# TOTAL MAXIMUM DAILY LOAD FOR METALS IN BALLONA CREEK

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

DRAFT: JULY 12, 2004
REVISED: MARCH 31, 2005
REVISED: MAY 31, 2005

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| | |
|---|---|
| **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** |

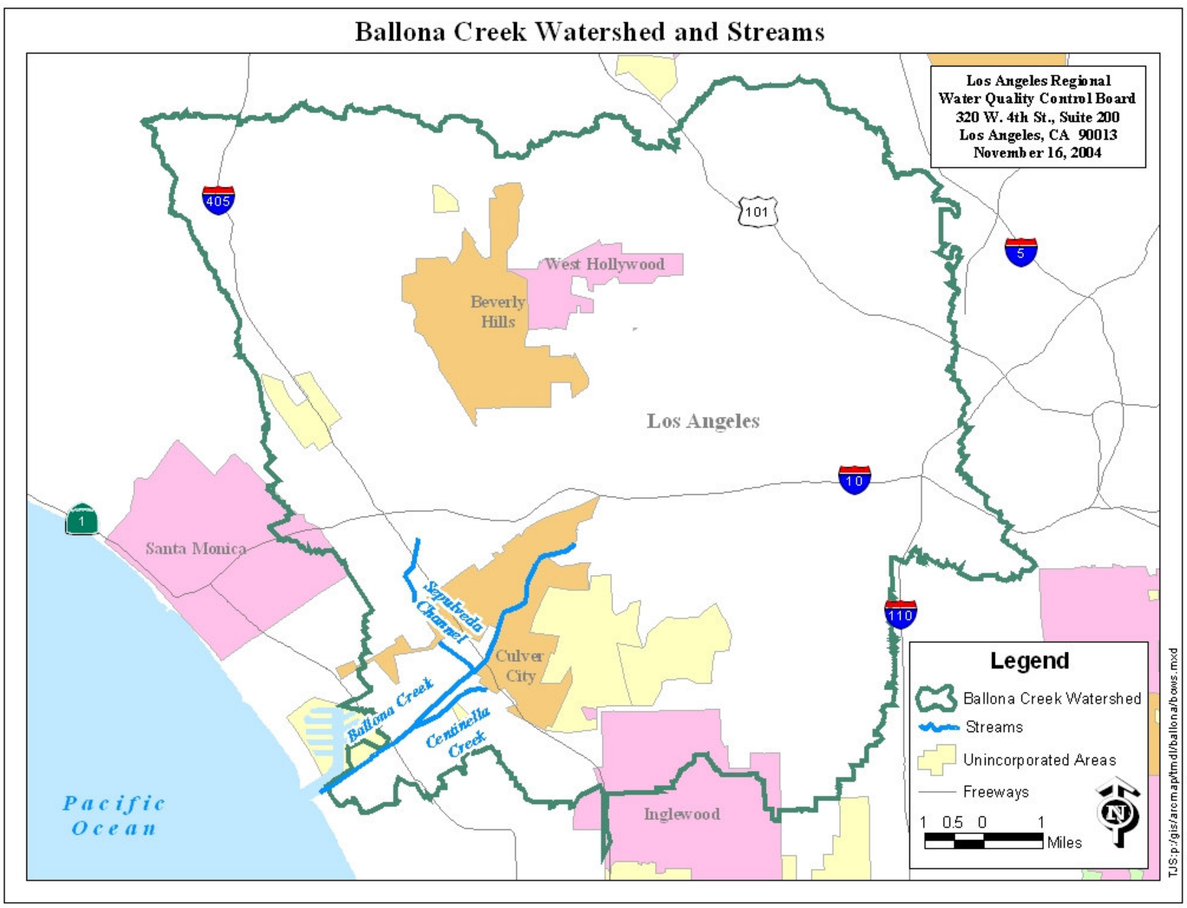
| | |
|---|---|
| **SPWN** | **Spawning, Reproduction, and/or Early Development** |
| **TMDL** | **Total Maximum Daily Load** |
| **USACE** | **United States Army Corps of Engineers** |
| **USEPA** | **United State Environmental Protection Agency** |
| **VOCs** | **Volatile Organic Compounds** |
| **WARM** | **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 Sepulveda Canyon Channel 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 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).

States must develop water quality management plans to implement the TMDL (40 CFR 130.6). The USEPA has oversight authority for the 303(d) program and is required to review and either approve or disapprove the TMDLs submitted by states. In California, the State Water Resources Control Board (State Board) and the nine Regional Water Quality Control Boards are responsible for preparing lists of impaired waterbodies under the 303(d) program and for preparing TMDLs, both subject to USEPA approval. If USEPA disapproves a TMDL submitted by a state, it is required to establish a TMDL for that waterbody. The Regional Boards hold regulatory authority for many of the instruments used to implement the TMDLs, such as the National Pollutant Discharge Elimination System (NPDES) permits and state-specified Waste Discharge Requirements (WDRs).

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 between USEPA and several environmental groups 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 was initially required to either approve a state TMDL or establish its own, by March 22, 2005. USEPA and the consent decree plaintiffs recently agreed to extend the completion deadline to December 22, 2005, in order to enable the State to complete its adoption process and USEPA to approve the State-adopted TMDLs for this water body.

**Table 1-1. 1998 303(d) 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 | |
| Silver | Tissue, Sediment | | |
| Zinc | | Sediment | |
| Toxicity | Water | | |

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 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) List of metal impairments in the Ballona Creek Watershed**

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

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 and is included in this TMDL because it is tributary to Ballona Creek.

On June 12, 2003, the Regional Board held a California Environmental Quality Act (CEQA) scoping meeting to solicit input from the public and interested stakeholders in determining the scope, content and implementation options of the proposed TMDL for metals in Ballona Creek and Estuary. At the scoping meeting, the CEQA checklist of significant environmental issues and mitigation measures were discussed. This meeting fulfilled the requirements under CEQA (Public Resources Code, Section 21083.9).

This TMDL will establish waste load allocations (WLAs) for copper, lead, selenium, 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 Watershed under Analytical Unit #57.

## 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.

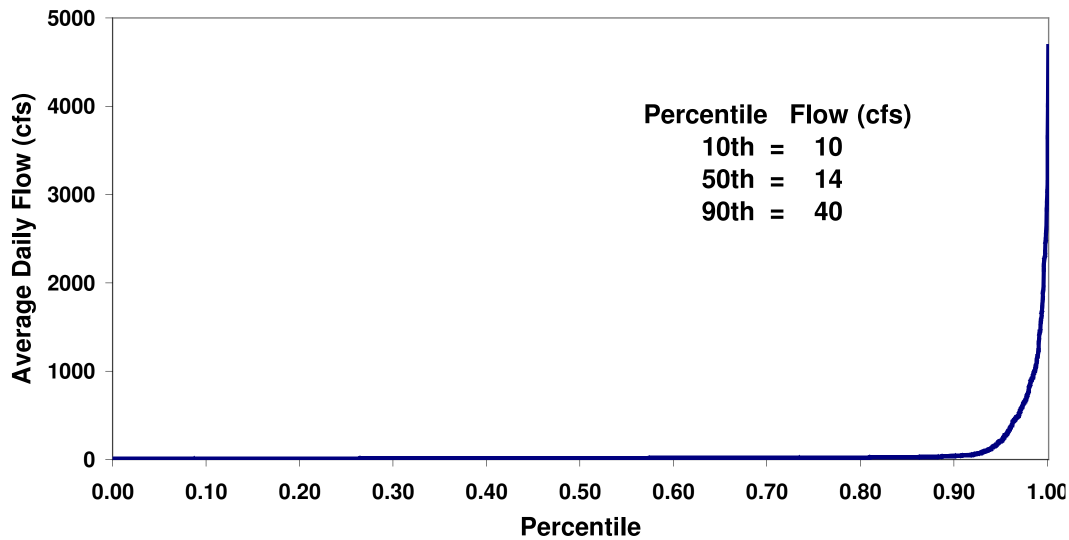
The Water Quality Control Plan for the Coastal Watersheds of Los Angeles and Ventura Counties (Basin Plan) defines three sections of the creek based on hydrologic units. The section referred to as "Ballona Creek" (Reach 1) is a 2-mile stretch from Cochran Avenue to National Boulevard. This area is characterized 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 Creek 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 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 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. The TMDL provides cost estimates to implement best management practices (BMPs) required throughout the Ballona Creek watershed to meet water quality objectives in the creek.
- 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. While the TMDL identifies the goals for a monitoring program, the Executive Officer will issue subsequent orders to identify the specific requirements and the specific entities that will development and implement a monitoring program and submit technical reports.

# 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.

For certain toxic pollutants, the EPA has established numeric criteria that serve as water quality standards for California's inland surface waters. (40 CFR 131.38.) EPA established the numeric criteria in the California Toxics Rule (CTR) at levels that reflect when toxic pollutants are present in toxic amounts. In other words, if a pollutant is present in a surface waterbody at a level higher than a CTR criterion, then the surface waterbody is toxic. The federal water quality criteria established by the CTR are equivalent to state water quality objectives and they serve the same purpose. For the Los Angeles region, numeric objectives for toxics can be found in the CTR.

### 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.*

The Regional Board's narrative toxicity objective reflects and implements national policy set by Congress. The Clean Water Act states that, "it is the national policy that the discharge of toxic pollutants in toxic amounts be prohibited." (33 U.S.C. 1251(a)(3).) In 2000, USEPA established numeric water quality objectives for pollutants addressed in this TMDL in the 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.

EPA expressed the CTR criteria as concentrations. Therefore, whenever a pollutant is present in a surface waterbody at a concentration in excess of a CTR criterion, the surface waterbody is toxic. EPA did not differentiate between wet and dry weather conditions in establishing the CTR. The CTR criteria therefore apply at all times to inland surface waters. This result is reached on both legal and technical grounds. Legally, the result is compelled because the CTR establishes water quality criteria (i.e., objectives) to protect aquatic life in all of California's inland surface waters. (See, 40 CFR 131.38(a), (c)(1), and (d)(1).) There is no exception for wet weather conditions in the CTR. Moreover, aquatic life is also present in wet weather conditions. The CTR is legally necessary to protect these uses in wet weather conditions. It would be illogical and illegal to conclude that the CTR does not apply in wet weather.

From a technical perspective, it would be equally inappropriate to find a wet weather exception in the CTR. Because the CTR criteria are expressed as concentrations, the volume of water is irrelevant. The concentration-based criteria essentially account for dilution in wet-weather conditions. In high-volume, wet-weather conditions, if the concentration of a toxic pollutant in a water body exceeds the CTR criterion, the water body is toxic.

