California Regional Water Quality Control Board
San Diego Region

Total Maximum Daily Loads for Dissolved Copper, Lead, and Zinc in Chollas Creek, Tributary to San Diego Bay

Chollas Creek Watershed

Technical Report

May 30, 2007

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN DIEGO REGION
9174 Sky Park Court, Suite 100, San Diego, California 92123-4340
Phone • (858) 467-2952 • Fax (858) 571-6972
http://www.waterboards.ca.gov/sandiego.

To request copies of the Basin Plan Amendment and Technical Report for Copper, Lead, and Zinc Total Maximum Daily Loads for Chollas Creek, Tributary to San Diego Bay, please contact Benjamin Tobler, Water Resources Control Engineer at (858) 467 – 2736, btobler@waterboards.ca.gov.

Documents also are available at: http://www.waterboards.ca.gov/sandiego.

TOTAL MAXIMUM DAILY LOADS FOR DISSOLVED COPPER, LEAD, AND ZINC IN CHOLLAS CREEK, TRIBUTARY TO SAN DIEGO BAY

Technical Report

Adopted by the
California Regional Water Quality Control Board
San Diego Region
on _____, 200 x
Approved by the
State Water Resources Control Board
on _____, 200 x
and the
Office of Administrative Law
on _____,200 x
and the
United States Environmental Protection Agency
on _____. 200 x

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN DIEGO REGION
9174 Sky Park Court, Suite 100
San Diego, California 92123-4340

Telephone (858) 467-2952

STATE OF CALIFORNIA

ARNOLD SCHWARZENEGGER, Governor
LINDA S. ADAMS, Agency Secretary, California Environmental Protection Agency

State Water Resources Control Board

Tam Doduc, *Chair*	Civil Engineer
Gary Wolff, *Vice Chair*	Professional Engineer
Charles R. Hoppin	Water Quality
Arthur G. Baggett, Jr.	Attorney
Frances Spivy-Weber	Public

Dorothy Rice, *Executive Director*

California Regional Water Quality Control Board
San Diego Region

Susan Ritschel *Chair*	Public
Richard Wright *Vice Chair*	County Government
Daniel Johnson	Water Quality
Eric Anderson	Irrigated Agriculture
David King	Recreation, Fish or Wildlife
Elizabeth Pearson-Schneider	Municipal Government

John H. Robertus, *Executive Officer*
Arthur L. Coe, *Assistant Executive Officer*

This report was prepared under the direction of

David T. Barker P.E., *Chief, Water Resource Protection Branch*
Julie Chan P.G., *Chief, Water Quality Standards Unit*

by

Benjamin Tobler, *Water Resource Control Engineer*
Jimmy G. Smith , *Environmental Scientist*
Lesley Dobalian, *Environmental Scientist*

with the assistance of

Christina Arias, *Water Resource Control Engineer*
Wayne Chiu, P.E., *Water Resource Control Engineer*
Michelle L. Hurst, *Environmental Engineer, Department of the Navy*
Melissa Swarts, *Chemical Engineer, Department of the Navy*

LIST OF ACRONYMS AND ABBREVIATIONS

ACQOP	Daily pollutant accumulation rate
ALERT	Automatic Local Evaluation in Real Time
BMPs	Best Management Practices
BASINS	Better Assessment Science Integrating Point and Nonpoint Sources
Basin Plan	Water Quality Control Plan for the San Diego Basin – Region 9
BIOL	Preservation of biological habitats of special significance
BLM	Biotic Ligand Model
$CaCO_3$	Calcium carbonate
Caltrans	California Department of Transportation
CCC	Criteria continuous concentration
CCR	California Code of Regulations
CEQA	California Environmental Quality Act
CF	Conversion factor
CFR	Code of Federal Regulations
Cfs	Cubic feet per second
CIMIS	California Irrigation Management Information System
CMC	Criteria maximum concentration
COMM	Commercial and sport fishing
CTR	California Toxics Rule
CWA	Clean Water Act
CWC	California Water Code
DEEPFR	Fraction of infiltrating water lost to inactive groundwater
DEM	Digital Elevation Model
DPR	California Department of Pesticide Regulation
EIR	Environmental Impact Report
EMC	Event mean concentration
EST	Estuarine habitat
GIS	Geographic Information System
HSPF	Hydrological Simulation Program - FORTRAN
IND	Industrial service supply
IMPLND	Impervious land
INFILT	Index to mean soil infiltration rate
IQUAL	Simulation of quality constituents for impervious land segments
IWATER	Water simulation for impervious land segments
LA	Load allocations
LACDPW	Los Angeles County Department of Public Works
LSPC	Load Simulation Program written in C++
LZETP	Lower zone evapotranspiration
LZSN	Lower zone nominal soil moisture storage
MAR	Marine habitat
METCMP	Computation of Meterological Time Series
MIGR	Migration of aquatic organisms
MOS	Margin of safety
MS4	Municipal Separate Storm Sewer Systems

Municipal Dischargers	Cities of San Diego, Lemon Grove, and La Mesa, County of San Diego, and the San Diego Unified Port District
NAV	Navigation
Navy	U.S. Navy
NCDC	National Climatic Data Center
NHD	National Hydrography Dataset
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge and Elimination System
NTR	National Toxics Rule
OAL	Office of Administrative Law
PEC	Probable Effects Concentration
PEL	Probable Effects Level
PERLND	Pervious land
Port	San Diego Unified Port District
PQUAL	Simulation of quality constituents for pervious land segments
PWATER	Water simulation for pervious land segments
RARE	Rare, threatened, or endangered species
RCHRES	Stream reach
REC1	Water contact recreation
REC2	Non-contact water recreation
ROWD	Report of Waste Discharge
SANDAG	San Diego Association of Governments
San Diego Water Board	California Regional Water Quality Control Board, San Diego Region
SCCWRP	Southern California Coastal Water Research Project
SHELL	Shellfish harvesting
SIYB	Shelter Island Yacht Basin
SQOLIM	Maximum storage level parameter
SSO	Site-specific objective
STATSGO	Natural Resources Conservation Services State Soil Geographic
SWAMP	Surface Water Ambient Monitoring Program
SWRCB	State Water Resources Control Board
TMDL	Total Maximum Daily Load
USDA	U.S. Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	U.S. Geological Survey
WARM	Warm fresh water habitat
WDR	Waste discharge requirements
WER	Water effects ratio
WILD	Wildlife habitat
WLA	Wasteload allocation
WSQOP	Rate of surface runoff that will remove 90 percent of the stored constituent per hour
WQO	Water quality objective
WQS	Water quality standard

TABLE OF CONTENTS

LIST OF ACRONYMS AND ABBREVIATIONS ..... **V**

TABLE OF CONTENTS ..... **VII**

TABLE OF TABLES ..... **IX**

TABLE OF FIGURES ..... **X**

LIST OF APPENDICES ..... **X**

EXECUTIVE SUMMARY **1**

1 BACKGROUND **15**

2 INTRODUCTION **17**

3 PROBLEM STATEMENT **19**

3.1 DE-LISTING OF CADMIUM 20
3.2 WATERSHED CHARACTERISTICS 21
3.3 APPLICABLE WATER QUALITY STANDARDS 23
3.4 METALS CHEMISTRY 24
3.5 SEDIMENT METALS 25
3.6 SAMPLING HISTORY IN THE WATERSHED 26

4 NUMERIC TARGETS **28**

4.1 CRITERIA FOR MAXIMUM AND CONTINUOUS CONCENTRATION 29
4.2 WATER-EFFECT RATIO 30
4.3 TOTAL-TO-DISSOLVED METAL CONVERSION FACTOR 30
4.4 HARDNESS 30
4.5 CORRELATION COEFFICIENTS 31
4.6 NEWLY PROPOSED COPPER CRITERIA 31

5 SOURCE ANALYSIS **33**

5.1 URBAN RUNOFF REGULATION IN CHOLLAS CREEK WATERSHED 33
5.1.1 San Diego Water Board Order No. R9-2007-0001 ..... *34*
5.1.2 Other Applicable Orders and Regulations *35*
5.2 ESTIMATION OF METAL MAGNITUDE AND LOCATION FROM URBAN RUNOFF 36
5.2.1 Land-use Modeling *36*
5.3 URBAN RUNOFF STUDIES IN OTHER WATERSHEDS 43
5.3.1 Santa Clara Valley Study *43*
5.3.2 Other Studies *46*
5.4 GENERAL URBAN RUNOFF SOURCES: BACKGROUND, ANTHROPOGENIC AND WATER SUPPLY 46
5.4.1 Background *47*
5.4.2 Atmospheric Deposition *48*
5.4.3 Sediment *49*
5.4.4 Groundwater *50*
5.4.5 Water Supply *50*
5.5 URBAN RUNOFF SOURCES FROM CHOLLAS CREEK LAND USE ACTIVITIES 52
5.5.1 Operating Automobiles *53*
5.5.2 Illegal Sources *53*
5.5.3 Industrial Facilities *54*
5.5.4 Pesticides *55*
5.5.5 Wood Preservatives *55*
5.5.6 Construction *55*
5.5.7 Galvanized Metals *56*
5.5.8 Paint *56*

5.5.9 Landfill *56*
5.6 SUMMARY OF SOURCES 57

6 LINKAGE ANALYSIS 58

7 MARGIN OF SAFETY 60

8 TMDL AND ALLOCATIONS 61

8.1 WASTELOAD ALLOCATIONS 62
8.2 LOAD ALLOCATIONS 63

9 SEASONAL VARIATIONS AND CRITICAL CONDITIONS 64

10 LEGAL AUTHORITY 65

10.1 CONTROLLABLE WATER QUALITY FACTORS 65
10.2 REGULATORY BACKGROUND 65
10.3 PERSONS RESPONSIBLE FOR POINT SOURCE DISCHARGES 67
10.4 CALIFORNIA DEPARTMENT OF TRANSPORTATION 67
10.5 CITIES OF SAN DIEGO, LEMON GROVE, AND LA MESA, SAN DIEGO COUNTY, AND THE SAN DIEGO UNIFIED PORT DISTRICT 68
10.6 U.S. NAVY 68
10.7 PERSONS DISCHARGING STORMWATER REGULATED UNDER STATEWIDE GENERAL NPDES WDRS 69
10.8 PERSONS DISCHARGING GROUNDWATER REGULATED UNDER SAN DIEGO WATER BOARD GENERAL NPDES WDRS 70
10.9 PERSONS DISCHARGING HYDROSTATIC TEST WATER REGULATED UNDER SAN DIEGO WATER BOARD GENERAL NPDES WDRS 70
10.10 SCHOOL DISTRICTS 70

11 IMPLEMENTATION PLAN 72

11.1 REGULATORY AUTHORITY FOR IMPLEMENTATION PLANS 72
11.2 IMPLEMENTATION PLAN OBJECTIVES 73
11.3 WASTE LOAD ALLOCATIONS AND RESPONSIBLE PERSONS 73
11.4 INTERIM GOALS FOR ACHIEVING WASTELOAD ALLOCATIONS 74
11.5 SAN DIEGO WATER BOARD ACTIONS 75
11.6 COMPLIANCE SCHEDULE 83

12 IMPLEMENTATION MONITORING PLAN 85

12.1 REGULATORY AUTHORITY FOR IMPLEMENTATION MONITORING PLAN 85
12.2 MONITORING OBJECTIVES 85
12.3 SAN DIEGO WATER BOARD ACTIONS 86
12.4 MUNICIPAL DISCHARGERS AND CALTRANS ACTIONS 87
12.5 REVISED IMPLEMENTATION MONITORING PLAN ELEMENTS 87

13 ENVIRONMENTAL ANALYSIS, CHECKLIST, AND ECONOMIC FACTORS 89

13.1 CALIFORNIA ENVIRONMENTAL QUALITY ACT REQUIREMENTS 89
13.2 ANALYSIS OF REASONABLY FORESEEABLE METHODS OF COMPLIANCE 90
13.3 POSSIBLE ENVIRONMENTAL IMPACTS 91
13.4 ALTERNATIVE MEANS OF COMPLIANCE 91
13.5 REASONABLY FORESEEABLE METHODS OF COMPLIANCE AT SPECIFIC SITES 91
13.6 ECONOMIC FACTORS 92
13.7 REASONABLE ALTERNATIVES TO THE PROPOSED ACTIVITY 92

14 NECESSITY OF REGULATORY PROVISIONS 94

15 PUBLIC PARTICIPATION 96

16 REFERENCES 97

TABLE OF TABLES

TABLE 3.1. Metal data summaries. 22
TABLE 3.2. Land use in the Chollas Creek Watershed. (URS Greiner Woodward Clyde 1999) 23
TABLE 3.3. Beneficial uses in the Chollas Creek Watershed and San Diego Bay. 23
TABLE 3.4. Summary of total metal concentrations in Chollas Creek sediments..... 26
TABLE 3.5. Land use distribution for Chollas Creek Watershed. 26
(URS Greiner Woodward Clyde 1999)..... 26
TABLE 4.1. Numeric targets for dissolved metals in Chollas Creek. 28
TABLE 4.2. Requirements for using sample results to evaluate CCCs and CMCs. 30
TABLE 4.3. Metal acute and chronic freshwater conversion factors for copper, lead, and zinc. 30
TABLE 4.4. Criteria correlation coefficients. 31
TABLE 5.1. Other applicable orders for land use practices in the Chollas Creek Watershed. 35
TABLE 5.2. Estimated existing total loads for Chollas Creek for both wet and dry weather conditions during a typical and critical year. 36
TABLE 5.3. Estimated existing wet weather total loads for Chollas Creek during a typical and critical year. 38
TABLE 5.4. For each metal, the top ten contributing subwatershed of mass loads relative to all thirty-seven subwatersheds. 39
TABLE 5.5. Existing dry weather load (grams per year) for both typical and critical years. 42
TABLE 5.6. Top five metal sources in urban runoff, in decreasing order 44
(SCV, 1997) 44
TABLE 5.7. Anthropogenic constituents in runoff from urban pavement. 46
(modified from USEPA 1993) 46
TABLE 5.8. Average metal concentration of treatment plant effluent in 2003. 51
TABLE 5.9. Industries with highest likelihood to discharge metals to stormwater. 54
(SCV, 1992) 54
TABLE 5.10. Pounds of chemicals containing copper and zinc applied in San Diego County in 2002 as reported to DPR. 55
TABLE 6.1. Dissolved metals loading capacities for acute and chronic conditions. 58
TABLE 8.1. The Total Maximum Daily Load (TMDL) for dissolved copper, lead, and zinc for acute and chronic conditions 62
TABLE 11.1 The Wasteload Allocations for dissolved copper, lead, and zinc for acute and chronic conditions 74
TABLE 11.2 Compliance schedule and interim goals for achieving Wasteload Allocations 75
TABLE 11.3 Compliance schedule milestones. 83
TABLE 16.1. Public Participation Milestones 96

TABLE OF FIGURES

FIGURE 3.1. Chollas Creek Watershed. 20
FIGURE 5.1. Chollas Creek Watershed divided into subwatersheds. 37
FIGURE 5.2. Land use distribution in the Chollas Creek Watershed. 38
FIGURE 5.3. Average annual wet weather loads for the main branches of the Chollas Creek Watershed. 39
FIGURE 5.4. Basin-wide wet weather copper contributions by land use in the Chollas Creek Watershed. 40
FIGURE 5.5. Basin-wide wet weather lead contributions by land use in the Chollas Creek Watershed. 41
FIGURE 5.6. Basin-wide wet weather zinc contributions by land use in the Chollas Creek Watershed. 41
FIGURE 5.9. Relative amounts of zinc loading in SCV, adjusted to omit sources from POTWs, reservoir releases and natural erosion. (Woodward Clyde, 1997) 45

LIST OF APPENDICES

Appendix	Title
A	Data
B	Cadmium Delisting
C	Chollas Creek Sediment Metals
D	Wet and Dry Weather Models
E	Land Use Loading Analyses
F	Statistical Comparison of Measured Values and Modeled Values for Flow and Water Quality
G	Metals Concentration Reduction Percentages
H	Site-Specific Objectives
I	Environmental Analysis, Checklist, and Economic Factors
J	Tentative Resolution No. R9-2007-0043 and Attachment A
K	Scientific Peer Review
L	Response to Peer Review Comments
M	Response to Comments

EXECUTIVE SUMMARY

Chollas Creek[1] is an urban coastal stream in southern San Diego County, tributary to San Diego Bay. Chollas Creek was placed on the Clean Water Act (CWA) section 303(d) List of Water Quality Limited Segments (List of Water Quality Limited Segments) in 1996 for the metals copper, lead, and zinc. Storm water samples from Chollas Creek collected between 1994 and 2003 periodically exceeded California Toxics Rule (CTR) water quality criteria for copper, lead, and zinc. The existing and potential beneficial uses of Chollas Creek and San Diego Bay described in the Water Quality Control Plan for the San Diego Basin (9) (Basin Plan) are adversely affected by these exceedances. Additionally, toxicity tests show that water quality objectives (WQOs) for toxicity are also violated.

