations and 100% of the dissolved copper samples taken at the Dominguez Channel monitoring station exceeded the CTR water quality standard.
- 50% of the dissolved lead samples collected at the Dominguez Channel monitoring station exceeded the CTR water quality standard. This is the only monitoring station that showed exceedances.

- San Gabriel River exceeded the cyanide Ocean Plan water quality standard in 75% of the samples. Ballona Creek, Los Angeles River, Coyote Creek, and Santa Clara River exceeded the standard in 50% of the samples.
- 75% of the total zinc samples from the Dominguez Channel monitoring station exceeded the Ocean Plan water quality standard. All the other stations except Ballona Creek had exceedances in 25% of the samples. Dominguez Channel also exceeded the CTR water quality standard for dissolved zinc in 50% samples.
- Sulfate and TDS were each exceeded in 50% of the samples at the Malibu Creek monitoring station. No other monitoring stations had any exceedances for these constituents.
- The Ocean Plan water quality standard for turbidity was exceeded in 50% of the samples at the San Gabriel River monitoring station.
- 50% of the total aluminum samples at the Santa Clara River monitoring station exceeded the Basin Plan water quality standard.
- Nitrite-N exceeded the Basin Plan water quality standard in 50% of the samples at the Coyote Creek monitoring station.

Dry Weather

Since the Municipal Storm Water Permit requires only two dry weather samples at each monitoring station, a 50% exceedance indicates only one sample exceeded the water quality standard and a 100% exceedance indicates both samples exceeded the water quality standard.

- There were no exceedances for any of the dissolved metals or diazinon during dry weather.
- Overall, there were a smaller percentage of exceedances for total coliform, fecal coliform, and fecal enterococcus during dry weather at all seven of the monitoring stations. Also, for most of the dry weather samples, the coliform densities were significantly lower than the densities for the wet weather samples. The total coliform criteria set in the Basin Plan was exceeded in 100% of the samples at the San Gabriel River and Dominguez Channel monitoring stations and in 50% of the samples at the Malibu Creek and Los Angeles River monitoring stations. No other monitoring station exceeded the total coliform criteria. The fecal coliform criteria was exceeded in 50% of the samples for all of the monitoring stations except San Gabriel River which exceeded the criteria in 100% of the samples. Fecal enterococcus criteria was exceeded in 100% of the samples at the Los Angeles River, Coyote Creek, and Dominguez Channel monitoring stations and in 50% of the samples at the other four monitoring stations.
- The ratio of fecal coliform to total coliform Basin Plan standard was exceeded in 50% of the samples at all of the monitoring stations except at Los Angeles River and Dominguez Channel, which had no exceedances.
- Unlike the wet weather samples, the Basin Plan water quality criteria for chloride was exceeded at three of the mass emission stations during dry weather. San Gabriel River and Dominguez Channel exceeded in 50% of the samples and Santa Clara River exceeded in 100% of the samples.

- 50% of the total copper samples exceeded the Ocean Plan water quality standard at the Ballona Creek, Malibu Creek, Los Angeles River, and Dominguez Channel monitoring stations. The San Gabriel River exceeded the standard in 100% of the samples.
- Ballona Creek, Malibu Creek, Los Angeles River, and Dominguez Channel were not within the pH water quality standard limits for 50% of the samples and Coyote Creek was not within the pH water quality standard limits for 100% of the samples. All of samples not within the pH limits showed high alkalinity. During wet weather, only 25% of the pH samples showed exceedances at Ballona Creek and Los Angeles River monitoring stations.
- The Ocean Plan water quality standard for total zinc was exceeded in 50% of the samples at the Malibu Creek, Los Angeles River, Coyote Creek, and Dominguez Channel monitoring stations.
- 100% of the total nickel samples exceeded the Ocean Plan water quality standard at the San Gabriel River monitoring station. 50% of the total nickel samples exceeded the standard at Ballona Creek, Los Angeles River, and Santa Clara River monitoring stations.
- Los Angeles River, Coyote Creek, and San Gabriel River exceeded the Ocean Plan water quality standard for cyanide in 50% of the samples.
- 50% of the dissolved oxygen samples at the Santa Clara River monitoring station were below the minimum water quality objective in the Basin Plan.
- Malibu Creek exceeded the Basin Plan water quality objective for sulfate in 50% of the samples.

4.2.1.2 Loading and Trend Analysis

An estimation of the total pollutant loads due to storm water and urban runoff for each mass emission station is shown on Table 4-11. As required by the Municipal Storm Water Permit, samples were collected and analyzed for TSS at all mass emission stations equipped with automated samplers for all storm events that resulted in at least 0.25 inches of rainfall. The concentrations for TSS for each storm is shown on Table 4-9 and the total pollutant loading for TSS for each mass emission station is shown on Table 4-10. By analyzing the pollutant loading at each mass emission station, it is possible to see if there is any correlation between storm events and the amount of pollutant loading. An analysis of trends in storm water or receiving water quality is represented in Figure 4-4. Although it is difficult to see any sustained trends at this time, they will become more apparent in years to come as sampling continues.

The following conclusions were deduced from the loading analysis:

- The total runoff volume at the Los Angeles River monitoring station was consistently higher than at the other monitoring stations. Los Angeles River also has approximately two times or more surface runoff area than the other watersheds. This creates more potential for surface runoff pollution and likely explains, in part, the increased loading of constituents at the Los Angeles River monitoring station when compared to the other monitoring stations.
- The storm on March 15, 2003 at the Ballona Creek, Malibu Creek, and Los Angeles River monitoring stations produced TSS loadings of 9,619 tons, 5,236 tons, and 53,027 tons,

respectively. Ballona Creek and Los Angeles River also produced loadings of 6,395 tons and 12,181 tons, respectively, during the February 11, 2003 storm. The loading during all other storm events at all the monitoring stations was below 4,000 tons.

- The Los Angeles River is the largest contributor of TSSs out of the seven mass emission stations monitored.
- San Gabriel River, Dominguez Channel, and Santa Clara River had generally lower TSS and metals loadings than the other monitoring sites.
- The February 11, 2003 storm produced the highest TDSs loadings at the Malibu Creek, Coyote Creek, Dominguez Channel, and Santa Clara River monitoring stations. The storm on December 16, 2002 produced the lowest TDS loading at all stations.
- Metal loading was the greatest for the Los Angeles River.
- Total and dissolved zinc appear to have the greatest loading during the February 11, 2003 storm at all of the monitoring stations except San Gabriel River.

The following conclusions were drawn from the trend analysis:

- The high levels of zinc found at monitoring stations between 1994-2000 were not present in the samples taken during the 2001-2002 storm season. During the 2002-2003 storm season the high levels of zinc were not present again, except for several exceedances at the Dominguez Channel monitoring station.
- The rainfall during the 2002-2003 storm season was only 0.06 inches below the annual rainfall average. However, it was about three times higher than amount of rainfall recorded during the 2001-2002 storm season. This may explain, in part, the increased loading as compared to the 2001-2002 storm season.

Pollutant Loading Example

At the request of the RWQCB, below is an example of the pollutant loading calculation:

Site:	Malibu Creek Mass Emission Station
Storm event:	12/16/2002
Constituent:	Nitrate
Concentration:	4.6 mg/L
Runoff Volume:	36.5 acre-ft (Runoff = 28.4 acre-ft + Base Flow = 8.1 acre-ft)

1lb = 454 g

1g = 1,000 mg = 1×10^6 μg

1L = 0.03531467 ft^3

1 ft^3 = 2.2957×10^{-5} acre-ft

Pollutant Loading = (Pollutant Concentration)(Runoff Volume)

Pollutant Load = (4.6 mg/L)(36.5 acre-ft)(1g/1,000 mg)(1 lb/454g)(1 ft^3/2.2957 x 10^{-5} acre-ft)(

Pollutant Load = 456.2

Conversion factors

4.2.1.3 Correlation Study

An analysis of the correlation between metals and TSS levels for the mass emission monitoring was performed. The study was only conducted on metals because the PAH samples at all of the monitoring stations were non-detects.

A trend line was projected on each of the metals-versus-TSS plots and the coefficient of determination (R^2) was calculated to see if there was any correlation between the concentrations for each metal and TSSs for the mass emission monitoring stations (Figure 4-5). The closer the value of R^2 is to the number one, the stronger the correlation of the two variables.

The following conclusions were deduced from the correlation study analysis:

- Unlike other watersheds, the Malibu Creek and San Gabriel River watersheds showed no strong correlation between metals and TSSs, except for dissolved arsenic and in the case of Malibu, dissolved zinc. Besides the R^2 values for dissolved arsenic and dissolved zinc, all of Malibu Creek's and San Gabriel River's R^2 values were below 0.3852 and below 0.5823, respectively.
- There were no strong correlations from any of the watersheds for the following constituents: total arsenic, total chromium, dissolved lead, and total nickel.
- Excluding Malibu Creek and San Gabriel River, all of the monitoring sites showed a strong correlation between total copper and TSSs, with R^2 values ranging from 0.4445 to 0.9856 (most of them closer to the upper range).
- Three of the mass emission monitoring sites, Ballona Creek, Coyote Creek, and Dominguez Channel, showed a correlation between total aluminum and TSSs, with R^2 values of 0.9158, 0.8199, and 0.8294, respectively.
- Five of the mass emission stations showed a strong correlation between dissolved antimony and TSSs. Ballona Creek and Los Angeles River showed a negative correlation, with R^2 values of 0.5347 and 0.799, respectively. Coyote Creek, Dominguez Channel, and Santa Clara River showed positive correlations, with R^2 values of 0.8151, 0.9777, and 0.7409, respectively.

4.2.2 Tributary Monitoring Analysis

This section provides a description and analysis of wet weather and dry weather tributary results generated during the 2002-2003 monitoring season.

Though only a requirement for the first storm of the season, tributary monitoring analyzes included all of the water quality constituents monitored under the mass emission monitoring program, the results of which are included in Appendix B. Flow was also measured and is reported as hydrographs, which can be found in Appendix A. In order to identify the subwatersheds where storm water discharges are causing or contributing to exceedances of water quality standards, a comparison was made between tributary water quality results and the water quality objectives outlined in the Ocean Plan, the Basin Plan, and the CTR. The lowest possible standard of the three documents was used for the comparison study. The freshwater final acute criteria set by the California Department of Fish and Game was also used to provide water quality standards for chlorpyrifos and diazinon.

Since the tributary monitoring stations collect samples from sub-watersheds within the Los Angeles River watershed, the results from the Los Angeles River mass emission station were also used in the analysis. It was not possible to accurately identify any problems based on dry weather results since only one sample was taken at each tributary monitoring station, as required by the Municipal Storm Water Permit. Constituents that exceeded the applicable water quality standards are highlighted in Appendix B and Table 4-5. Table 4-5 and Figure 4-3 summarize this comparison analysis.

The following conclusions were drawn from the wet weather tributary comparison study:

- As with the mass emission monitoring program, the tributary monitoring program identified the nearly ubiquitous existence of bacteria during wet weather at all six stations. Densities of total coliform, fecal coliform, and fecal enterococcus exceeded the public health criteria of the Basin Plan for each storm at each monitoring station 100% of the time. This corresponds to the results obtained from the Los Angeles River mass emission station.
- The ratio of fecal coliform to total coliform Basin Plan water quality standard was exceeded 80-100% of the time in all sub-watersheds, except Bull Creek which only exceeded in 40% of the samples.
- Bull Creek and Verdugo Wash exceeded the Ocean Plan water quality standard for turbidity in 80% of the samples. Rio Hondo exceeded the turbidity standard in 40% of the samples.
- Diazinon criteria was exceeded at each tributary monitoring station. 60% of the samples were exceeded at Aliso Creek monitoring station, 40% of the samples were exceeded at Arroyo Seco Channel and Rio Hondo Channel monitoring stations, and 20% of the samples were exceeded at Bull Creek, Burbank Western Channel, and Verdugo Wash monitoring stations. Los Angeles River only exceeded the diazinon criteria in 25% of the samples.
- 60% of the samples at the Verdugo Wash monitoring station exceeded the Basin Plan water quality standard for total aluminum. There were no exceedances at Los Angeles River monitoring station.
- Total Copper exceeded the Ocean Plan water quality standard in more than 60% of the samples at all of the tributary stations except Bull Creek, which exceeded the standard in 20% of the samples.
- Total Zinc exceed the Ocean Plan water quality standard in 40-60% of the samples at Burbank Western Channel, Verdugo Wash, Arroyo Seco Channel, and Rio Hondo Channel.

- 80%, 50%, and 40% of the total lead samples exceeded the Ocean Plan water quality standard at Verdugo Wash, Arroyo Seco Channel, and Burbank Western Channel, respectively.
- Rio Hondo Channel exceeded the CTR water quality standard for dissolved copper in 100% of the samples. Burbank Western Channel exceeded in 80% of the samples, Aliso Creek exceeded in 50% of the samples, and Arroyo Seco Channel exceeded in 25% of the samples. The other tributary monitoring stations exceeded the standard in 20% of the samples.
- 40% of the samples at Burbank Western System and Rio Hondo Channel exceeded the Ocean Plan water quality standard for cyanide.
- Though there were no dissolved oxygen or nitrite-N exceedances at Los Angeles River monitoring station, 20% of the samples at Burbank Western Channel and Arroyo Seco Channel exceeded the Basin Plan criteria for each constituent.
- Burbank Western Channel and Verdugo Wash exceeded the CTR water quality standard for dissolved lead in 40% of the samples and Rio Hondo Channel exceeded in 20% of the samples. There were no exceedances at the Los Angeles River monitoring station.

4.2.3 Water Column Toxicity Analysis

This section describes the water column toxicity results generated during the 2002-2003 storm season. Water column toxicity monitoring was performed at all mass emission site in accordance with the Municipal Storm Water Permit. In total, four samples were analyzed for toxicity at each site. Dry weather samples were collected on October 9, 2002, and April 23, 2003. The results obtained from these samples are found in Table 4-8a. Wet weather samples were collected during the first rain event of the season on November 8, 2002, and also on December 12, 2002. The results obtained from these samples are found in Table 4-8b.

A minimum of one freshwater and one marine species was used for toxicity testing, specifically Ceriodaphnia dubia (water flea) 7-day survival/reproduction and Strongylocentrotus purpuratus (sea urchin) fertilization. The sea urchin fertilization test could not be performed on the October 9, 2002 wet weather sample because the purple sea urchin did not spawn due to seasonal variability.

Results calculated from the Ceriodaphnia dubia and sea urchin tests included the No Observed Effect Concentration (NOEC), 50% Lethal Concentration (LC50), 50% Inhibitory Concentration (IC50), and toxicity unit (TU). NOEC is the highest concentration causing no effect on the test organisms. LC50 is the concentration that produces a 50% reduction in survival. IC50 is the concentration causing 50% inhibition in growth or reproduction. TU is defined in the permit as 100/(LC50 or IC50). A TU value greater than or equal to one is considered substantially toxic and requires a toxicity identification evaluation (TIE).

The following conclusions were deduced from water column toxicity testing:

- Ceriodaphnia dubia survival was only significantly affected by exposure to the wet weather samples collected from the Coyote Creek and Dominguez Channel mass emission stations on November 8, 2002. These samples from Coyote Creek and the Dominguez Channel had a TU value equal to 4.40 and 1.33, respectively. In accordance with the Permit, a TIE was performed on these samples. The TIE for the sample collected from Coyote Creek found that the toxicity was due to one or more non-polar organic compounds as well as metabolically-activated organophosphates. The TIE for the sample collected from the Dominguez Channel found that the toxicity was due to one or more non-polar organic compounds and cationic metals as well as metabolically-activated organophosphates. The remaining samples were not substantially toxic to Ceriodaphnia dubia survival.
- Ceriodaphnia dubia reproduction was only significantly affected by exposure to the wet weather samples collected from the Coyote Creek and Dominguez Channel mass emission stations on November 8, 2002. These samples from Coyote Creek and the Dominguez Channel had a TU value equal to 3.65 and 1.33, respectively. In accordance with the Permit, a TIE was performed on these samples. The TIE for the sample collected from Coyote Creek found that the toxicity was due to one or more non-polar organic compounds as well as metabolically-activated organophosphates. The TIE for the sample collected from the Dominguez Channel found that the toxicity was due to one or more non-polar organic compounds and cationic metals as well as metabolically-activated organophosphates. The remaining samples were not substantially toxic to Ceriodaphnia dubia reproduction.
- Sea urchin fertilization was only significantly affected by exposure to the wet weather samples collected from the Coyote Creek and Ballona Creek mass emission stations on November 8, 2002. These samples from Coyote Creek and Ballona Creek had TU values equal to 1.16 and 1.45, respectively. In accordance with the Permit, a TIE was performed on these samples. The TIE for the sample collected from Coyote Creek found that the toxicity was due to one or more non-polar organic compounds and cationic metals as well as metabolically-activated organophosphates. The TIE for the sample collected from Ballona Creek found that the toxicity was due to particulate-bound toxicants, one or more non-polar organic compounds and cationic metals. The remaining samples were not substantially toxic to sea urchin fertilization.