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 one 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 generally 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:

$$\text{Acute Criterion} = \text{WER} \times \text{ACF} \times \text{EXP}[(m_a)(\ln(\text{hardness}))+b_a] \quad (1)$$
$$\text{Chronic Criterion} = \text{WER} \times \text{CCF} \times \text{EXP}[(m_c)(\ln(\text{hardness}))+b_c] \quad (2)$$

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:

$$\text{Cadmium ACF} = 1.136672 - [(\ln\{\text{hardness}\})(0.041838)] \quad (3)$$
$$\text{Cadmium CCF} = 1.101672 - [(\ln\{\text{hardness}\})(0.041838)] \quad (4)$$
$$\text{Lead ACF} = 1.46203 - [(\ln\{\text{hardness}\})(0.145712)] \quad (5)$$
$$\text{Lead CCF} = 1.46203 - [(\ln\{\text{hardness}\})(0.145712)] \quad (6)$$

**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 numeric 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.

### 2.2.1 Ballona Creek

Cadmium. There was little evidence of cadmium exceeding the CTR values. During dry weather, cadmium was not detected in either the City's or the SCCWRP's database at concentrations above the criteria. However, the detection limit for the SCCWRP data set was greater than the chronic standard. Cadmium was only detected once in storm water at a concentration greater than the acute and chronic 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 and chronic standards were exceeded 18% and 31% of the time, respectively.

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

Zinc. There is little evidence of zinc exceedances in dry weather. Based on the City's data set, zinc was detected twice in concentrations greater than the acute and chromic standards. None of the samples from the SCCWRP data set exceeded either of the standards. In the storm water data, the acute and chronic standards for zinc 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 are inconclusive. Selenium was rarely detected in wet weather and the detection limits for dry weather precluded evaluation against the standards.

**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.

**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/RL (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/RL 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 Tables 2-7 and 2-8. In brief, the data suggests that there may be exceedances of the copper and lead standards, however, it is not possible to confirm impairment since the detection levels for copper and lead in several samples exceeded the CTR limits. Ballona Creek Estuary is not currently listed for metals in the water column.

**Table 2-7. 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. The reporting limits for dissolved cadmium and total selenium were both greater than the chronic criteria for these metals.

**Table 2-9. 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 water quality impairments associated with copper, lead, and zinc is clear. There is no evidence of water quality impairments associated with cadmium and silver. 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.**

| Waterbody | Pollutant | Exceedances during Dry Weather | Exceedances during Wet Weather |
|---|---|---|---|
| **Ballona Creek:** | Cadmium | | |
| | Copper | X | X |
| | Lead | X | X |
| | Selenium | | X |
| | Silver | | |
| | Zinc | X | X |

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. Additional monitoring of the Estuary, using procedures that will ensure a detection limit below the CTR criteria, is recommended. It is likely that reductions by the Ballona Creek Metals TMDL or the Ballona Creek Estuary Contaminated Sediments TMDL will reduce copper concentrations in the water column of the estuary.

TMDLs are developed for copper, lead, selenium, 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 are developed for dry and wet weather because hardness values and flow conditions in Ballona Creek and its tributaries differ significantly between these conditions. For the purpose of this TMDL, wet weather is defined in terms of flow rather then rain fall. Wet weather is defined as any day when the maximum daily flow is equal to or greater than 40 cfs. This is based on the $90^{th}$ percentile of flows measured at Sawtelle Boulevard over a 10-year period. The numeric targets for this TMDL are described in the following section.

## 3.1 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 copper, lead, selenium, and zinc (Table 3-1), therefore, were used as the basis for developing waste load allocations for dry weather.

The numeric targets in Table 3-1 require conversion to total recoverable metal concentrations for comparison to existing conditions for TMDL development. Data are insufficient to develop site-specific conversion factors, so the 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, the freshwater conversion factor for lead is 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 factor for lead.

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

| Metal | Target* (µg/L) Dissolved | Conversion Factor | Target (µg/L) Total Recoverable |
|---|---|---|---|
| Copper | 23 | 0.96 | 24 |
| Lead | 8.1 | 0.631*** | 13 |
| Selenium** | --- | --- | 5.0 |
| Zinc | 300 | 0.986 | 304 |

* *Freshwater targets are based on a hardness of 300 mg/L.*
** *Selenium is expressed in the total recoverable form.*
*** *Conversion factor is hardness dependent, based on a hardness of 300 mg/L.*

## 3.2 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 values 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 a shorter time interval 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. The resulting conversion factors for freshwater are listed in Table 3-2 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 factor for lead was calculated based on a hardness of 77 mg/L.

**Table 3-2. Wet-weather 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 | $R^2$ |
| Copper | 0.96 | 50 | 0.62 | 0.70 |
| Lead | 0.829* | 7 | 0.60 | 0.77 |
| 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 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. Because of the low number of samples, the default CTR conversion factors will be used for lead.

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 recoverable fraction.**

| Metal | Target* (µg/L) Dissolved | Conversion factor used | Target (µg/L) Total Recoverable |
|---|---|---|---|
| Copper | 11 | 0.62 | 18 |
| Lead | 49 | 0.829*** | 59 |
| Selenium** | --- | --- | 5.0 |
| Zinc | 94 | 0.79 | 119 |

* *Targets are based on a hardness of 77 mg/L.*
** *For selenium the criterion is expressed in the total recoverable form.*
*** *Conversion factor is hardness dependent, based on a hardness of 77 mg/L.*

# 4 SOURCE ASSESSMENT

This section identifies the potential sources of metals to Ballona Creek and its tributaries. 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 that are not regulated through NPDES permits. The Regional Board, under the authority of the Porter-Cologne Water Quality Control Act, issues WDRs for discharges to groundwater from nonpoint sources. In Los Angeles County urban runoff to Ballona Creek and Sepulveda Canyon Channel are regulated under storm water NPDES permits, which are regulated as a point source discharge.

## 4.1 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, general construction storm water permits, general industrial storm water permits, minor NPDES permits, and 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) | 12~~3~~ |
| General NPDES Permits: | |
| Construction and Project Dewatering | 92 |
| Petroleum Fuel Cleanup Sites | 15 |
| VOCs Cleanup Sites | 7 |
| Potable Water | 7 |
| Non-Process Wastewater | 5 |
| Hydrostatic Test Water | 1 |
| **Total** | **172~~3~~** |

### 4.1.1 Storm Water Permits

Storm water runoff in the Ballona Creek watershed is regulated through a number of permits. The first is the municipal separate storm sewer system (MS4) permit issued to the County of Los Angeles. 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 Permit and the fourth is the statewide Industrial Activities Storm Water General Permit. 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.

#### 4.1.1.1 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 discharged 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 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.

#### 4.1.1.2 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 (State Board 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 most of these Caltrans properties and facilities eventually end 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 1.3% (approximately 1080 acres). This area represents Caltrans' right-of-way that drains to Ballona Creek (Caltrans comment letter dated 8/26/04). This percentage does not represent all the watershed area that Caltrans is responsible for under the storm water permit. For example, the park and ride facilities and the maintenance yards were not included in the estimate.

#### 4.1.1.3 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) to reduce or prevent non-conventional and toxic pollutants, including metals, associated with industrial activity in storm water discharges and authorized non-storm discharges.

The regulations also 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 of total land area) to obtain an NPDES permit and to implement BAT 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. Now, under Phase II, any construction site that is greater than one acre must obtain a storm water permit.

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. As of the writing of this TMDL, there are fourteen discharges enrolled under the general industrial storm water permit 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. There is a potential for metals loadings from these types of facilities, especially transportation, recycling and manufacturing facilities.

During wet weather, runoff from industrial sites has the potential to contribute metals loadings to the creek. This finding is supported by Stenstrom et al. in their final report on the industrial storm water monitoring program under the existing general permit. In the summary of existing data, the report found that although the data collected by the monitoring program were highly variable, the mean values for copper, lead and zinc were 1010, 2960, and 4960 µg/L, respectively (Stenstrom et al., 2005). During dry weather, the potential contribution of metals loadings from industrial storm water is low. Under Order No. 97-03-DWQ, non-storm water discharges are authorized only when they do not contain significant quantities of pollutants, where BMPs are in place to minimize contact with significant materials and reduce flow, and when they are in compliance with Regional Board and local agency requirements.

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). As of the writing of this TMDL, there are seventeen construction sites enrolled under the general construction storm water permit within the Ballona Creek watershed. Potential pollutants from construction sites include sediment, which may contain metals as well as metals 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 metals. During wet weather, runoff from construction sites has the potential to contribute metals loadings to the creek. In their final report to SWRCB, Raskin et al. found that building materials and construction waste exposed to storm water can leach metals and contribute metals loadings to waterways (Raskin et al., 2004). During dry weather, the potential contribution of metals loadings is low. Under Order No. 99-08-DWQ, discharges of non-storm water are authorized only where they do not cause or contribute to a violation of any water quality standard and are controlled through implementation of appropriate BMPs for elimination or reduction of pollutants.

### 4.1.2 Other NPDES Permits

There are two types of NPDES permits: individual and general permits. An individual NPDES permit is classified as either a major or a minor permit. Other than the MS4 and Caltrans storm water permits, there are no major individual NPDES permits in the Ballona Creek watershed. 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 within the Ballona Creek watershed are also for episodic discharges.

#### 4.1.2.1 Minor Individual NPDES Permits

There were 1~~2~~~~3~~ minor individual discharges to Ballona Creek, for a combined permitted discharge flow of approximately 9.1~~1~~ 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 9.1 MGD.~~

The Inglewood Oil Field located in Baldwin Hills (7.55 MGD) 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.

#### 4.1.2.2 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 92 dischargers enrolled under this Order in the Ballona Creek watershed for a combined total discharge flow of approximately 14.1 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.

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 15 dischargers enrolled under this Order in the Ballona Creek watershed for a combined total discharge flow of 1.5 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.

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 seven dischargers enrolled under this Order in the Ballona Creek watershed for a combined total discharge flow of approximately 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.

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 seven dischargers enrolled under this Order in the Ballona Creek watershed for a combined total discharge flow of 1.2 MGD. The effluent limits for metals are not based on CTR. Therefore, these discharges may exceed the numeric targets established in Section 3, however, the potential is low since the discharge is potable water.

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 five 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.

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 0.98 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, however, the potential is low since the discharge is domestic or potable water.

### 4.1.3 Summary Point Sources

The total loading of metals reflects the 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 thirteen 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) | 12~~3~~ | 9.1 | Yes | Not CTR | Medium |
| **Other General Permits** | | | | | |
| Construction and Project Dewatering | 92 | 14.1 | Yes | CTR | Low |
| Petroleum Fuel Cleanup Sites | 15 | 1.5 | Yes | CTR (lead only) | Low |
| VOCs Cleanup Sites | 7 | 0.5 | Yes | CTR (lead only) | Low |
| Potable Water | 7 | 1.2 | Yes | Not CTR | Low |
| Non-Process Wastewater | 5 | 0.2 | Yes | CTR | Low |
| Hydrostatic Test Water | 1 | 0.98 | Yes | Not CTR | Low |

## 4.2 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, and zinc) are attributable to ongoing activities in the watershed. This is reflected in routine storm water monitoring performed by LACDPW under the MS4 permit (LACDPW, 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).

### 4.2.1 Dry-Weather Urban Runoff

Dry-weather urban runoff is a significant 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). However, 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 4-3. 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 4-3. Average total recoverable metals concentrations (µg/L) from storm drains in Ballona Creek during three dry-weather sampling events during 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 4-4.[1] The small storm drains below Overland Avenue[2] account for a relatively small percentage of the total loads.