E.1. Problem Statement

While only the lowest 3.5 miles of Chollas Creek comprise the actual listed segment of the water body, all upstream tributaries to this section are considered in this TMDL project. The California Regional Water Quality Control Board, San Diego Region (San Diego Water Board) has established Total Maximum Daily Loads (TMDLs) for copper, lead, and zinc as required by the CWA for water quality limited segments.

Chollas Creek is also listed as impaired for the metal cadmium. The available data suggest that concentrations of dissolved cadmium in Chollas Creek exceed neither acute nor chronic CTR water quality criteria. Consequently, the San Diego Water Board has recommended Chollas Creek for delisting with respect to cadmium to the State Water Resources Control Board (State Water Board). The State Water Board is preparing the latest update of the List of Water Quality Limited Segments.

The purpose of this TMDL project is to attain WQOs for copper, lead, and zinc, and restore and protect the beneficial uses of Chollas Creek. TMDLs represent a strategy for meeting WQOs by allocating quantitative limits for point and nonpoint pollution sources. A TMDL is defined as the sum of the individual wasteload allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background [40 CFR section 130.2] such that the capacity of the waterbody to assimilate pollutant loading (i.e., the loading capacity) is not exceeded. In order to achieve the TMDLs, an Implementation Action Plan is also developed that describes the pollutant reduction actions that must be taken by various responsible persons to meet the wasteload and load allocations. The Implementation Action Plan includes a time schedule for meeting the required allocations and requirements for monitoring to assess the effectiveness of the load reduction activities in attaining water quality objectives and restoring beneficial uses.

Once established, the regulatory provisions of this TMDL project are incorporated into the Basin Plan. Additional requirements of the Basin Plan amendment process also include an evaluation of environmental and economic considerations. As with any Basin

[1] The Chollas Creek Watershed comprises Hydrologic Unit number 908.22.

Plan amendment involving surface waters, a TMDL project will not take effect until it has undergone subsequent agency approvals by the State Water Board, and the Office of Administrative Law (OAL). The U.S. Environmental Protection Agency (USEPA) must also approve the TMDL.

E.2. Numeric Targets

When calculating TMDLs, numeric targets are established to ensure that WQOs are met and beneficial uses are protected. The CTR is the basis of the numeric targets. Specifically, the numeric targets for the Chollas Creek TMDLs were set equal to the CTR's WQOs, which are comprised of hardness-based equations for dissolved copper, lead, and zinc. Equations, rather than numbers comprise the WQOs because the toxicity of dissolved copper, lead, and zinc varies significantly depending on hardness.[2] The CTR was chosen as the basis for these numeric targets because it has the most current, defendable WQOs for dissolved copper, lead, and zinc concentrations in fresh water (USEPA, 2000a). Additionally, the CTR is legally applicable in inland surface waters (e.g., Chollas Creek), enclosed bays and estuaries of California for all purposes and programs under the CWA (USEPA, 2000a).

E.3. Source Analysis

For Chollas Creek, essentially all metals sources (point and nonpoint) are discharged through municipal separate storm sewer systems (MS4) that are regulated under waste discharge requirements (WDRs) prescribed in Order No. R9-2007-0001.[3] Metals sources are thus collectively considered point sources due to their release from channelized, discrete conveyance pipe systems and outfalls. Known point source discharges to the MS4s include stormwater discharges from industrial facilities, construction sites, underground utility vaults, and groundwater discharges from de-watering sites. These discharges are regulated under different statewide and San Diego Water Board orders prescribing general WDRs. Because there are no other known point sources, urban runoff is considered the most significant source of metals to Chollas Creek.

Watershed models were developed by Tetra Tech, Inc. to estimate the magnitude of land uses that generate existing annual metal loadings to the Chollas Creek Watershed during both wet and dry weather conditions of a typical year. Modeling results based on land use category parameters, hydrological characteristics and observed metal concentrations provided estimates of the magnitude of metal loadings. The top two land use categories in Chollas Creek, freeways and commercial/institutional, contribute over 75 percent of the total load for each metal. Significant sources of all three metals to urban runoff are thought to include automobile operation (especially brake pads and tires) and industries with practices that may expose metals to stormwater. Water supply infrastructure

[2] As hardness increases, it competes with metals for binding sites on animals and effectively reduces the toxicity of metals. Therefore, as hardness increases the CTR metals criteria also increase to maintain the same allowable amount of toxicity.

[3] Order No. R9- 2007-0001, *Waste Discharge Requirements for Discharges of Urban Runoff from the Municipal Separate Storm Sewer Systems Draining the Watersheds of the County of San Diego, the Incorporated Cities of San Diego County, and the San Diego Unified Port District*, NPDES No. CAS0108758 or subsequent superseding NPDES renewal Orders.

corrosion, and pesticide application are also among the identified potential sources. Additionally, another potential source of metals in urban runoff from activities outside and inside of the Chollas Creek Watershed boundaries is atmospheric deposition.

Nonpoint sources are washed into and conveyed to Chollas Creek through the MS4 systems and thus, are accounted for in the point source MS4 discharges. Because of this, and the lack of data to prove otherwise, any nonpoint source that discharges directly into Chollas Creek is assumed to be comparatively insignificant.

E.4. Linkage Analysis

The TMDL technical report must estimate total assimilative capacity (loading capacity) of Chollas Creek for the metals and describe the relationship between Numeric Targets and identified metal sources. Collectively, these requirements are termed the linkage analysis and provide the necessary quantitative link between the TMDL and attainment of water quality standards.

The total assimilative capacity, or loading capacity, is the maximum amount of pollutant that a water body can assimilate while maintaining WQSs. The loading capacity is also a function of different hydrodynamic processes that affect the environmental fate and transport of dissolved metals as they move through the system. At Chollas Creek, the loading capacity for each metal is estimated to be equal to its respective Numeric Target. The Numeric Targets are to be protective of aquatic life and are thus conservatively considered the total loading capacity for Chollas Creek. These loading capacities will attain WQSs because they are set equal to the CTR equations that are protective of aquatic life. Table E.1 presents the loading capacities for metals copper, lead, and zinc.

TABLE E.1 Dissolved metals loading capacities for acute and chronic conditions.

Metal	Loading Capacity for Acute Conditions – One-Hour Average[1]	Loading Capacity for Chronic Conditions – Four-Day Average[1]
Copper	(0.96) * {e^ [0.9422 * ln (hardness) - 1.700]}	(0.96) * {e^[0.8545 * ln (hardness) - 1.702]}
Lead	[1.46203 – 0.145712 * ln (hardness)] * {e^ [1.273 * ln (hardness) - 1.460]}	[1.46203 – 0.145712 * ln (hardness)] * {e^[{1.273 * ln (hardness)} - 4.705]}
Zinc	(0.978) * {e^ [0.8473 * ln (hardness) + 0.884]}	(0.986) * {e^[0.8473 * ln (hardness) + 0.884]}

The natural log and exponential functions are represented as "ln" and "e", respectively.
[1] Loading capacities equal numeric targets that equal the CTR WQOs.

These loading capacities, which are equal to the Numeric Targets, will apply to the entirety of Chollas Creek and during all times of the year. Regulated discharges from each of the land uses identified in the Source Analysis portion of this TMDL will not be allowed to have dissolved metals concentrations that causes in-stream waters to exceed the loading capacities. Furthermore, all other sources of copper, lead, and zinc to Chollas

Creek will be expected to not cause the creek to exceed these loading capacities. Once these capacities are achieved, Chollas Creek copper, lead, and zinc concentrations will be protective of the creek's beneficial uses.

A concentration-based approach was chosen to link the Numeric Targets with the largest identified metal source -- urban runoff. This approach is considered more appropriate than a mass-based approach, because not only does it take into account the dynamic nature of urban runoff, which is greatly affected by stormwater, but it also accommodates the dynamic nature of freshwater systems that have a myriad of flow and hardness conditions.

In addition, a mass-based approach would be more sensitive to concerns of accumulated bottom sediment in fresh water bodies and down stream sediment toxicity. However, sediment is not considered a source of metals due to the nature of Chollas Creek and due to low sediment toxicity results. In addition, downstream sediment toxicity is to be addressed in a separate TMDL for San Diego Bay at the mouth of Chollas Creek once adequate data are collected and applicable models are developed for the Chollas Creek Watershed.

E.5. Margin of Safety

The TMDLs must contain a margin of safety (MOS) to account for uncertainty in the analysis. The MOS for Chollas Creek is explicit as well as implicit. The explicit MOS was incorporated by setting the wasteload allocations equal to 90 percent of the total loading capacity as generated from the CTR equations, using the sampled hardness concentrations. The use of actual hardness values in the CTR equation in order to calculate TMDLs established an implicit MOS.

E.6. TMDLs and Allocations

The TMDLs must be less than or equal to the loading capacities after taking into account allocations to all sources. A TMDL is the combination of a total wasteload allocation (WLA) that allocates loadings for point sources, a total load allocation (LA) that allocates loadings for nonpoint sources and background sources and a MOS that may either explicitly reserve an allocation for or implicitly account for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. In this TMDL, 10 percent of the load is reserved for an MOS, or not allocated to sources, in order to account for identified uncertainties in the TMDL in addition to conservative assumptions made in the TMDL analysis (Margin of Safety Section).

In TMDL development, allowable WLA and LA from pollutant sources that cumulatively amount to no more than the TMDL must be established; this provides the basis to establish water quality-based controls. For Chollas Creek, the WLAs and LAs and consequently the TMDLs, are expressed as concentrations derived from the CTR acute and chronic WQO equations for dissolved copper, lead, and zinc. In addition, the concentration-based TMDLs will account for any future point or nonpoint sources, because any future sources will also be required to be below the same concentration.

Mass-based TMDLs typically are described by the following equation:

$$TMDL_{mass} = \Sigma\ WLAs + \Sigma\ LAs + MOS$$

However, in concentration-based TMDLs, the allocations are not additive. Additionally, the allocation concentrations for point sources (WLAs), and nonpoint and background sources (LAs) will be equivalent for each metal. Thus, only one term is needed in the equation for the allocations. Because significant nonpoint sources and background sources were not identified in the Chollas Creek watershed, the WLA term was retained in the equation and the LA term dropped. The MOS also is not additive in concentration-based TMDLs. As described previously, the MOS is incorporated into the WLAs, rather than added to them. This reduces the equation to:

$$TMDLs_{conc} = WLAs$$

The explicit MOS reserves 10 percent of the allocation and is incorporated into the WLAs by setting them equal to 90 percent of the loading capacity. Because the loading capacities are equal to the numeric targets, which are equal to the CTR WQOs, the TMDLs are equal to 90 percent of the CTR WQO concentrations. In other words:

CTR WQOs = Numeric Targets
Numeric Targets = Loading Capacities
WLAs = Loading Capacities * 0.9

Substituting CTR WQOs for Loading Capacity results in:

$$TMDLs = WLAs = CTR\ WQOs * 0.9$$

The hardness-based equations for calculating TMDL concentrations are shown in Table E.3.

If all copper, lead, and zinc concentrations in urban runoff to Chollas Creek meet their respective TMDL concentrations, the loading capacity of the creek should not be exceeded.

TABLE E.2 Dissolved metals loading capacities for acute and chronic conditions, as determined by sampling requirements in TABLE 4.2.

Metal	Loading Capacity for Acute Conditions – One-Hour Average	Loading Capacity for Chronic Conditions – Four-Day Average
Copper	(0.96) * {e^ [0.9422 * ln (hardness) - 1.700]}	(0.96) * {e^[0.8545 * ln (hardness) - 1.702]}
Lead	[1.46203 – 0.145712 * ln (hardness)] * {e^ [1.273 * ln (hardness) - 1.460]}	[1.46203 – 0.145712 * ln (hardness)] * {e^[{1.273 * ln (hardness)} - 4.705]}
Zinc	(0.978) * {e^ [0.8473 * ln (hardness) + 0.884]}	(0.986) * {e^[0.8473 * ln (hardness) + 0.884]}

The natural log and exponential functions are represented as "ln" and "e", respectively.

TABLE E.3 Total Maximum Daily Loads for dissolved copper, lead, and zinc for acute and chronic conditions

Metal	TMDL for Acute Conditions – One-Hour Average	TMDL for Chronic Conditions – Four-Day Average
Copper	(0.96) * {e^ [0.9422 * ln (hardness) - 1.700]}*0.9	(0.96) * {e^[0.8545 * ln (hardness) - 1.702]}*0.9
Lead	[1.46203 – 0.145712 * ln (hardness)] * {e^ [1.273 * ln (hardness) - 1.460]} * 0.9	[1.46203 – 0.145712 * ln (hardness)] * {e^[{1.273 * ln (hardness)} - 4.705]} * 0.9
Zinc	(0.978) * {e^ [0.8473 * ln (hardness) + 0.884]} * 0.9	(0.986) * {e^[0.8473 * ln (hardness) + 0.884]} * 0.9

The natural log and exponential functions are represented as "ln" and "e", respectively.

E.7. Wasteload Allocations

The Chollas Creek metals WLAs are expressed as concentrations equal to 90 percent of the loading capacities for the three metals. Federal regulations require TMDLs to include individual WLAs for each point source discharge. The point source discharges that could affect Chollas Creek are the MS4 discharges, stormwater discharges from industrial sites, and discharges of extracted groundwater. All point source discharges to Chollas Creek will be required to achieve this WLA.

Modeling results demonstrate the possible land use specific and sub-watershed specific contributions of copper, lead, and zinc. However because this WLA is concentration-based it will apply to each land use and each sub-watershed at all times and will not be specific to any land use or sub-watershed. Therefore, the model predictions of the relative

metal contribution from each category will be useful in targeting problem areas during implementation.

E.8. Load Allocations

The LAs are assigned to nonpoint sources and natural background sources in the watershed. Background sources can include air deposition of metals in the watershed and any groundwater contributions. Because of the regulatory definition of the MS4 system, all source (point and nonpoint sources) contributions of metals to Chollas Creek come via the MS4s and are therefore accounted for when an allocation is made for the MS4. The only other possible sources that may end up directly in Chollas Creek would be direct air deposition and groundwater, which may or may not include anthropogenic sources. These two sources are not considered significant at this time. These sources may be re-evaluated at a future date if any additional data become available. Currently, the point sources not already accounted for in the WLAs to the MS4s are considered to be relatively insignificant. Thus, the LAs are equal to zero in these TMDLs, and the TMDL calculations are equal to the WLAs.