4.2.4 Trash Monitoring Analysis

This section describes the trash monitoring results generated during the 2002-2003 storm season. For each catch basin insert and Continuous Deflective System (CDS) devices, the anthropogenic trash was separated from the sediment and vegetation and weights were recorded per device. The land uses monitored were commercial, high density single family residential, industrial, low density single family residential, and open space/parks. Three CDS units were installed during the 2002-2003 storm season and monitoring of two additional CDS units will commence during the 2003-2004 storm season. Table 4-12 summarizes the results of the sampling events with totals for the collected anthropogenic trash and the sediment/vegetation per land use. The Municipal Storm Water Permit requires a minimum of one photograph at each mass emission station after the first storm event and three additional storm events per year. Pictures can be found in Appendix C.

The following conclusions were drawn from the sampling results for anthropogenic trash:

- The amount of trash collected for the first storm event of the season constituted 39.4% of the total trash collected during the entire season for the Los Angeles River and the Ballona Creek watersheds combined.
- In the Los Angeles River watershed, the commercial landuse was the largest contributor of trash during the first storm of the season with 40.5%. The industrial landuse was the second largest contributor with 35.8% of the total trash collected. Open Space/Parks, High Density Single Family Residential, and Low Density Single Family Residential combined to produce 23.7 % of the trash with Low Density Single Family Residential producing only 2.6%.
- In the Ballona Creek watershed, the Low Density Single Family Residential was the largest contributor of trash during the first storm of the season with 32.1%. The remaining landuses combined for the remaining 67.9% with a relatively even distribution of approximately 17% each, on average.
- Based on the total amount of trash collected for the Los Angeles River watershed during the 2002-2003 storm season, the largest contributors by landuse were the industrial and the commercial landuses with 46.4%, and 33.9 %, respectively, for a combined 80.3% of the total trash collected. High Density Single Family Residential and Open Space/Parks contributed 8.6% and 8.8%, respectively. Low Density Single Family Residential produced only 2.3%.
- Based on the total amount of trash collected for the Ballona Creek watershed during the 2002-2003 storm season, the Low Density Single Family Residential and the commercial landuses combined to produce about half of the total trash collected. Low Density Single Family Residential produced 26.0% and the commercial landuse produced 25.1%. Open Space/Parks and industrial produced 17.8% and 16.5%, respectively. High Density Single Family Residential produced the least trash with 14.5% of the total.

4.2.5 Identification of Possible Sources

This section describes the possible sources of the constituents that did not meet the water quality standards during the 2002-2003 monitoring season in all or most of the watersheds, as discussed above in Section 4.2.1 and 4.2.2.

The source of bacteria is hard to pinpoint. According to the *Draft Total Maximum Daily Load to Reduce Bacterial Indicator Densities at Santa Monica Bay Beaches* published on November 8, 2001 by the California Regional Water Quality Control Board, Los Angeles Region, urban runoff from the storm drain system may have elevated levels of bacterial indicators due to sanitary sewer leaks and spills, illicit connections of sanitary lines to the storm drain system, runoff from homeless encampments, illegal discharges from recreational vehicle holding tanks, and malfunctioning septic tanks among other things. Fecal matter from animals and birds can also elevate bacteria levels.

An article titled *Residential Sources of Contamination* on EPA's website states that elevated levels of chloride may be a result of fertilizers, animal sewage, industrial wastes, minerals, or seawater. It also shows that many metals, such as aluminum, silver, iron, and zinc, could be a result of natural deposits.

According to the report *Regulating Copper in Urban Stormwater Runoff* by G. Fred Lee, PhD and Anne Jones-Lee, PhD, copper can come from brake pads or industrial (such as the textile industry) and mining sources. A metals source study is discussed in the article *Loadings of Lead, Copper, Cadmium, and Zinc in Urban Runoff from Specific Sources* by A.P. Davis, M. Shokouhian, and S. Ni. The study concludes that significant levels of metals were found from urban areas, especially in highway runoff. The abstract identifies important sources, such as building siding for lead, copper, cadmium, and zinc, vehicle brake emissions for copper and tire wear for zinc. Atmospheric deposition was also identified as an important source of cadmium, copper, and lead.

4.2.6 Recommendations

New monitoring components conducted during the 2002-2003 monitoring season included tributary monitoring and trash monitoring at mass emission stations. The Santa Clara River mass emission monitoring station was also added to the monitoring program. In addition, all required samples were taken, including dry weather and toxicity samples. Below are some recommendations that were identified based on results from the 2002-2003 monitoring season.

The Municipal Storm Water Permit requires only one dry weather sample to be taken at each tributary monitoring station. Although it was possible to see the various concentrations from each subwatershed, these values may not be entirely reliable due to the inherent variability of many constituents, especially bacteria. LACDPW recommends taking at least two dry weather samples at each tributary station to better characterize the concentrations of each constituent and verify the accuracy of the results of the first sample.

Many of the polychlorinated biphenyls, SOVs, and chlorinated pesticides cannot be compared to the water quality standards because there are no standards listed in the Basin Plan, Ocean Plan, or CTR. However, even if there were water quality standards, all of these constituents were not detected at any of the mass emission or tributary monitoring stations. We recommend sampling for these constituents for one more year. If they are not detected, we recommend to discontinue sampling for these constituents, except during the first storm event of every year.

Some constituents sampled at the tributary stations showed exceedances of water quality standards. The Municipal Storm Water Permit requires the initiation of a focused effort to identify sources of pollutant within that subwatershed when a constituent exceeds a water quality standard in three out of four samples. We recommend looking at the landuse make up of the watersheds and use water quality data collected from the landuse monitoring stations to begin identifying possible trends or correlations based on landuse. We also recommend using water quality data collected by SCCWRP in their landuse studies.

We collected valuable data from the first year of the tributary monitoring in the Los Angeles River Watershed. We believe that one year worth of data is not sufficient as there can be variability from year to year. Based on discussions with staff from the RWQCB, we recommend performing a second year of monitoring in the Los Angeles River Watershed in order to make better use of the data we collect in order to assist us in prioritizing drainage and sub-drainage areas that need management actions.

In order to identify and better understand the source(s) of pollution, mass emission monitoring, toxicity monitoring, trash monitoring, and tributary monitoring will be continued in the future in addition to the regional monitoring and special studies, as required by the Municipal Storm Water Permit.

Table 1-1. Bioasessment Sampling Station Locations Within Los Angeles County

Updated Bioassessment Sampling Station Locations Within Los Angeles County

No.	Name	TG Pg #	Location	Comments	Justification
Los Angeles River Watershed					
6	Arroyo Seco Unlined bottom	535 F4	upstream of Arroyo Seco Spreading Grounds	Tributary to the LA River - upstream of Devil's Gate Dam and the Rose Bowl	Upper to mid watershed and residential land use
7	Arroyo Seco Unlined/Lined bottom	565 F4	@ the 134 Fwy/Colorado Street Bridge	Tributary to the LA River - downstream location	Upper to mid watershed and residential land use
8	Compton Creek Unlined bottom	765 C5	@ approx. 500' upstream of the confluence with the LA River	Tributary to the LA River - lower watershed	Assess the effect of the Compton Creek - high urban pollution impact
9	Zone 1 Ditch/Whittier Narrows Dam Unlined bottom	636 J7		Flows from the San Gabriel River to Rio Hondo Channel	Involves both LA and SG watersheds
10	Eaton Wash Unlined bottom	566 E1	@ New York Dr (upstream of Eaton Wash Canyon Reservoir)	Tributary to the LA River - upper east watershed	LA river tributary
11	LA River Unlined bottom	563 J3	@ Victory Blvd.	Main stem of the LA River	Main river; look at the effects of the adjacent equestrian area
12	LA River Lined bottom	594 J7	downstream of the confluence with the Arroyo Seco Channel	Main stem of the LA River	Main river
13	LA River Unlined bottom	561 F2	upstream of the Sepulveda Dam @ Burbank Blvd.	Main stem of the LA River	Upstream reference site
Alternative Station					
3A	PD 1845 Unlined bottom	559 G5	@ Valmar Rd and Park Ora	Tributary to the LA River - located in the mountainous, western watershed	LA river tributary, upstream reference site, and residential

Table 1-1. Bioasessment Sampling Station Locations Within Los Angeles County

Updated Bioassessment Sampling Station Locations Within Los Angeles County					
No.	**Name**	**TG Pg #**	**Location**	**Comments**	**Justification**
San Gabriel River Watershed					
2	Coyote Creek[1] Lined bottom	796 G4	upstream of the confluence with San Gabriel River	Tributary to the San Gabriel River - lower watershed	LACSD SEP Project (baseline established)[2]
3	San Jose Creek[1] Unlined bottom	637 E5	unlined portion @ the 605 Fwy	Tributary to the San Gabriel River - mid watershed	LACSD SEP Project (baseline established)[2]
4	San Gabriel River Unlined bottom	509 E2	upstream of San Gabriel Dam	Main stem of the San Gabriel River - upper watershed	Upstream reference site, pristine
5	Walnut Channel Unlined bottom	637 G2	upstream of the confluence with the San Gabriel River	Tributary to the San Gabriel River - mid watershed	Look at impacts of upstream tributary land uses; adjacent to nursery and residential area
Alternative Stations					
1A	San Gabriel River Lined bottom	766 G7	@ El Dorado Park and E. Wardlow Road	Main stem of the San Gabriel River - central location	Mid watershed in the main river
2A	Buena Vista Spreading Basin Unlined bottom	597 J1		Within the SG River and adjacent to the Buena Vista Channel that conveys flow to the LA River	Involves both the LA and SG watersheds Proposed watershed management planning

1 Stations from the LA County Sanitation Districts (LACSD) Study

2 LACSD conducted a bioassessment assessment in October of 2002 to 1) Establish a base line 2) Describe the macroinvertibrate assemblages 3) Provide recommendations and strategies for continued monitoring

Table 1-1. Bioasessment Sampling Station Locations Within Los Angeles County

Updated Bioassessment Sampling Station Locations Within Los Angeles County					
No.	**Name**	**TG Pg #**	**Location**	**Comments**	**Justification**
Santa Clara Watershed					
1	Santa Clara River Unlined bottom	4550 B2	@ The Old Road	Main stem of the channel	Location of DPW mass emission monitoring site
20	Bouquet Canyon Unlined bottom	4461 G2	Below Vasquez Canyon Rd		Upstream of Diazinon findings

Table 1-1. Bioasessment Sampling Station Locations Within Los Angeles County

Updated Bioassessment Sampling Station Locations Within Los Angeles County

No.	Name	TG Pg #	Location	Comments	Justification
Ballona Creek Watershed					
14	Ballona Creek Unlined bottom	702 C1	@ Culver Blvd. and Lincoln Blvd.	Main stem of the river - lower west watershed	Coastal area and to see the downstream effects of urban runoff
Malibu Creek Watershed[3]					
15	Medea Creek Unlined bottom	558 A5	Near Chumash Park – Thousand Oaks Blvd. and Kanan Road	Tributary to Malibu Creek	Look at contribution from Medea Creek to Malibu Creek
16	Las Virgenes Creek Unlined bottom	558 H3	@ the county line As far upstream as possible while staying within the County line	Tributary to Malibu Creek - upper watershed	Ideally we would like the sample to be collected at the confluence of East Las Virgenes and West Las Virgenes
17	Cold Creek Unlined bottom	589 E6	Stunt Road @ Cold Creek Preserve	Reference site tributary to Malibu Creek	Reference site
18	Triunfo Creek Unlined bottom	587 H3	Downstream of the nursery and Troutdale Dr	Tributary to Malibu Creek	Look at the effects of the nursery.
Dominguez Watershed					
19	Dominguez Channel Unlined (Rip rap sides - clay bottom)	794 H6	@ Anaheim Street	Tributary to Dominguez Channel	Main channel - lower watershed
Alternative Station					
4A	Dominguez Channel Unlined (Rip rap sides - clay bottom)	794 J1	@ Alameda Street	Main stem of the channel	Main channel - lower watershed

[3] Coordinated with Heal the Bay to complement their study

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TOTAL MAXIMUM DAILY LOAD FOR METALS IN BALLONA CREEK

PREPARED BY
U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION 9
AND
CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
LOS ANGELES REGION

DRAFT: JULY 12, 2004
REVISED: JANUARY 9, 2005

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LIST OF ACRONYMS

μg/g	Micrograms per Gram
μg/L	Micrograms per Liter
ACF	Acute Conversion Factor
BMPs	Best Management Practices
CalTrans	California Department of Transportation
CCF	Chronic Conversion Factor
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
cfs	Cubic Feet per Second
COMM	Commercial and Sport Fishing
CTR	California Toxics Rule
CWA	Clean Water Act
DL	Detection Limit
EST	Estuarine Habitat
FHWA	Federal Highway Administration
FR	Federal Register
GIS	Geographic Information System
HSPF	Hydrological Simulation Program FORTRAN
HTP	Hyperion Treatment Plant
IPWP	Integrated Plan for the Wastewater Program
IRP	Integrated Resources Plan
LACDPW	Los Angeles County Department of Public Works
LARWQCB	Los Angeles Regional Water Quality Control Board
MAR	Marine Habitat
mg/L	Milligrams Per Liter
MGD	Million Gallons Per Day
MIGR	Migration of Aquatic Organisms
MS4	Municipal Separate Storm Sewer System
MUN	Municipal and Domestic Water Supply
NA	Not Applicable
NAV	Navigation
ND	Non Detect
NHD	National Hydrography Data Set
NPDES	National Pollutant Discharge Elimination System
O&M	Operation and Maintenance
ppt	Parts per Thousand
RARE	Rare, Threatened, or Endangered Species
REC1	Water Contact Recreation
REC2	Non-Contact Water Recreation
RL	Reporting Limit
SCCWRP	Southern California Coastal Water Research Project
SD	Standard Deviation
SHELL	Shellfish Harvesting
SMBRP	Santa Monica Bay Restoration Project

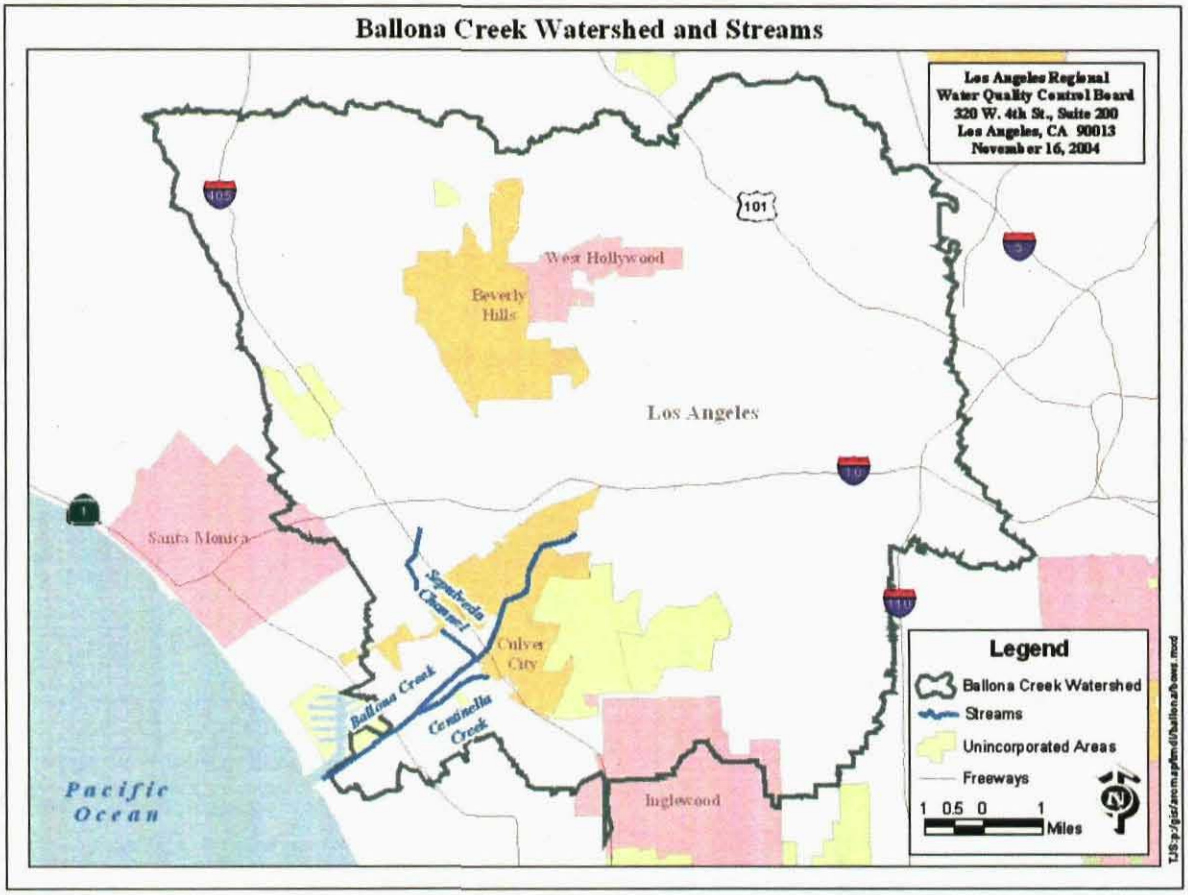
SPWN	Spawning, Reproduction, and/or Early Development
TMDL	Total Maximum Daily Load
USACE	United States Army Corps of Engineers
USEPA	United State Environmental Protection Agency
VOCs	Volatile Organic Compounds
WARM	Warm Freshwater Habitat
WDRs	Waste Discharge Requirements
WER	Water-Effect Ratio
WILD	Wildlife Habitat
WLAs	Waste Load Allocations
WQA	Water Quality Assessment
WQOs	Water Quality Objectives

1 Introduction

This report presents the required elements of the Total Maximum Daily Load (TMDL) for metals in Ballona Creek and summarizes the technical analyses performed by the United States Environmental Protection Agency, Region 9 (USEPA) and the California Regional Water Quality Control Board, Los Angeles Region (Regional Board) to develop this TMDL. The goal of this TMDL is to determine and set forth measures needed to prevent impairment of water quality due to metals in Ballona Creek and Sepulveda Canyon Channel (Figure 1).