**Table 4-4. 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 |

### 4.2.2 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

[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] Loads from small storm drains were quantified for Ballona Creek and Ballona Creek Estuary between Overland Avenue and Pacific Avenue. Upstream storm drain loads are included in the Ballona Creek (at Overland) loads.

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 of 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 4-5 presents these loads for comparison (no values were reported for silver).

**Table 4-5. 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 NONPOINT SOURCES

A nonpoint source is a source that discharges to water of the US and/or State via sheet flow or natural discharges. 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[3] (0.5% of the watershed). While not subject to the MS4 Permit, in the highly urbanized Ballona Creek watershed the contribution of runoff from these areas drain to the MS4 system, therefore, this discharge is regulated as a point source.

Atmospheric deposition may be a potential nonpoint source of metals to the watershed, through either direct deposition or indirect deposition. Direct atmospheric deposition during dry weather was quantified by multiplying the surface area of the waterbody times the rate of atmospheric deposition by Sabin et al. (2004). 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 4-6). 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

[3] 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~~since the Ballona Wetlands discharge directly to the Estuary.

tributaries. By dividing the typical annual loading to Ballona Creek (Table 4-5) by the estimates of indirect atmosphere deposition on the watershed (Table 4-6), 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 19% to 53% of the mass loading from indirect atmospheric deposition. In the Ballona Creek watershed, 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 4-6. Estimate of direct and indirect atmospheric deposition (kg/year). (Source: Sabin et al., 2004)**

| Type of Deposition | Copper | Lead | Zinc |
|---|---|---|---|
| Direct | 1.3 | 0.9 | 4.3 |
| Indirect | 3,500 | 2,000 | 13,000 |

# 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. 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 load capacity or 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 to assess of alternative management schemes. 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.

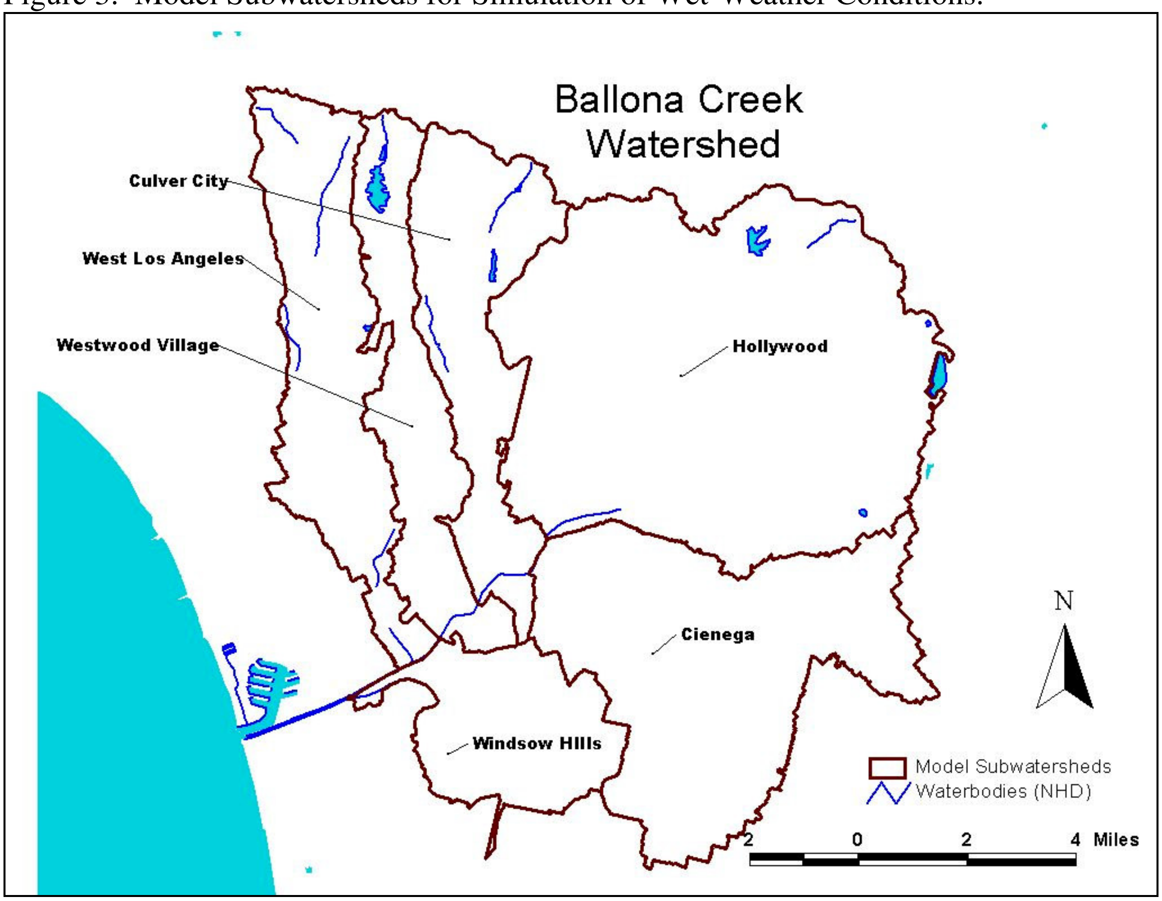
## 5.2 WET-WEATHER MODELING ANALYSIS

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.

The Ballona Creek discharge, upstream of the discharge of Sepulveda Canyon Channel near Overland Avenue, corresponded to the combined modeled discharge from the subwatersheds "Cienega," "Hollywood," "Culver City," and "Westwood Village." Modeled discharge from the "West Los Angeles" subwatershed corresponded to the discharge of Sepulveda Canyon Channel and the modeled discharge from the "Windsow Hills" subwatershed corresponded to the discharge from Centinela Channel. This TMDL used model results from the six sub-watersheds, which drain to Ballona Creek (Figure 3). The watershed draining to the Estuary was not considered in the TMDL.

Figure 3. 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 drives 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 TOTAL MAXIMUM DAILY LOADS

In this section, we develop the loading capacity, pollutant allocations and margin of safety for metals in Ballona Creek and Sepulveda Canyon Channel. 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)) and load allocations (LAs), which identify the portion of the loading capacity allocated to nonpoint sources (40 CFR 130.2(g)). It is not necessary that every individual point source have an 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-weather and wet-weather periods. In this TMDL, concentration-based and mass-based waste load allocations were developed for dry-weather urban runoff and mass-based waste load 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 AND TMDLS

Ballona Creek and Sepulveda Canyon Channel are listed as impaired waterbodies due to metals. The dry-weather loading capacities for these two reaches are used to establish the dry-weather TMDL. Loadings from Centinela Creek are not considered in this TMDL because it is not listed and it drains directly to the Estuary rather than the Creek.

The dry-weather loading capacity of Ballona Creek and Sepulveda Canyon Channel for each metal was derived by multiplying the hardness-adjusted dry-weather numeric targets expressed as total recoverable (Table 3-1) 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 Sawtelle Boulevard (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 presents the loading capacities for Ballona Creek and Sepulveda Canyon Channel.

**Table 6-1. Dry-weather loading capacity (TMDL) expressed as total recoverable metals (grams/day)**

| Waterbody/Discharge | Flow | Copper | Lead | Selenium | Zinc |
|---|---|---|---|---|---|
| Ballona Creek (at Overland) | 14.0 cfs | 821 | 440 | 171 | 10,423 |
| Sepulveda Canyon Channel | 6.3 cfs | 371 | 199 | 77 | 4,712 |
| Totals | 20.3 cfs | 1,192 | 639 | 248 | 15,135 |

## 6.2 DRY-WEATHER ALLOCATIONS

Allocations are assigned to point and nonpoint sources throughout the watershed in order to meet the TMDLs for Ballona Creek and Sepulveda Canyon Channel. Mass-based load allocations are developed for direct atmospheric deposition. A grouped mass-based waste load allocation is developed for storm water permittees (Los Angeles County MS4, Caltrans, General Industrial and General Construction) for both dry weather and wet weather by subtracting the mass-based waste load and load allocations from the total loading capacity according to the following equation:

TMDL = Direct Atmospheric Deposition + Open Space + Combined Storm Water Sources (7)

In this equation "Open Space" refers to opens space that discharges directly to Ballona Creek or a tributary and not through the storm drain system. Once drainage from open space is collected by the storm drain system, it becomes a point source and is included with the storm water allocation. In the Ballona Creek Watershed, there is no allocation for open space because the limited open space in this watershed drains to the storm drain system before reaching Ballona Creek or its tributaries. The Ballona Wetlands discharge through a tide gate directly to the estuary, which is not addressed in this TMDL. Therefore, for the Ballona Creek watershed equation 7 becomes:

TMDL = Direct Atmospheric Deposition + Combined Storm Water Sources (8)

Concentration-based waste load allocations are developed for other point sources in the watershed. These other point sources have intermittent flows and calculation of mass-based waste load allocations is not possible. These sources will have a minor impact on metals loading if they are limited by concentration to the applicable CTR-based waste load allocations.

### 6.2.1 Dry-Weather Load Allocations

Dry-weather load allocations for direct atmospheric deposition are based on the calculations by Sabin et al. and allocated to Ballona Creek and Sepulveda Canyon Channel based on the length of each segment (Table 6-2). The ratio of the length of each segment over the total length of all segments is multiplied by the estimates of direct atmospheric loading (Table 4-6). No value for atmospheric deposition of selenium was available, therefore, an allocation of zero is assigned.

**Table 6-2. Dry-weather load allocation for direct atmospheric deposition expressed as total recoverable metals (grams/day)**

| Waterbody | Length (m) | Copper | Lead | Selenium | Zinc |
|---|---|---|---|---|---|
| Ballona Creek | 6 | 2.0 | 1.4 | 0 | 6.8 |
| Sepulveda Canyon Channel | 0.83 | 0.3 | 0.2 | 0 | 0.9 |
| Ballona Creek Estuary | 3.5 | 1.2 | 0.8 | 0 | 4.0 |
| Total | 10.33 | 3.5 | 2.4 | 0 | 11.7 |

### 6.2.2 Dry-Weather Waste Load Allocation for Storm Water

A dry-weather mass-based waste load allocation is developed for the storm water permittees according to the following equation:

Combined Storm Water Sources = TMDL - Direct Atmospheric Deposition (9)

As stated previously, the TMDL was calculated for each waterbody by multiplying the dry-weather critical flow by the hardness adjusted dry-weather numeric targets for each metal. Therefore, equation 9 becomes:

Combined Storm Water Sources = Critical Flow x Target - Direct Air Deposition (10)

For accounting purposes, it is assumed that Caltrans and the general storm water permittees discharge entirely to the MS4 system. This assumption has been supported though review of the permits. A waste load allocation of zero is assigned to all general industrial and construction storm water permits during dry weather. Order Nos. 97-03 DWQ and 99-08 DWQ already prohibit non-storm water discharges with few exceptions as discussed in Section 4.1.1.3. The remaining waste load allocation (Table 6-3) is shared by the MS4 permittees and Caltrans.