E.9. Seasonal Variations and Critical Conditions

In accordance with federal regulations, a TMDL must consider seasonal variations and critical conditions (e.g. stream flows, pollutant loadings and other water quality parameters). A flow-based approach was used for the Chollas Creek Metals TMDL, and defines critical conditions solely based on freshwater flow rates regardless of season. No matter the time of year or situation, toxicity allocations that are based on the CTR equations will be required throughout all segments of Chollas Creek and therefore, by definition, will always be protective of aquatic life.

Furthermore, the flow-based approach is appropriate because the main sources of metal accumulation in the Chollas Creek Watershed are non-seasonal (e.g. automobile wear, exhaust emissions, industry contributions). Urban runoff, which is the main mechanism by which these accumulated metals reach Chollas Creek, can occur in both dry and wet weather.

The allowable concentrations will be determined with hardness values measured at the time of compliance. These data will provide a direct measure of any seasonal variations and/or critical conditions effects on hardness. Since hardness is an essential component of the WLAs, seasonal variations and/or critical conditions will be covered by this TMDL. This method of using sampled hardness as the variable instead of an estimated hardness, will account for these effects because it is an absolute representation of current conditions and thus will account for any effects that may be caused by seasonal variations or extreme conditions. Other stream chemistry, which may or may not be a function of seasonal variations and critical conditions, were not taken into consideration as an implicit MOS and will therefore not have a bearing, with respect to seasonal variations and critical conditions, on the TMDL.

E.10. Implementation Plan

Following TMDL project initiation, the San Diego Water Board is required to incorporate the regulatory provisions of the TMDL into all applicable orders prescribing WDRs, or other regulatory mechanisms. Water quality based effluent limitations (WQBELs) for the impairing pollutant in the subject watershed must be added to the appropriate WDRs to implement and make the TMDL enforceable. WQBELs can be either numeric or non-numeric. Non-numeric effluent limitations typically are a program of expanded or better-tailored BMPs. The CWA requires that WDRs that implement federal NPDES regulations be consistent with all applicable TMDLs. The San Diego Water Board can issue new NPDES WDRs for all discharges in the Chollas Creek watershed, can issue new NPDES WDRs in a region-wide TMDL order, or reissue or revise existing NPDES WDRs.

The purpose of these TMDLs is to attain and maintain the applicable WQOs in Chollas Creek through mandated wasteload reductions of pollutants in point sources discharging to the creek. The TMDL requires dischargers to improve water quality conditions in the Chollas Creek receiving water by achieving wasteload reductions in their discharges. The copper, lead, and zinc TMDLs shall be implemented with a monitoring component to determine the effectiveness of each phase and guide the selection of BMPs.

Concentrations of metals in urban runoff shall only be allowed to exceed the WLAs by a certain percentage for the first nineteen years after adoption of this TMDL. Allowable concentrations shall decrease to the amounts indicated below (Table E.4). For example, if the measured hardness ten years after initiation of this TMDL project dictates the WLA for copper in urban runoff is 10 µg/l, the maximum allowable measured copper concentration would be 12.0 µg/L. The phases require loading reductions in steps through the use of expanded or better tailored BMPs to achieve the ultimate goal of attaining and maintaining compliance with copper, lead, and zinc water quality objectives. By the end of the twentieth year after initiation of this TMDL, the WLAs of this TMDL shall be met. This will ensure that copper, lead, and zinc water quality objectives are being met at all locations in the creek during all times of the year.

Compliance with the interim goals in this schedule can be assessed by showing that dissolved metals concentrations in the receiving water exceed the WQOs for copper, lead, and zinc by no more than the allowable exceedances for WLAs shown in Table E.4. The first ten years will require the bulk of the metal load reduction, while the remaining ten years provide for adequate construction and implementation time for potential structural BMPs, to achieve the full (100 percent) metal load reduction. As described in Appendix I section 8.4, this compliance schedule of 20 years requires comprehensive BMP planning for all pollutants impairing Chollas Creek, including coordination with all TMDLs and all other water quality project requirements within the Chollas Creek watershed.

The cities of San Diego, Lemon Grove, and La Mesa, the County of San Diego and the San Diego Unified Port District (Municipal Dischargers) are all in the Chollas Creek

Watershed and should be involved in addressing water quality concerns for the MS4 in the Chollas Creek Watershed. Specifically, the San Diego Water Board shall issue new WDRs or amend Order No. R9-2007-0001 to require that MS4 discharges to Chollas Creek not exceed the WLAs for copper, lead, and zinc as established in this TMDL in accordance with a 20-year time schedule to reduce metal concentrations in urban runoff to achieve the WLAs. The San Diego Water Board shall also issue new WDRs or amend Order No. R9-2004-0277, pursuant to CWC section 13383, requiring the Municipal Dischargers and the California Department of Transportation (Caltrans) to investigate excessive levels of metals in Chollas Creek and feasible management strategies to reduce metal loadings in Chollas Creek. Annual reporting on the progress and efficacy of implementation elements will be required.

Caltrans is responsible for the design, construction, maintenance, and operation of the California State Highway System, including the portion of the Interstate Highway System within the state's boundaries. The roads and highways operated by Caltrans are legally defined as MS4s and discharges of pollutants from Caltrans MS4s to waters of the U.S., such as Chollas Creek, constitute a point source discharge that is subject to regulation under WDRs implementing federal NPDES regulations. Discharges of storm water from the Caltrans owned right-of-ways, properties, facilities, and activities, including stormwater management activities in construction, maintenance, and operation of state-owned highways are regulated under Order No. 99-06-DWQ.[4] Caltrans is responsible, under the terms and conditions of these WDRs, for ensuring that their operations do not contribute to violations of water quality objectives in Chollas Creek. The San Diego Water Board can issue new WDRs to Caltrans, or request that the State Water Board amend Order No. 99-06-DWQ to implement the WLA and other requirements established in this TMDL project, including the requirement to submit annual reports on Caltrans' progress in achieving the WLAs in discharges from its MS4s.

The U.S. Navy (Navy) generates urban runoff at Naval Station San Diego near the mouth of Chollas Creek Watershed. Upon submittal of a complete Report of Waste Discharge (ROWD), these MS4 discharges can be regulated by the State Water Board via their general order prescribing WDRs for small MS4s.[5] These WDRs regulate MS4 discharges not covered by the San Diego Water Board's Order No. R9-2007-0001, including those from MS4s on military bases. The San Diego Water Board will require the Navy to submit a ROWD.

Stormwater from certain industrial sites and construction sites can contribute metals to Chollas Creek. The San Diego Water Board shall request the State Water Board amend Order No. 97-03-DWQ, the statewide general WDRs that regulate stormwater discharges from industrial sites, and Order No. 97-03-DWQ, the statewide general WDRs that regulate stormwater discharges from construction sites to implement the WLAs.

---

[4] Order No. 99-06-DWQ *National Pollutant Discharge Elimination System Permit, Statewide Storm Water Permit, and Waste Discharge Requirements for the State of California, Department of Transportation (Caltrans)* or subsequent superseding NPDES renewal orders.

[5] State Water Resources Control Board Water Quality Order No. 2003-0005-DWQ, NPDES General Permit No. CAS000004, *Waste Discharge Requirements for Storm Water Discharges from Small Municipal Separate Storm Sewer Systems* or subsequent superseding NPDES renewal Orders.

The San Diego Water Board will amend Orders No. 2000-90,[6] and No. 2001-96[7] which regulate temporary groundwater extraction discharges to San Diego Bay and its tributaries, and to surface waters throughout the region. The existing effluent limitations for copper, lead, and zinc for extracted groundwater discharges to MS4s in the Chollas Creek watershed, and directly to Chollas Creek, shall be revised to equal the WLAs of this TMDL. Regulated groundwater discharges to Chollas Creek must meet the WLAs at the initiation of the discharge. No compliance schedule to meet interim and final goals will be allowed in the case of groundwater discharges.

There is only one landfill in the Chollas Creek Watershed and it was closed in 1981. Order No. 97-11[8] and Addendum No. 4 require monitoring of groundwater below and near the South Chollas Landfill. The San Diego Water Board will revise this WDR to re-institute analysis for metals and begin analysis for hardness as part of the monitoring requirements. Furthermore, if the data indicate that metal concentrations are in excess of the WLAs of this TMDL, the San Diego Water Board may require additional actions. Since the landfill is down gradient from Chollas Reservoir and is up gradient from Chollas Creek, the possibility exists that groundwater recharge from the reservoir may be transporting landfill pollutants to the creek. The WDR may be revised or the San Diego Water Board may issue an investigative order (under the authority of the California Water Code section 13267) to require a technical report examining this potential metals pathway to Chollas Creek.

The first few years after initiation of this TMDL project are not likely to realize a reduction from current concentrations of all three metals. These years will provide the dischargers time to develop plans, and implement enhanced and expanded Best Management Practices (BMPs) that should result in immediate decreases of metal concentrations in the Chollas Creek water column. Year ten will see a maximum of 20 percent in the allowable percentage exceedance of the water quality objectives for copper, lead, and zinc. Finally, at year twenty, dischargers will be expected to meet the WLAs in their effluent discharges and WQOs for metals in Chollas Creek.

The Compliance Schedule, which includes the implementation actions of the San Diego Water Board and the dischargers, the due dates, and the interim and final allowable exceedances of the WLAs is shown in Table E. 4.

TABLE E.4 Compliance Schedule.

[6] Order No. 2000-90, NPDES Permit No. CAG919001, *General Waste Discharge Requirements for Temporary Groundwater Extraction and Similar Waste Discharges to San Diego Bay and Storm Drains or Other Conveyance Systems Tributary Thereto* or subsequent superseding NPDES renewal orders.
[7] Order No. 2001-96, NPDES Permit No. CAG919002, *General Waste Discharge Requirements for Groundwater Extraction Waste Discharges from Construction, Remediation and Permanent Groundwater Extractioi Projects to Surface Waters within the San Diego Region Except for San Diego Bay* or subsequent superseding NPDES renewal orders.
[8] Order No. R9-97-11, *General Waste Discharge Requirements for Post-Closure Maintenance of Inactive Nonhazardous Waste Landfills within the San Diego Region* or subsequent superseding NPDES renewal orders.

Item	Implementation Action	Responsible Parties	Date
1	Effective date of Chollas Creek Metals TMDL Waste Load Allocations.	San Diego Water Board, Municipal Dischargers, Caltrans, Navy, Industrial Stormwater Dischargers, Construction Stormwater Dischargers, Landfill Stormwater Dischargers	Effective date[9]
2	Recommend High Priority for grant funds.	San Diego Water Board	Immediately after effective date
3	Submit annual Progress Report to San Diego Water Board due January 1 of each year.	Municipal Dischargers	Annually after reissue of NPDES WDRs.
4	Submit annual Progress Report to San Diego Water Board due April 1 of each year.	Caltrans	Annually after reissue of NPDES WDRs.
5	Submit annual Progress Report to San Diego Water Board due July 1 of each year.	Industrial Stormwater Dischargers	Annually after reissue of NPDES WDRs.
6	Submit annual Progress Report to San Diego Water Board due July 1 of each year.	Construction Stormwater Dischargers	Annually after reissue of NPDES WDRs.
7	Municipal NPDES WDRs shall be issued, reissued, or revised to include WQBELs consistent with the assumptions and requirements of the Chollas Creek WLAs.	San Diego Water Board	Within 5 years of effective date
8	Caltrans NPDES WDRs shall be issued, reissued, or revised to include WQBELs consistent with the assumptions and requirements of the Chollas Creek WLAs.	State Water Board	Within 5 years of effective date
9	Construction NPDES WDRs shall be issued, reissued, or revised to include WQBELs consistent with the assumptions and requirements of the Chollas Creek WLAs.	State Water Board	Within 5 years of effective date
10	Industrial NPDES WDRs shall be issued, reissued, or revised to include WQBELs consistent with the assumptions and requirements of the Chollas Creek WLAs.	State Water Board	Within 5 years of effective date
11	Amend Orders No. 2000-90, and No. 2001-96 (or superseding renewal orders) which regulates temporary groundwater extraction discharges to San Diego Bay and its tributaries to include WQBELs consistent with the assumptions and requirements of the Chollas Creek WLAs.	San Diego Water Board	Within 5 years of effective date
12	Municipal and Navy WDR Order No. R9-2004-0277 shall amended to require additional monitoring for metals and hardness.	San Diego Water Board	Within 5 years of effective date
13	Landfill NPDES WDR Order No. 97-11 (or superseding renewal orders) shall be issued, reissued, or revised to monitor for metals and hardness.	San Diego Water Board	Within 5 years of effective date

[9] Upon approval of by OAL.

Item	Implementation Action	Responsible Parties	Date
14	Navy and all other Phase II small MS4 permittees in the Chollas Creek watershed shall be enrolled in Order No. 2003-0005-DWQ (or superseding renewal orders).	San Diego Water Board	Immediately after effective date.
15	Take enforcement actions	San Diego Water Board	As needed after effective date.
16	Meet 80% Chollas Creek Metals TMDL WLA reductions.	Municipal Dischargers, Caltrans, Navy, Industrial Stormwater Dischargers, Construction Stormwater Dischargers, Landfill Stormwater Dischargers	10 years after effective date.
17	Meet 100% Chollas Creek Metals TMDL WLA reductions.	Municipal Dischargers, Caltrans, Navy, Industrial Stormwater Dischargers, Construction Stormwater Dischargers, Landfill Stormwater Dischargers	20 years after effective date.

E.11. Implementation Monitoring Plan

Compliance monitoring will be required in the creek itself to measure the progress of BMP implementation effectiveness and finally to ensure that the water quality objectives for copper, lead, and zinc are being achieved. Order No. R9-2004-0277 (the Chollas Creek Investigation Order for Diazinon and Metals) will be reviewed by the San Diego Water Board, and if needed, amended to require the dischargers to collect the data necessary to refine the watershed model so that mass loads of copper, lead, and zinc leaving the Chollas Creek watershed can be more accurately estimated. This information will be used to refine the TMDLs and in the development of the TMDL for Metals in San Diego Bay at the mouth of Chollas Creek. The San Diego Water Board has considered the costs of the reasonably foreseeable methods of compliance with the load and wasteload reductions specified in this TMDL.

E.12. Environmental Review and Economic Analysis

The San Diego Water Board is the lead agency for evaluating the environmental impacts of this Basin Plan amendment pursuant to the California Environmental Quality Act (CEQA). The Basin Planning process has been certified as functionally equivalent to CEQA requirements for preparing environmental documents and is, therefore, exempt from those requirements (Public Resources Code section 21000 et seq.). The required environmental documentation (Basin Plan amendment, Technical Report, and Environmental Checklist) has been prepared. The San Diego Water Board has identified environmental impacts, reasonable alternatives, and mitigation measures to minimize any significant adverse environmental impacts of the proposed Basin Plan amendment.

Attainment of the WLAs will be achieved through discharger implementation of structural and nonstructural BMPs designed to reduce metals concentrations in urban runoff and stormwater. The environmental analysis contains examples of BMPs that might reasonably be implemented by the dischargers to comply with the TMDLs. Nonstructural BMPs identified included, among others, education and outreach, road and street maintenance, elimination of illicit discharges, and inspections of commercial and industrial facilities. Structural BMPs included, among others, construction of vegetated swales and buffer strips, bioretention, detention basins, retention ponds, sand filters, and diversion systems.