Segments of Ballona Creek and Sepulveda Canyon Channel are listed for cadmium, copper, lead, selenium, silver, zinc and toxicity. These segments (reaches) of Ballona Creek were included on the 1996, 1998 and 2002 California 303(d) list of impaired waterbodies (LARWQCB, 1996, 1998a, and 2002). The Clean Water Act (CWA) requires a TMDL be developed to restore the impaired waterbodies to their full beneficial uses.

Figure 1. Ballona Creek Watershed



This TMDL complies with 40 CFR 130.2 and 130.7, Section 303(d) of the CWA and USEPA guidance for developing TMDLs in California (USEPA, 2000a). This document summarizes the information used by the USEPA and the Regional Board to develop a TMDL for metals. The TMDL also includes an implementation plan and cost estimate to achieve the waste load allocations (WLAs) and attain water quality objectives (WQOs). The California Water Code (Porter-Cologne Water Quality Control Act) requires that an implementation plan be developed to achieve water quality objectives. The waterbodies addressed in this TMDL are shown in Figure 1.

1.1.1 Regulatory Background

Section 303(d) of the 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 objective applicable to such waters." The CWA also requires states to establish a priority ranking for waters on the 303(d) list of impaired waters and establish TMDLs for such waters.

The elements of a TMDL are described in 40 CFR 130.2 and 130.7 and Section 303(d) of the CWA, as well as in the USEPA guidance (USEPA, 2000a). 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 waterbody to assimilate pollutant loads (the loading capacity) is not exceeded. A TMDL is also required to account for seasonal variations and include a margin of safety to address uncertainty in the analysis (USEPA, 2000).

As part of its 1996 and 1998 regional water quality assessments, the Regional Board identified over 700 waterbody-pollutant combinations in the Los Angeles Region where TMDLs would be required (LARWQCB, 1996, 1998a). These are referred to as "listed" or "303(d) listed" waterbodies or waterbody segments. A 13-year schedule for development of TMDLs in the Los Angeles Region was established in a consent decree approved on March 22, 1999 (*Heal the Bay Inc., et al. v. Browner, et al.* C 98-4825 SBA).

For the purpose of scheduling TMDL development, the consent decree combined the more than 700 waterbody-pollutant combinations into 92 TMDL analytical units. Analytical Unit 57 is for metals listings in the Ballona Creek Watershed (Table 1-1). The consent decree also prescribed schedules for certain TMDLs, and according to this schedule, a TMDL for Analytical Unit 57 was to be adopted by the Regional Board by March 22, 2004. Under the terms of the consent decree, USEPA must either approve a state TMDL or establish its own, by March 22, 2005.

Table 1-1. List of impairments identified in Consent Decree under Analytical Unit #57

TMDL Analytical Unit 57	Ballona Creek	Ballona Creek Estuary	Ballona Wetlands
Arsenic	Tissue		Tissue
Cadmium	Sediment		
Copper	Tissue, Sediment		
Lead	Tissue, Sediment	Sediment	
Selenium			
Silver	Tissue, Sediment		
Zinc		Sediment	
Toxicity	Water, Sediment	Sediment	

Paragraph 8 of the consent decree provides that TMDLs need not be completed for specific waterbody by pollutant combinations if the State or EPA determines that TMDLs are not needed for these combinations, consistent with the requirements of Section 303(d). The consent decree provides that this determination may be made either through a formal decision to remove a combination from the State Section 303(d) list or through a separate determination that the specific TMDLs are not needed.

On the 2002 303(d) list, the Regional Board delisted arsenic, copper, lead, and silver in fish tissue. The tissue listing for arsenic in Ballona Creek and Ballona Creek Wetlands was removed because the maximum tissue residue level upon which the 1998 listing was based does not protect aquatic life and does not exist for arsenic. The tissue listings for copper, lead, and silver in Ballona Creek were removed because the elevated data levels upon which the 1998 listings were based no longer reflect valid assessment guidelines.

The Regional Board added new listings to the 2002 303(d) list for dissolved copper, dissolved lead, dissolved zinc and total selenium in Ballona Creek based on elevated water quality data reported by the Los Angeles County Department of Public Works (LACDPW) storm water program.

Table 1-2. 2002 303(d) listings for metals listings in Ballona Creek Watershed

Parameter	Ballona Creek	Sepulveda Channel	Ballona Creek Estuary
Cadmium	Sediment	-	-
Copper	Water		
Lead	Water	Water	Sediment
Silver	Sediment	-	-
Selenium	Water	-	-
Zinc	Water	-	Sediment
Toxicity	Water, Sediment	-	Sediment

EPA finds that the Ballona Creek listings for cadmium and silver were made in error and should be applied to the estuary. The basis for this finding is discussed in Section 2 of the "TMDL for Contaminated Sediments for Ballona Creek Estuary". The sediments of Ballona Creek were not listed in the 2002 303(d) list. We believe that was is an oversight by the Regional Board as there is no documentation in the 2002 303(d) to support this delisting. EPA finds that these listings should be the estuary as well. This constitutes the notice pursuant to paragraph 9 of the consent decree.

Impairments associated with metals in sediments are addressed in the Total Maximum Daily Loads for Contaminated Sediments in Ballona Creek Estuary. TMDLs for nearby Marina del Rey Harbor (AU #56) are not addressed in this document. Sepulveda Canyon Channel is listed in the Consent Decree under Analytical Unit #60. It is included in this TMDL because it is tributary to the Creek.

This TMDL will establish waste load allocations (WLAs) for cadmium, copper, lead, selenium, silver and zinc to the water column in Ballona Creek and Sepulveda Canyon Channel. The water column toxicity will be addressed by the WLAs for the listed metals. This TMDL meets the objective of the consent decree to develop a TMDL for Ballona Creek Waterhsed under Analytical Unit #57.

1.1.2 Environmental Setting

Ballona Creek flows as an open channel for just under 10 miles from Los Angeles (South of Hancock Park) through Culver City, reaching the Pacific Ocean at Playa del Rey. North of Hancock Park, the channels continue in a network of underground storm drains. Ballona Creek and its tributaries drain a watershed with an area of approximately 128 square miles. Approximately 60% of the land use can be categorized as residential, 17% as recreation/open space, 16% as commercial, 5% as industrial, and 2% as other. The Ballona Creek watershed is comprised of the Cities of Beverly Hills and West Hollywood, and portions of the cities of Culver City, Inglewood, Los Angeles, Santa Monica, and unincorporated areas of Los Angeles County.

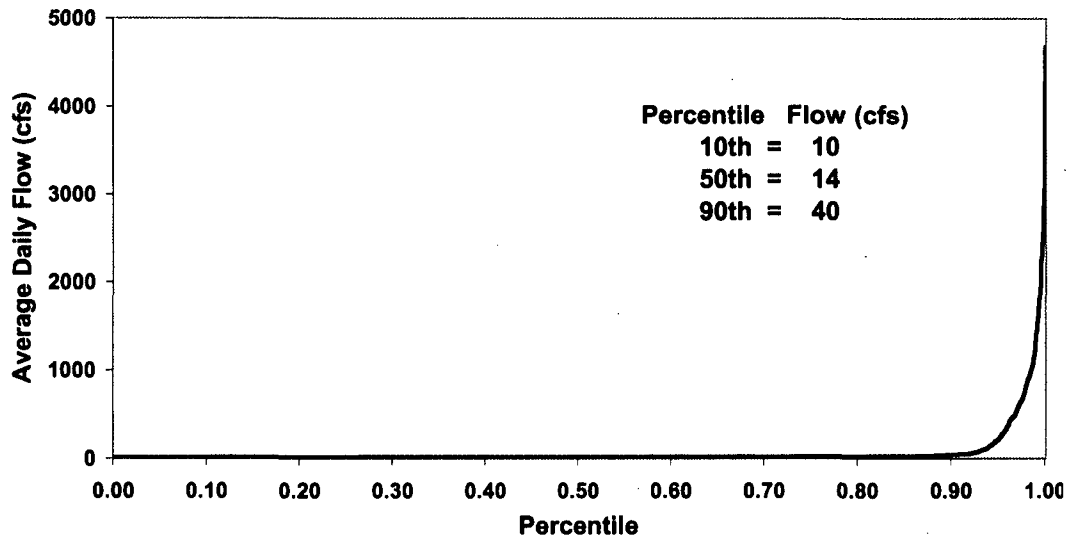
Channelization and construction of Marina del Rey Harbor altered the natural hydrology of Ballona Creek Estuary, Ballona Creek and its tributaries. Except for the estuarine section of the creek, which is composed of grouted rip-rap sloped sides and an earthen bottom, Ballona Creek is entirely lined in concrete and extends into a complex underground network of storm drains, which reaches north to Beverly Hills and West Hollywood. Tributaries of Ballona Creek include Centinela Creek, Sepulveda Canyon Channel, Benedict Canyon Channel, and numerous storm drains (Figure 1). All of these tributaries are concrete lined channels that lead to covered culverts upstream.

The *Water Quality Control Plan for the Coastal Watersheds of Los Angeles and Ventura Counties* (*Basin Plan*) defines three sections of the creek based on hydrologic units. The section referred to as "Ballona Creek" (Reach 1) is a 2-mile stretch from Cochran Avenue to National Boulevard. This area is characterized by vertical concrete walls, which line the creek from the point where it emerges from the underground network of drains at Cochran Avenue, in the City of Los Angeles, to National Boulevard in Culver City. "Ballona Creek to Estuary" (Reach 2) is the longest segment of the creek (approximately 4 miles) continuing on from National Boulevard and ending at Centinela Avenue where the estuary begins. Sepulveda Canyon Channel discharges into Ballona Creek Reach 2. Centinela Channel drains directly to Ballona Creek Estuary just below the boundary with Reach 2. The estuary continues to the Pacific Ocean for 3.5 miles and its lower portion runs parallel to the main channel of Marina del Rey Harbor (Figure 1).

The bike path along the creek provides opportunities for recreation in the area. This path extends almost seven miles from Ballona Creek at National Boulevard in Culver City to the end of Ballona Creek Estuary in Marina del Rey. The bike path is connected to another path along Dockweiler Beach by the Pacific Bridge, which links Marina del Rey to Playa del Rey.

Dry-weather flows are estimated at 14 cubic feet per second (cfs) (Ackerman et al., 2001) and can be up to 36000 cfs for a 100-year storm event (SMBRP, 1997). As shown in Figure 2 the average daily flows during dry weather in Ballona Creek are very consistent. The 90th percentile is considered the inflection point between dry and wet weather. Ballona Creek was channeled to quickly convey storm water to the ocean. Therefore, the relationship between rain events in the watershed and increased flow in the creek is strong and immediate (Ackerman and Weisberg, 2003).

Figure 2. Flow in Ballona Creek at Sawtelle Avenue (1987 to 1998)



1.1.3 Elements of a TMDL; Organization of This Document

Guidance from USEPA (1991) identifies seven elements of a TMDL. Sections 2 through 8 of this document are organized such that each section describes one of the elements, with the analysis and findings of this TMDL for that element. The required elements are as follows:

- Section 2: Problem Identification. This section reviews the metals data used to add the waterbody to the 303(d) list, and summarizes existing conditions using that evidence along with any new information acquired since the listing. This element identifies those reaches that fail to support all designated beneficial uses; the beneficial uses that are not supported for each reach; the water quality objectives (WQOs) designed to protect those beneficial uses; and, summarizes the evidence supporting the decision to list each reach, such as the number and severity of exceedances observed.
- Section 3: Numeric Targets. For this TMDL, the numeric targets are based upon the WQOs described in the California Toxics Rule (CTR).
- Section 4: Source Assessment. This section develops the quantitative estimate of metals loading from point sources and non-point sources into Ballona Creek and Sepulveda Canyon Channel.
- Section 5: Linkage Analysis. This analysis shows how the sources of metals pollutants into the waterbody are linked to the observed conditions in the impaired waterbody. The linkage analysis addresses the critical conditions of stream flow, loading, and water quality parameters.
- Section 6: Pollutant Allocation. Each pollutant source is allocated a quantitative load of metals that it can discharge to meet the numeric targets. Allocations are designed such that the waterbody will not exceed numeric targets for any of the compounds or related

effects. Allocations are based on critical conditions, so that the allocated pollutant loads may be expected to remove the impairments at all times.

- Section 7: Implementation. This section describes the plans, regulatory tools, or other mechanisms by which the waste load allocations are to be achieved.
- Section 8: Monitoring. This TMDL includes a requirement for monitoring the waterbody to ensure that the water quality standards are attained. If the monitoring results demonstrate that the TMDL has not succeeded in removing the impairments, then revised allocations will be developed.

2 Problem Identification

This section provides an overview of water quality standards for Ballona Creek, Sepulveda Canyon Channel, and Ballona Creek Estuary and reviews water quality data used in the 1998 water quality assessment (WQA), the 2002 303(d) listing, and additional data used to analyze sources in this TMDL.

2.1 *Water Quality Standards*

California state water quality standards consist of the following elements: 1) beneficial uses; 2) narrative and/or numeric water quality objectives; and 3) an antidegradation policy. In California, the Regional Boards define beneficial uses in their *Basin Plans*. Numeric and narrative objectives designed to be protective of these beneficial uses are specified in each region's *Basin Plan*, or State Water Quality Control Plans. Numeric objectives for toxics can be found in the California Toxics Rule (40 CFR 131.38).

2.1.1 *Beneficial Uses*

The *Basin Plan* for the Los Angeles Regional Board (1994) defines 13 existing (E), potential (P), or intermittent (I) beneficial uses for Ballona Creek, Sepulveda Canyon Channel, and Ballona Creek Estuary (Table 2-1). The municipal and domestic supply (MUN) use designation is conditional, as noted by the asterisk in Table 2-1. Conditional designations are not recognized under federal law and are not subject to water quality objectives requiring TMDL development at this time. (Letter from Alexis Strauss [USEPA] to Celeste Cantú [State Board], February 15, 2002.)

Table 2-1. Beneficial Uses of Ballona Creek, Sepulveda Canyon Channel, and Ballona Creek Estuary (LARWQCB, 1994)

Ballona Creek Watershed	Hydro Unit #	MUN	NAV	REC1	REC2	COMM	WARM	EST	MAR	WILD	RARE	MIGR	SPWN	SHELL
Ballona Creek Estuary	405.13		E	E	E	E		E	E	E	Ee	Ef	Ef	E
Ballona Creek to Estuary	405.13	P*		Ps	E		P			P				
Ballona Creek and Sepulveda Canyon Channel	405.15	P*		Ps	E		P			E				

Beneficial use designations apply to all tributaries to the indicated waterbody, if not listed separately.
E: Existing beneficial use
P: Potential beneficial use
s: Access prohibited by Los Angeles County Department of Public Works
e: One or more rare species utilize all oceans, bays, estuaries, and wetlands for foraging and/or nesting.
f: Aquatic organisms utilize all bays, estuaries, lagoons, and coastal wetlands, to a certain extent, for spawning and early development. This may include migration into areas that are heavily influenced by freshwater inputs.
* Conditional designation

Metals loading to these waterbodies may result in impairments of beneficial uses associated with aquatic life (WARM, EST, MAR, WILD, RARE, MIGR, and SPWN), human use of these resources (COMM and SHELL), and recreational uses (REC1 and REC2).

Ballona Creek Estuary has existing designated uses to protect aquatic life that use the estuarine, marine, and wildlife habitat (EST, MAR and WILD). The RARE use designation is designed to protect rare, threatened or endangered species that may utilize the estuary and adjacent wetlands for foraging or nesting habitat. Also, there are existing uses to protect aquatic organisms utilizing the estuary for migration (MIGR) or for spawning, reproduction, and/or early development (SPWN). There are also beneficial uses associated with human use of the estuary including navigation (NAV), commercial and sport fishing (COMM), and shellfish harvesting (SHELL). In the creek, there are potential designated beneficial uses to protect warm freshwater habitat (WARM) and wildlife habitat (WILD). The recreational use for water contact (REC1) applies as an existing use for the estuary and a potential use in the creek. The secondary non-contact water recreation (REC2) applies as an existing use in both the estuary and creek.