**Table 6-3. Dry-weather combined mass-based waste load allocations for Caltrans and MS4 permittees expressed as total recoverable metals (grams/day)**

| Waterbody | Copper | Lead | Selenium | Zinc |
|---|---|---|---|---|
| Ballona Creek | 818.9 | 438.6 | 171 | 10,416.2 |
| Sepulveda Canyon Channel | 370.7 | 198.8 | 77 | 4,711.1 |
| Totals | 1,189.6 | 637.4 | 248 | 15,127.3 |

EPA regulation allows allocations for NPDES-regulated municipal storm water discharges from multiple point sources to be expressed as a single categorical waste load allocation when data and information are insufficient to assign each source or outfall an individual allocation. We recognize that these municipal storm water allocations may be rudimentary because of data limitations and variability in the system. The combined storm water waste load allocation is partitioned among the MS4 permittees (77,546 ac.) and Caltrans (1080 ac.) based on an estimate of the percentage of land area covered under each permit. Based on these areas, the waste load allocations for Caltrans and the MS4 permittees are presented in Table 6-4.

**Table 6-4. Dry-weather mass-based waste load allocations for Caltrans and MS4 permittees expressed as total recoverable metals (grams/day)**

| Pollutant | Ballona Creek | | Sepulveda Canyon Channel | |
|---|---|---|---|---|
| | Caltrans | MS4 Permittees | Caltrans | MS4 Permittees |
| Copper | 11.2 | 807.7 | 5.1 | 365.6 |
| Lead | 6.0 | 432.6 | 2.7 | 196.1 |
| Selenium | 2 | 169 | 1 | 76 |
| Zinc | 143.1 | 10,273.1 | 64.7 | 4646.4 |

### 6.2.3 Dry-Weather Waste Load Allocation for other NPDES Permits

Concentration-based waste load allocations are established for the minor NPDES permits and general non-storm water NPDES permits that discharge to Ballona Creek or its tributaries to ensure that these do not contribute to exceedances of the CTR limits. The concentration-based waste load allocations are equal to the dry-weather numeric targets expressed as total recoverable metals as provided in Table 3-1.

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 non-storm water NPDES permit will also be subject to the concentration-based waste load allocations.

## 6.3 WET-WEATHER LOADING CAPACITY (LOAD-DURATION CURVES) AND TMDLS

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, a load duration curve approach is 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 wet-weather TMDLs for metals are defined by these load-duration curves.

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 included. Loading capacities were calculated by multiplying the daily storm volume by the appropriate numeric water quality target (Table 6-5). The wet-weather loading capacity applies to any day when the maximum daily flow measured at a location down stream of Sepulveda Canyon Channel, such as Inglewood Boulevard is equal to or greater than 40 cfs, which represents the 90$^{th}$ percentile flow.

**Table 6-5. Wet-weather load capacity (TMDLs) for metals expressed in terms of total recoverable metals.**

| Metal | Load Capacity ~~Duration curve~~ |
|---|---|
| Copper | Daily storm volume x 18 μg/L |
| Lead | Daily storm volume x 59 μg/L |
| Selenium | Daily storm volume x 5.0 μg/L |
| Zinc | Daily storm volume x 119 μg/L |

Numeric Targets for wet-weather are based on a hardness value of 77 mg/L and conversion factors specified in Table 3-3.

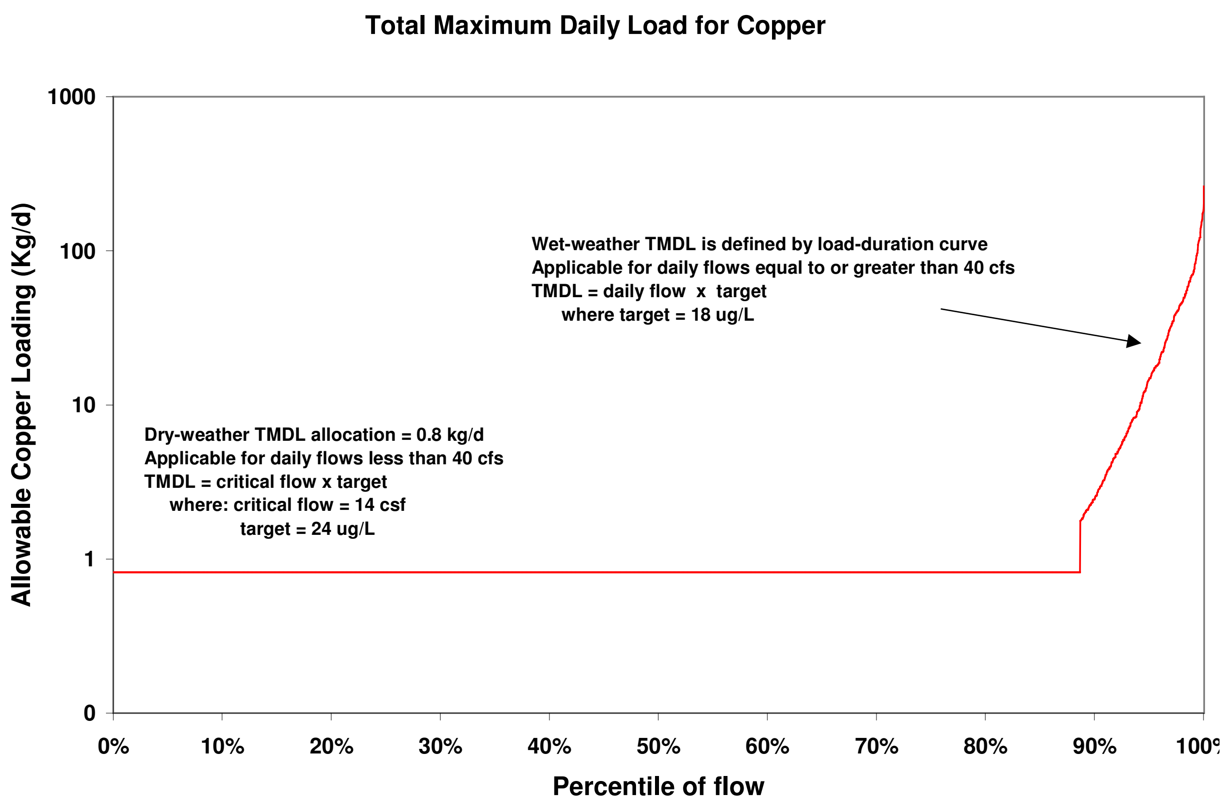
This TMDL is based on total recoverable metals concentrations, so for those metals with criteria expressed as dissolved metals concentrations, targets were converted to total recoverable metals concentrations using appropriate conversion factors. For wet weather, site-specific conversion factors were used for copper and zinc, based on the regressions in Table 3-2. The CTR default conversion factors were used for cadmium, lead and silver.

An example of a load duration curve is presented in Figure 4. This example is generated by multiplying the wet-weather numeric target for copper by the daily storm volumes generated by the wet-weather model. A daily flow of 40 cfs (daily storm volume = $9.8 \times 10^7$ liters) results in the loading capacities presented in Table 6-6. For practical purposes the wet-weather loading capacity defined using the load-duration curve approach, is equivalent to a storm water event mean concentration (EMC) based on a flow-weighted composite.

**Table 6-6. Wet-weather loading capacities based on a daily flow equal to 40 cfs.**

| Metal | Load Capacity (g/day) |
|---|---|
| Copper | 1,762 |
| Lead | 5,774 |
| Selenium | 489 |
| Zinc | 11,646 |

Figure 4. Example of Load Duration Curve




## 6.4 WET-WEATHER ALLOCATIONS

Wet-weather allocations are assigned in the same manner as the dry-weather allocations (equation 8), except that there are no individual allocations for Ballona Creek and Sepulveda Canyon Channel. The wet-weather allocations are based on the sum of the flows for Ballona Creek and Sepulveda Canyon Channel measured at a location down stream of Sepulveda Canyon Channel, such as Inglewood Boulevard.

### 6.4.1 Wet-Weather Load Allocations

Wet-weather load allocations are developed for direct atmospheric deposition. An estimate of direct atmospheric deposition was developed based on the percent area of surface water, which is about 0.6% of the total watershed area. The load allocation for atmospheric deposition is calculated by multiplying this percentage by the total loading capacity, according to the following equation:

Direct Atmospheric Deposition = 0.006 x TMDL (11)

The loadings associated with indirect deposition are included in the wet-weather storm water waste load allocations.

### 6.4.2 Wet-Weather Waste Load Allocation for Storm Water

Wet-weather waste load allocations for the storm water permittees are calculated in the same manner as the dry-weather allocation (equation 9). Since, the direct atmospheric deposition is calculated as a percentage of the TMDL equation 9 becomes:

Combined Storm Water Sources = TMDL – 0.006 x TMDL (12)

Combined Storm Water Sources = 0.994 x Target x Daily storm volume (13)

Allocations for direct atmospheric deposition and storm water are presented in Table 6-7. For example, a daily flow of 40 cfs (daily storm volume = $9.8 \times 10^7$ liters) results in the allocations presented in Table 6-8.

**Table 6-7. Wet-weather mass-based allocations**

| Metal | Direct Atmospheric Deposition (g/day) | Combined Storm Water Permittees (g/day) |
|---|---|---|
| Copper | 1.05E-07 * daily storm volume (L) | 1.79E-05 * daily storm volume (L) |
| Lead | 3.54E-07 * daily storm volume (L) | 5.87E-05 * daily storm volume (L) |
| Selenium | 3.00E-08 * daily storm volume (L) | 4.97E-06 * daily storm volume (L) |
| Zinc | 7.14E-07 * daily storm volume (L) | 1.18E-04 * daily storm volume (L) |

L = Liters

**Table 6-8. Wet-weather mass-based allocations based on a daily flow equal to 40 cfs.**

| Metal | Direct Atmospheric Deposition (g/day) | Combined Storm Water Permittees (g/day) |
|---|---|---|
| Copper | 10 | 1,751 |
| Lead | 34 | 5,740 |
| Selenium | 3 | 486 |
| Zinc | 68 | 11,578 |

The combined storm water waste load allocation is partitioned among the four storm water permittees (MS4, Caltrans, general industrial and general construction) based on an estimate of the percentage of land area covered under each permit (Table 6-9).

**Table 6-9. Areal extent of watershed and percent area covered under stormwater permits**

| Category | Area in acres | Percent area of Watershed |
|---|---|---|
| MS4 Permit | 77,546 | 94.7% |
| Caltrans Stormwater Permit | 1,080 | 1.3% |
| General Construction Stormwater Permit | 2,250 | 2.7% |
| General Industrial Stormwater Permit | 564 | 0.7% |
| Water | 480 | 0.6% |
| **Total** | **81,920** | **100%** |

Based on these areas, the waste load allocations for each storm water permittee are presented in Table 6-10.