The CEQA checklist identified potential adverse environmental impacts that might result from implementation of the identified BMPs unless mitigation is incorporated into the projects. Potential adverse impacts to the environment were identified for earth, air, water, plant life, animal life, transportation/circulation, public services, human health, aesthetics, recreation, archeological, overall potential to degrade, cumulative impacts, and substantial adverse impacts categories of the CEQA checklist. The environmental analysis included discussion regarding mitigation measures that could be implemented to minimize these potential impacts.

The San Diego Water Board must also consider the economic costs of the reasonably foreseeable methods of compliance with this Basin Plan amendment to reduce copper, lead, and zinc loads to surface waters through implementation of BMPs. The economic analysis discloses the costs of implementing typical stormwater BMPs for reduction of metals. Monitoring and reporting costs are not disclosed in this report since monitoring and reporting is a requirement of existing orders and the need for additional monitoring is unknown at this time.

The specific BMPs to be implemented will be chosen by the dischargers after adoption of this TMDL project. All costs are preliminary estimates only, since particular elements of a BMP, such as type, size, and location, would need to be developed to provide a basis for more accurate cost estimations. Typical costs of conventional stormwater BMPs are provided in the following two tables (Tables E.5 and E.6). Costs for structural BMPs were estimated for treatment of ten percent of urbanized watershed area (approximately 1,370 acres) with the exception of diversion structures, which are costs per unit.

TABLE E.5: Summary of Cost Estimates for Non-Structural BMPs

Non-Structural BMPs	Estimated Cost*	Estimated Cost Adjusted For Inflation 2006 Dollars**
Education and Outreach	$1,000 - $200,000 per program	$1,210 - $242,000 per program
Street Sweeping	$ 60,000 - $180,000 per unit	$ 72,600 - $218,000 per unit
Illicit Discharges	$0 to $1,750	$0 to $2,120

*The costs were obtained from USEPA, 1999. Preliminary Data Summary of Urban Storm Water Best Management Practices. (EPA-821-R-99-012). August 1999.
** Sahr, R.C. 2007. Consumer Price Index (CPI) Conversion Factors 1800 to Estimated 2016 to Convert to Dollars of 2006. Oregon State University, Political Science Department, Corvallis, OR. Revised January 18, 2006.

TABLE E.6: Summary of Cost Estimates for Structural BMPs

Structural BMPs	Estimated Cost to treat 10% of Urbanized Area (ECUA 10%)	ECUA 10% Adjusted For Inflation 2006 Dollars*****	Estimated Yearly Maintenance Cost (EYMC)	EYMC Adjusted For Inflation 2006 Dollars*****
Vegetated Swale	$960,000*	$1.2 million	$67,000	$81,000
Vegetated Buffer Strip	$1.2 million*	$1.45 million	$120,000	$145,000
Infiltration Trench	$60 Million	$64 Million	$5.8 Million	$6.2 Million
Bioretention	$16.4 million*	$19.9 million	$1.1 million	$1.3 million
Detention Basins and Retention Ponds	$2.7million*	$3.3 million	$27,000	$33,000
Sand Filters	$15 million*	$18.2 million	$2 million	$2.4 million
Austin Sand Filters	$119 million**	$127 million	$6.4 Million	$6.8 Million
Porous Pavement	$490 Million***	$593 Million	$274,000	$332,000
Diversion	$1 million****	$1.03 million	$10,000	$10,300

* Based on USEPA, 1999. Preliminary Data Summary of Urban Storm Water Best Management Practices. [EPA-821-R-99-012. August 1999].
** Based on Caltrans, 2004. Report ID CTSW-RT-01-050.
*** Based on USEPA, 1999 Storm Water Technology Fact Sheet Porous Pavement [EPA 823-F-023]
**** Cost per unit. Based on personal communication with Ruth Kolb, City of San Diego, March 14, 2005.
***** Sahr, R.C. 2007. Consumer Price Index (CPI) Conversion Factors 1800 to Estimated 2016 to Convert to Dollars of 2006. Oregon State University, Political Science Department, Corvallis, OR. Revised January 18, 2006.

E.13. Peer Review

The scientific basis of this TMDL has undergone external peer review pursuant to Health and Safety Code section 57-004. The San Diego Water Board has considered and responded to all comments submitted by the peer review panel. Interested persons and the public have had reasonable opportunity to participate in review of the amendment to the Basin Plan. Efforts to solicit public review and comment include five public workshops held between April 1999 and April 2005; a public review and comment period of 45 days preceding the San Diego Water Board public hearing; and written responses from the San Diego Water Board to oral and written comments received from the public. The San Diego Water Board has notified all known interested parties and the public of its intent to consider adoption of this Basin Plan amendment in accordance with CWC section 13244.

TECHNICAL ANALYSIS

1 Background

Chollas Creek[10] is an urban coastal stream in southern San Diego County, and a tributary to San Diego Bay. Portions of the cities of San Diego, Lemon Grove, and La Mesa are located within the Chollas Creek Watershed. Chollas Creek was placed on the Clean Water Act (CWA) section 303(d) List of Water Quality Limited Segments (List of Water Quality Limited Segments) in 1996 for the metals cadmium,[11] copper, lead, and zinc. The San Diego Water Board has established Total Maximum Daily Loads (TMDLs) for copper, lead, and zinc as required by the CWA for water quality limited segments.

Chollas Creek is an urban creek with highly variable flows. The highest flow rates are associated with storm events. Extended periods with no surface flows occur during dry weather, although pools of standing water may be present. Much of the creek has been channelized and concrete lined, but some sections of earthen creek bed remain. The mouth of the creek is located on the eastern shoreline of the central portion of San Diego Bay. San Diego Bay at the mouth of Chollas Creek is also on the List of Water Quality Limited Segments; being impaired for sediment toxicity and degraded benthic community.

The watershed of Chollas Creek encompasses 16,273 acres. The area of the north fork of the watershed (9,276 acres) is larger than that of the south fork (6,997 acres) (URS Greiner Woodward Clyde 1999). Land use is predominantly residential, with some commercial/institutional and industrial use. A significant portion of the remainder of the watershed consists of roadways, while the rest is open space. Portions of the cities of San Diego, Lemon Grove, and La Mesa are located within the watershed. A small portion of the watershed consists of "tidelands" immediately adjacent to San Diego Bay. Some of this tideland area is under the jurisdiction of the San Diego Unified Port District (Port); the remainder is under the jurisdiction of the U.S. Navy (Navy). San Diego County also holds jurisdiction over a small portion of the watershed.

The Introduction section of this report describes the TMDL process in general. Sections 3 through 9 comprise the seven required components of a TMDL technical report.

[10] The Chollas Creek Watershed comprises Hydrologic Unit number 908.22.
[11] Cadmium was delisted in 2006. See Appendix B.

2 Introduction

Section 303(d)(1)(A) 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 standard (WQS) applicable to such waters." The CWA also requires states to establish a priority ranking of Water Quality Limited Segments and to establish TMDLs for such waters.

The purpose of a TMDL is to attain water quality objectives (WQOs) and restore and protect the beneficial uses of an impaired waterbody. TMDLs represent a strategy for meeting WQOs by allocating quantitative limits for point and nonpoint pollution sources. A TMDL is defined as the sum of the individual waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background [40 CFR 130.2] such that the capacity of the waterbody to assimilate pollutant loading (i.e., the loading capacity) is not exceeded.

The TMDL process begins with the development of a technical report which includes the following 7 components: (1) a **Problem Statement** describing which WQOs are not being attained and which beneficial uses are impaired; (2) identification of **Numeric Targets** which will result in attainment of the WQOs and protection of beneficial uses; (3) a **Source Analysis** to identify all of the point and nonpoint sources of the impairing pollutant in the watershed and to estimate the current pollutant loading for each source; (4) a **Linkage Analysis** to calculate the **Loading Capacity** of the waterbody for the pollutant; which is the maximum amount of the pollutant that may be discharged to the waterbody without causing exceedances of WQOs and impairment of beneficial uses; (5) a **Margin of Safety** (MOS) to account for uncertainties in the analysis; (6) the division and **Allocation** of the TMDL among each of the contributing sources in the watershed, WLAs for point sources and LAs for nonpoint and background sources; and (7) a description of how **Seasonal Variation and Critical Conditions** are accounted for in the TMDL determination. A document, like this report, containing the above components is generally referred to as the technical report.

The report also includes an **Implementation Plan** that describes the pollutant reduction actions that must be taken by various persons accountable for taking actions to meet the allocations specified in the technical report. A time schedule for meeting the required pollutant allocations is included in the Implementation Plan. In addition, the Implementation Plan also includes requirements for an Implementation Monitoring Plan that must be implemented to assess the effectiveness of the load reduction activities in attaining allocations and WQOs in Chollas Creek and restoring beneficial uses. Public participation is a key element of the TMDL process and stakeholder involvement is encouraged and required.

Once established, the regulatory provisions of the TMDL, Implementation Plan and Implementation Monitoring Plan are incorporated into the Water Quality Control Plan for the San Diego Basin (9) (Basin Plan; San Diego Water Board, 1994). The San Diego Water Board, following a public comment period and hearing process, adopts a resolution that amends the Basin Plan to incorporate the TMDL. Additional requirements of the

Basin Plan amendment process also include an evaluation of economic and environmental considerations. As with any Basin Plan amendment involving surface waters, a TMDL amendment will not take effect until it has undergone subsequent agency approvals by the State Water Resources Control Board (State Water Board), the Office of Administrative Law (OAL). The United States Environmental Protection Agency (USEPA) must also approve the Amendment; however, it will take effect following approval by OAL.

Following these approvals, the San Diego Water Board is required to incorporate the regulatory provisions of the TMDL into all applicable orders prescribing waste discharge requirements (WDRs), or other regulatory mechanisms. Water Quality Based Effluent Limits (WQBELs) for the impairing pollutant in the subject watershed are incorporated in the appropriate WDRs to implement and make the TMDL enforceable. WQBELs can consist of either numeric effluent limitations, or an iterative Best Management Practice (BMP) approach of expanded or better tailored BMPs. The CWA requires that WDRs issued pursuant to the National Pollutant Discharge Elimination System (NPDES) provisions of the CWA be consistent with all applicable TMDLs.

The final and most important step in the process is the implementation of the TMDL by dischargers. Per the governing WDR order (or other regulatory mechanism), each discharger must reduce its current loading of the pollutant to its assigned allocation of the pollutant in accordance with the time schedule specified in the technical report (and implementing WDR order). When each responsible party has achieved its required load reduction, water quality standards for the impairing pollutants are expected to be restored in the receiving water.

3 Problem Statement

The lowest 1.2 miles of Chollas Creek were placed on the List of Water Quality Limited Segments in 1996 for stormwater toxicity, coliform[12] and the metals cadmium[13] copper, lead, and zinc. While only the lowest 3.5 miles of Chollas Creek comprise the actual impaired and listed segment of the water body, all upstream tributaries to this section are considered in this TMDL because they deliver metals loads to the lower segments. Samples collected at station SD8(1) (Figure 3.1) pursuant to Order No. R9-2001-01,[14] repeatedly showed toxicity to the water flea, *Ceriodaphnia dubia*. A subsequent Toxicity Identification Evaluation (SCCWRP, 1999) for three storm events identified copper and the pesticide diazinon[15] as the principal causes of toxicity to *C. dubia* and zinc as the cause of toxicity to the purple sea urchin, *Strongylocentrotus purpuratus*.

Since 1994, stormwater samples from Chollas Creek have frequently exceeded both chronic and acute water quality criteria established in the National Toxics Rule (NTR) in federal regulations [40 CFR 131.36 (d)(10)(ii)] for copper, lead, zinc and cadmium. In the NTR, both 1-hour acute and 4-day chronic water quality criteria are calculated as a function of hardness and the criteria are then compared against measured event mean concentrations (EMC). The EMC is defined as the total pollutant load divided by the total runoff volume. If the measured EMC was equal to or greater than acute or chronic criteria, the result was considered to exceed water quality criteria. Comparisons against NTR criteria were partially responsible for the original listing of Chollas Creek in 1996 for cadmium, copper, lead, and zinc.

In April 2000, the USEPA promulgated the California Toxics Rule (CTR) [40 CFR 131.38] that established new water quality criteria for waters in California, including water quality criteria for copper, lead, zinc and cadmium. As in the NTR, both 1-hour acute and 4-day chronic water quality criteria are calculated as a function of hardness.

The criteria are compared against measured concentrations of the dissolved metal (NTR assessed total metal concentration). Storm water samples from Chollas Creek collected between 1994 and 2003 periodically exceeded CTR water quality criteria for only copper, lead, and zinc (Table 3.1 and Appendix A). For each concentration that exceeded criteria, an exceedance factor was calculated. For example, if a concentration was two times greater than criteria, the exceedance factor was 2.0. Analysis of the exceedance factors showed that many concentrations of copper, lead, and zinc were more than double

[12] This section 303(d) listing for coliform has since been changed to "Bacterial Indicators." A separate TMDL is currently under development that addresses several Bacterial Indicator listings throughout the region.
[13] Cadmium is recommended for de-listing. See Appendix B.
[14] Order No. 2001-01, *Waste Discharge Requirements for Discharges of Urban Runoff from the Municipal Separate Storm Sewer Systems Draining the Watersheds of the County of San Diego, the Incorporated Cities of San Diego County, and the San Diego Unified Port District*, NPDES No. CAS0108758.
[15] A separate TMDL for diazinon was developed by the San Diego Water Board and adopted by the USEPA in November 2003. Order No. R9-2001-01 was superseded by Order No. R9-2007-0001 in January 2007.

their allowable limit. California must comply with the more stringent criteria of CTR rather than NTR.

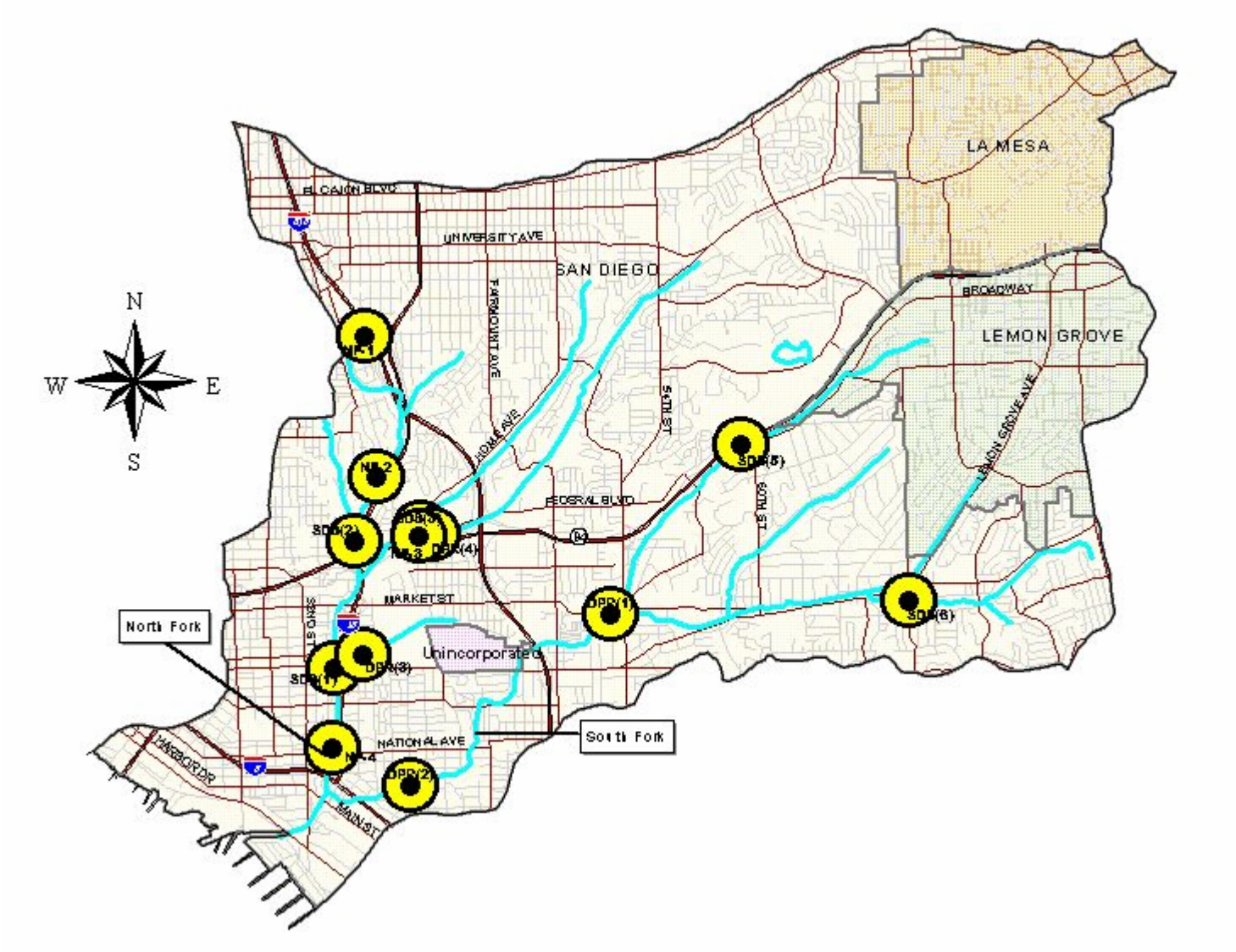

FIGURE 3.1. Chollas Creek Watershed.