2.1.2 Water Quality Objectives

As stated in the *Basin Plan,* water quality objectives (WQOs) are intended to protect the public health and welfare and to maintain or enhance water quality in relation to the designated existing and potential beneficial uses of the water. Narrative WQOs are specified in the 1994 Regional Board *Basin Plan.* The following narrative objectives are most pertinent to the metals TMDL.

> *Surface waters shall not contain concentrations of chemical constituents in amounts that adversely affect any designated beneficial use.*
>
> *Toxic pollutants shall not be present at levels that will bioaccumulate in aquatic life to levels, which are harmful to aquatic life or human health.*
>
> *All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life.*

Numeric water quality objectives for pollutants addressed in this TMDL were promulgated by USEPA in 2000 in the California Toxics Rule (CTR). The CTR establishes freshwater and saltwater aquatic life criteria for 23 priority toxic pollutants and numeric human health criteria for 57 priority toxic pollutants. The selenium and cadmium objectives were established contingent on an USEPA commitment to revise the objectives promptly to better protect wildlife.

The CTR establishes short-term (acute) and long-term (chronic) aquatic life criteria for metals in both freshwater and saltwater. The acute criterion, defined in the CTR as the Criteria Maximum Concentration, equals the highest concentration of a pollutant to which aquatic life can be exposed for a short period of time without deleterious effects. The chronic criterion, defined in the CTR as the Criteria Continuous Concentration, equals the highest concentration of a pollutant to which aquatic life can be exposed for an extended period of time (4 days) without deleterious effects. Freshwater aquatic life criteria apply to waters in which the salinity is equal to or less than 1 part per thousand (ppt) 95 percent or more of the time. Saltwater aquatic life criteria apply to waters in which salinity is equal to or greater than 10 ppt 95 percent or more of the time.

For waters in which the salinity is between 1 and 10 ppt, the more stringent of the freshwater or saltwater aquatic life criteria apply.

CTR freshwater aquatic life criteria for certain metals are expressed as a function of hardness because hardness and/or water quality characteristics that are usually correlated with hardness can reduce or increase the toxicity of some metals. Hardness is used as a surrogate for a number of water quality characteristics, which affect the toxicity of metals in a variety of ways. Increasing hardness has the effect of decreasing the toxicity of metals. Water quality criteria to protect aquatic life may be calculated at different concentrations of hardness measured in milligrams per liter (mg/L) as calcium carbonate (CaCO3). The CTR lists freshwater aquatic life criteria based on a hardness value of 100 mg/L and provides hardness dependent equations to calculate the freshwater aquatic life metals criteria using site-specific hardness data.

In the CTR, freshwater and saltwater criteria for metals are expressed in terms of the dissolved fraction of the metal in the water column. These criteria were calculated based on methods in USEPA's *Summary of Revisions to Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses* (50 FR 30792, July 29, 1985), developed under Section 304(a) of the CWA. This methodology is used to calculate the total recoverable fraction of metals in the water column and then appropriate conversion factors, included in the CTR are applied, to calculate the dissolved criteria.

Table 2-2 summarizes the applicable aquatic life criteria for metals in Ballona Creek, Sepulveda Canyon Channel, and Ballona Creek Estuary expressed in terms of the dissolved fraction of the metal in the water column.

Table 2-2. Water quality objectives established in the CTR for the protection of aquatic life. Objectives are established for dissolved metals concentrations except selenium as noted.

Metal	Freshwater Acute* (µg/L)	Freshwater Chronic* (µg/L)	Saltwater Acute (µg/L)	Saltwater Chronic (µg/L)
Cadmium	4.3	2.2	42	9.3
Copper	13	9.0	4.8	3.1
Lead	65	2.5	210	8.1
Selenium	Reserved	5.0**	290	71
Silver	3.4	---	1.9	--
Zinc	120	120	90	81

* *Criteria are hardness dependent. Values in the table are based on a hardness of 100 mg/L.*
** *This criterion is expressed in the total recoverable form and is not hardness dependent.*

The CTR allows for the adjustment of criteria through the use of a water-effect ratio (WER) to assure that the metals criteria are appropriate for the site-specific chemical conditions under which they are applied. A WER represents the ratio between metals that are measured and metals that are biologically available and toxic. A WER is a measure of the toxicity of a material in site water divided by the toxicity of the same material in laboratory dilution water. No site-specific WER has been developed for Ballona Creek, Sepulveda Canyon Channel, or Ballona Creek Estuary. Therefore, a WER default value of 1.0 is assumed.

The equations for calculating the freshwater criteria for metals are:

$$\text{Acute Criterion} = \text{WER x ACF x EXP}[(m_a)(\ln(\text{hardness}))+b_a]$$
$$\text{Chronic Criterion} = \text{WER x CCF x EXP}[(m_c)(\ln(\text{hardness}))+b_c]$$

Where: WER = Water Effects Ratio (assumed to be 1)
ACF = Acute conversion factor (to convert from the total to the dissolved fraction)
CCF = Chronic conversion factor (to convert from the total to the dissolved fraction)
m_a = slope factor for acute criteria
m_c = slope factor for chronic criteria
b_a = y intercept for acute criteria
b_c = y intercept for chronic criteria

The coefficients needed for the calculation are provided in the CTR for most metals (Table 2-3). The conversion factors for cadmium and lead in freshwater are dependent on hardness. The following equations can be used to calculate the conversion factors based on site-specific hardness data:

Cadmium ACF = 1.136672 - [(ln{hardness})(0.041838)]
Cadmium CCF = 1.101672 - [(ln{hardness})(0.041838)]
Lead ACF = 1.46203 - [(ln{hardness})(0.145712)]
Lead CCF = 1.46203 - [(ln{hardness})(0.145712)]

Table 2-3. Coefficients used in formulas for calculating CTR freshwater criteria for metals.

Metal	ACF	m_a	b_a	CCF	m_c	b_c
Cadmium	0.944*	1.128	-3.6867	0.909*	0.7852	-2.715
Copper	0.960	0.9422	-1.700	0.960	0.8545	-1.702
Lead	0.791*	1.273	-1.460	0.791*	1.273	-4.705
Silver	0.85	1.72	-6.52	**	**	**
Zinc	0.978	0.8473	0.884	0.986	0.8473	0.884

** The ACF and CCF for cadmium and lead are hardness dependent. Conversion factors are based on a hardness of 100 mg/L.*
*** No value was reported in the CTR*

2.1.3 Antidegradation

State Board Resolution 68-16, "Statement of Policy with Respect to Maintaining High Quality Water in California," known as the "Antidegradation Policy," protects surface and ground waters from degradation. Any actions that can adversely affect water quality in all surface and ground waters must be consistent with the maximum benefit to the people of the state, must not unreasonably affect present and anticipated beneficial use of such water, and must not result in water quality less than that prescribed in water quality plans and policies. Furthermore, any actions that can adversely affect surface waters are also subject to the federal Antidegradation Policy (40 CFR 131.12). The proposed TMDL will not degrade water quality, and will in fact improve water quality as it will lead to meeting the water quality standards.

2.2 Water Quality Data Review

Water quality was assessed using data from the City of Los Angeles and the Southern California Coastal Water Research Project (SCCWRP) to address dry-weather conditions and data from the Los Angeles County Department of Public Works storm water program to assess wet-weather conditions.

The metals data from the City of Los Angeles were from four locations along Ballona Creek at National Boulevard, Overland Avenue, Centinela Boulevard, and Pacific Avenue sampled on a monthly basis between January 2002 through May 2003. The data from National and Overland Boulevards are representative of Ballona Creek Reaches 1 and 2, respectively. The data from Centinela Boulevard and Pacific Avenue are representative of the estuary and these data were used to assess conditions in the estuary.

The metals data from SCCWRP were from a characterization study of Ballona Creek and Estuary to identify relative metals contributions of runoff discharges during dry conditions. Sampling was conducted on May 17, July 16, and September 24, 2003 at 12 in-stream sites and at the discharge of 35-40 storm drains (number depended on whether there was flow from the drain on the sampling day). Nine of the in-stream sites were from the Creek and three of the in-stream sites were from the estuary. One of the storm drains was Sepulveda Canyon Channel and this data was used to assess conditions for that listed reach.

Dry-weather metals concentrations were compared to CTR values to analyze the relative frequencies of exceedances of acute and chronic criteria. To calculate the freshwater criteria for cadmium, copper, lead, silver, and zinc, a hardness value of 300 mg/L was used, which was the median value of the dry-weather hardness data collected in the freshwater portions of Ballona Creek by SCCWRP (2004).

To assess wet-weather conditions, we evaluated dissolved metals and hardness data collected from Ballona Creek by the LACDPW storm water program at Sawtelle Boulevard (1996 – 2002). The storm water data were compared to the freshwater CTR values based on the actual hardness measured for each sample. The results are summarized in Table 2-6.

2.2.1 Ballona Creek.

Table 2-4. Summary of 2002-2003 Ballona Creek dry-weather metals data relative to freshwater criteria (hardness of 300 mg/L). Data are based on dissolved metals concentrations except selenium, which is based on total selenium. (Source: City of LA).

Metal	N	DL (µg/L)	# > DL	# > Acute	# > Chronic
Cadmium	48	1	1	0	0
Copper	48	10	16	4	7
Lead	48	10	7	0	7*
Total Selenium	44	10	0	NA	0*
Silver	48	5	2	1	NA
Zinc	47	10	31	2	2

* Detection limit higher than the CTR criterion.

Cadmium. There was little evidence of cadmium exceeding the CTR values. It was not detected either the City's or SCCWRP database. Cadmium was only detected once in storm water at a concentration greater than the standards.

Copper. Based on the data from the City of LA, the acute standard for copper was exceed 8% and the chronic standard for copper was exceeded 15% of the time. There were no copper exceedances observed in the SCCWRP data. In storm water, the acute standard was exceeded 18% of the time and the chronic standard 31% of the time.

Lead. For the chronic standard was exceeded 15% of the time based on the City's data. This may be a low estimate since the detection limits for lead were greater than the chronic standard. Based on the SCCWRP data there were no exceedances of the lead standard. In storm water there were only two instances where the lead concentration exceeded the standards.

Selenium. There were no exceedances of the selenium standard in either of the dry weather data sets. However, in both cases the detection limits were greater than the chronic standard. Selenium was measured twice in storm water at concentrations which exceed the chronic standard.

Silver. There is little evidence of silver exceeding the standards. Silver was only measured once at concentrations which exceed the acute standard in the City's database. There were no incidences of exceedances in the SCCWRP data or the LADPW storm water data.

Zinc. There is little evidence of zinc exceedances in dry weather. Based on the City's dataset, tt was detected only twice in concentrations greater than the standards. None of the samples from the SCCWRP dataset exceeded either of the standards. In the storm water data, zinc concentrations were exceeded in 11% of the samples.

Summary of Ballona Creek. There is clear evidence of water column exceedances for copper and lead in dry-weather. During wet weather there are exceedances of copper, lead, and zinc. There is very little evidence that cadmium and silver are exceeding the standards in either dry or wet-weather conditions. The selenium data is inconclusive. It was rarely detected in wet-weather. The detection limits for dry-weather precluded evaluation against the standards.

Table 2-5. Summary of 2003 Ballona Creek dry-weather metals data relative to freshwater criteria (hardness of 300 mg/L). Data are based on dissolved metals concentrations except selenium, which is based on total selenium. (Source: SCCWRP)

Metal	N	DL (µg/L)**	# > DL/RL**	# > Acute	# > Chronic
Cadmium	70	10	0	0	0*
Copper	70	10	10	0	0
Lead	70	5	10	0	0
Total Selenium	70	100	0	NA	0*
Silver	50	10	0	0	NA
Zinc	70	20	27	0	0

* Detection limit higher than the CTR criterion.

** DL reported as the maximum of the detection limit (DL) or the reporting limit (RL).

Table 2-6. Summary of 1996-2002 Ballona Creek wet-weather metals data relative to freshwater criteria. Data are based on dissolved metals concentrations except selenium, which is based on total selenium. (Source: LACDPW).

Metal	N	# > DL	# > Acute	# > Chronic
Cadmium	55	2	1	1
Copper	55	50	10	17
Lead	55	7	2	2
Total Selenium	55	3	NA	2
Silver	55	1	0	NA
Zinc	55	22	6	6

2.2.2 Ballona Creek Estuary

As part of this review, we evaluated conditions in the estuary. These data are presented in Table 2-7 and 2-8. In brief, the data suggests that there may be exceedances of the copper standards and the lead standards. These are not listed. The State should consider the possibility of listing the estuary for lead and copper in the next cycle.

Table 2-5. Summary of 2002-2003 Ballona Creek Estuary dry-weather dissolved metals data relative to saltwater criteria. (Source: City of LA)

Metal	N	DL (µg/L)	# > DL	# > Acute	# > Chronic
Cadmium	48	1	3	0	0
Copper	48	10	10	10*	10*
Lead	48	10	7	0	7*
Selenium	44	10	4	0	0
Silver	48	5	0	0*	NA
Zinc	48	10	18	2	2

* Detection limit higher than the CTR criterion.

Table 2-8. Summary of 2003 Ballona Creek Estuary dry-weather dissolved metals data relative to saltwater criteria. (Source: SCCWRP)

Metal	N	DL/RL (µg/L)**	# > DL/RL**	# > Acute	# > Chronic
Cadmium	27	10	0	0	0*
Copper	27	10	5	5*	5*
Lead	27	5	15	0	5
Selenium	27	100	0	0	0*

Silver	18	10	0	0*	NA
Zinc	27	20	10	0	0

* Detection limit higher than the CTR criterion.
** DL/RL reported as the maximum of the detection limit (DL) or the reporting limit (RL).

2.2.3 Sepulveda Canyon Channel.

Sepulveda Canyon Channel is listed for lead. Based on the three dry-weather sampling events conducted by SCCWRP in 2003, there were no exceedances of the acute or chronic criteria in Sepulveda Canyon Channel. However, the reporting limits for dissolved cadmium and total selenium were both greater than the chronic criteria for these metals.

Table 2-7. Summary of 2003 Sepulveda Canyon Channel dry-weather metals data relative to freshwater criteria (hardness of 300 mg/L). Data are based on dissolved metals concentrations except selenium, which is based on total selenium. (Source: SCCWRP)

Metal	N	DL/RL (μg/L)**	# > DL/RL**	# > Acute	# > Chronic
Cadmium	6	10	0	0	0*
Copper	6	10	2	0	0
Lead	6	5	0	0	0
Total Selenium	3	100	0	NA	0*
Silver	4	10	0	0	NA
Zinc	6	20	0	0	0

* Detection limit higher than the CTR criterion.
** DL/RL reported as the maximum of the detection limit (DL) or the reporting limit (RL).

2.2.4 Conclusions of Water Quality Assessment

This re-assessment confirms the existence of metals impairments identified in the 2002 303(d) list. The evidence for impairments associated with copper, lead, and zinc is clear. The evidence for impairments associated with cadmium and silver are also clear, but less compelling in terms of the magnitude, frequency, and extent of the impairment. The data for the selenium impairment is the least conclusive, since the detection and reporting limits are greater than the water quality criteria. The data for selenium are not sufficient to delist at this time. Further characterization is needed to clearly identify impairment

Table 2-10. Summary of water quality impairments in Ballona Creek and level of confidence in assessment.

Waterbody	Pollutant	Exceedances during Dry Weather	Exceedances during Wet Weather
Ballona Creek:	Cadmium		L
	Copper	H	H
	Lead	H	L
	Selenium	L	L
	Silver	L	
	Zinc	L	H

New data from Sepulveda Canyon Channel indicates compliance with CTR standards, but the new data is limited and not sufficient for delisting at this time.

There is some indication that concentrations of copper and possibly lead in the water column of the estuary may be higher than the CTR standards. The estuary is not listed at this time based on water column exceedances. The Regional Board may want to consider listing the Estuary in future 303(d) listing cycle. It is possible that reductions by this Ballona Creek TMDLs or the Ballona Creek Estuary TMDLs may be sufficient to control copper in the water column of the estuary. Further characterization is needed.

TMDLs are developed for cadmium, copper, lead, selenium, silver and zinc for Ballona Creek and Sepulveda Canyon Channel.

3 Numeric Targets

Numeric targets for the TMDL have been calculated based on the numeric objectives in the CTR. The numeric objectives in the CTR are expressed in terms of dissolved metals (USEPA 2000a) because the dissolved forms are the most bioavailable to aquatic organisms.

USEPA and the Regional Board recognize the potential for transformation between total recoverable metals and the dissolved metals fraction. The partitioning between dissolved and particulate phases of total recoverable metals is highly dependent upon the conditions observed during the period of sampling. During dry conditions, metals are primarily in the dissolved state, which is consistent with default conversion factors defined in the CTR. For wet conditions, the partitioning between particulate and dissolved metals often does not achieve equilibrium as the metals are transported with storm flows. Conversion factors are used to convert the dissolved metal numeric targets to total recoverable metals for calculation of the WLAs in this TMDL. The linkage analysis and pollutant allocations to meet the numeric targets (Section 5 and 6) will be based on total recoverable metals.