**Table 6-10. Wet-weather combined storm water allocations apportioned based on percent of watershed.**

| Metal | General Construction permittees (g/day) | General Industrial permittees (g/day) | Caltrans (g/day) | MS4 Permittees (g/day) |
|---|---|---|---|---|
| Copper | 4.94E-07 * daily storm volume (L) | 1.24E-07 * daily storm volume (L) | 2.37E-07 * daily storm volume (L) | 1.70E-05 * daily storm volume (L) |
| Lead | 1.62E-06 * daily storm volume (L) | 4.06E-07 * daily storm volume (L) | 7.78E-07 * daily storm volume (L) | 5.58E-05 * daily storm volume (L) |
| Selenium | 1.37E-07 * daily storm volume (L) | 3.44E-08 * daily storm volume (L) | 6.59E-08 * daily storm volume (L) | 4.73E-06 * daily storm volume (L) |
| Zinc | 3.27E-06 * daily storm volume (L) | 8.19E-07 * daily storm volume (L) | 1.57E-06 * daily storm volume (L) | 1.13E-04 * daily storm volume (L) |

For example, a daily flow of 40 cfs (daily storm volume = $9.8 \times 10^7$ liters) results in the storm water waste load allocations presented in Table 6-11.

**Table 6-11. Wet-weather waste load allocations for storm water based on a daily flow of 40 cfs.**

| Metal | General Construction permittees (g/day) | General Industrial permittees (g/day) | Caltrans (g/day) | MS4 Permittees (g/day) |
|---|---|---|---|---|
| Copper | 48 | 12 | 23 | 1,667 |
| Lead | 159 | 40 | 76 | 5,466 |
| Selenium | 13 | 3 | 6 | 463 |
| Zinc | 320 | 80 | 154 | 11,024 |

Each storm water permittee enrolled under the general construction or~~and~~ industrial storm water permits will receive individual waste load allocations on a per acre basis, based on the acreage of their ~~individual construction or industrial~~ facility as presented in Table 6-12.

**Table 6-12. Per acre waste load allocation for an individual general construction or industrial storm water permittee (g/day/ac).**

| Metal | Individual General Construction or Individual General Industrial Permittee (g/day/ac) |
|---|---|
| Copper | 2.20E-10 * daily storm volume (L) |
| Lead | 7.20E-10 * daily storm volume (L) |
| Selenium | 6.10E-11 * daily storm volume (L) |
| Zinc | 1.45E-09 * daily storm volume (L) |

For example, a daily flow of 40 cfs (daily storm volume = $9.8 \times 10^7$ liters) results in the general construction and industrial storm water waste load allocations presented in Table 6-13.

**Table 6-13. Wet-weather per acre waste load allocations for an individual general construction or industrial storm water permittee (kg/day/acre) based on a daily flow of 40 cfs.**

| Metal | Individual General Construction or Individual General Industrial Permittee (g/day/ac) |
|---|---|
| Copper | 0.022 |
| Lead | 0.070 |
| Selenium | 0.006 |
| Zinc | 0.142 |

### 6.4.3 Wet-Weather Waste Load Allocation for other NPDES Permits

Concentration-based waste load allocations are established for the minor NPDES permits and general non-storm water NPDES permits that discharge to Ballona Creek or its tributaries to ensure that these do not contribute to exceedances of the CTR limits. The concentration-based waste load allocations are equal to the wet-weather numeric targets expressed as total recoverable metals as provided in Table 3-3.

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 non-storm water NPDES permit will also be subject to the concentration-based waste load allocations.

## 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 values for the conversion from total recoverable metals to the dissolved fraction during dry and wet weather. In addition, the TMDL includes a margin of safety by evaluating dry-weather and wet-weather conditions separately and assigning allocations based on two disparate critical conditions. During wet weather, when the greatest loadings are discharged, the hardness value is 77 mg/L, which is less than the default CTR value.

### 6.6 SUMMARY OF TMDL

The TMDL is based on pollutant loadings to the water column in Ballona Creek and Sepulveda Canyon Channel. For dry weather 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 permittees (MS4, Caltrans, general industrial and construction storm water permittees). Concentration-based WLAs will also be applied to the other non-storm water NPDES permittees. It is anticipated that implementation for storm water discharges will be based on BMPs which address pollution prevention. The effectiveness of the BMPs to meet the TMDL allocations 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

This section describes the implementation procedures that will be used to provide reasonable assurances that water quality standards will be met. Further, the reasonably foreseeable means of compliance with the TMDL are discussed.

## 7.1 INTRODUCTION

Nonpoint sources will be regulated through the authority contained in Sections 13263 and 13269 of the Water Code, in conformance with the State Water Resources Control Board's Nonpoint Source Implementation and Enforcement Policy (May 2004).

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 an 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.

The concentration-based waste load allocations for the minor NPDES permits and general non-storm water NPDES permits will be implemented through NPDES permit conditions~~limits~~. The dry- and wet-weather waste load allocations are equal to the dry- and wet-weather numeric targets, expressed as total recoverable metals, listed in Tables 3-1 and 3-3, respectively. Permit writers for the non-storm water permits 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 authorized under federal regulations. Compliance schedules may be established in the individual NPDES permits, allowing up to 5 years within a permit cycle to achieve compliance. Compliance schedules may not be established in general NPDES permits. A discharger that could not comply immediately with effluent limitations specified to meet waste load allocations would be required to apply for an individual permit, in order to, demonstrate the need for a compliance schedule. Permittees that hold individual NPDES permits and solely discharge storm water may be allowed (at Regional Board discretion) compliance schedules up to 10 years from the effective date of the TMDL to achieve compliance with final WLAs.

~~The general construction and industrial storm water permittees are assigned a dry-weather waste load allocation equal to zero. The current general permits (Order Nos. 97-03-DWQ and 99-08-DWQ) prohibit the discharge of non-storm water flow, with certain exceptions.~~ Non-storm water flows authorized by Order N. 97-03 DWQ, or any successor order, are exempt from the dry-weather waste load allocation equal to zero. Instead these authorized non-stormwater flows shall meet the reach-specific concentration–based waste load allocations assigned to the "other NPDEs permits" as described in Section 6.2.3 and Table 3-1. The dry-weather waste load allocations equal to zero applies to non-authorized non-storm water flows, which are prohibited by Order No. 97-03 DWQ.~~-~~It is anticipated that the dry-weather waste load allocation equal to zero will be implemented in future general permits through the requirement of improved BMPs to eliminate the discharge of non-storm water flows. The wet-weather mass-based waste load allocations for the general construction and industrial storm water permittees (Table 6-12) will be incorporated into watershed specific general permits. ~~—~~Concentration-based permit ~~limits~~conditions may be set to achieve the mass-based waste load allocations. These concentration-based ~~limits~~conditions would be equal to the concentration-based waste load allocations assigned to the other NPDES permits as described in Section 6.4.3 and ~~(~~Table 3-3~~)~~. Compliance with permit conditions may be demonstrated through the installation, maintenance, and monitoring of Regional Board-approved BMPs. If this method of compliance is chosen~~-It is expected that permit writers will translate both the dry-weather and wet-weather waste load allocations into BMPs, based on BMP performance data.~~ However, 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. A group monitoring effort will not only assess individual compliance, but will also assess the effectiveness of chosen BMPs to reduce pollutant loading on an industry-wide or permit category basis. 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 concentration-based wet-weather 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 to all industry sectors~~, including construction~~ and will apply for a period not to exceed ten years from the effective date of the TMDL.

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

| Copper | Lead | Selenium | Zinc |
|---|---|---|---|
| 63.6 | 81.6 | 238.5 | 117 |

*Based on USEPA benchmarks for industrial storm water sector.

In the first five years from the effective date of the TMDL, interim wet-weather 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. It is anticipated that monitoring results and any necessary BMP improvements would occur as part of an annual reporting process. After five years from the effective date of the TMDL, interim waste load allocations shall be translated into enforceable permit~~-limits~~ conditions. Compliance with conditions may be demonstrated through the installation, maintenance, and monitoring of Regional Board-approved BMPs. Permit writers must provide adequate justification and documentation to demonstrate that specified BMPs are expected to result in attainment of waste load allocations. In addition, permittees shall begin an iterative BMP process to meet final waste load allocations. Concentration-based permit limits may be set to achieve the mass-based waste load allocations. These concentration-based limits would be equal to the concentration-based waste load allocations assigned to the other NPDES permits. Permittees shall comply with final waste load allocations within 10 years from the effective date of the TMDL, which shall be expressed as water quality based effluent limititations. Effluent limits may be expressed as permit conditions. Compliance with conditions may be demonstrated through the installation, maintenance, and monitoring of Regional Board-approved BMPs. Permit writers must provide adequate justification and documentation to demonstrate that specified BMPs are expected to result in attainment of waste load allocations.

Waste load allocations for the general construction storm water permits will be incorporated into the State Board general permit upon renewal or into a watershed-specific general permit developed by the Regional Board. Non-stormwater flows authorized by the General Permit for Storm Water Discharges Associated with Construction Activity (Water Quality Order No. 99-08 DWQ), or any successor order, are exempt from the dry-weather waste load allocation equal to zero as long as they comply with the provisions of sections C.3 and A.9 of the Order No. 99-08 DWQ, which state that these authorized non-storm water discharges shall be (1) infeasible to eliminate (2) comply with BMPs as described in the Storm Water Pollution Prevention Plan prepared by the permittee, and (3) not cause or contribute to a violation of water quality standards, or comparable provisions in any successor order. Unauthorized non-storm water flows are already prohibited by Order No. 99-08 DWQ.

Within five years fo the effective date of the TMDL, the construction industry will submit the results of BMP effectiveness studies to determine BMPs that will achieve compliance with the final waste load allocations assigned to construction storm water permittees. Regional Board staff will bring the recommended BMPs before the Regional Board for consideration within six years of the effective date of the TMDL. General construction storm water permittees will be considered in compliance with the final waste load allocations if they implement these Regional Board approved BMPs. All permittees must implement the approved BMPs within seven years of the effective date of the TMDL. If no effectiveness studies are conducted and no BMPs are approved by the Regional Board within six years of the effective date of the TMDL, each general construction storm water permit holder will be subject to site-specific BMPs and monitoring requirements to demonstrate compliance with final waste load allocations.

The County of Los Angeles, City of Los Angeles, Beverly Hills, Culver City, Inglewood, Santa Monica, and West Hollywood are jointly responsible for meeting the mass-based waste load allocations for the MS4 permittees. Caltrans is responsible for meeting their mass-based waste load allocations, however, they may choose to work with the MS4 permittees. 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.

EPA policy requires that the waste load allocations for storm water be expressed in numeric form. For the dry-weather condition, mass-based waste load allocations (Table 6-4) will be incorporated into the permits of the NPDES-regulated municipal stormwater discharges. A review of available water quality data suggests that applicable CTR limits are being met most of the time during dry weather, with episodic exceedances. Due to the expense of obtaining accurate flow measurements required for calculating loads, concentration-based permit limits may apply during dry weather. These concentration-based limits would be equal to the dry-weather numeric targets (Table 3-1). For wet weather, the mass-based storm water waste load allocations are presented in Table 6-10. These waste load allocations may be allocated to each jurisdiction within a subwatershed based on the drainage area.

As mentioned earlier, each municipality and permittee will be responsible for 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 storm water waste load allocations. The administrative record and the fact sheets for the MS4 and Caltrans storm water permits 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, permittees will 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 grouped storm water 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. In figures C-1 through C-8, the load capacity curve is a black line. For figures C-1 through C-6, 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 selenium was not modeled, the model-predicted historic loads could not be simulated for inclusion with the load capacity curves.

## 7.2 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 treat 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 has been the removal of sediments and other pollutants.

## 7.3 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 environmental 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.