3.1 De-listing of Cadmium

The available data suggest that concentrations of dissolved cadmium in Chollas Creek exceed neither acute nor chronic CTR water quality criteria. Most samples were below DLs, though some of the DL concentrations exceed CTR acute and chronic criteria. Since cadmium did not appear to exceed dissolved CTR criteria and was not found to cause toxicity in test organisms, a TMDL for cadmium was not established in this project. Based on this evidence, the San Diego Water Board recommended that cadmium be removed from the List of Water Quality Limited Segments in the 2006 listing update undertaken by the State and Regional Water Boards. The State Water Board removed the Cadmium listing from the 2006 list. The USEPA has yet to approve the delisting. The USEPA has recommended (USEPA, 2001) a more stringent dissolved cadmium criteria

that it plans to incorporate in to the CTR by 2008. These criteria are approximately ten-fold more stringent than current CTR criteria; and would warrant listing for exceedances of the chronic criteria (see Table 3.1 below). However, these criteria are only proposed and have not been promulgated by the USEPA.

When and if the CTR is updated to incorporate these criteria, the San Diego Water Board will re-evaluate the potential listing of cadmium for Chollas Creek. Appendix B contains the details supporting the cadmium delisting recommendation.

3.2 Watershed Characteristics

Chollas Creek is an urban creek with highly variable flows. The highest flow rates are associated with storm events. Extended periods with no surface flows occur during dry weather, although pools of standing water may be present. The annual average rainfall in the Chollas Creek Watershed is approximately 9 inches (URS Greiner Woodward Clyde 1999). The average annual rainfall in the watershed (from October 1948 through February 2002) measured at La Mesa, CA is approximately 12.6 inches (Western Regional Climate Center, 2003). Rainfall statistics for the San Diego International Airport (Lindbergh Field, located approximately 4 miles northwest of Chollas Creek, near San Diego Bay) indicate that an average of 18 storms occur each year (URS Greiner Woodward Clyde 1999).

Much of the creek has been channelized and concrete lined, but some sections of earthen creek bed remain. The mouth of the creek is located on the eastern shoreline of the central portion of San Diego Bay. San Diego Bay at the mouth of Chollas Creek is also on the List of Water Quality Limited Segments; being impaired for sediment toxicity and degraded benthic community.

The watershed of Chollas Creek encompasses 16,273 acres. The area of the north fork of the watershed (9,276 acres) is larger than that of the south fork (6,997 acres) (URS Greiner Woodward Clyde 1999). However, a 2000 report by the San Diego Association of Governments reported the Chollas Creek Watershed to contain 28.52 square miles (18,253 acres). As Table 3.2 indicates, the watershed is highly urbanized. Land use is predominantly residential, with some commercial/institutional and industrial use. A significant portion of the remainder of the watershed consists of roadways, while the rest is open space. Portions of the cities of San Diego, Lemon Grove, and La Mesa are located within the watershed. A small portion of the watershed consists of “tidelands” immediately adjacent to San Diego Bay. Some of this tideland area is under the jurisdiction of the San Diego Unified Port District (Port); the remainder is under the jurisdiction of the U.S. Navy (Navy). San Diego County also holds jurisdiction over a small portion of the watershed (<1.0 percent) as shown in Figure 3.1.

TABLE 3.1. Metal data summaries.

CADMIUM			Concentrations reported in ug / L				# of exceedances (CTR) [D]		# of exceedances (USEPA, 2001) [D]	
Collection Dates	Organization	n	min	max	mean	median	CMC	CCC	CMC	CCC
Feb 94 - Feb 03	MS4 Copermittees	42	0.2 [A]	3.93 [B]	0.8 [C]	0.5 [C]	0 of 4	0 of 4	0 of 4	3 of 4
Feb 00 - Apr 00	CalTrans	4	0.2 [A]	0.3	0.2 [C]	0.2 [C]	NA [E]	NA [E]	NA [E]	NA [E]
Mar 99 - Apr 99	SCCWRP	3	< 0.3	< 2.0	< 2.0	< 2.0	NA [F]	NA [F]	NA [F]	NA [F]
Jun 91 & Mar 92	Regional Board	5	1.0 [A]	< 1.0	0.5 [C]	0.5 [C]	NA [F]	NA [F]	NA [F]	NA [F]

COPPER			Concentrations reported in ug / L				# of exceedances (CTR) [D]	
Collection Dates	Organization	n	min	max	mean	median	CMC	CCC
Feb 94 - Feb 03	MS4 Copermittees	58	2.5 [A]	81.6 [B]	16.4 [C]	11.0 [C]	16 of 32	20 of 32
Feb - Apr, 00	CalTrans	4	5.1	11	7.8	7.5	NA [E]	NA [E]
Feb - Mar, 00	SCCWRP	2	51.2	63	57.1	57.1	NA [E]	NA [E]
Jan , Feb & Nov, 01	DPR	14	5	34	11.7	9.8	5 of 12	7 of 12
Sep-00	ES Babcock	4	1.92	28.8	9.8	4.3	NA [G]	NA [G]
Mar - Apr 99	SCCWRP (TIE)	3	10	30	18.3	15	2 of 3	3 of 3
Jun 91 & Mar 92	Regional Board	5	3	8	6.4	7	0 of 5	0 of 5

LEAD			Concentrations reported in ug / L				# of exceedances (CTR) [D]	
Collection Dates	Organization	n	min	max	mean	median	CMC	CCC
Feb 94 - Feb 03	MS4 Copermittees	57	1.0 [A]	118 [B]	16.4 [C]	3.0 [C]	0 of 19	10 of 19
Feb - Apr, 00	CalTrans	4	2.9	11	5.5	4	NA [E]	NA [E]
Jan , Feb & Nov, 01	DPR	14	1..0 [A]	46	7.3	2	1 of 12	6 of 12
Sep-00	ES Babcock	4	2.0 [A]	4.1	1.9	1.2	NA [G]	NA [G]
Mar - Apr 99	SCCWRP (TIE)	3	10.0 [A]	82	39	30	1 of 2	2 of 2
Jun 91 & Mar 92	Regional Board	5	5.0 [A]	29	12.2	11	0 of 3	1 of 3

ZINC			Concentrations reported in ug / L				# of exceedances (CTR) [D]	
Collection Dates	Organization	n	min	max	mean	median	CMC	CCC
Feb 94 - Feb 03	MS4 Copermittees	57	8	548 [B]	105.6 [C]	73 [C]	12 of 42	12 of 42
Feb - Apr, 00	CalTrans	4	17	42	28.8	28	NA [E]	NA [E]
Feb - Mar, 00	SCCWRP	2	146	150.8	148.4	148.4	NA [E]	NA [E]
Jan , Feb & Nov, 01	DPR	14	16.8	370	137.6	105	7 of 12	7 of 12
Sep-00	ES Babcock/RB	4	10.0 [A]	45	21.3	17.5	NA [G]	NA [G]
Mar - Apr 99	SCCWRP (TIE)	3	90	220	173.3	210	2 of 3	2 of 3
Jun 91 & Mar 92	Regional Board	5	3	188	45	11	0 of 5	1 of 5

[A] sample below Reporting Limit [B] calculated from total concentration
[C] using all samples (measured dissolved and calculated from total). Samples below detection limit entered as 1/2 detection limit for calculations
[D] considering only measured dissolved concentrations and samples not below DL or RL. (number in parenthesis represents available sample pool under these criteria)
[E] no associated hardness values available [F] all samples reported as "less than"
[G] all dissolved samples calculated from total [ ]

TABLE 3.2. Land use in the Chollas Creek Watershed. (URS Greiner Woodward Clyde 1999)

Land Use	Percent of Total Area (Entire Watershed)
Residential	67%
Commercial/Institutional	5%
Industrial	7%
Roadways	4%
Open Space	16%

3.3 Applicable Water Quality Standards

WQSs consist of beneficial uses, WQOs and an anti-degradation policy. The Basin Plan (San Diego Water Board, 1994) specifies WQSs for all waters in the San Diego region, including Chollas Creek and San Diego Bay. The WQSs that apply to this TMDL are the existing and potential beneficial uses in Chollas Creek that could be adversely affected by toxicity, combined with the Basin Plan narrative WQOs for toxicity, and the numeric criteria for toxic pollutants found in the federal California Toxics Rule. The beneficial uses for Chollas Creek and San Diego Bay are listed in Table 3.3. Chollas Creek is also subject to State Water Board Resolution No. 68-16, *Statement of Policy with Respect to Maintaining High Quality of Waters in California*, which establishes a general principle of non-degradation.

TABLE 3.3. Beneficial uses in the Chollas Creek Watershed and San Diego Bay.

Beneficial Use	Chollas Creek	San Diego Bay
Industrial service supply		•
Navigation		•
Contact water recreation	o	•
Non-contact water recreation	•	•
Commercial and sport fishing		•
Preservation of biological habitats of special significance		•
Estuarine habitat		•
Warm freshwater habitat	•	
Wildlife habitat	•	•
Rare, threatened, or endangered species		•
Marine habitat		•
Migration of aquatic organisms		•
Shellfish harvesting		•

• Existing Beneficial Use
o Potential Beneficial Use

The following Basin Plan narrative WQO (Basin Plan p. 3.15) for toxicity is applicable to all inland surface waters (including Chollas Creek), enclosed bays (including San Diego Bay) and estuaries, coastal lagoons and ground waters of the San Diego region.

Water Quality Objective for Toxicity
All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life. Testing of indicator organisms, analyses of species diversity, population density, growth anomalies, bioassays of appropriate duration, or other appropriate methods as specified by the San Diego Water Board will be used to determine compliance with this objective.

The survival of aquatic life in surface waters subjected to a waste discharge or other controllable water quality factors, shall not be less than that for the same water body in areas unaffected by the waste discharge or, when necessary, for other control water that is consistent with requirements specified in USEPA, State Water Resources Control Board or other protocol authorized by the San Diego Water Board. As a minimum, compliance with this objective as stated in the previous sentence shall be evaluated with a 96-hour acute bioassay.

In addition, effluent limits based upon acute bioassays of effluents will be prescribed where appropriate, additional numerical receiving water objectives for specific toxicants will be established as sufficient data become available and source control of toxic substances will be encouraged.

In addition to Basin Plan objectives, the CTR also establishes numeric water quality criteria legally applicable in the state of California as WQOs for inland surface waters and enclosed bays and estuaries. These criteria are discussed in full in section 4 of this chapter.

3.4 Metals Chemistry

Copper and zinc are essential elements for all living organisms, but elevated levels may cause adverse effects in all biological species. Lead is presumed to be a non-essential element for life; more importantly, even at extremely low environmental concentrations this element may create adverse impacts on biota. Dissolved forms of these metals are directly taken up by bacteria, algae, plants and planktonic and benthic organisms. Dissolved metals can also adsorb to particulate matter in the water column and enter aquatic organisms through various routes. Copper, lead, and zinc may bioaccumulate within lower organisms, yet they are not expected to biomagnify up the food chain as do mercury and selenium (Moore and Ramamoorthy, 1984). The issue of biomagnification is still being debated among the scientific community (Besser, et al, 200) and cannot be assessed in Chollas Creek with the available information. Of all of these metals, copper is considered the most potent toxicant at environmentally relevant aqueous concentrations. Copper is more commonly found at higher concentrations in herbivorous fish than carnivorous fish from the same location (USF&W, 1998). Copper is used as an aquatic herbicide to reduce algae growth in reservoirs and is applied (via antifouling paints) to boat hulls in marinas.

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

Exposure to two or more chemicals may result in toxicity that is additive or a simple summation of the toxicity of the individual chemicals. Likewise, the presence of two or more chemicals may result in a synergistic effect, or toxicity that is greater than would be expected based on a simple summation of the individual toxicities of the chemicals. Copper and zinc have been shown to have an additive toxic effect on aquatic life (Taylor and Francis, 1995). However, there is insufficient data to determine if these effects are found in Chollas Creek. This will be addressed as part of the monitoring required in the implementation (sections 11 and 12) phase of the TMDL.

3.5 Sediment Metals

Sediment samples have been collected for chemical analysis in Chollas Creek since 1994 (Appendix C), generally as a single sampling event every late spring and early fall. Extensive sampling occurred during June 1998 at several stations within the creek. All samples were analyzed for total cadmium, copper, lead, and zinc (Table 3.4). With few exceptions, all four metals were below their applicable Probable Effects Level (PEL) (MacDonald et al., 1996). The PEL or Probable Effects Concentration (PEC) (MacDonald et al., 2000) is an empirical approach to determine what concentration of a chemical is likely to have an environmental impact. In the PEL approach, the chemical concentrations of the samples are ranked from high to low toxicity. The PEL is the geometric mean of the 50th percentile of the effects data and the 85th percentile of the no effects data. The PEL represents the concentration above which adverse effects are expected to occur frequently (Smith et al., 1996). Freshwater sediment chemistry regulations to protect aquatic life in California have not been promulgated. However, PELs were used to screen sediment chemistry data from San Diego Creek in a TMDL written by USEPA (2002) and are therefore appropriate to use as screening values in this TMDL.

TABLE 3.4. Summary of total metal concentrations in Chollas Creek sediments.

Metal	no. of detections / no. of samples analyzed	Average[1] (mg/kg, dry wt.)	Median[1] (mg/kg, dry wt.)	Std Dev[1] (mg/kg, dry wt.)	PEL [2] (mg/kg, dry wt.)	no. of samples > PEL[2]	no. of samples > PEL[2]
Cadmium	11 of 81	2.10	2.50	2.54	3.53	1	1.2%
Copper	45 of 81	10.2	3.6	17.9	197	0	0.0%
Lead	37 of 81	18.7	6.3	27.4	91.3	3	3.7%
Zinc	81 of 81	61.6	42.2	62.4	315	1	1.2%

[1] Non-detects are considered as 1/2 of the Reporting Limit for calculations of average, median and standard deviation.