Separate numeric targets were developed for dry and wet weather because conditions in the Ballona Creek and tributaries differ significantly between dry and wet weather. For the purpose of this TMDL wet weather is defined in terms of flow rather then rain fall. Wet weather is defined as the point during a storm event in which flow in Ballona Creek reaches 40 cfs. This is based on the 90^{th} percentile of flows measured at Sawtelle Boulevard over a 10-year period. The following sections describe the numeric targets for this TMDL.

3.1.1 Dry-Weather TMDL Targets

As discussed in Section 2, the freshwater aquatic life criteria for metals in the CTR are expressed as a function of hardness of the receiving water. Dry-weather hardness data, reported by SCCWRP (2004), for Ballona Creek were analyzed and a median hardness value of 300 mg/L was determined. The chronic criteria are the most limiting values for cadmium, copper, lead, selenium, and zinc (Table 3-1), therefore, were used as the basis for developing waste load allocations for dry weather. For silver there is no chronic criterion, therefore, the acute criterion was used for developing the waste load allocations.

Table 3-1. Dry-weather numeric targets expressed in terms of the dissolved fraction and total recoverable fraction

Metal	Dissolved Target*	Conversion Factor	Target Total Recoverable
Cadmium	5.0	0.86	5.8
Copper	23	0.96	24
Lead	8.1	0.63	13
Selenium*	-	-	5.0
Silver	23	0.85	27
Zinc	300	0.99	312

* *Freshwater targets are based on a hardness of 300 mg/L.*
** *This criterion is expressed in the total recoverable form.*

The numeric targets in Table 3-1 require conversion to total recoverable metals concentrations for comparison to existing conditions for TMDL development. Data is insufficient to develop site-specific conversion factors, so default conversion factors in the CTR are used. The freshwater chronic criterion for selenium is expressed as total recoverable metals; therefore, no conversion is required. As discussed in Section 2.1.2, freshwater conversion factors for cadmium and lead are dependent on hardness. Based on analysis of 2003 sampling data (SCCWRP, 2004), the freshwater dry-weather median hardness value was 300 mg/L. Therefore, a hardness value of 300 mg/L was used to calculate the freshwater conversion factors for cadmium and lead.

3.1.2 Wet-Weather TMDL Targets

As discussed above, the freshwater aquatic life criteria for metals in the CTR are expressed as a function of hardness of the receiving water. For the wet-weather numeric target, we evaluated hardness values from storm water data collected in Ballona Creek by the LACDPW as part of the NPDES program. These data represent 55 storm water composite samples collected between 1996 and 2002. The average and median hardness from these data were 108 mg/L and 77 mg/L, respectively. These values do not vary greatly from the CTR default hardness of 100 mg/L. However, using the default hardness value of 100 mg/L may not be fully protective. Therefore, the median hardness of 77 mg/L is assumed to be representative of wet-weather conditions.

The chronic criteria are typically based on exposures, which occur over a 4-day time interval. Storms of this duration are a rare occurrence in Southern California. Most storms are of shorter duration. Most rainfall events in the Ballona Creek watershed are less than 6 hours in duration, with only 6% of the storms greater than 1 day (Ackerman and Weisberg, 2003). The acute criteria are typically based on 1-hour time intervals and are more appropriate for setting numeric targets for wet-weather conditions. For selenium there is no acute criterion, therefore, the chronic criterion was used for developing the waste load allocations for wet weather.

To evaluate the potential for site-specific wet-weather conversion factors, storm water data collected by LACDPW from Ballona Creek between Sawtelle and Sepulveda Boulevards was evaluated. To establish the relationship, dissolved metals were regressed against total recoverable metals in the storm water data set. Data from December 1994 through January 2002 were regressed and conversion factors determined for copper, lead, and zinc. There were not enough samples with detectable levels of dissolved cadmium, selenium, or silver present to determine a relationship for these metals. The resulting conversion factors for freshwater are listed in Table 3-4 along with the default CTR conversion factors for comparison. As stated previously, a conversion factor is not needed for the freshwater selenium chronic criterion, since, this criterion is already expressed as a total recoverable metal. The freshwater CTR conversion factors for cadmium and lead were calculated based on a hardness of 77 mg/L.

Table 3-4. Conversion factors for total recoverable metals to dissolved metals concentrations.

Metal	CTR Conversion Factor for Freshwater Acute Criteria	Wet-Weather Data (LACDPW)		
		N	Conversion Factor	R^2
Cadmium	0.955*	2	-	-
Copper	0.96	50	0.62	0.70
Lead	0.829*	7	0.60	0.77
Selenium	---			
Silver	0.85	1	-	-
Zinc	0.978	22	0.79	0.89

* *Conversion factor is hardness dependent, based on a hardness of 77 mg/L.*

These results suggest that a large fraction of the total recoverable metals in storm water is associated with the particles. This is consistent with expectations and with values from the literature. McPherson et al., 2002 estimated that 83% of the cadmium, 63% of the copper, and 86% of the lead were associated with the particle phase in Ballona Creek. Use of the CTR default values would be overly conservative, therefore, we propose using the slope of the regression as conversion factors for copper and zinc. Given the low number of samples, default CTR conversion factors will be used for lead, as well as for lead, cadmium, and silver.

The freshwater numeric targets used to calculate the wet-weather waste load allocations are listed in Table 3-3.

Table 3-3. Wet-weather numeric targets* expressed in terms of dissolved and total fraction.

Metal	Target (µg/L) Dissolved	Conversion factor used	Target (µg/L) Total Recoverable
Cadmium	3.2	0.96	3.4
Copper	11	0.62	18
Lead	49	0.83	59
Selenium*	-	-	5.0
Silver	2.2	0.85	2.6
Zinc	94	0.79	98

**Targets are based on a hardness of 77 mg/L.*

*** For selenium, the chronic criterion is used, since, there is not an acute criterion included in the CTR. This criterion is expressed in the total recoverable form.*

4 SOURCE ASSESSMENT

This section identifies the potential sources of metals to Ballona Creek. The toxic pollutants can enter surface waters from both point and nonpoint sources. Point sources typically include discharges from a discrete human-engineered point. These types of discharges are regulated through the federal National Pollutant Discharge Elimination System (NPDES) program, which the Regional Boards have been delegated to implement through the issuance of Waste Discharge Requirements (WDRs). Nonpoint sources, by definition, include pollutants that reach surface waters from a number of diffuse land uses and activities. The Regional Board, under the authority of the Porter-Cologne Water Quality Control Act, issues WDRs for discharges to groundwater from nonpoint sources. The distinction between point and nonpoint sources is not always clear in the Ballona Creek watershed area. In Los Angeles County urban runoff to Ballona Creek and Estuary is regulated under NPDES permits, which are regulated as a point source discharge.

4.1 Background on Metals

Cadmium is a trace element used in a wide variety of applications, including, electroplating, the manufacture of pigments, storage batteries, telephone wires, photographic supplies, glass, ceramics, some biocides, and as a stabilizer in plastics. The main anthropogenic sources of cadmium appear to be metal smelting, industries involved in the manufacture of alloys, paints, batteries, and plastics, agricultural uses of sludge, fertilizers and pesticides that contain cadmium, and the burning of fossil fuels.

Lead and its compounds are used in electroplating, metallurgy, construction materials, coating and dyes, electronic equipment, plastics, veterinary medicines, fuels and radiation shielding. Lead is also used for ammunition, corrosive-liquid containers, paints, glassware, fabricating storage tank linings, transporting radioactive materials, solder, piping, cable sheathing, and roofing (MacDonald, 1994). Prior, to the phasing out of leaded gasoline, lead additives in gasoline was a significant source of lead in the environment. Since the phasing out of leaded gasoline, there has been a gradual decline of lead concentrations in the environment.

Silver is used extensively in photographic materials. Other uses of silver include the manufacture of sterling and planted ware, jewelry, coins and medallions, electrical and electronic products, brazing alloys and solders, catalysts, mirrors, fungicides, and dental and medical supplies. Potential sources of silver to surface waters include leachates from landfills, waste incineration, and effluents from the iron, steel and cement industries

Zinc is primarily used as a coating on iron and steel to protect against corrosion, in alloys for die casting, in brass, in dry batteries, in roofing and exterior fittings for buildings, and in some printing processes. The principal sources of zinc in the environment include smelting, and refining activities, wood combustion, waste incineration, iron and steel production and tire wear.

4.2 Point Sources

A point source, according to 40 CFR 122.3, is defined as "any discernable, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel, or other floating craft from which pollutants are or may be discharged." The NPDES program, under CWA Sections 318, 402, and 405, requires permits for the discharge of pollutants from point sources.

The NPDES permits in the Ballona Creek Watershed include the MS4 and Caltrans Storm Water Permits, minor NPDES permits, general NPDES permits, general industrial storm water permits and general construction storm water permits (Table 4-1).

Table 4-1. NPDES Permits in the Ballona Creek Watershed

Type of NPDES Permit	Number of Permits
Municipal Storm water	1
California Department of Transportation Storm water	1
Minors	16
General Permits:	
Construction Dewatering	83
Treated Groundwater from Construction Dewatering	15
Petroleum Fuel Cleanup Sites	18
VOCs Cleanup Sites	7
Potable Water	6
Non-Process Wastewater	3
Hydrostatic Test Water	1
General Construction Storm water	17
General Industrial Storm water	14
Total	**182**

4.2.1. *Storm water Permits*

Storm water runoff in the Ballona Creek watershed is regulated through a number of permits. The first is the municipal storm water (MS4) permit. The second is a separate statewide storm water permit. The third is the statewide Construction Activities Strom Water General Permit. The fourth is the statewide Industrial Activities Storm Water General Permit. There are fourteen general industrial storm water permits and seventeen general construction permits within the watershed. The permitting process defines these discharges as point sources because the storm water discharges from the end of a storm water conveyance system. Since the industrial and construction storm water discharges are enrolled under NPDES permits, these discharges are treated as point sources in this TMDL.

MS4 Storm Water Permits

In 1990 USEPA developed rules establishing Phase I of the NPDES storm water program, designed to prevent harmful pollutants from being washed by storm water runoff into municipal separate storm sewer systems (MS4s) (or from being dumped directly into the MS4s) and then discharged from the MS4s into local waterbodies. Phase I of the program required operators of medium and large MS4s (those generally serving populations of 100,000 or more) to implement a storm water management program as a means to control polluted discharges from the MS4s. Approved storm water management programs for medium and large MS4s are required to address a variety of water quality-related issues, including roadway runoff management, municipally owned operations, and hazardous waste treatment. Large and medium MS4 operators are required to develop and implement Storm Water Management Plans that address, at a minimum, the following elements:

- Structural control maintenance
- Areas of significant development or redevelopment
- Roadway runoff management
- Flood control related to water quality issues
- Municipally owned operations such as landfills, and wastewater treatment plants
- Municipally owned hazardous waste treatment, storage, or disposal sites
- Application of pesticides, herbicides, and fertilizers
- Illicit discharge detection and elimination
- Regulation of sites classified as associated with industrial activity
- Construction site and post-construction site runoff control
- Public education and outreach

The County of Los Angeles Municipal Storm Water NPDES permit (MS4 Permit) was renewed in December 2001 (Regional Board Order No. 01-182) and is on a five-year renewal cycle. There are 85 co-permittees covered under this permit including 84 cities and the County of Los Angeles.

Caltrans Storm Water Permit

As stated previously, Caltrans is regulated by a statewide storm water discharge permit that covers all municipal storm water activities and construction activities (Order No. 99-06-DWQ). The Caltrans storm water permit authorizes storm water discharges from Caltrans properties such as the state highway system, park and ride facilities, and maintenance yards.

The storm water discharges from these Caltrans properties and facilities eventually ends up in either a city or county storm drain. The metals loading specifically from Caltrans properties have not been determined in the Ballona Creek watershed. A conservative estimate of the percentage of the Ballona Creek watershed covered by state highways is 1% (approximately 970 acres). This percentage does not represent all the watershed area that Caltrans is responsible for under the stormwater permit. The park and ride facilities and the maintenance yards were not included in the estimate. Although, the percentage is low the associated metals loading may be high especially for zinc and copper used in tires and brake pads.

General Storm Water Permits

Federal regulations for controlling pollutants in storm water discharges were issued by the USEPA on November 16, 1990 (40 Code of Federal Regulations [CFR] Parts 122, 123, and 124). The regulations require operators of specific categories of facilities where discharges of storm water associated with industrial activity occur to obtain an NPDES permit and to implement Best Available Technology Economically Achievable (BAT) and Best Conventional Pollutant Control Technology (BCT) to reduce or prevent pollutants associated with industrial activity in storm water discharges and authorized non-storm discharges. In addition, the regulations require discharges of storm water to surface waters associated with construction activity including clearing, grading, and excavation activities (except operations that result in disturbance of less than five acres) to obtain an NPDES permit and to implement BAT and BCT to reduce or eliminate storm water pollution. On December 8, 1999, federal regulations promulgated by USEPA (40CFR Parts 122, 123, and 124) expanded the NPDES storm water program to include storm water discharges from construction sites that resulted in land disturbances equal to or greater than one acre but less then five acres.

On April 17, 1997, State Board issued a statewide general NPDES permit for Discharges of Storm Water Associated with Industrial Activities Excluding Construction Activities Permit (Order No. 97-03-DWQ). This Order regulates storm water discharges and authorized non-storm water discharges from ten specific categories of industrial facilities, including but not limited to manufacturing facilities, oil and gas mining facilities, landfills, and transportation facilities. On August 19, 1999, State Board issued a statewide general NPDES permit for Discharges of Storm Water Runoff Associated with Construction Activities (Order No. 99-08-DQW). All dischargers covered under these general NPDES storm water permits are required to develop and implement an effective Storm Water Pollution Prevention Plan (SWWPPP) and Monitoring Program. The SWPPP has two main objectives. One, to identify and evaluate sources of pollutants associated with industrial or construction activities that may affect the quality of storm water discharges. Two, to identify and implement site-specific BMPs to reduce or prevent pollutants associated with industrial activities in storm water discharges.

There are fourteen general industrial storm water permits and seventeen general construction storm water permits within the Ballona Creek watershed. Potential pollutants from an industrial site will depend on the type of facility and operations that take place at that facility. In the Ballona Creek watershed, there are sand and gravel operations, oil and natural gas facilities, transportation, recycling and manufacturing facilities. Potential pollutants from construction sites include sediment, which may contain metals (e.g. lead and zinc) from construction materials and the heavy equipment used on construction sites. In addition, in the highly urbanized Ballona Creek watershed re-development of former industrial sites has a higher potential to discharge sediments laden with pollutants such as metals.

4.2.1 Other Individual NPDES Permits

The individual NPDES permit is classified as either major or a minor permits. The discharges flows associated with minor individual NPDES permits and general NPDES permits are typically less than 1 million gallons per day (MGD). General NPDES permits often regulate episodic discharges (e.g. dewatering operations) rather than continuous flows. The minor NPDES permits issued with the Ballona Creek watershed are also for episodic discharges.

Minor Individual NPDES Permits

There were 16 minor individual discharges to Ballona Creek, for a combined permitted discharge of approximately 11 MGD. Actual combined discharges at any one time are probably less due to the intermittent nature of the permitted activities. The two largest dischargers are the Inglewood Oil Field located in Baldwin Hills (7.55 MGD) and the City of Santa Monica water supply treatment plant (1.6 MGD). However, the City of Santa Monica discontinued the operation of the treatment plant on August 22, 2000, because the effluent from the water softener did not meet the discharge limits. Therefore, the existing combined discharge from the individual NPDES permits is now estimated to be 9.4 MGD.

The Inglewood Oil Field makes up the majority of the flow from the individual minor dischargers. This permit is for the discharge of storm water from on-site retention basins, during or immediately after a rain event. The NPDES permit was issued in 1994 and only contains effluent limits for oil and grease and phenols. Therefore, it is possible that this discharge may exceed the numeric targets established in Section 3. The impact of this discharge is most realized during wet weather.

Three individual minor NPDES permits were issued in 1999 to gasoline service stations for the discharge of treated contaminated groundwater. The effluent limits (e.g., lead) are not based on CTR, therefore, these discharges may exceed the numeric targets established in Section 3. These discharges would have the greatest impact during dry weather.

Other permits issued under this category address intermittent, small volume discharges of cooling tower blowdown, groundwater dewatering, pool or fountain filter backwash, and water softener waste. The permits for these discharges were issued in 1997, and effluent limits for metals are not based on CTR. Therefore, the discharges may exceed the numeric targets established in Section 3. These discharges would have the greatest impact during dry weather.

Other General NPDES Permits

Pursuant to 40 CFR parts 122 and 123, the State Board and the Regional Boards have the authority to issue general NPDES permits to regulate a category of point sources if the sources: involve the same or substantially similar types of operations; discharge the same type of waste; required the same type of effluent limitations; and require similar monitoring. The Regional Board has issued general NPDES permits for six categories of discharges: construction and project dewatering; petroleum fuel cleanup sites; volatile organic compounds (VOCs) cleanup sites; potable water; non-process wastewater; and hydrostatic test water.