### 7.3.1 Non-Structural Best Management Practices

The non-structural 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.

A known source of copper loading is from brake pads. The use of alternative materials for brake pads would help to reduce the discharge of metals in all watersheds. Staff acknowledges the Brake Pad Partnership, a multistakeholder effort in the San Francisco Bay to understand and address as necessary the impacts of surface water quality that may arise from brake pad wear debris.

### 7.3.2 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.

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.

### 7.3.3 Diversion and Treatment Strategy

The diversion and treatment strategy includes the installation of facilities to provide capture and storage of dry- and/or wet-weather runoff and diversion of the stored runoff to the wastewater collection system for treatment at the City's Hyperion Treatment Plant (HTP) during low flow conditions at the plant (typically during the early morning hours of 12-6 a.m.), if possible. If diversion to the HTP is not an option, other strategies such as small dedicated runoff treatment facilities such as the Santa Monica Urban Runoff Recycling Facility or alternative BMPs may be implemented to meet the TMDL requirements.

The volume of flow requiring treatment would have to be estimated in order to size the storage facilities, estimate diversion flow rates, and determine the collection system and treatment capacities needed to accommodate these diverted flows. Wet-weather flows beyond the capacities of these facilities will be bypassed, however, a portion of these larger storm events will still be captured and treated, thereby eliminating the metals loading of small storms and reducing those of larger storms. Overflows from these systems could be routed through structural BMPs designed to remove sediment for further reduction of metal loads.

To assist responsible jurisdictions and agencies in determining the optimal volume of flow to be diverted, analyses were performed to assess relative improvements and benefits associated with capture of storm volumes. The capture of storm volumes reduces the associated metals loads, and therefore reduces the likelihood of exceedances of loading capacities of the receiving waters. These analyses were based primarily on conceptual assumptions and analyses of model results for guidance in future planning. The initial step in the analyses was the prediction of storm volumes resulting from total amounts of rainfall for each storm. Model-predicted storm volumes (Section 5.2) were compared to total rainfall over the storm periods to determine if relationships could be established. Figures D-1 through D-3 of Appendix D show results of these analyses. For storms with rainfall greater than 0.1 inch, a correlation could be established for Ballona Creek and Sepulveda Canyon Channel for prediction of storm volumes as a function of rainfall. For storms less than 0.1 inch, no correlation was found.

For Ballona Creek and Sepulveda Canyon Channel storm volumes were predicted for various rainfalls greater than 0.1 inch (using regression equations reported in Figures D-1 and D-2). These volumes were assumed to be equivalent to design volumes for storm capture and treatment. For example, capture of 0.1 inch of rainfall in Ballona Creek is equivalent to approximately 44 million gallons of storm volume from the watershed. For each storm predicted over the 10-year modeling period for TMDL analysis, assumed volumes associated with storm capture were subtracted from the total storm volume to simulate varying benefits resulting from different volumes of design. Metals loads associated with these storm captures were estimated using model-predicted event mean concentrations specific to each storm. The results of this analysis can be translated to benefits received from the capture of various amounts of storm volumes in terms of inches of rainfall.

Figures D-3 through D-8 report results of these analyses. For these figures, the "percent exceedance" corresponds to the number of storms exceeding the loading capacity defined for each waterbody and metal in the load duration analyses utilized for TMDL development (Appendix C). This percentage should not be confused with the TMDL percent reductions, which are expressed as reductions in loads rather than number of storms that exceedances were observed. A single storm where an exceedance of the loading capacity is predicted can have a large load associated, which results in a relatively large load reduction required.

In Figures D-3 through D-8, reductions in the percent exceedances were predicted for various magnitudes of storm capture volumes (expressed as inches of rainfall). By increasing the storm volume captured and treated, reductions in the likelihood of exceedances of the loading capacities and corresponding WQOs were determined to be possible. The model suggest that the percent of storms exceeding the allowable loads are reduced to 10% for copper and zinc through the capture of a 0.5 inch storm in Ballona Creek. These analyses are provided as guidance only and are not meant to imply that facilities designed to capture and treat storm water are either necessary or adequate to meet the load reductions prescribed in this TMDL. Clearly a combination of approaches will be required utilizing BMPs that result in source reduction and load reduction. Additional studies that evaluate the effect of short duration rainfall intensity (i.e., one-year, one-hour rainfall event) on the mobilization and transport of metals are encouraged and would be useful in designing the flow through design capacity of in-line BMPs.

The value of the facilities installed for this strategy can be realized as part of a long-term integrated water resources strategy by planning for the future use of the collection, storage and transmission facilities to provide storm water for potential reuse opportunities.

## 7.4 IMPLEMENTATION SCHEDULE

The implementation schedule for all permittees is summarized in Table 7-3. For the MS4 and Caltrans storm water permittees the proposed implementation schedule shall consist of a phased approach, with compliance to be achieved in prescribed percentages of the watershed, with total compliance to be achieved within 15 years. The dry-weather implementation schedule is more accelerated because the dry-weather exceedances occur infrequently and major structural BMPs are not anticipated. The MS4 and Caltrans storm water permittees are encourage to work together to identify subwatershed areas to be addressed first.

The Regional Board intends to reconsider this TMDL in five years after the effective date of the TMDL to re-evaluate the waste load allocations based on the additional data obtained from the special studies. Until the TMDL is revised, the waste load allocations will remain as presented in Section 6. Revising the TMDL will not create a conflict, since full compliance with the dry-weather WLAs and wet-weather WLAs are not required until 10 and 15-years after the effective date, respectively.

**Table 7-3. Implementation Schedule**

| Date | Action |
|---|---|
| Effective date of the TMDL | Regional Board permit writers shall incorporate the WLAs into the NPDES permits. WLAs will be implemented through NPDES permit limits in accordance with the implementation schedule contained herein, at the time of permit issuance, renewal or re-opener. |
| 4 years after effective date of the TMDL | Responsible jurisdictions and agencies shall provide to the Regional Board results of the special studies. |
| 5 years after effective date of the TMDL | The Regional Board shall reconsider this TMDL to re-evaluate the waste load allocations and the implementation schedule. |
| **NON-STORM WATER NPDES PERMITS (INCLUDING MINOR AND GENERAL PERMITS)** | |
| Upon permit issuance, renewal or re-opener | The non-storm water NPDES permittees shall achieve the WLAs, which shall be expressed as NPDES water quality-based effluent limitations specified in accordance with federal regulations and state policy on water quality control. Compliance schedules may allow up to five years in individual NPDES permits to meet permit requirements. Compliance schedules may not be established in general NPDES permits. Permittees that hold individual NPDES permits and solely discharge storm water may be allowed (at Regional Board discretion) compliance schedules up to 10 years from the effective date of the TMDL to achieve compliance with final WLAs. |
| **GENERAL INDUSTRIAL STORM WATER ~~AND GENERAL CONSTRUCTION~~ STORM WATER PERMITS** | |
| Upon permit issuance, renewal or re-opener | The general industrial ~~and construction~~ storm water NPDES permittees shall achieve dry-weather waste load allocations of zero, which shall be expressed as NPDES water quality-based effluent limitations specified in accordance with federal regulations and state policy on water quality control. Effluent limitations may be expressed as permit conditions, such as installation, maintenance, and monitoring of Regional Board approved BMPs. Permittees shall begin to install and test BMPs to meet the interim wet-weather WLAs. BMP effectiveness monitoring will be implemented to determine progress in achieving interim wet-weather waste load allocations. |

| Date | Action |
|---|---|
| 5 years after effective date of the TMDL | The general industrial and construction storm water NPDES permittees shall achieve the interim wet-weather WLAs, which shall be expressed as NPDES water quality-based effluent limitations, such as installation, maintenance, and monitoring of Regional Board-approved BMPs. ~~specified in accordance with federal regulations and state policy on water quality control~~. Permittees shall ~~allow an~~ begin an iterative BMP process including BMP effectiveness monitoring to achieve compliance with final waste load allocations ~~permit requirements~~. |
| GENERAL CONSTRUCTION STORM WATER PERMITS | |
| Upon permit issuance, renewal, or re-opener | Non-storm water flows not authorized by Order No. 99-08 DWQ, or any successor order, shall achieve dry-weather waste load allocations of zero. Waste load allocations shall be expressed as NPDES water-quality based effluent limitations specified in accordance with federal regulations and state policy on water quality control. Effluent limitations may be expressed as permit conditions, such as installation, maintenance, and monitoring of Regional Board-approved BMPs. |
| Five years from the effective date of the TMDL | The construction industry will submit the results of wet-weather BMP effectiveness studies to the Regional Board for consideration. In the event that no effectiveness studies are conducted and no BMPs are approved, permittees shall be subject to site-specific BMPs and monitoring to demonstrate BMP effectiveness. |
| Six years from the effective date of the TMDL | The Regional Board will consider the wet-weather BMP effectiveness studies and consider approval of BMPs no later than six years from the effective date of the TMDL. |
| Seven years from the effective date of the TMDL | All general construction storm water permittees shall implement Regional Board-approved BMPs. |

| Date | Action |
|---|---|
| 10 years after the effective date of the TMDL | The general industrial and construction storm water NPDES permittees shall achieve the final wet-weather WLAs, which shall be expressed as NPDES water quality-based effluent limitations ~~specified in accordance with federal regulations and state policy on water quality control~~. Effluent limitations may be expressed as permit conditions, such as installation, maintenance, and monitoring of Regional Board-approved BMPs ~~Permits shall allow iterative BMP process including BMP effectiveness monitoring to achieve compliance with permit requirements~~. |
| **MS4 AND CALTRANS STORM WATER PERMITS** | |
| 12 ~~6~~ months after the effective date of the TMDL | In response to an order issued by the Executive Officer, the MS4 and Caltrans storm water NPDES permittees must submit a coordinated monitoring plan, to be approved by the Executive Officer, which includes both ambient monitoring and TMDL effectiveness monitoring. Once the coordinated monitoring plan is approved by the Executive Officer, ambient monitoring shall commence. |
| 18 ~~12~~ months after effective date of TMDL (Draft Report)<br><br>24 ~~16~~ months after effective date of TMDL (Final Report) | MS4 and Caltrans storm water NPDES permittees shall provide a written report to the Regional Board outlining the drainage areas to be address and how these areas will achieve compliance with the waste load allocations. The report shall include implementation methods, an implementation schedule, proposed milestones, and any applicable revisions to the TMDL effectiveness monitoring plan. |
| 6 years after effective date of the TMDL | The MS4 and Caltrans storm water NPDES permittees shall demonstrate that 50% of the total drainage area served by the MS4 system is effectively meeting the dry-weather waste load allocations and 25% of the total drainage area served by the MS4 system is effectively meeting the wet-weather waste load allocations. |
| 8 years after effective date of the TMDL | The MS4 and Caltrans storm water NPDES permittees shall demonstrate that 75% of the total drainage area served by the MS4 system is effectively meeting the dry-weather WLAs. |
| 10 years after effective date of the TMDL | The MS4 and Caltrans storm water NPDES permittees shall demonstrate that 100% of the total drainage area served by the MS4 system is effectively meeting the dry-weather WLAs and 50% of the total drainage area served by the MS4 system is effectively meeting the wet-weather WLAs. |
| 15 years after effective date of the TMDL | The MS4 and Caltrans storm water NPDES permittees shall demonstrate that 100% of the total drainage area served by the MS4 system is effectively meeting both the dry-weather and wet-weather WLAs. |

## 7.5 IMPLEMENTATION COST ANALYSIS AND CEQA CONSIDERATIONS

This section takes into account a reasonable range of economic factors in estimating potential costs associated with this TMDL. This analysis, together with the other sections of this staff report, CEQA checklist, response to comments, Basin Plan amendment and supporting documents were completed in fulfillment of the applicable provisions of the California Environmental Quality Act (Public Resources Code Section 21159.)[4]

This cost analysis focuses on achieving the grouped waste load allocation by the MS4 and Caltrans storm water permittees in the urbanized portion of the watershed[5]. The BMPs and potential compliance approaches analyzed here could apply to the general industrial and construction storm water permittees as well. An evaluation of the costs of implementing this TMDL amounts to evaluating the costs of preventing metals and sediment from entering storm drains and/or reaching Ballona Creek. Most permittees would likely implement a combination of the structural and non-structural BMPs to achieve their waste load allocations. This analysis considers a potential strategy combining structural and non-structural BMPs through a phased implementation approach and estimates the costs for this strategy. It will also be important to document any possible reductions in metals loading that may be incidentally already being achieved via BMPs currently employed under the Trash TMDL.