[2] PEL = Probable Effects Level

A review of the available sediment metal chemistry data indicate that accumulation of metals above potentially harmful concentrations is unlikely. Additionally, metals are expected to continuously partition out of the dissolved phase and settle out of the water column with particulate organic matter. Residence time in the creek is likely less than one year because each season's major storms will effectively remove any metals accumulated in the creek sediment and transport them downstream to San Diego Bay.[16] Therefore, this TMDL will focus on water column concentrations of dissolved metals.

3.6 Sampling History in the Watershed

Stormwater monitoring of Chollas Creek began in the 1993-94 rainy season under the MS4 stormwater order in effect at that time. Each rainy season, stormwater samples are collected from two or three storms at a station located on the north fork of Chollas Creek near the intersection of 33rd and Durant Streets. To avoid tidal influence, the monitoring station is installed on the north fork above the north and south fork confluence. Runoff from approximately 57 percent of the entire watershed is sampled at the monitoring site (URS Greiner Woodward Clyde 1999). This station samples run-off that is representative of the entire watershed because the land use distribution in the north fork portion of the watershed is nearly identical to the land use distribution of the entire watershed as shown in Table 3.5 below.

TABLE 3.5. Land use distribution for Chollas Creek Watershed. (URS Greiner Woodward Clyde 1999)

Land Use	Percent of Total Acreage (Entire Watershed)	Percent of Sampled Acreage (North Fork Watershed)
Residential	67%	62%
Commercial/Institutional	5%	9%
Industrial	7%	10%
Open Space	16%	14%
Roadways	4%	5%

[16] The sediment deposited in San Diego Bay will be addressed in the "San Diego Bay Shoreline, near Chollas Creek" TMDL currently under development.

Since the 1993-94 rainy season, stormwater samples have been analyzed for general physical constituents, nutrients, biochemical oxygen demand, chemical oxygen demand, bacteriological constituents, organic constituents and total recoverable metals. Since 2000, samples have also been analyzed for dissolved metals. Toxicity testing began with the 1994-95 rainy season and is conducted using the water flea *Ceriodaphnia dubia* and the fish commonly known as a fathead minnow (*Pimephales promelas*). Toxicity as indicated by mortality was found in every test run on the water flea for the municipal stormwater program. Reproduction of the water flea was generally not impaired. Toxicity was generally not found in tests run on the fathead minnow, but frequently some inhibition of growth was found.

The San Diego Water Board, the California Department of Transportation (Caltrans), the Southern California Coastal Water Research Project (SCCWRP) and the Department of Pesticide Regulation (DPR) have also conducted metals sampling and analysis in the Chollas Creek Watershed. Appendix A has a summary of the data used in this TMDL. Currently, dischargers in the watershed are under order to file monitoring program reports for dissolved metals and diazinon.[17] Monitoring results are filed in the Watershed Urban Runoff Management Plans required in the San Diego County stormwater WDRs.[18]

[17] Order No. R9-2004-0277
[18] Order No. R9-2007-0001

4 Numeric Targets

When calculating TMDLs, numeric targets are established to ensure that WQOs are met and beneficial uses are protected. The CTR criteria for metals are the basis of the numeric targets. However, because dissolved metals toxicity is a function of hardness, the CTR criteria for copper lead, and zinc are expressed as hardness-based equations. The numeric target equations are shown in Table 4.1. This section will discuss why CTR was chosen as the basis for the numeric targets in this TMDL and will discuss the following different factors/variables of the numeric target equations: continuous and maximum criteria concentrations (CCC and CMC), Water-effect Ratios (WER), total-to-dissolved metal conversion factor (CF), hardness, and correlation coefficients (m and b, respectively). Newly proposed copper criteria will also be mentioned at the end of this section.

TABLE 4.1. Numeric targets for dissolved metals in Chollas Creek.

Metal	Numeric Target for Acute Conditions: Criteria Maximum Concentration	Numeric Target for Chronic Conditions: Criteria Continuous Concentration
Copper	(1) * (0.96) * {e^ [0.9422 * ln (hardness) - 1.700]}	(1) * (0.96) * {e^[0.8545 * ln (hardness) - 1.702]}
Lead	(1) * {1.46203 – [0.145712 * ln (hardness)]} * {e^ [1.273 * ln (hardness) - 1.460]}	(1) * {1.46203 – [0.145712 * ln (hardness)]} * {e^[1.273 * ln (hardness) - 4.705]}
Zinc	(1) * (0.978) * {e^ [0.8473 * ln (hardness) + 0.884]}	(1) * (0.986) * {e^[0.8473 * ln (hardness) + 0.884]}

Hardness is expressed as milligrams per liter.
Calculated concentrations should have two significant figures [40 CFR 131.38(b)(2)].
The natural log and exponential functions are represented as “ln” and “e,” respectively.

The CTR criteria were chosen as the basis for these numeric targets, because they are the most current, defendable WQOs for dissolved copper, lead, and zinc concentrations in fresh water (USEPA, 2000a). The Basin Plan (San Diego Water Board, 1994) provides only narrative WQOs for determining allowable concentrations of copper, lead, and zinc in Chollas Creek. CTR criteria are legally applicable as WQOs in inland surface waters (e.g., Chollas Creek), enclosed bays and estuaries of California for all purposes and programs under the CWA (USEPA, 2000a).

Specifically, the numeric targets for the Chollas Creek TMDLs were set equal to the CTR’s hardness-based equations criteria for dissolved copper, lead, and zinc (Table 3.1) and are shown below in their simplified forms (Equations 4.1 and 4.2). These equations were derived by USEPA in order to calculate the criteria that a metal concentration must be below in order to protect freshwater aquatic life from toxicity. Therefore by this definition, setting the numeric targets equal to the CTR equations will also ensure that the narrative water quality objectives for toxicity are met in the water column for copper, lead, and zinc. In addition, because they are equations, the numeric targets for Chollas

Creek do not vary spatially or temporally and thus apply throughout all freshwater portions of Chollas Creek at all times.

EQUATION 4.1: General Criteria Continuous Concentration (CCC)

$$CCC = (WER) * (CF_C) * \{e^{[(m_C * \ln hardness) + b_C]}\}$$

Where: CCC = Criteria Continuous Concentration
WER = Water-effect Ratio
CF_C = Conversion Factor for freshwater chronic criteria
m_C = correlation coefficient
b_C = correlation coefficient

The subscript "c" stands for "chronic" and designates a variable in the CCC equation. The natural log and exponential functions are represented as "ln" and "e," respectively [40 CFR 131.38(b)(2)].

EQUATION 4.2: General Criteria Maximum Concentration (CMC)

$$CMC = (WER) * (CF_A) * \{e^{[(m_A * \ln hardness) + b_A]}\}$$

Where: CCC = Criteria Continuous Concentration
WER = Water-effect Ratio
CF_A = Conversion Factor for freshwater chronic criteria
m_A = correlation coefficient
b_A = correlation coefficient

The subscript "A" stands for "acute" and designates a variable in the CMC equation. The natural log and exponential functions are represented as "ln" and "e," respectively [40 CFR 131.38(b)(2)].

4.1 Criteria for Maximum and Continuous Concentration

Table 4.1 (above) identifies targets for both chronic and acute conditions: the CCC equation (Equation 4.1) and the CMC equation (Equation 4.2), respectively. The CMC is the highest concentration that will protect aquatic life from acute or short-term effects, such as mortality. In order to protect aquatic life, the one-hour average water column concentration must be below the CMC. Similarly, the CCC is the highest concentration that will protect aquatic life from chronic or long-term effects, such as reduced birth rates. In order to protect aquatic life, the four-day average water column concentration must be below the CCC. Neither the CCC nor the CMC can be exceeded more than once every three years [40 CFR 131.38 (c)(2)]. For purposes of evaluating if the Numeric Targets have been attained, sample results should be used according to the requirements in Table 4.2.

TABLE 4.2. Requirements for using sample results to evaluate CCCs and CMCs.

1. If only one sample is collected during the time period associated with the Numeric Target (e.g., one-hour average), the single measurement shall be used to determine attainment of the numeric target for the entire time period.
2. The one-hour average shall be the moving arithmetic mean of grab samples over the specified one-hour period.
3. The four-day average shall apply to flow-weighted composite samples for the duration of a storm, or shall be the moving arithmetic mean of flow weighted 24-hour composite samples or grab samples.

4.2 Water-effect Ratio

The WER is a mechanism for developing site-specific criteria by comparing bioavailability and toxicity of a specific pollutant in receiving waters and laboratory waters and is provided as a variable in the concentration criteria equations (Equations 4.1 and 4.2; USEPA, 2000a). A site-specific WER has not been developed for Chollas Creek. In such circumstances, a WER of unity is assumed and used in the equations. Site-specific criteria are discussed in further detail in Appendix H.

4.3 Total-To-Dissolved Metal Conversion Factor

Prior to 2000, metal criteria for the protection of aquatic life were based on total metal concentrations, that is, the concentration of all sized metal fractions in the water column. Since then the USEPA recommends dissolved metal concentrations, or metals in solution, be used for metal criteria, because dissolved metals more closely represent the fraction of metals bioavailable to aquatic organisms than do total metals (USEPA, 2000a). The CTR criteria equations (Equations 4.1 and 4.2) incorporate total-to-dissolved conversion factors (CFs) to account for that fact [40 CFR 131.38 (b)(2)(iv)]. The CFs for each metal, with respect to acute and chronic conditions, are listed in Table 4.3. The CF for lead is a function of hardness. Concern has arisen in the past that non-dissolved metal in the water column, such as particulate metal, could become bioavailable. Although the Federal Register provides good reasons why this should not be a concern, an explicit MOS was applied in this TMDL to address this possibility.

TABLE 4.3. Metal acute and chronic freshwater conversion factors for copper, lead, and zinc.

Metal	CF_A	CF_C
Copper	0.960	0.960
Lead	1.46203 – [0.145712 * ln (hardness)]	1.46203 – [0.145712 * ln (hardness)]
Zinc	0.978	0.986

Reference: [40 CFR 131.38(b)(2)].

4.4 Hardness

As discussed above, CTR criteria are based on empirical relationships of toxicity (metal concentrations) to water hardness (Table 4.1). Hardness is defined as the concentration

of calcium carbonate ($CaCO_3$) in the water column and has the units of milligram per liter (mg/L). 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 toxicities of some metals. Hardness is used as a surrogate for a number of water quality characteristics that affect the toxicity of metals in a variety of ways. Increasing hardness has the effect of decreasing the toxicity of metals. Water quality criteria to protect aquatic life may be calculated at different concentrations of hardness, measured in milligrams per liter as calcium carbonate.

Like many flowing freshwater bodies, Chollas Creek waters exhibit a wide range of hardness levels. Because hardness data to accurately assess this range were limited, hardness was set as a variable in the numeric targets. Consequently, hardness concentrations must be measured at the time of compliance and the criteria subsequently determined using the equations in Table 4.1. Further, because hardness will be determined at the time of compliance and included as a variable in the CTR equation, a more site-specific and temporal-specific numeric target is achieved.

At times when the hardness concentration exceeds 400 mg/L, a value of 400 mg/L will be used for hardness no matter what the extent of the exceedance. This is because the CTR caps the allowable hardness value that can be used to calculate the resulting water quality criteria. As hardness increases, so do the numeric targets. Conversely, decreasing hardness results in decreasing the numeric targets. Without the use of a WER, the maximum hardness value for associated use with the numeric targets is 400 mg/L $CaCO_3$. The available data suggests that few metal concentrations will exceed CTR criteria at a hardness of 400 mg/L $CaCO_3$.

4.5 Correlation Coefficients

The last variables are the correlation coefficients (m and b) shown in Equations 4.1 and 4.2. These coefficients are the result of fitting acute freshwater toxicity metal concentration data to hardness in a log-log relationship and are specified for each metal in Table 4.4 below (USEPA, 1985).

TABLE 4.4. Criteria correlation coefficients.

Metal	m_A	b_A	m_C	b_C
Copper	0.9422	-1.700	0.8545	-1.702
Lead	1.273	-1.460	1.273	-4.705
Zinc	0.8473	0.884	0.8473	0.884

Reference: [40 CFR 131.38(b)(2)]

4.6 Newly Proposed Copper Criteria

The USEPA has published a document, *2003 Draft Update of Ambient Water Quality Criteria for Copper* (EPA-822-R-03-026), containing updated freshwater and saltwater aquatic life criteria for copper. These criteria revisions are based in part on new data that have become available since the USEPA's last comprehensive criteria updates for copper.

In addition to incorporating new data, the freshwater criteria also incorporate the use of the biotic ligand model (BLM) in the criteria derivation procedures (USEPA, 2003).

The newly recommended freshwater criteria (the CMC and CCC is 2.1 micrograms per liter (µg/L) and 1.3 µg/L, respectively) differ from CTR's current metals criteria primarily with regard to how metal availability to organisms is addressed. As mentioned above, CTR criteria were based on empirical relationships of toxicity to water hardness. The newly recommended criteria use a BLM instead (Di Toro et al. 2001). The BLM is based on the premise that toxicity is related to metal bound to a biotic site (the biotic ligand) and that binding is related to dissolved metal concentrations and complexing ligands in the water.

The newly recommended criteria do not supersede the CTR criteria. At this time, the San Diego Water Board will continue to use CTR as the basis for the metals TMDLs numeric targets. When the TMDLs are revisited in the future, the San Diego Water Board may re-evaluate the numeric targets set forth here, based on the newly recommended criteria.

5 Source Analysis

The source analysis summarizes the major suspected sources of dissolved copper, lead, and zinc to the Chollas Creek Watershed. This includes consideration of point sources and nonpoint sources (which include background) and an estimate of their magnitude and location. Metals, such as copper, lead, and zinc, enter surface waters from point and nonpoint sources. Point sources typically discharge at specific locations from pipes, outfalls and conveyance channels from municipal wastewater treatment plants, industrial waste treatment facilities and stormwater conveyance systems. Nonpoint sources are diffuse sources that reach receiving waters from different routes of entry and originate from multiple land uses.

Essentially all sources (point and nonpoint) enter Chollas Creek through the stormwater conveyance system that is regulated by WDRs prescribed in Order No. R9-2007-0001. This order regulates discharges to surface waters from municipal separate storm sewer systems (MS4s) in San Diego County. MS4 discharges are collectively considered to be point sources of urban runoff discharges due to their release from channelized, discrete conveyance pipe systems and outfalls. Because there are currently no other known point sources, urban runoff is considered the most significant source of metals to Chollas Creek and will be the main focus of this analysis. In addition, this analysis will detail potential sources of urban runoff from activities outside and inside of the Chollas Creek Watershed boundaries, including atmospheric deposition. Estimates are drawn from several studies conducted outside the watershed as well as modeling results based on land use classifications within the watershed. Broad classes of sources (for example, urban runoff, atmospheric deposition, etc.) and specific individual sources (for example, land uses, cars, etc.) will be discussed.

Specifically, modeling results based on land use category parameters, hydrological characteristics and observed metal concentrations provided estimates of the magnitude of metal loadings (Appendix D). The top two land use categories in Chollas Creek, freeways and commercial/institutional, contribute over 75 percent of the total load for each metal (Figures 5.4, 5.5 and 5.6). Significant sources of all three metals to urban runoff are thought to include automobile operation (especially brake pads and tires) and industries with practices that may expose metals to stormwater. Water supply infrastructure corrosion, pesticide application and atmospheric deposition are also among the identified potential sources.

5.1 Urban Runoff Regulation in Chollas Creek Watershed

Urban runoff discharges from MS4s are a leading cause of receiving water quality impairments in the Chollas Creek Watershed. In addition, a direct linkage has been established between toxicity and stormwater discharges in the watershed (Schiff, 2001). According to Order No. R9-2007-0001 requirements, all entities that share a particular stormwater system are responsible for urban runoff discharges both (1) into their stormwater conveyance system and (2) from their stormwater conveyance system. Order No. R9-2007-0001 for San Diego County names 20 different entities responsible for stormwater discharges in the San Diego Region. Other than the MS4, there are no known direct point source discharges of metals to water bodies in the Chollas Creek Watershed.