The general NPDES permit for Discharges of Groundwater from Construction and Project Dewatering to Surface Waters (Order No. R4-2003-0111) covers wastewater discharges, including but not limited to, treated or untreated groundwater generated from permanent or temporary dewatering operations. Currently, there are 98 dischargers enrolled under this Order in the Ballona Creek watershed for a combined total discharge flow of approximately 14 MGD.

The actual combined discharges at any one time are probably less due to the intermittent nature of the permitted activities. The effluent limits for metals are based on CTR. Therefore, these discharges are not expected to exceed the numeric targets established in Section 3. These discharges would have the greatest impact during dry weather.

The general NPDES permit for Treated Groundwater and Other Wastewaters from Investigation and/or Cleanup of Petroleum Fuel-Contaminated Sites to Surface Waters (Order No. R4-2002-0125) covers discharges, including but not limited to, treated groundwater and other wastewaters from the investigation, dewatering, or cleanup of petroleum contamination arising from current and former leaking underground storage tanks or similar petroleum contamination. Currently, there are 18 dischargers enrolled under this Order in the Ballona Creek watershed for a combined total discharge flow of 1.6 MGD. There are no effluent limitations for metals with the exception of lead. The effluent limitation for lead is based on CTR and a hardness value of 100 mg/L. Therefore, these discharges may exceed the numeric targets, with the exception of lead, established in Section 3. These discharges would have the greatest impact during dry weather.

The general NPDES permit for Discharges of Treated Groundwater from Investigation and/or Cleanup of VOCs-Contaminated Sites to Surface Waters (Order No. R4-2002-0107) covers discharges, including but not limited to, treated groundwater and other wastewaters from the investigation, cleanup, or construction dewatering of VOCs only (or VOCs commingled with petroleum fuel hydrocarbons) contaminated groundwater. Currently, there are approximately seven dischargers enrolled under this Order in the Ballona Creek watershed for a combined total discharge flow of 0.5 MGD. There are no effluent limitations for metals with the exception of lead. The effluent limitation for lead is based on CTR with a hardness value of 100 mg/L. Therefore, these discharges may exceed the numeric targets, with the exception of lead, established in Section 3. These discharges would have the greatest impact during dry weather.

The general NPDES permit for Discharges of Groundwater from Potable Water Supply Wells to Surface Waters (Order No. R4-2003-0108) covers discharges of groundwater from potable supply wells generated during well purging, well rehabilitation and redevelopment, and well drilling, construction and development. Currently, there are six dischargers enrolled under this Order in the Ballona Creek watershed for a combined total discharge flow of 1 MGD. The effluent limits for metals are not based on CTR. Therefore, these discharges may exceed the numeric targets established in Section 3. These discharges would have the greatest impact during dry weather.

The general NPDES permit for Discharges of Nonprocess Wastewater to Surface Waters (Order No. R4-2004-0058) covers waste discharges, including but not limited to, noncontact cooling water, boiler blowdown, air conditioning condensate, water treatment plant filter backwash, filter backwash, swimming pool drainage, and/or groundwater seepage. Currently, there are three dischargers enrolled under this Order in the Ballona Creek watershed for a combined total discharge flow of 0.2 MGD. The effluent limits for metals are based on CTR. Therefore, these discharges are not expected to exceed the numeric targets established in Section 3. These discharges would have the greatest impact during dry weather.

The general NPDES permit for Discharges of Low Threat Hydrostatic Test Water to Surface Waters (Order No. R4-2004-0109) covers waste discharges from hydrostatic testing of pipes, tanks, and storage vessels using domestic/potable water. Currently, there is one discharger, with a design flow of 0.72 MGD, enrolled under this Order in the Ballona Creek watershed. The effluent limits for metals are not based on CTR. Therefore, these discharges may exceed the numeric targets established in Section 3. These discharges would have the greatest impact during dry weather.

4.2.3. SUMMARY POINT SOURCES

The total loadings of metals reflects sum of inputs from urban runoff and multiple NPDES permits within the watershed (Table 4.2). In the Ballona Creek Watershed storm water discharges are regulated under the MS4 permit, the Caltrans permit, the general industrial storm water permit and the general construction storm water permit. There are sixteen minor NPDES permits with the potential to contribute loadings to the system. There are also over 100 non storm water general permits with low potential to contribute significant loadings to the system on an individual basis but may in the aggregate contribute significantly to the system.

Table 4.2 Summary of permits in Ballona Creek Watershed

Type of NPDES Permit	Number of Permits	Permitted Volume (MGD)	Screening for pollutants?	Permit Limits for metals?	Potential for significant contribution?
Municipal Storm Water	1	NA	Yes	No	High
Caltrans Storm Water	1	NA	Yes	No	High
General Construction Storm Water	17	NA	Yes	No	High
General Industrial Storm Water	14	NA	Yes	No	High
Individual NPDES Permits (minors)	16	9.4	Yes	Not CTR	Medium
Other General Permits					
Construction and Project Dewatering	98	14	Yes	CTR	Low
Petroleum Fuel Cleanup Sites	18	1.6	Yes	CTR (lead only)	Medium
VOCs Cleanup Sites	7	0.5	Yes	CTR (lead only)	Medium
Potable Water	6	1	Yes	Not CTR	Medium
Non-Process Wastewater	3	0.2	Yes	CTR	Low
Hydrostatic Test Water	1	0.7	Yes	Not CTR	Medium

4.3 Quantifying Urban Runoff.

Urban storm water has been recognized as substantial source of metals (Characklis and Wiesner 1997, Davis et al. 2001, Buffleben et al. 2002. The most prevalent metals in urban storm water (i.e., copper, lead, zinc, and to a lesser degree cadmium) are consistently associated with the suspended solids (Sansalone and Buchberger 1997, Davis et al. 2001). These metals are typically associated with fine particles in storm water runoff (Characklis and Wiesner 1997, Liebens 2001), and have the potential to accumulate in estuarine sediments posing a risk of toxicity (Williamson and Morrisey, 2000). Locally, McPherson et al. (2002) have documented that the majority of storm water metals loading in Ballona Creek is associated with the particle phase. The loadings of metals (cadmium lead, silver, zinc) are attributable to ongoing activities in the watershed. This is reflected in routine storm water monitoring performed by LADPW under the MS4 permit (LADPW, 2002). Studies have also shown that dry-weather pollutant loadings are not insignificant (McPherson et al., 2002) and in dry-years may be a large fraction of the total loadings (Stein et al., 2004).

4.3.1 Wet-Weather Urban Runoff

The metals that build up on the surface as the result of various land use activities are washed off during rainfall events and into the waterbodies. McPherson et al. (2002) estimated that 70% to 90% of the annual volume of water discharged from the Ballona Creek watershed between 1991 and 1996 was from wet-weather runoff. During these years, wet weather runoff accounted for 58%, 91%, and 92% of the cadmium, copper, and lead annual watershed loads, respectively. The fraction of the annual volume from rain is less during dry years. For instance, in 2001-2002 most of the annual flow volume was from dry-weather flow SCCWRP (2003). These differences aside, most pollutant loadings are associated with wet-weather runoff. Even in the relatively dry 2001-2002 water year, wet-weather loadings for lead were greater than dry-weather loadings. Wet weather loadings copper and zinc were comparable to dry season loadings (SCCWRP (2003).

SCCWRP (2003) estimated 30-year average wet-weather loads of cadmium, copper, lead, selenium, and zinc based on land use distributions, historic rainfall, and land use runoff data from LACDPW. In addition, LACDPW (2000 and 2001) estimated annual loads (1996-2001) of copper, lead, and zinc using annual mean concentrations and annual runoff volumes from a mass emission station located between Sawtelle and Sepulveda Boulevards at the non-tidal portion of Ballona Creek. Table 4-4 presents these loads for comparison (no values were reported for silver).

Table 4-4. Typical annual wet-weather loading (kg/yr) to Ballona Creek. (Source: SCCWRP, 2003; LACDPW, 2000 and 2001)

Metal	Typical Year (SCCWRP)	1996/97 (LACDPW)	1997/98* (LACDPW)	1998/99 (LACDPW)	1999/2000 (LACDPW)	2000/01 (LACDPW)
Cadmium	7	-	-	-	-	-
Copper	1,081	328	889	251	398	432
Lead	381	239	794	86	122	179
Selenium	16	-	-	-	-	-
Zinc	6,901	2,195	8,618	1,266	1,810	2,545

* Sampler was out of service the month of February 1998.

4.3.2 Dry-Weather Urban Runoff

Dry-weather urban runoff is a major source of metals loading to receiving waters in the watershed. During wet-years (1991 to 1996), the dry-weather loadings accounted for less than 10% of the annual copper and lead loadings (McPherson et al., 2002). During dry years (2000 to 2002), the dry-weather loadings account for 25-35% of the metals loads.

Dry-weather runoff often varies substantially over any given period. For instance, flows in the morning can be much greater than flows in the afternoon, but these flows can increase again in the evening. SCCWRP (2003) reported that dry-weather flows could also vary significantly from year to year.

The concentrations are also highly variable. Average total recoverable metals concentrations from storm drain samples are reported in Table 4-2. The dissolved fraction of total recoverable metals concentrations during the dry period was observed as close to unity. SCCWRP (2004) found that high concentrations of metals in the creek correspond to locations of storm drains associated with high concentrations. They concluded that although most in-stream metals samples were below water quality criteria during the 2003 sampling events, the magnitude and variability of storm drain concentrations lead to reasonable assumptions that in-stream concentrations may exceed water quality objectives at some point in time. During dry weather, the metals concentrations are predominately in the dissolved phase and may be more bioavailable (SCCWRP, 2004).

Table 4-2. Average total recoverable metals concentrations (µg/L) from storm drains in Ballona Creek during three dry-weather sampling events of 2003. In all cases n = 103. (Source: SCCWRP, 2004).

Metal	Numeric Target	Mean	SD	% ND
Cadmium	5.8*	0.13	0.33	75%
Copper	24*	19.85	28.98	3%
Lead	13*	4.41	12.66	60%
Selenium	5	7.19	12.72	53%
Silver	27*	0.47	1.54	93%
Zinc	300*	83.25	241.18	2%

* Numeric Target is based on a hardness of 300 mg/L and is expressed as total recoverable metals.

The variability in dry-weather storm drain flows along with the variability in metals concentrations makes it difficult to develop precise estimates of dry-weather loadings. Estimates of the average total recoverable metals loads (based on the three sampling events in 2003) from Centinela Channel, Sepulveda Canyon Channel, and the portion of Ballona Creek (at Overland Avenue) upstream of the discharge of Sepulveda Canyon Channel are listed in Table 4-3.[1] The small storm drains below Overland account for a relatively small percentage of the total loads.

Table 4-3. Average dry-weather total recoverable metals loads (grams/day) from Ballona Creek (at Overland Avenue), Sepulveda Canyon Channel, Centinela Channel, and small storm drain loads to Ballona Creek (below Overland). (Source: SCCWRP, 2004)

Waterbody/Discharge	Cadmium	Copper	Lead	Selenium	Silver	Zinc
Ballona Creek at Overland Avenue	2	348	97	97	6	1493
Sepulveda Canyon Channel	2	328	37	163	2	540
Centinela Channel	0.5	201	37	252	25	354
Small Storm Drains Below Overland	0.2	13	3	14	0.1	42

4.4 Nonpoint Sources

A nonpoint source is, by definition, runoff that is not covered under any of the storm water permits. An example of this would be the runoff from National Parks and State lands. In the Ballona Creek watershed National Park Service and State lands cover approximately 430 acres[2] (0.5% of the watershed). While not subject to the MS4 Permit, the contribution of runoff from these exempted areas must be accounted for in the TMDL. This can be done through the development of pollutant allocations for the National Parks and State lands or by treating the runoff from these areas as natural background in the TMDL calculation.

[1] Daily loads differ from estimates reported by SCCWRP (2004) due to differences in methods of calculation (e.g., treatment of detection limits; flow-weighted estimates verses independent averages of flows and metals concentrations)

[2] This acreage does not include the approximate 400 acres that the State purchased from the Playa Capital Company LLC in 2003. This land is open space and is not expected to contribute to the metals loading in Ballona Creek or estuary.

Atmospheric deposition is another potential nonpoint source of metals to the watershed, through either direct deposition or indirect deposition. Direct atmospheric deposition was quantified by multiplying the surface area of the waterbody times the rate of atmospheric deposition. These numbers are generally small because the portion of Ballona Creek watershed that is covered by water is small, approximately 480 acres or 0.6% of the watershed (Table 4-5). Therefore, direct deposition of metals is insignificant relative to the annual dry-weather loading or the total annual loading. Indirect atmospheric deposition reflects the process by which metals deposited on the land surface may be washed off during storm events and be delivered to Ballona Creek and its tributaries. By dividing the typical annual loading to Ballona Creek (Table 4-4) by the estimates of indirect atmosphere deposition on the watershed (Table 4-5), it can be shown that not all the metals deposited on the watershed are discharged to the creek. Using the typical year calculated by SCCWRP, the mass loading in storm water ranges from 54% to 67% of the mass loading from indirect atmospheric deposition. Sabin et al. (2004) calculated the ratio of storm water runoff to indirect atmospheric deposition as 21% for copper, 11% for lead, and 29% for zinc. The loading of metals associated with indirect atmospheric deposition are accounted for in the estimates of the storm water loading.

Table 4-5. Estimate of direct and indirect atmospheric deposition (kg/year). (Source: Sabin et al., 2004)

Type of Deposition	Copper	Lead	Zinc
Direct	21	12	78
Indirect	3,500	2,000	13,000
Total	3,521	2,012	13,078

5 Linkage Analysis

Information on sources of pollutants provides one part of the TMDL equation. To determine the effects of these sources on water quality, it is also necessary to determine the assimilative capacity of the receiving water. The delivery of metals to Ballona Creek and the assimilative capacity of the creek to accommodate these loadings can be strongly affected by variations between dry and wet weather. Given the differences in sources and flows between dry and wet weather, two distinct approaches were developed for dry and wet weather. This section describes the use of a hydrodynamic and water quality models to assess the effects of metals loading in Ballona Creek on water quality under both dry- and wet-weather conditions.

5.1 Dry-Weather Modeling Analysis

The model was used to simulate total recoverable metals concentrations in the waterbodies during steady state, low-flow conditions representative of average dry-weather conditions. The dry-weather model is based on RMA2 and RMA4 models first developed by Norton, King and Orlob (1973), of Water Resources Engineers, for the U.S. Corps of Engineers, with subsequent enhancements by U.S. Army Engineer and Development Center at the Waterways Experiment Station Coastal and Hydraulics Laboratory. RMA2 is a two-dimensional, depth-averaged, finite element, hydrodynamic numerical model. It computes water surface elevations and horizontal velocity components for sub-critical, free-surface, two-dimensional flow fields. The water quality model, RMA4 is designed to simulate the depth-average advection-diffusion process in an aquatic environment. The model can be used for the evaluation of any conservative substance that is either dissolved in the water or can be assumed neutrally buoyant within the water column.

The portion of the model configured for Ballona Creek was determined useful for prediction of metals transport through the creek. This model was upgraded and calibrated for metals transport through the creek, using data collected in the 2003 monitoring study (SCCWRP, 2004). Model simulations were performed assuming steady-state conditions representative of each sampling event. A complete description of the model, including configuration and calibration, is provided in Appendix A.

The dry-weather model was not used to develop the carrying capacity load allocations for the TMDL. Rather, analysis of empirical data is determined sufficient in developing TMDLs for Ballona Creek and Sepulveda Canyon Channel. The technical approach for this TMDL does not require model simulation. However, the model serves two purposes. First, it can be used as a management tool for assessment of alternative management schemes. The Regional Board has expressed interest in refining the model so that it can be used to refine allowable loads and allocations in the future. Second, the model can serve as a foundation of future modeling work for simulation of boundary conditions of Ballona Creek Estuary. A three-dimensional model of the estuary is proposed for a future study to provide complete understanding of the system.

5.2 Wet-Weather Modeling Analysis

Wet-weather sources of metals are generally associated with wash-off of pollutant loads accumulated on the land surface. During rainy periods, these metals loads are delivered to the waterbody through creeks and storm water collection systems. Often, metals sources can be linked to specific land use types that have higher relative accumulation rates of metals, or are more likely to deliver metals to waterbodies due to transport through storm water collection systems. To assess the link between sources of metals and the impaired waters, a modeling system may be utilized that simulates the build up and wash off of metals and the hydrologic and hydraulic processes that affect delivery.

The wet-weather TMDL calculation was based on a watershed model of the drainage area associated with each impaired waterbody. USEPA's Hydrological Simulation Program – FORTRAN (HSPF) was selected to simulate the hydrologic processes and metals loading from the Ballona Creek watershed. The HSPF model was configured for seven subwatersheds of the Ballona Creek watershed.