In addition to achieving compliance with this TMDL, such a strategy could be used to achieve compliance with the Ballona Creek and Wetlands Trash TMDL as well as the upcoming Ballona Creek and Estuary Toxics and Bacteria TMDLs. Therefore, this cost analysis reflects the potential costs of compliance with multiple TMDLs based on likely implementation scenarios.

### 7.5.1 Phased Implementation

Under a phased implementation approach, it is assumed that compliance with the grouped waste load allocation could be achieved in 30% of the urbanized portion of the watershed through an IRP. Costs of implementing an IRP are not estimated for the purposes of this analysis because metals removal is not the primary goal of the IRP, which addresses multiple wastewater and water resource management needs. Compliance in another 30% of the urbanized portion of the watershed could be achieved through various iterations of non-structural BMPs. Compliance with the remaining 40% of the urbanized portion of the watershed could be achieved through structural BMPs. These percentages are approximately estimated based on the removal efficiencies of various non-structural and structural BMPs, as discussed below.

The first step of the potential phased approach would include the implementation of non-structural BMPs by the permittees, such as increasing the frequency and efficiency of street sweeping. In their National Menu of Best Management Practices for Stormwater – Phase II, USEPA reports that conventional mechanical street sweepers can reduce non-point source pollution by 5 to 30% (USEPA, 1999a). The removal efficiencies of sediment for conventional

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[4] Because this TMDL implements existing water quality objectives (namely, the numeric CTR criteria established by EPA), it does not, "establish" water quality objectives and no further analysis of the factors identified in Water Code section 13241 is required. However, the staff notes that its CEQA analysis provides the necessary information to properly "consider" the factors specified in Water Code section 13241. As a result, the section 13241 analysis would at best be redundant.

[5] The Ballona Creek watershed is 128 square miles. Open space comprises 17.5 square miles and water comprises 0.75 square miles of the Ballona Creek watershed. It is not expected that the MS4 and Caltrans permittees will need to address areas of open space to meet the waste load allocations (Table 7-2). Therefore, areas of open space and water are not considered in the calculation of the cost analysis. The remaining 110 square miles is considered the portion of the watershed that may require BMPs and therefore, used in the cost analysis for the purposes of this TMDL.

sweepers are dependent on the size of particles. Conventional sweepers, including mechanical broom sweepers and vacuum-assisted wet sweepers, have removal efficiencies of approximately 15 to 50% for particles less than 500 micrometers and up to approximately 65% for larger particles (Walker and Wong, 1999). USEPA reports that vacuum-assisted dry street sweeping can remove significantly more pollution, including fine sediment and metals, before the pollutants are mobilized by rainwater. USEPA reports a 50 to 88% overall reduction in annual sediment loading for residential areas by vacuum-assisted dry street sweepers. Sutherland and Jelen (1997) showed a total removal efficiency of 70% for fine particles and up to 96% for larger particles by vacuum – assisted dry sweepers (also known as small-micron surface sweepers). Upgrading to vacuum-assisted dry sweeping would translate to a significant reduction of metals in the particulate phase. In their 1999 Preliminary Data Summary of Urban Stormwater Best Management Practices, USEPA estimated cost data for both standard mechanical and vacuum-assisted dry sweepers as shown in Table 7-4.

**Table 7-4. Estimated costs for two types of street sweepers. (Source: USEPA, 1999b.)**

| Sweeper Type | Life (Years) | Purchase Price ($) | O&M Cost ($/curb mile) |
|---|---|---|---|
| Mechanical | 5 | 75,000 | 30 |
| Vacuum-assisted | 8 | 150,000 | 15 |

Table 7-4 illustrates that while the purchase price of vacuum-assisted dry sweepers is higher, the operation and maintenance costs are lower than for standard sweepers. Based on this information, USEPA determined the total annualized cost of operating street sweepers per curb mile, for a variety of frequencies (Table 7-5). In their estimates, USEPA assumed that one sweeper serves 8,160 curb miles during a year and assumed an annual interest rate of 8 percent (USEPA, 1999b). According to Table 7-5, permittees would save money in the long-term by switching to vacuum-assisted dry sweepers.

**Table 7-5. Annualized sweeper costs, including purchase price and operation and maintenance costs ($/curb mile/year).**

| **Sweeper Type** | **Sweeping Frequency** | | | | | |
|---|---|---|---|---|---|---|
| | **Weekly** | **Bi-weekly** | **Monthly** | **Quarterly** | **Twice per year** | **Annually** |
| Mechanical | 1,680 | 840 | 388 | 129 | 65 | 32 |
| Vacuum-Assisted | 946 | 473 | 218 | 73 | 36 | 18 |

Under a phased implementation approach, the permittees could monitor compliance using flow-weighted composite sampling of runoff throughout representative storms to determine the effectiveness of this first step of implementing non-structural BMPs. If monitoring showed non-compliance, permittees could adapt their approach by increasing frequency of street sweeping or incorporating other non-structural BMPs.

If compliance could still not be achieved through non-structural BMPs, permittees could incorporate structural BMPs. Two potential structural BMPs were analyzed in this cost analysis:

- Infiltration trenches
- Sand filters

These approaches are specifically designed to treat urban runoff and to accommodate high-density areas. They were chosen for this analysis because in addition to addressing metals loadings to the creek, they have the additional positive impact of addressing the effects of development and increased impervious surfaces in the watershed. Both approaches can be designed to capture and treat 0.5 to 1 inch of runoff. When flow exceeds the design capacity of each device, untreated runoff is allowed to bypass the device and enter the storm drain.

Both infiltration trenches and sand filters must be used in conjunction with some type of pretreatment device such as a biofiltration strip or gross solids removal system to remove sediment and trash in order to increase their efficiency and service life. This combination could be used to achieve compliance with both the Ballona Creek Trash TMDL and the Metals TMDL. The Trash TMDL provided a cost estimate of gross solids removal systems, including structural vortex separation systems and end of pipe nets. This analysis provides an estimate of the additional costs associated with installing sand filters or infiltration trenches.

In addition, both infiltration trenches and sand filters are efficient in removing bacteria and could be used to achieve compliance with the upcoming bacteria TMDL. USEPA reports that sand filters have a 76% removal rate and infiltration trenches have a 90% removal rate for fecal coliform (USEPA, 1999c).

As stated previously, it is assumed that 40% of the urbanized portion of the watershed would need to be treated by structural BMPs. In this cost analysis, it was assumed that 20% of the watershed would be treated by infiltration trenches and sand filters would treat the other 20%. Costs were estimated using data provided by USEPA (USEPA, 1999a and 1999c) and the Federal Highway Administration (FHWA, 2003). USEPA cost data were reported in 1997 dollars. FHWA costs were reported in 1996 dollars for infiltration trenches and 1994 dollars for sand filters. Where costs were reported as ranges, the highest reported cost was assumed. These costs were then compared to costs determined by Caltrans in their BMP Retrofit Pilot Program (Caltrans, 2004). Caltrans costs were reported in 1999 dollars. Analysis of costs based on EPA, FHWA estimates those reported by Caltrans, as well as estimations of sizing constraints are included in Appendix III, which could be used to estimate land acquisition costs. To estimate land acquisition costs for individual projects in this cost analysis would be purely speculative.

Infiltration trenches. Infiltration trenches store and slowly filter runoff through the bottom of rock-filled trenches and then through the soil. Infiltration trenches can be designed to treat any amount of runoff, but are ideal for treating small urban drainage areas less than five to ten acres. Soils and topography are limiting factors in design and siting, as soils must have high percolation rates and groundwater must be of adequate depth. Potential impacts to groundwater by infiltration trenches could be avoided by proper design and siting. Infiltration trenches are reported to achieve 75 to 90% suspended solids removal and 75 to 90% metals removal by USEPA and FHWA. In their BMP Retrofit Pilot Program, Caltrans assumed that constituent removal was 100 percent for storm events less than the design storm, because all runoff would be infiltrated.

Table 7-6 presents estimated costs for infiltration trenches designed to treat 0.5 inches of runoff over a five-acre drainage area with a runoff coefficient equal to one. Staff determined that 2,816 devices, designed to treat five acres each, would be required to treat 20% of the urbanized portion of the watershed.

**Table 7-6. Estimated Costs for Infiltration Trenches.**

| | Construction Costs ($ million) | Maintenance Costs ($ million/year) |
|---|---|---|
| Based on USEPA estimate | 128 | 26 |
| Based on FHWA estimate | 122 | Not reported |

Sand Filters. Sand filters work by a combination of sedimentation and filtration. Runoff is temporarily stored in a pretreatment chamber or sedimentation basin, and then flows by gravity or is pumped into a sand filter chamber. The filtered runoff is then discharged to a storm drain or natural channel. As with infiltration trenches, the costs of two types of sand filters were analyzed: 1) the Delaware sand filter, which is installed underground and suited to treat drainage areas of approximately one acre and 2) the Austin sand filter, which is installed at-grade and suited to larger drainage areas up to 50 acres. The underground sand filter is especially well adapted for applications with limited land area and is independent of soil conditions and depth to groundwater. However, both types of sand filters must consider the imperviousness of the drainage areas in their design.

USEPA estimated a 70% removal of total suspended solids and 45% removal of lead and zinc for both types of sand filters. FHWA reported high sediment, zinc and lead removal, but low copper removal for Austin sand filters and high sediment and moderate to high metals removal for Delaware sand filters. Caltrans reported a 50% reduction in total copper, a 7% reduction in dissolved copper, an 87% reduction in total lead, a 40% reduction in dissolved lead, an 80% reduction in total zinc and a 61% reduction in dissolved zinc by the Austin sand filters they tested. Caltrans reported a 66% reduction in total copper, a 40% reduction in dissolved copper, an 85% reduction in total lead, a 31% reduction in dissolved lead, a 92% reduction in total zinc and a 94% reduction in dissolved zinc by the Delaware sand filter they tested.