The small size of the creek's riparian zone and the encroachment of development along the creek make the amount of run-off directly to the creek much smaller than that entering from storm drains. Furthermore, under Order No. R9-2007-0001, the creek itself is considered part of the storm drain system. Therefore, parties named in Order No. R9-2007-0001 are responsible for not only the run-off entering the creek, but also for the water in the creek itself.

Other responsible persons are those that hold general or individual Waste Discharge Requirements applicable in Chollas Creek. Some of the other major dischargers include Caltrans and the Navy. Caltrans is regulated under statewide Order No. 99-06-DWQ. Storm water runoff from the U.S. Navy's MS4 system, as discussed in Section 5.1.1, will also be regulated.

5.1.1 San Diego Water Board Order No. R9-2007-0001

In 1990, the USEPA developed rules establishing Phase I of the NPDES stormwater program, designed to prevent harmful pollutants from being washed by urban runoff into MS4s or from being dumped directly into MS4s and then subsequently into local water bodies. Phase I of the program required operators of medium and large MS4s (those generally serving populations of 100,000 or more) to implement an urban runoff management program as a means to control polluted discharges from MS4s. Approved urban runoff 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. More specifically, large and medium operators are required to develop and implement Urban Runoff Management Plans that address, at a minimum, the following elements:

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

Of the 20 entities identified in Order R9-2007-0001, the cities of San Diego, Lemon Grove, and La Mesa, the County of San Diego, and the Port (Municipal Dischargers) are all in the Chollas Creek Watershed and are responsible for addressing metal water quality concerns for the MS4 in the Chollas Creek Watershed, as applicable. One exception to note is that the Navy has runoff from its community facilities (Naval Base San Diego) in the Chollas Creek Watershed regulated under its industrial discharge WDRs prescribe in

Order No. 2002-0169.[19] Order No. 2002-0169 does regulate urban runoff discharges from MS4s, and the facility is not currently regulated under the MS4 WDRs prescribed in Order No. R9-2007-0001. The Navy is expected to be enrolled in the statewide general WDRs prescribed for small MS4s in Order No. 2003-0005-DWQ.[20]

5.1.2 Other Applicable Orders and Regulations

Table 5.1 lists other applicable WDR orders in the Chollas Creek Watershed. With respect to the source analysis, these orders regulate activities that may be contributing metals to Chollas Creek through urban runoff. All applicable orders must be made

TABLE 5.1. Other applicable orders for land use practices in the Chollas Creek Watershed.

Order General Name	Order Number	NPDES Permit Number	Sections[1]
Statewide Caltrans MS4, industrial, construction Stormwater WDRs	99-06-DWQ	CAS 000003	5.5.1, 5.5.3 and 5.5.6
Statewide General Industrial Stormwater WDRs	97-03-DWQ	CAS 000001	5.5.6
Statewide General Construction Stormwater WDRs	99-08-DWQ	CAS 000002	5.5.3
Landfill, burn sites - South Chollas Creek WDRs			
Temporary Groundwater Extraction and Discharge to San Diego Bay and Its Tributaries (Dewatering) WDRs	R9-97-11, Addendum No. 4		5.5.9
Groundwater Extraction Waste Discharges From Construction, Remediation, and Permanent Groundwater Extraction Projects to Surface Waters within the San Diego Region except for San Diego Bay	R9-2000-90	CAG 919001	N/A
	R9-2001-96	CAG 919002	N/A

[1] The section in this analysis of which the respective land use practice is discussed is listed beside the order.

[19] Order No. R9-2002-0169 NPDES Permit No. CA0109169, *Waste Discharge Requirements for U.S. Navy Naval Base San Diego, San Diego County*.
[20] State Water Board Order No. 2003-0005-DWQ, NPDES General Permit No. CAS000004, *Waste Discharge Requirements for Storm Water Discharges from Small Municipal Separate Storm Sewer Systems*.

consistent with the load and waste load allocations of this TMDL. In addition, other regulatory agencies may regulate other urban runoff sources, such as atmospheric deposition from industry and auto emissions, domestic water supply and various pesticide applications (sections 5.4.2, 5.4.5 and 5.5.4). Other sources, such as sewage spills and disposal of particular household products (section 5.5.2) are prohibited by law.

5.2 Estimation of Metal Magnitude and Location from Urban Runoff

Multiple sources of copper, lead, and zinc contribute to the accumulated metal on the surfaces of the Chollas Creek Watershed. Rainfall events and dry-weather urban runoff transfer these accumulated metals to Chollas Creek via the MS4 system. Because the relative loads entering Chollas Creek depend on wet or dry weather conditions, an assessment of existing loads requires separate analyses.

5.2.1 Land-use Modeling

Watershed models were developed by Tetra Tech, Inc. (Appendix D) to estimate the magnitude and source land uses of existing annual metal loadings to the Chollas Creek Watershed during both wet and dry weather conditions of a typical year. In addition, loads for a critical year, a year in which extraordinary rain volumes result in a higher mass load contribution, were also estimated. Table 5.2 shows the total estimate (wet and dry weather condition loads added together) for dissolved metal loading for both a typical and a critical year. All concentrations reported in this section are dissolved metals.

TABLE 5.2. Estimated existing total loads for Chollas Creek for both wet and dry weather conditions during a typical and critical year.

	Copper (dissolved) (g/yr)	Lead (dissolved) (g/yr)	Zinc (dissolved) (g/yr)
Typical Year	232,829	194,175	1,327,393
Critical Year	985,241	705,310	5,994,241

Unfortunately, limited data prevented complete utilization of the watershed models. Because the dry weather model simulation of metal concentration could not be properly calibrated and validated, the dry weather portion of the total estimate was calculated based only on the average observed concentrations. In addition, further refinement of both models is needed before results could be used in calculating a mass load allocation for a TMDL. Regardless, the model results quantify land use metal contributions and will be helpful in targeting higher priority subwatersheds and land uses for implementation of the TMDL during wet weather conditions. Further, the data to be collected as part of compliance monitoring for this TMDL will be used to complete the dry weather model as well as further refine the wet weather model. If modeling results warrant, the TMDL estimates could be adjusted as necessary at that time.

5.2.1.1 Urban Runoff from Wet Weather

Estimating wash-off from various land uses is an appropriate way to quantify the primary sources of copper, lead, and zinc loading during wet conditions. Runoff volume and

metal concentrations from each subwatershed are therefore dependent on build-up and wash-off rates, which differ depending on the subwatershed's land uses (Figures 5.1 and 5.2). The land uses incorporated into the wet weather watershed model are described in Appendix E.

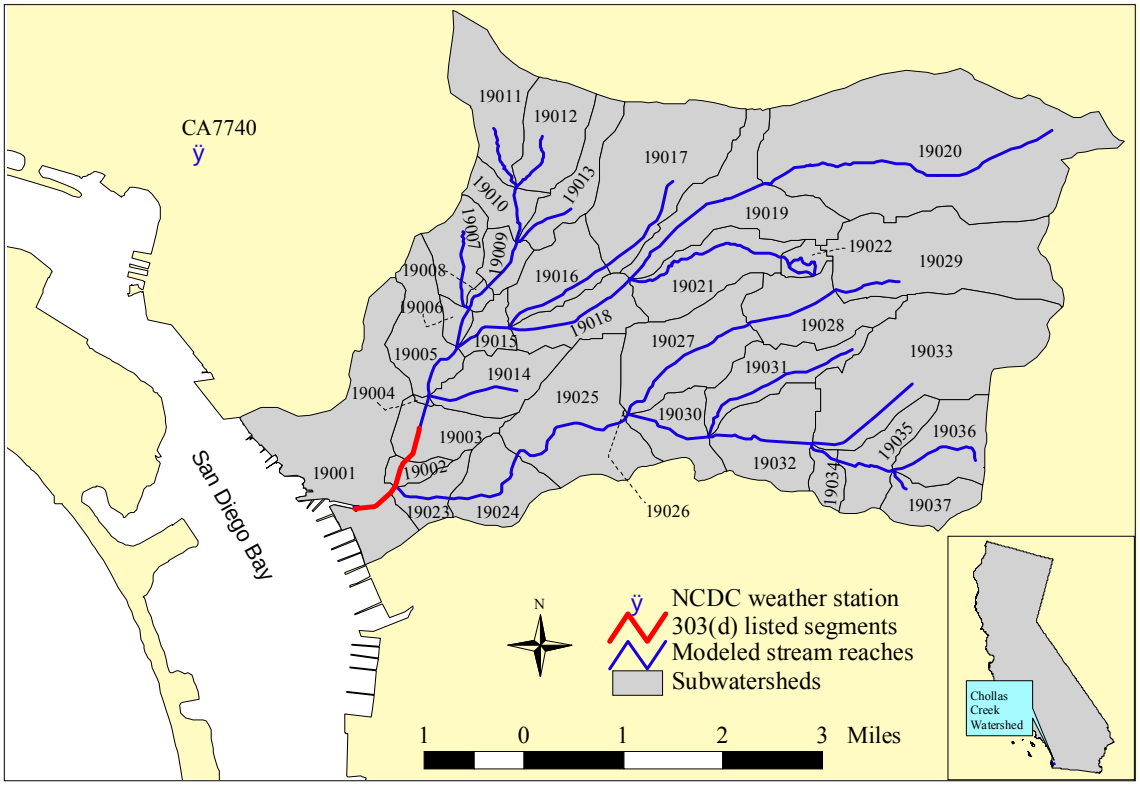

FIGURE 5.1. Chollas Creek Watershed divided into subwatersheds. (referenced by number)

To estimate total copper, lead, and zinc loadings during wet weather events, a watershed model was developed (Appendix D). Hydrology and water quality simulations were performed for 1990 through 2003. Data collected from the San Diego County stormwater programs and other special studies were used to calibrate model outputs (metal loadings) in the watershed. Table 5.3 presents the average annual wet weather load to Chollas Creek (based on model results from 1990-2003) for a typical and critical year. In comparison to the total estimate (Table 5.2), wet weather comprises at least 99.7 percent of the total load for each metal. A critical year was selected in order to understand conditions during maximum flow conditions. For the time period of 1990 through 2003, 1993 was selected as the critical year. This critical wet condition was selected based on the identification of the 93rd percentile of annual rainfall observed at multiple rainfall gages in the San Diego Region during this time period.

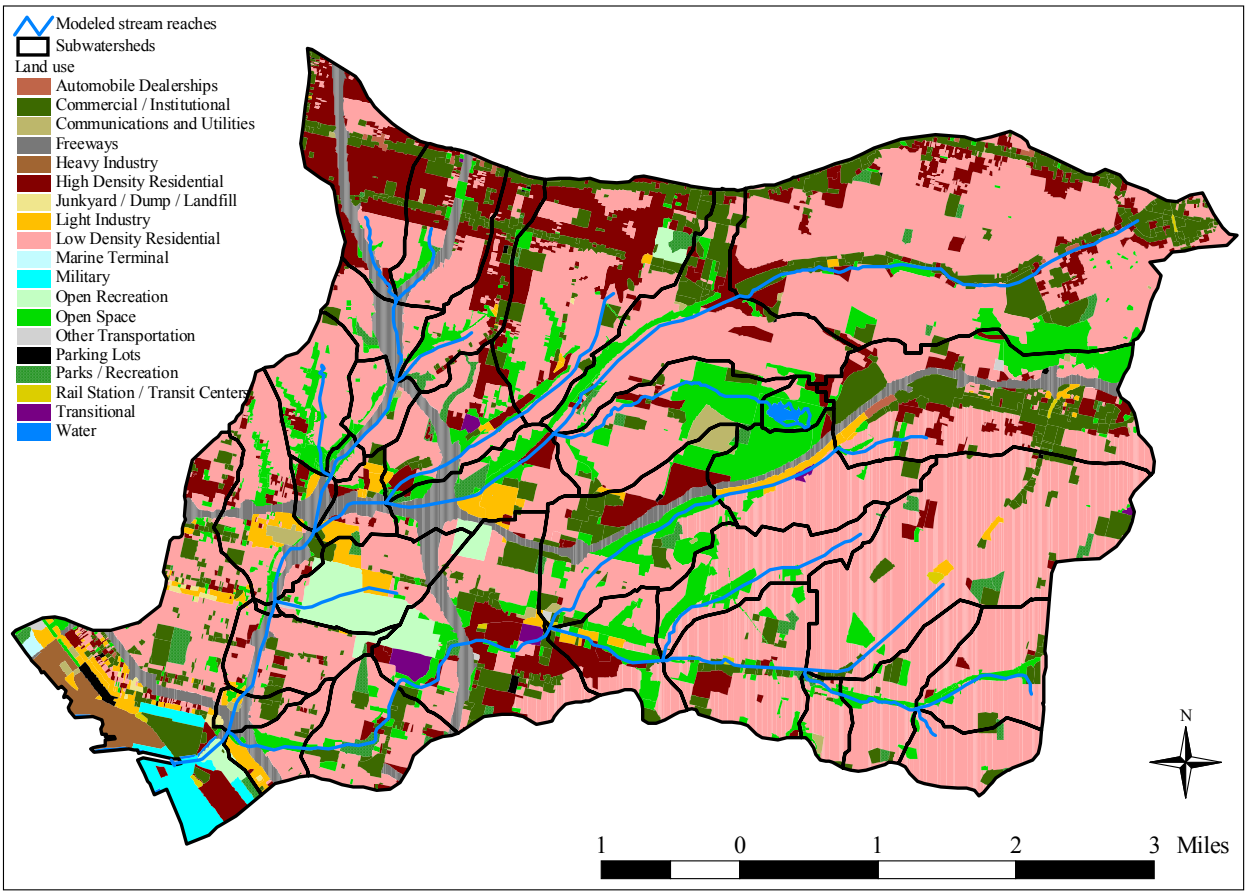

FIGURE 5.2. Land use distribution in the Chollas Creek Watershed.

TABLE 5.3. Estimated existing wet weather total loads for Chollas Creek during a typical and critical year.

	Copper (dissolved) (g/yr)	Lead (dissolved) (g/yr)	Zinc (dissolved) (g/yr)
Typical	232,137	194,007	1,326,407
Critical	984,549	705,142	5,993,255

Because the model estimated loads based on subwatershed characteristics (and hence associated land uses), the location of areas with relatively higher loading can be identified. Figure 5.3 shows annual wet weather loads from the North and South Forks of Chollas Creek. The North Fork contributes a greater pollutant load than the South Fork. These differences are most likely due to the different size and land use distribution of the two drainage areas. For another perspective, Table 5.4 summarizes the top 10 watershed mass load contributors in Chollas Creek for each subwatershed (Figure 5.1).