Ballona Creek discharge, upstream of the discharge of Sepulveda Canyon Channel near Overland Avenue, corresponded to the combined model output of subwatersheds "Cienega," "Hollywood," "Culver City," and "Westwood Village." Model output from the "West Los Angeles" subwatershed corresponded to the discharge of Sepulveda Canyon Channel.Model output from the "Windsow Hills" subwatershed corresponded to the discharge of Centinela Channel. This TMDL used model results from five sub-watersheds which drain to Ballona Creek. The two watersheds draining to the Estuary and Marina del Rey were not considered in the TMDL.

(Figure 4).

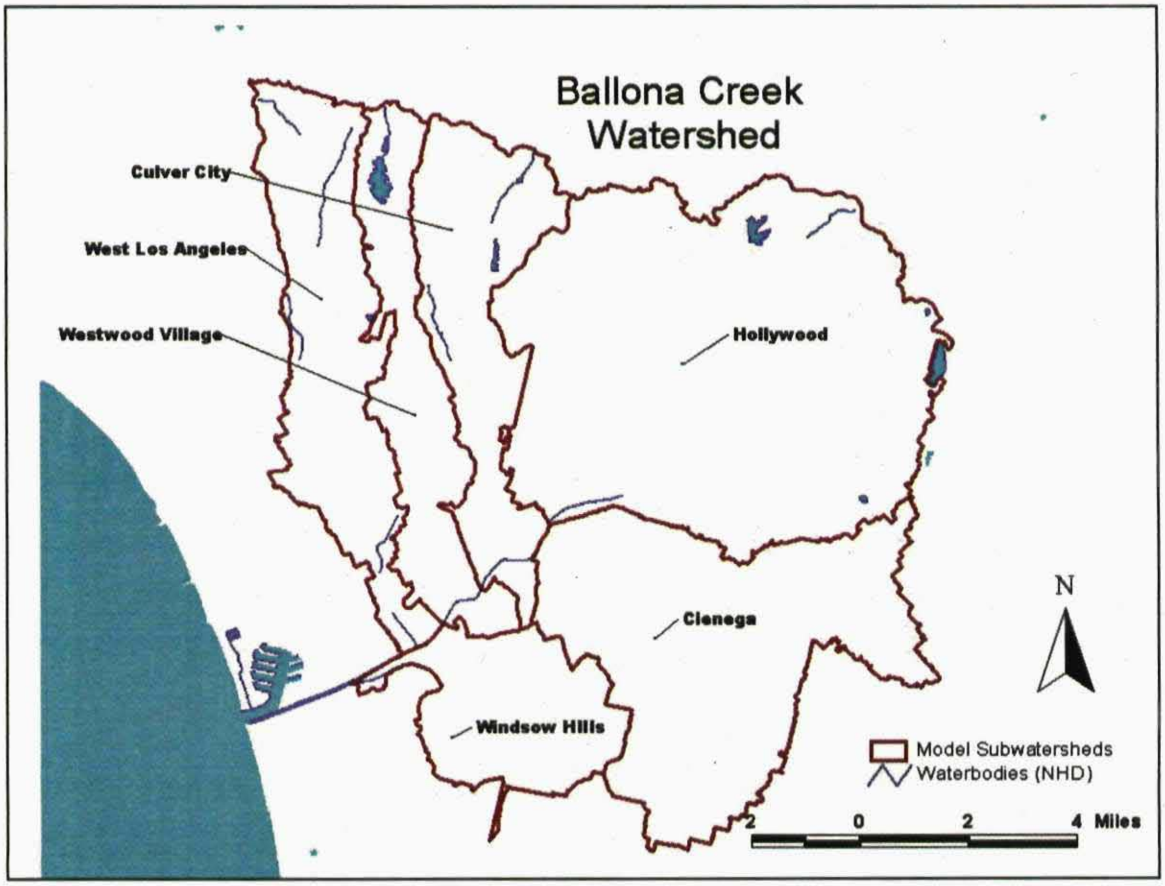


Figure 4. Model subwatersheds for simulation of wet-weather conditions

Configuration of the watershed model involved consideration of four major components: meteorological data, land use representation, hydrologic and pollutant representation, and waterbody representation. These components provided the basis for the model's ability to estimate flow and pollutant loading. Meteorological data essentially drive the watershed model. Rainfall and other parameters are key inputs to HSPF's hydrologic algorithms. The land use representation provides the basis for distributing soils and metals loading characteristics throughout the basin. Hydrologic and pollutant representation refers to the HSPF modules or algorithms used to simulate hydrologic processes (e.g., surface runoff, evapotranspiration, and infiltration) and pollutant loading processes. Waterbody representation refers to HSPF modules or algorithms used to simulate flow and pollutant transport through streams and rivers.

Loading processes for metals (copper, lead, and zinc) for each land-use was represented in HSPF through their associations with sediment. The accumulation and washoff of sediments were modeled using the SDMNT module for pervious lands and the SOLIDS module for impervious lands. Sediments washed off by rain are delivered to the stream channel by overland flow. Processes such as transport, deposition and scour of sediments in the stream channels were modeled using the SEDTRN module. These processes depend on sediment characteristics such as particle size distribution (which define settling velocities and the critical shear stresses for deposition and re-suspension), and the bottom shear stress predicted by the model.

The model was then used to simulate the in-stream total suspended solids concentrations. Metals associated with these sediments were simulated using the HSPF water quality module. The relationships between sediment and total recoverable metals (copper, lead and zinc) were parameterized as potency factors developed by SCCWRP. Potency factors were defined for copper, lead and zinc for each of seven land-uses categories (agriculture, commercial, high-density residential, industrial, low-density residential, mixed urban and open). After the model was configured, model calibration and validation were performed. This is generally a two-phase process, with hydrology calibration and validation completed before repeating the process for water quality. Total suspended solids and the potency factors were developed and calibrated by SCCWRP at specific watersheds in the Los Angeles area. These were validated for use in the Ballona Creek watershed. Upon completion of the calibration and validation at selected locations, a calibrated data set containing parameter values for each modeled land use and pollutant was developed. A complete description of model configuration and calibration is provided in Appendix B.

6 Pollutant Allocation

In this section, we develop the loading capacity and pollutant allocations for metals in Ballona Creek and Estuary. USEPA regulations require that a TMDL include waste load allocations (WLAs), which identify the portion of the loading capacity allocated to existing or future point sources (40 CFR 130.2(h)). It is not necessary that every individual point source have a portion of the allocation of pollutant loading capacity. It is necessary, however, to allocate the loading capacity among individual point sources as necessary to meet the water quality objective.

As discussed in previous sections, the sources of metals and the relative magnitude of the inputs vary between dry and wet periods. In this TMDL concentration-based and mass-based waste load allocations were developed for dry-weather urban runoff and mass-based waste allocations for stormwater runoff. Concentration-based waste load allocations are developed for all other NPDES permitted discharges based on dry- and wet-weather conditions.

6.1 Dry-Weather Loading Capacity

This TMDL addresses metals load reductions from controllable sources from the watershed through analysis of critical loads from freshwater discharges to Ballona Creek and Sepulveda Canyon Channel.

Ballona Creek and Sepulveda Canyon Channel, are listed as impaired waterbodies due to metals. Estimates of the existing dry-weather loadings associated with these waterbodies were provided in Table 4-3. Loadings from Centinela Creek are not considered in this TMDL because it is not listed and it drains to the estuary rather than the Creek.

The loading capacity of Ballona Creek and Sepulveda Canyon Channel for each metal was derived by multiplying the hardness-adjusted numeric targets (Table 3-1) as defined in the CTR, by the critical flow assigned to these two waterbodies. The loading capacities are presented as total recoverable metals for quantification of total recoverable metals loads.

Based on long-term flow records, Ackerman et al. (2001) estimated dry-weather flows in Ballona Creek to be 14 cfs. This flow was used to define the critical dry-weather flow for Ballona Creek at Overland Avenue (upstream of Sepulveda Canyon Channel). There were no historic flow records to determine the average long-term flows for Sepulveda Canyon Channel. Therefore, the 2003 measurements were assumed reasonable estimates of flows for these reaches. The average flow for Sepulveda Canyon Channel was 6.3 cfs.

Table 6-1. Dry-weather loading capacity for Ballona Creek and Sepulveda Canyon Channel (grams/day of total recoverable metals)

Waterbody/Discharge	Dry-flow	Cadmium	Copper	Lead	Selenium	Silver	Zinc
Ballona Creek (at Overland)	14.0 cfs	198	821	440	171	927	10,423
Sepulveda Canyon Channel	6.3 cfs	90	371	199	77	419	4,712
Total (Ballona Creek at Sawtelle?)	20.3 cfs	288	1192	639	248	1346	15,135

6.2 Wet-Weather Loading Capacity (Load Duration Curves)

During wet weather, the allowable load is a function of the volume of water in the creek. Given the variability in wet-weather flows, the concept of a single critical flow is not justified. Instead, load duration curves were used to establish the wet-weather loading capacity. In brief, a load duration curve is developed by multiplying the wet-weather flows by the in-stream numeric target. The result is a curve, which identifies the allowable load for a given flow.

The calibrated watershed model (HSPF) was used to simulate flows and metals concentrations from January 1990 through December 1999, providing 10 years of continuous hourly predictions. Next, hourly flows and metals concentrations were condensed to daily flow volumes and metals loads. By including all storm flows over the 10-year period, analysis of critical conditions was provided. Loading capacities were calculated by multiplying the flow by the appropriate numeric water quality target (load capacity = storm volume x numeric wet-weather water quality target). The wet-weather loading capacity applies for storm flows greater than 40 cfs, which represents the 90th percentile flow.

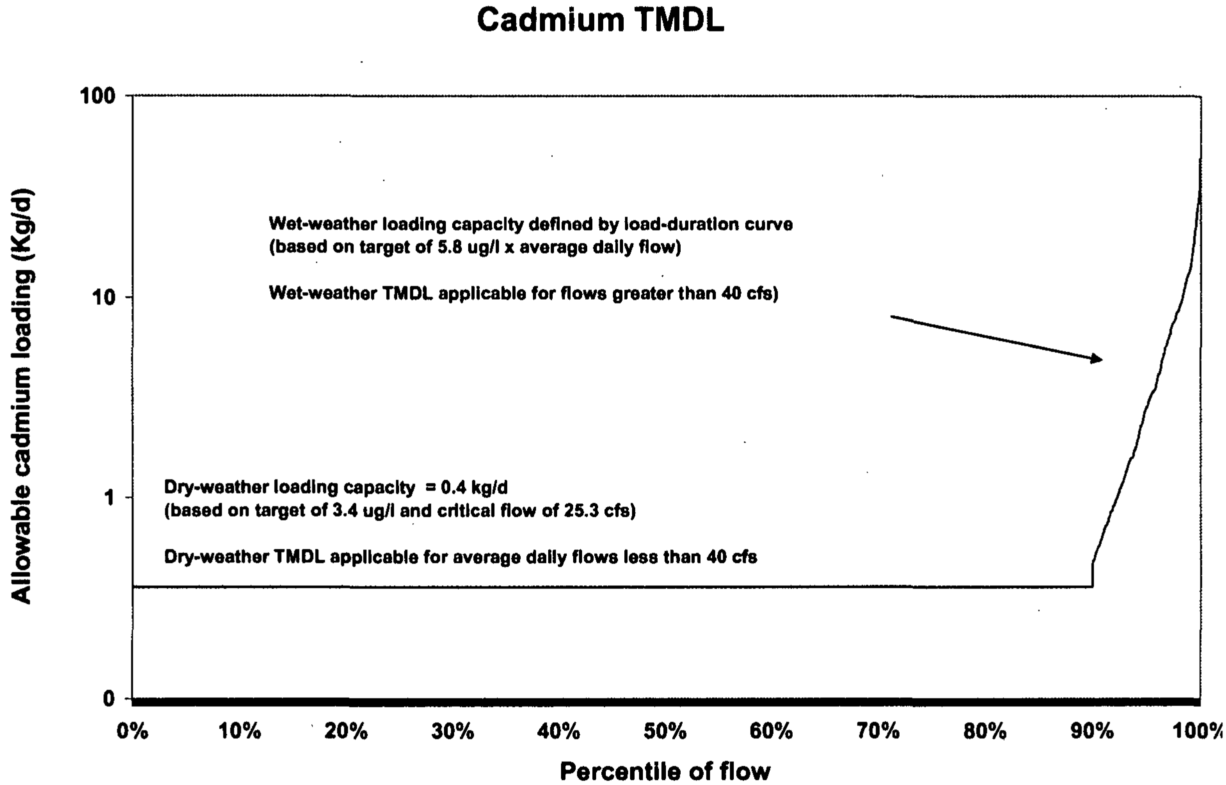
Table 6-2. Wet-weather load capacity for metals expressed in terms of total recoverable metals.

Metal	Load Duration curve
Cadmium	Storm volume x 3.4 ug/l (total recoverable)
Copper	Storm volume x 11 ug/l (total recoverable)
Lead	Storm volume x 59 ug/l (total recoverable)
Selenium	Storm volume x 5.0 ug/l (total)
Silver	Storm volume x 2.6 ug/l (total recoverable)
Zinc	Storm volume x 96 ug/l (total recoverable)

*Targets for wet targets are based on a hardness value of 77 mg/l.

This TMDL is based on total recoverable metals concentrations, so for those metals with criteria expressed as dissolved metals concentrations, targets were converted to total recoverable metals concentrations using appropriate conversion factors. For wet weather, site-specific conversion factors were used for copper and zinc, based on the regressions in Table 3-4. The CTR default conversion factors were used for cadmium, lead and silver.

An example of a load duration curve is presented in Figure x. For practical purposes the wet-weather loading capacity defined using the load-duration curve approach is equivalent to a storm water event-mean concentration based on a flow-weighted composite.



6.3 Waste Load Allocations

Most contaminants generated in the watershed are transported to the estuary through the storm water conveyance system. These are regulated directly in the NPDES process through storm water permits or indirectly through the issuance of NPDES permits for discharges to the storm water system. Mass-based allocations are developed for the storm water permittees for both dry-weather and wet-weather conditions. Loadings from other point sources are thought to be minor. However to ensure that these sources do not contribute significant loadings, concentration-based allocations are developed for all other NPDES dischargers based on the water quality standards in the CTR.

USEPA requires that waste load allocations be developed for NPDES-regulated storm water discharges. Allocations for NPDES-regulated storm water discharges from multiple point sources may be expressed as a single categorical waste load allocation when data and information are insufficient to assign each source or outfall individual allocations. For the dry-weather condition, the WLAs consist of pollutant loadings of metal must be less than the dry-weather loading capacity (Table 6-1). The WLAs were partitioned among the four storm water permitees (MS4 storm water permittees, Caltrans storm water permit, the general industrial storm water and the general construction storm water permittees) based on an estimate of the percentage of land area covered under each permit (Table 6-3).

Table 6-3. Areal extent of watershed and percent area covered under stormwater permits

Category	Area in acres	Percent area
MS4 Permit	79,840	97.5%
Caltrans Stormwater Permit	970	1.1%
General Industrial Stormwater Permit	100	0.1%
General Construction Stormwater Permit	100	0.1%
Parks (LA for non-permitted runoff)	430	0.5%
Water (LA for direct atmospheric dep)	480	0.6%
Total	**81,920**	**99.9%**

The dry-weather mass-based WLAs for the storm water permitees are presented in Table 6-4. Estimates of the areas covered under the general industrial storm water and general construction storm water permits were made assuming an average of 20 permits in any given year and a maximum size of 5 acres (which is the size limit for coverage under the general permits). Both assumptions are conservative. The contributions of pollutants from area not covered under the storm permits such as park areas or direct atmospheric deposition were estimated in a similar manner and assigned as load allocations for nonpoint sources. In the storm water permits, permit writers may translate the numeric waste load allocations to BMPs, based on BMP performance data.

Table 6-4. Dry-weather mass-based waste load allocations and load allocations for metals (grams/day)

Waste Load Allocations	**Cadmium**	**Copper**	**Lead**	**Selenium**	**Silver**	**Zinc**
MS4 Permit	280.8	1162.2	623.0	241.8	1312.4	14756.6
Caltrans Stormwater Permit	3.2	13.1	7.0	2.7	14.8	166.5
General Industrial Stormwater	0.3	1.2	0.6	0.2	1.4	15.1
General Construction Stormwater	0.3	1.2	0.6	0.2	1.3	15.1
Load Allocations	**Cadmium**	**Copper**	**Lead**	**Selenium**	**Silver**	**Zinc**
Parks (LA for non-permitted runoff)	1.4	6.0	3.2	1.2	6.7	75.7
Water (LA for direct atmospheric dep)	1.7	7.2	3.8	1.5	8.1	90.8
Total (grams/day)	288	1192	639	248	1346	15135

The wet-weather mass-based loading capacities are expressed as load duration curves. The mass-based wet-weather and wasteload and load allocations are expressed as percentage of the loadings defined in the load duration curves (Table 6-5).