USEPA and FHWA reported costs per acre for 0.5 inches of runoff. Total costs were calculated by multiplying the per-acre cost by the total acreage of the urbanized portion of the watershed not addressed through an integrated resources plan or non-structural BMPs. Estimated costs are presented in Table 7-7. There are significant economies of scale for Austin filters. USEPA reported that costs per acre decrease with increasing drainage area. FHWA reported two separate costs based on drainage area served. Economies of scale are not a factor for Delaware filters, as they are limited to drainage areas of about one acre.

**Table 7-7. Estimated Costs for Austin and Delaware Sand Filters**

| | Austin Sand Filter Construction Costs ($ million) | Austin Sand Filter Maintenance Costs ($ million/year) | Delaware Sand Filter Construction Costs ($ million) | Delaware Sand Filter Maintenance Costs ($ million/year) |
|---|---|---|---|---|
| Based on USEPA estimate | 130 | 7 | 77 | 4 |
| Based on FHWA estimate* | 24 | Not reported | 99 | Not reported |

*FHWA cost estimate for Austin filter was calculated assuming a drainage area greater than five acres. The costs would be $113 million for Austin filters designed for a drainage area of less than two acres.

Based on the adaptive management approach, and some assumptions about the efficiencies of each stage of the approach, the cost analysis arrived at the total costs for compliance with the

Metals TMDL as shown in Table 7-8. The total costs do not include the cost savings associated with switching to vacuum-assisted street sweepers. As stated previously, the costs associated with this adaptive management approach could be applied towards the cost of compliance with the Metals TMDL, and upcoming Toxics and Bacteria TMDLs.

**Table 7-8. Total Estimated costs of adaptive management approach.**

| | Total Construction ($ million) | Total Maintenance ($ million/year) |
|---|---|---|
| Based on USEPA estimate | 335 | 37 |
| Based on FHWA estimate | 245 | Not reported |

### 7.5.2 Comparison of Costs Estimates with Caltrans Reported Costs

Estimated costs for structural BMPs were compared to costs reported by Caltrans in their BMP Retrofit Pilot Program (Caltrans, 2004). Caltrans sited five Austin sand filters and one Delaware sand filter as part of their study. The five Austin sand filters served an average area of 2 acres and the Delaware sand filter served an area of 0.7 acres. Caltrans sited two infiltration trench/biofiltration strip combinations as part of their study. Each trench and biofiltration strip used in combination served an area of 1.7 acres. Based on these drainage areas, the average adjusted cost of the Austin sand filters in the Caltrans study was $156,600 per acre, the adjusted cost of the Delaware filter was $310,455 per acre and the average adjusted cost of the infiltration trench/biofiltration strips was $84,495 per acre. These costs are approximately an order of magnitude greater than the costs determined using estimates provided by USEPA and FHWA. It should be noted that costs calculated using USEPA and FHWA estimates were based on infiltration trench and sand filter designs that would treat 0.5 inches of runoff, while Caltrans study costs were based on an infiltration trench design that would treat 1 inch of runoff and sand filter designs that would treat 0.56 to 1 inches of runoff. This could explain some of the differences in costs.

The differences in costs can also be explained by ~~Caltrans study was subject to~~ a third party review of the Caltrans study, conducted by Holmes & Narver, Inc. and Glenrose Engineering (Caltrans, 2001). The review compared adjusted Caltrans costs with costs of implementing BMPs by other state transportation agencies and public entities. The adjusted costs exclude costs associated with the unique pilot program and ancillary costs such as improvements to access roads, landscaping or erosion control, and non-BMP related facilities. For the comparison, all costs were adjusted for differences in regional economies. The third party review determined that the median costs reported by Caltrans were higher than the median costs reported by the other agencies for almost every BMP considered, including sand filters and infiltration BMPs. The review attributed the higher Caltrans costs to the small scale and accelerated nature of the pilot program. The third party review then gave recommendations for construction cost reductions based on input from other state agencies. These included simplifying design and material components, combining retrofit work with ongoing construction projects, changing methods used to select and work with construction contractors, allowing for a longer planing horizon, constructing a larger number of BMPs at once, and implementing BMPs over a larger drainage area.

### 7.5.3 Results of a Region-wide Cost Study

In their report entitled "Alternative Approaches to Storm Water Quality Control, Prepared for the Los Angeles Regional Water Quality Board," Devinny et al. estimated the total costs for compliance with Regional Board storm water quality regulations as ranging from $2.8 billion, using entirely non-structural systems, to between $5.7 billion and $7.4 billion, using regional treatment or infiltration systems. The report stated that final costs would likely fall somewhere within this range. Table 7-9 presents the report's estimated costs for the various types of structural and non-structural systems that could be used to achieve compliance with municipal storm water requirements throughout the Region.

**Table 7-9. Estimated costs of structural and non-structural compliance measures for the entire Los Angeles Region. (Source: Devinny et al.)**

| **Compliance Approach** | **Estimated Costs** |
|---|---|
| Enforcement of litter ordinances | $9 million/year |
| Public Education | $5 million/year |
| Increased storm drain cleaning | $27 million/year |
| Installation of catch basin screens, enforcing litter laws, improving street cleaning | $600 million |
| Low –flow diversion | $28 million |
| Improved street cleaning | $7.5 million/year |
| On-site BMPs for individual facilities | $240 million |
| Structural BMPs – 1st estimation method | $5.7 billion |
| Structural BMPs – 2nd estimation method | $4.0 billion |

The Devinny et al. study calculates costs for the entire Los Angeles Region, which is 3,100 square miles, while the Ballona Creek watershed is 128 square miles. When compared on a per square mile basis, the costs estimated in section 6.5.1 are within the range calculated by Devinny et al. (Table 7-10).

**Table 7-10. Comparison of costs for storm water compliance on a per square mile basis.**

| | **Construction Costs ($ million/square mile)** |
|---|---|
| Based on U.S. EPA estimate | 2.62 |
| Based on FHWA estimate | 1.91 |
| Maximum cost calculated by Devinny et al. | 1.84 –2.39 |

The Devinny et al. study also estimated benefits associated with storm water compliance. It was determined that the Region-wide benefits of a non-structural compliance program would equal approximately $5.6 billion while the benefits of non-structural and regional measures would equal approximately $18 billion. Region-wide estimated benefits included:

- Flood control savings due to increased pervious surfaces of about $400 million,
- Property value increase due to additional green space of about $5 billion,
- Additional groundwater supplies due to increased infiltration worth about $7.2 billion,
- Willingness to pay to avoid storm water pollution worth about $2.5 billion,
- Cleaner streets worth about $950 million,
- Improved beach tourism worth about $100 million (not applicable to Ballona Creek),
- Improved nutrient recycling and atmospheric maintenance in coastal zones worth about $2 billion,
- Savings from reduction of sedimentation in Regional harbors equal to about $330 million, and
- Unquantifiable health benefits of reducing exposure to fine particles from streets.

# 8 MONITORING

The monitoring program associated with the TMDL has three objectives. The first is to collect additional water quality data (e.g., hardness and background total recoverable metals and dissolved metals concentrations) to evaluate assumptions made in the TMDL, including the frequency and extent of exceedances. The second is to assess compliance with the WLAs. The third is to conduct special studies to address the uncertainties in the TMDL and to assist in the design and sizing of BMPs and stormwater retention facilities.

The monitoring program and any required technical reports will be established pursuant to a subsequent order issued by the Executive Officer. As a planning document, the TMDL identifies the type of information necessary to refine and to update the TMDL, and to assess the TMDL's effectiveness. The Executive Officer will comply with any necessary legal requirements in developing the monitoring program, requiring technical reports, and establishing special studies.

## 8.1 AMBIENT MONITORING

An ambient monitoring program is necessary to assess water quality throughout Ballona Creek and its tributaries. Data on background water quality will help refine the numeric targets and confirm selenium impairment. The MS4 and Caltrans storm water NPDES permittees are jointly responsible for implementing the ambient monitoring program. At a minimum, ambient monitoring shall be conducted at the locations listed in Table 8-1. Until the TMDL is reconsidered in the fifth year, samples shall be analyzed for hardness, and total recoverable metals and dissolved metals once a month at detection limits that are lower than the CTR criteria to determine if water quality objectives are being met.

**Table 8-1. Monitoring Locations**

| Waterbody | Ambient Monitoring Location |
|---|---|
| Ballona Creek | At Sawtelle Boulevard |
| Sepulveda Canyon Channel | Just Above the Confluence with Ballona Creek |
| Ballona Creek | At Inglewood Boulevard |

## 8.2 TMDL EFFECTIVENESS MONITORING

The MS4 and Caltrans storm water NPDES permittees are jointly responsible for assessing the progress in reducing pollutant loads to achieve the TMDL. The permittees are required to submit for approval of the Executive Officer a coordinated monitoring plan that will demonstrate the effectiveness of the phased implementation schedule, which requires attainment of the waste load allocations in prescribed percentages of the watershed over a 15-year period. The monitoring locations specified for the ambient monitoring program may be used as the effectiveness monitoring locations.

The general industrial storm water permit shall contain a model monitoring and reporting program to evaluate BMP effectiveness. A permittee enrolled under the general industrial storm water permit shall have the choice of conducting individual monitoring based on the model program or participating in a group monitoring effort. A group monitoring effort will not only assess individual compliance, but will also assess the effectiveness of chosen BMPs to reduce pollutant loading on an industry-wide or permit category basis. MS4 permittees are encouraged to take the lead in group monitoring efforts for industrial and construction facilities within their jurisdiction because compliance with waste load allocations by these facilities will translate to reductions in metals loads to the MS4 system.

General Construction and Industrial storm water permittees are assigned zero waste load allocation during dry weather. The MS4 and Caltrans storm water NPDES permittees will be found to be effectively meeting the waste load allocations during dry weather if the in-stream pollutant concentrations at the downstream monitoring location is equal to or less than the corresponding concentration- or mass-based WLA. Alternatively, effectiveness with the interim reductions may be assessed at the storm drain outlet based on the concentration-based WLA for the receiving water. For storm drains that discharge to other storm drains, effectiveness will be based on the numeric target for the ultimate receiving water for that storm drain system.

Collectively the storm water NPDES permittees will be found to be effectively meeting the waste load allocations during wet weather if the loading at the downstream monitoring location is equal to or less then the daily storm volume multiplied by the wet-weather numeric target. Compliance with individual general construction and industrial storm water permittees will be based on monitoring of discharges at the property boundary. Compliance may be assessed based on concentration and/or load allocations.

## 8.3 SPECIAL STUDIES

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

- Refinement of the hydrologic and water quality models
- Additional source assessment
- Refinement of the potency factors correlation between total suspended solids and metals loading during dry and wet weather
- Correlation between short-term rainfall intensity and metals loading for use in sizing in-line structural BMPs
- Correlation between storm volume and total recoverable metals loading for use in sizing storm water retention facilities
- Refined estimates of metals partitioning coefficients, conversion factors, and site-specific toxicity.
- Evaluation of potential contribution of aerial deposition and sources of aerial deposition.

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