Table 6-5. Wet-weather mass-based waste load allocations and load allocations for metals (expressed as a percentage of total wet-weather loadings)

Waste Load Allocations	**Cadmium**	**Copper**	**Lead**	**Selenium**	**Silver**	**Zinc**
MS4 Permit	97.5%	97.5%	97.5%	97.5%	97.5%	97.5%
Caltrans Stormwater Permit	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
General Industrial Stormwater	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
General Construction Stormwater	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Load Allocations	**Cadmium**	**Copper**	**Lead**	**Selenium**	**Silver**	**Zinc**

Parks (LA for non-permitted runoff)	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Water (LA for direct atmospheric dep)	0.6%	0.6%	0.6%	0.6%	0.6%	0.6%

Concentration-based WLAs are established for minor NPDES permits and general NPDES permits (other than stormwater permitees) that discharge to Ballona Creek or its tributaries to ensure that these do not contribute significant loadings to the system. This was done since there is insufficient flow information from these discharges to develop individual mass-based WLAs. The concentration-based WLAs are based on CTR targets adjusted for hardness and expressed as total recoverable metals. The concentration-based WLAs for dry and wet-weather are presented in Table 6-6.

Table 6-6. Concentration-based waste load allocations for metals expressed in terms of total recoverable metals (from Ballona Creek Metals TMDL).

Metal	Dry-weather WLAs* (µg/L)	Wet-weather WLAs* (µg/L)
Cadmium	5.8	3.4
Copper	24	18
Lead	13	59
Selenium	5.0	5.0
Silver	27	2.6
Zinc	312	98

* Freshwater targets for dry weather are based on a hardness of 300 mg/L. Freshwater targets for wet targets are based on a hardness value of 77 mg/l.

Monitoring requirements will be placed on these discharges as appropriate in their respective NPDES permits. Any future minor NPDES permits or enrollees under a general NPDES permit, general industrial storm water permit or general construction storm water permit will also be subject to the concentration-based WLAs.

6.4 Load Allocations

The only expected significant source of metals to Ballona Creek and Estuary is from storm water runoff. The storm water in the Ballona Creek watershed is covered under the MS4 permit, Caltrans permit, and the general industrial and general construction storm water permits. There is very little area in the watershed. Approximately 99.5% of the land area of watershed is covered under these permits. The land area belonging to the National Park Service and State Lands in the Ballona Creek Watershed is about 0.5% of the total area. The area of surface water subject to loadings from direct atmospheric deposition is about 0.5% of the total area. The loadings of pollutants from these areas are small. The cumulative load from these sources is about 1% of the total load. The load allocation is 1.0% of the estimated total loading capacity. The mass-based load allocations from these two sources for metals are presented in Tables 6-3 for dry-weather. These load allocations may change if it is determined through future studies that the contributions from natural sources or atmospheric deposition are significant.

6.5 Margin of Safety

The statute and regulations require that a TMDL include a margin of safety to account for any lack of knowledge concerning the relationships between effluent limitations and water quality. A margin of safety is appropriate for each TMDL because there is significant uncertainty in the analysis of pollutant loads and effects on water quality. This TMDL utilizes an implicit margin of safety through the use of conservative assumptions for the conversion of dissolved metals numeric targets from total recoverable metals.

6.6 Summary of TMDL.

The TMDL is based on pollutant loadings to the water column in Ballona Creek and Sepulveda Canyon Channel. For the dry-weather condition the allowable loads are based on the average dry-weather volume in the two reaches. For the wet-weather condition, the allowable loads are expressed as a function of storm water volume using the load-duration curves. An implicit margin of safety is provided through the use of conservative conversion factors for the translation of total recoverable metals to dissolved metals concentration. A grouped mass-based waste load allocation has been developed for the storm water permitees (MS4, Caltrans, general industrial and construction storm water permittees). Concentration-based WLAs will also be applied to all other NPDES permittees. It is anticipated that implementation will be based on BMPs which address pollution prevention. The effectiveness of the BMPs to meet the TMDL allocations TMDL will be determined through ambient water quality monitoring. The effectiveness of measures to meet the wet-weather targets will be assessed through evaluation of storm water monitoring data.

Further characterization of selenium is needed to clearly identify if there is impairment. At this time a TMDL has been developed based on the 2002 303(d) listing. If additional data, indicates that there is no impairment then the TMDL can be revisited. If there is no impairment then the permittees will be able to meet the WLAs with no load reduction necessary.

7 IMPLEMENTATION

7.1.1 Introduction

As required by the federal Clean Water Act, discharges of pollutants to Ballona Creek and its tributaries from municipal storm water conveyances are prohibited, unless the discharges are in compliance with a NPDES permit. In December 2001, the Los Angeles County Municipal NPDES Storm Water Permit was re-issued jointly to Los Angeles County and 84 cities as co-permittees. The regulatory mechanisms used to implement the TMDL will include the Los Angeles County Municipal Storm Water NPDES Permit, the State of California Department of Transportation (Caltrans) Storm Water Permit, minor NPDES permits, general NPDES permits, general industrial storm water permits, and general construction storm water permits. Each NPDES permit assigned a WLA shall be reopened or amended at re-issuance, in accordance with applicable laws, to address implementation and monitoring of this TMDL and to be consistent with the waste load allocations of this TMDL.

Permit writers may translate applicable waste load allocations into effluent limits for the minor and general NPDES permits by applying the SIP procedures or other applicable engineering practices. Compliance schedules may be established in the NPDES permits, allowing up to 5 years within a permit cycle to achieve compliance.

The Regional Board will develop watershed specific general industrial and construction storm water permits to incorporate waste load allocations. Permit writers for the stormwater permits may set dry- and wet-weather permit limits, as applicable. It is expected that permit writers will translate concentration-based waste load allocations into best management practices (BMPs), based on BMP performance data. The permit writers must provide adequate justification and documentation to demonstrate that specified BMPs are expected to result in attainment of the numeric waste load allocations.

The general storm water permits shall contain a model monitoring and reporting program to evaluate BMP effectiveness. A permittee enrolled under the general storm water permits shall have the choice of conducting individual monitoring based on the model program or participating in a group monitoring effort. MS4 permittees are encouraged to take the lead in group monitoring efforts for industrial and construction facilities under their jurisdiction because compliance with waste load allocations by these facilities will translate to reductions in metals loads to the MS4 system. The general industrial and construction storm water permittees are allowed interim waste load allocations based on benchmarks contained in EPA's Storm Water Multi-sector General Permit for Industrial Activities. The interim waste load allocations apply for a period not to exceed ten years from the effective date of the TMDL.

Table 7-1. Interim dry- and wet-weather WLAs for general industrial and construction storm water permittees, expressed as total recoverable metals (µg/L)

Cadmium	Copper	Lead	Selenium	Silver	Zinc
15.9	63.6	81.6	238.5	31.8	117

In the first five years from the effective date of the TMDL, interim waste load allocations will not be interpreted as enforceable permit limits. If monitoring demonstrates that interim waste load allocations are being exceeded, the permittee shall evaluate existing and potential BMPs, including structural BMPs, and implement any necessary BMP improvements. After five years from the effective date of the TMDL, interim waste load allocations shall be translated into enforceable permit limits. In addition, permittees shall begin an iterative BMP process to meet final waste load allocations. Permittees shall comply with final waste load allocations within 10 years from the effective date of the TMDL.

The County of Los Angeles, City of Los Angeles, Beverly Hills, Culver City, Inglewood, Santa Monica, West Hollywood, and Caltrans are jointly responsible for meeting the waste load allocations. The primary jurisdiction for the Ballona Creek watershed is the City of Los Angeles. Staff expects that after additional studies and monitoring are conducted, the new information will assist municipalities in focusing their implementation efforts on key land uses, critical sources and/or storm periods.

The County of Los Angeles, City of Los Angeles, Beverly Hills, Culver City, Inglewood, Santa Monica, West Hollywood, and Caltrans may jointly decide how to achieve the necessary reductions in metals loading by employing one or more of the implementation strategies discussed below or any other viable strategy. The Porter Cologne Water Quality Control Act prohibits the Regional Board from prescribing the method of achieving compliance with water quality standards, and likewise TMDLs. Below staff have identified some potential implementation strategies; however, there is no requirement to follow the particular strategies proposed herein as long as the allowable metals loading is not exceeded.

As mentioned earlier, each municipality and permittee will be required to meet the waste load allocations at the designated TMDL effectiveness monitoring locations, not necessarily an allocation for their jurisdiction or for specific land uses. Therefore, the focus should be on developed areas where the contribution of metals is highest and areas where activities occur that contribute significant loading of metals (e.g., high-density residential, industrial areas and highways). Flexibility will be allowed in determining how to reduce metals as long as the waste load allocations are achieved. A phased implementation approach, using a combination of non-structural and structural BMPs could be used to achieve compliance with the municipal stormwater waste load allocations. The administrative record and the fact sheets for the MS4 and Caltrans storm water permittees must provide reasonable assurance that the BMPs selected will be sufficient to implement the WLAs in the TMDL.

To achieve the necessary reductions to meet the allowable waste load allocations presented in Section 6, Regional Board staff recognizes the need to balance short-term capital investments directed to addressing this and other TMDLs in the Ballona Creek watershed with long-term planning activities for storm water management in the region as a whole. It should be emphasized that the potential implementation strategies discussed below may contribute to the implementation of other TMDLs for Ballona Creek and estuary. Likewise, implementation of other TMDLs in the Ballona Creek Watershed may contribute to the implementation of this TMDL.

Appendix C presents the estimated load reductions needed for the MS4 and Caltrans permittees to meet the wet-weather waste load allocations. In these figures, allowable loads are plotted against storm volume to assist permittees in the design of BMPs to achieve the necessary load reductions. As described in Section 5.2 and Appendix B, the HSPF model was used to simulate storm volumes and associated loads over a 10-year period. For these figures, C-1 through C-9, the load capacity curve is a black line, the model-predicted historical loads below the load capacity curve are represented as vertical bars and the model-predicted historic loads above the load capacity curve are represented as diagonal lines. Determination of required loads reductions assumed that all loads below the load-capacity curve are allowable and loads above the load-capacity curve are not allowed. The percent reduction is calculated by dividing the required load reduction by the total historic load. Since cadmium, selenium and silver were not modeled, the model-predicted historic loads could not be simulated for inclusion with the load capacity curves.

7.1.2 Implementation Strategies of related TMDLs in Ballona Creek Watershed

The Regional Board supports in concept an integrated water resources approach to improving water quality during wet weather, such as the City of Los Angeles' Integrated Plan for the Wastewater Program (IPWP). An integrated water resources approach takes a holistic view of regional water resources management by integrating planning for future wastewater, stormwater, recycled water, and potable water needs and systems, and focusing on beneficial re-use of stormwater at multiple points throughout a watershed to preserve local groundwater resources and reduce the need for imported water where feasible. The City's IPWP is intended to meet the wastewater and water resource management needs for year 2020.

The Integrated Resources Plan (IRP) is Phase 2 of the IPWP. The IRP is a City-wide strategy developed by the City of Los Angeles and does not specifically focus on the Ballona Creek Watershed. The goal of the plan is to increase the amount of wet-weather urban runoff that can be captured and beneficially used in Los Angeles; however, it is not known what portion of this runoff will be in the Ballona Creek Watershed. Furthermore, increasing capture and beneficial use of wet weather urban runoff may not achieve the waste load allocations during very wet years. The implementation strategy proposed below could be designed to achieve the TMDL requirements, while remaining consistent with the goals of the City's IPWP and addressing any shortfall of the IRP in achieving implementation with this TMDL.

One component of the IRP is a Runoff Management Plan, which could provide a framework for implementing runoff management practices to meet the IRP goals and address protection of public health and the environment. The Runoff Management Plan as described in the IRP will include consideration of structural Best Management Practices (BMPs) to achieve reduction of pollutant loadings to receiving waters. Urban runoff can be treated at strategic locations throughout the watershed or subwatersheds. This is also similar to the structural and non-structural BMPs described below.

The Ballona Creek and Wetlands Trash TMDL, effective date August 2, 2002, is now in its first year of implementation. Compliance with the Trash TMDL requires permittees to install either full capture systems, partial capture systems and/or implement institutional controls. At a minimum, the full capture systems must be designed to treatment the peak flow rate resulting from a one-year, one-hour storm. A secondary benefit of the trash removal systems also referred to as gross solids removal systems, such as vortex separation systems or catch basin inserts, has been the removal of sediments and other pollutants.

7.1.3 Potential Implementation Strategies

The implementation strategy selected will need to address the different sources of metals loading during dry and wet weather. During dry weather, metals loading are predominately in the dissolved phase as demonstrated by the default CTR conversion factors. During wet weather, the metals loading are predominately bound to sediment, which are transported with storm runoff. During rain events, partitioning between particulate and dissolved metals often does not reach equilibrium. Municipalities may employ a variety of implementation strategies to meet the required WLAs such as non-structural and structural best management practices, and/or diversion and treatment. Specific projects, which may have a significant impact, would be subject to a separate environmental review. The lead agency for subsequent projects would be obligated to mitigate any impacts they identify, for example by mitigating potential flooding impacts by designing the BMPs with adequate margins of safety.

Non-Structural Best Management Practices

The non-structural best management practices (BMPs) are based on the premise that specific land uses or critical sources can be targeted to achieve the TMDL waste load allocations. Non-structural BMPs provide several advantages over structural BMPs. Non-structural BMPs can typically be implemented in a relatively short period of time. The capital investment required to implement non-structural BMPs is generally less than for structural BMPs. However, the labor costs associated with non-structural BMPs may be higher, therefore, in the long-term the non-structural BMPs may be more costly. Examples of non-structural controls include more frequent and appropriately timed storm drain catch basin cleanings; improved street cleaning by upgrading to vacuum type sweepers; and, educating industries of good housekeeping practices.

Since dry-weather exceedances appear to be episodic the permittees are encouraged to initially concentrate on source reduction strategies including detection and elimination of illicit discharges, reduction of dry-weather nuisance flows, and increased inspection of industrial facilities. In addition, improved enforcement of BMPs for construction sites and improved detection and elimination of illicit connections to the storm drain system may result in significant reductions in discharges of metal pollutants to Ballona Creek. Special attention should be focused on the source of high lead concentrations entering the Ballona Creek Estuary near Pacific Avenue.

A known source of copper loading is from brake pads. The permittees could sponsor legislative actions with state and federal agencies to pursue the development of alternative materials for brake pads. The use of alternative materials for brake pads would help to reduce the discharge of metals in all watersheds. Just as the phase out of leaded gasoline resulted in the gradual decline of lead concentrations in the environment, a phase out of copper brake linings would also be expected to reduce the amount of copper in storm water runoff.

Structural Best Management Practices

The structural BMPs are based on the premise that specific land uses, critical sources, or specific periods of a storm event can be targeted to achieve the TMDL waste load allocations. Structural BMPs may include placement of storm water treatment devices specifically designed to reduce metals loading such as infiltration trenches or filters at critical points in the storm water conveyance system. During storm events, when flow rates are high these types of filters may require surge control, such as an underground storage vault or detention basin. If these filters are placed in series with the gross solids removal systems being installed to meet the Ballona Creek Trash TMDL, then these filters will operate more efficiently and will require less maintenance. These structural solutions may be designed to capture the runoff from a specific storm period such as the first 0.1 inch or 0.5 inch.

To assist responsible jurisdictions and agencies in identifying potential upstream structural BMPs for targeted land uses or critical areas in the Ballona Creek watershed, an analysis was performed to assess land-use-specific contributions to the total existing metals loading from the watershed. The wet-weather watershed model was used to simulate metals loading from surface runoff from each land use included in the model. Contributions to the total copper, lead, and zinc loads are expressed as percentages in Table 7-2. Relative contributions of loadings from land uses are consistent among the metals. High-density residential areas contributed the highest percentage between 70.8 and 75.8%. This may be due in part because high-density residential accounts for the majority of the land use in the Ballona Creek watershed. The commercial areas also contributed a high loading between 18.8 and 20.2%. The relatively high metals loading from these land uses results from a combination of higher percentage of land use area in the watershed, as well as relatively high loadings rates associated with these land use practices.

Table 7-2. Land use contributions to total recoverable metals loads from surface runoff from the Ballona Creek watershed

Land Use	% of Land Use	Copper	Lead	Zinc
Agricultural	0.0%	0.0%	0.0%	0.0%
Commercial	15.8%	18.8%	19.8%	20.2%
High Density Residential	55.7%	72.0%	75.8%	70.8%
Industrial	5.1%	5.8%	3.1%	8.1%
Low Density Residential	3.6%	2.8%	1.0%	0.6%
Mixed Urban	0.1%	0.2%	0.1%	0.1%
Open Space	17.1%	0.4%	0.2%	0.1%

The information presented in Table 7-2 provides useful information for watershed planning and design of BMPs. Land use distributions in the watershed can guide planners in determining key locations where metals reductions need to be focused, and can be determined from aerial photography or commonly used GIS data sets, including, but not limited to, data sets from the Southern California Association of Governments (used for this modeling analysis) or the U.S. Geological Survey's Multi-Resolution Land Characteristic.

In addition, the Regional Board encourages the responsible agencies to utilize the results of the "Characterization of Dry Weather Metals and Bacteria Levels in Ballona Creek" (SCCWRP, 2004) study to identify potential structural or non-structural controls for targeted land uses, or critical storm drains.