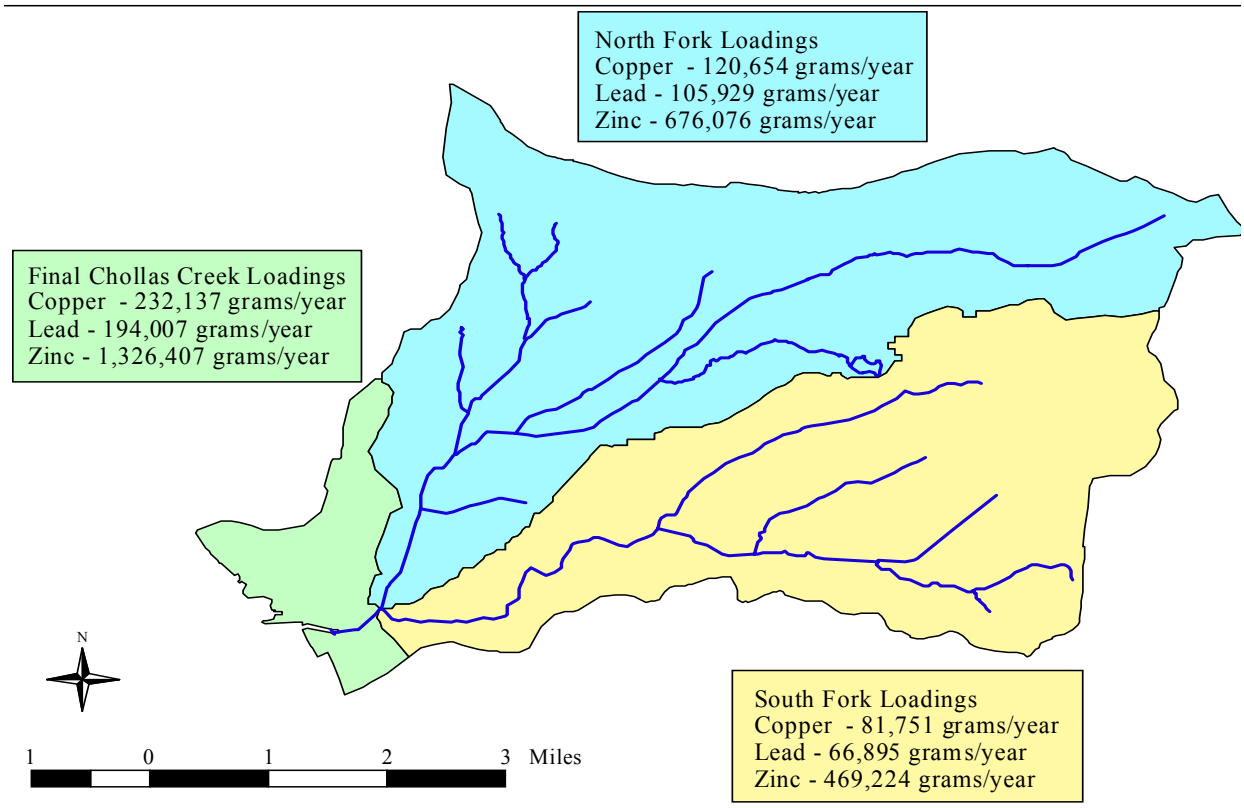

FIGURE 5.3. Average annual wet weather loads for the main branches of the Chollas Creek Watershed.

TABLE 5.4. For each metal, the top ten contributing subwatershed of mass loads relative to all thirty-seven subwatersheds.

Rank	Copper	Lead	Zinc
1	19001*	19001*	19001*
2	19020	19029	19020
3	19029	19020	19029
4	19025	19025	19027
5	19011	19011	19025
6	19027	19027	19011
7	19017	19018	19017
8	19012	19012	19012
9	19018	19017	19018
10	19005	19005	19005

**Subwatershed 19001 was assumed to drain entirely to Chollas Creek, however, portions of the watershed drain to San Diego Bay. Due to the limitations of model set-up, the watershed could only drain either to the Bay or Chollas Creek. The conservative decision was made that all drainage was to Chollas Creek.*

Relative basin-wide contributions from each land use are illustrated in Figures 5.4 through 5.6. For all three metals, freeways and commercial/institutional land uses have the highest relative loading contributions; together, these two land uses account for over 75 percent of the metal loadings. Appendix E gives average annual loadings for dissolved copper, lead, and zinc (1990 to 2003) with respect to subwatersheds and land uses and also gives subwatershed areas.

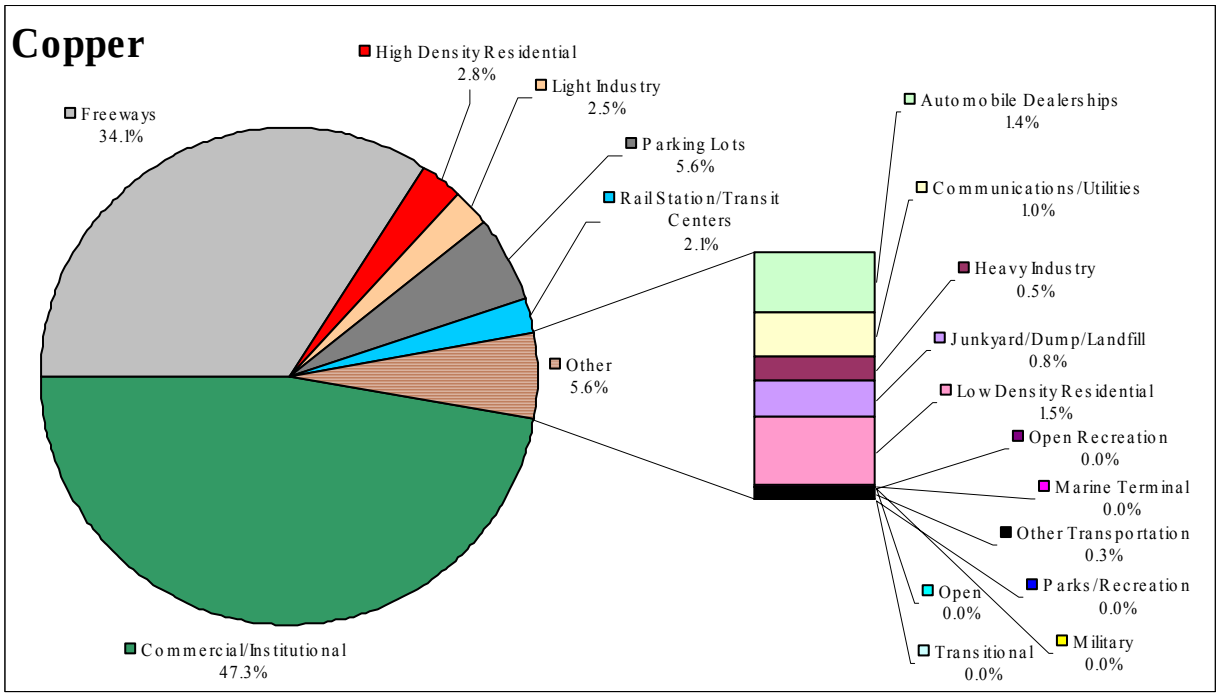

FIGURE 5.4. Basin-wide wet weather copper contributions by land use in the Chollas Creek Watershed.

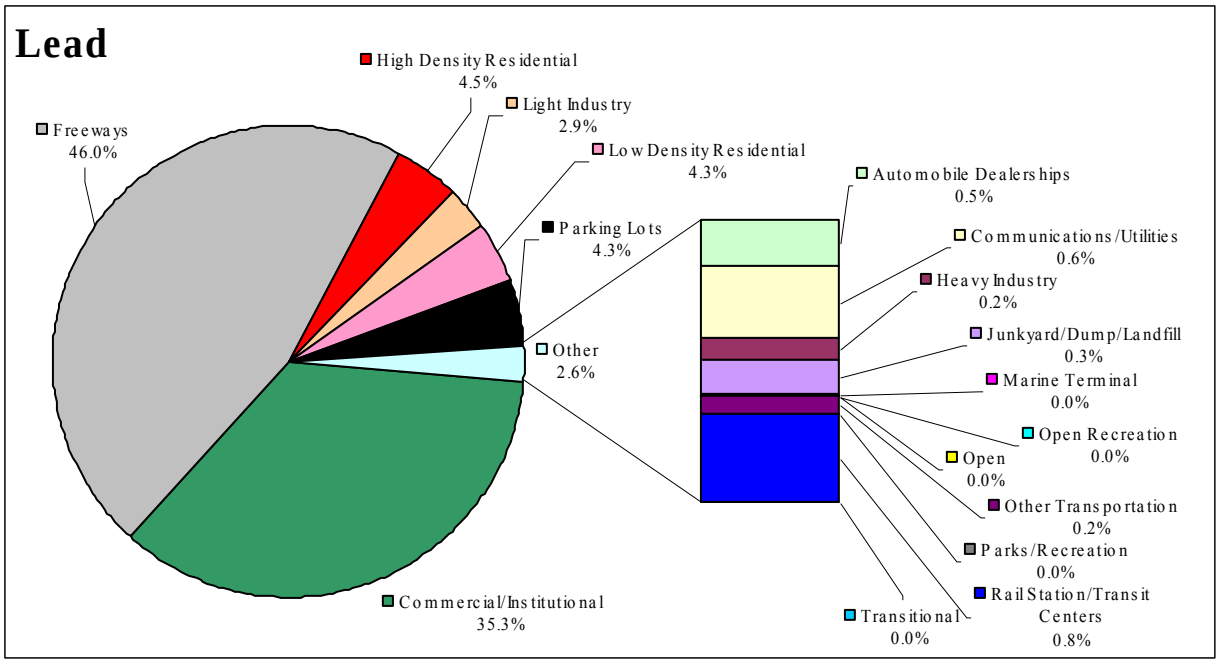

FIGURE 5.5. Basin-wide wet weather lead contributions by land use in the Chollas Creek Watershed.

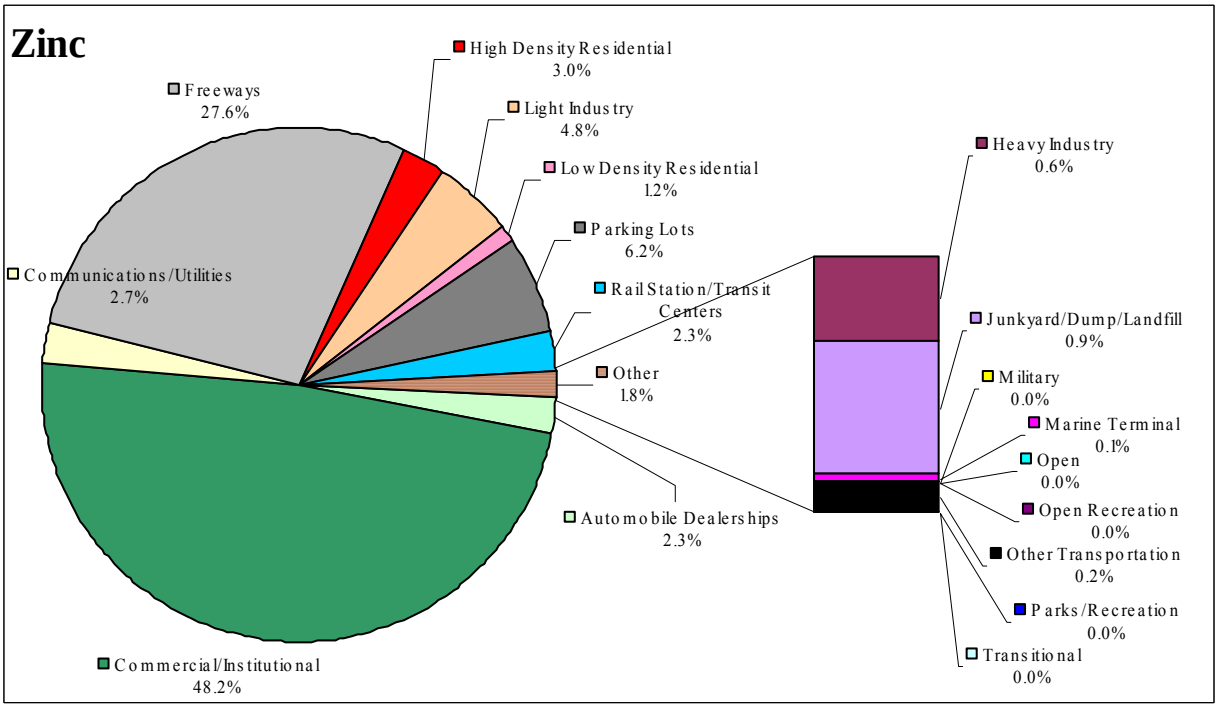

FIGURE 5.6. Basin-wide wet weather zinc contributions by land use in the Chollas Creek Watershed.

5.2.1.2 Urban Runoff from Dry Weather

During dry weather conditions, impaired streams can exhibit a sustained flow even if no rainfall has occurred for a significant period to provide runoff or groundwater flows. These flows are generally understood to result from various urban land use practices that cause water to enter storm drains and inland surface waters. Sources of urban flow in Chollas Creek include lawn irrigation runoff, car washing and sidewalk washing. Not only can these urban flows initially contain metals, they may accumulate metals as they travel across lawns and urban surfaces, transporting them to the MS4 system and thus, into Chollas Creek.

To quantify sources from runoff during dry weather, a steady state spreadsheet model was developed to estimate dry weather flow in the watershed (Appendix D). As mentioned before, because limited in-stream dry weather data were available for model calibration and validation, copper, lead, and zinc concentrations could not be simulated. Therefore, the simulated flow value was combined with average in-stream dry weather concentrations for dissolved copper, lead, and zinc to calculate estimated basin-wide existing loads for each metal (Table 5.5). Since dry weather days were selected based on the criterion that less than 0.2 inches of rain fell during the previous 72 hours, Table 5.5 values also represent the maximum loading (critical condition) during dry weather. Data limitations prohibited the calculation of land use specific loadings and more detailed analyses. Again, the dry weather contributions for each metal comprise at most 0.3 percent of the total estimated existing annual load (Table 5.2).

TABLE 5.5. Existing dry weather load (grams per year) for both typical and critical years.

Copper (dissolved)	Lead (dissolved)	Zinc (dissolved)
692	168	986

5.2.1.3 Discrepancies from Stormwater Monitoring Reports

The San Diego County dischargers regulated under Order No. R-2007-0001 (Stormwater WDR Order) are required to send in annual Stormwater Monitoring Reports containing estimates of existing metal loads from watersheds through out San Diego County, including the Chollas Creek Watershed. The method used to estimate existing metal loads in these annual monitoring reports is different than the modeling method used by Tetra Tech, Inc. for this Chollas Creek Metals TMDL project; thus, different existing metal loads are estimated from each method.

The modeling method used by Tetra Tech, Inc. incorporates a dynamic calculation of loads based on accumulated pollutants during antecedent dry conditions, amount of pollutants washed off during a rainfall event and the flow resulting from rainfall events. The Stormwater Monitoring Reports currently uses a spreadsheet to calculate loads by first estimating flow volumes based on precipitation and estimating EMCs from local monitoring and literature values. Comparatively, the modeling included a more detailed representation of the Chollas Creek Watershed, including current land use coverage,

delineated subwatersheds, soil layers and 14 years of local rainfall data, which captured a wide range of meteorological conditions.

The most likely significant difference between the approaches is the land use coverage. For instance, determining how land use impacted the loads in the spreadsheet model was difficult, because specifics were not provided in Annual Reports on the land uses draining to the mass emissions stations or how this influenced the EMC calculation. Furthermore, in order to take into account recent changes in regional land uses, the most current data were needed to populate the model (LSPC used the 2000 SANDAG coverage; Stormwater Monitoring Reports used 1990 SANDAG coverage). For these reasons, the Stormwater Monitoring Report estimates are considered less robust than the modeling estimates.

5.3 Urban Runoff Studies in Other Watersheds

Many studies have been done worldwide to identify the sources of metals in urban runoff, including several studies in California, although there is minimal information available specifically for San Diego. In this section, the general conclusions of some of these studies, applicable to Chollas Creek, are presented. The main purpose is to provide information regarding potential individual sources of metals in urban runoff and the relative contribution of each of the potential sources. This information is not intended to quantify existing loads. In later sections these studies will be referred to as support of more specific metal contributions to urban runoff from outside and inside the Chollas Creek Watershed.

5.3.1 Santa Clara Valley Study

The various sources of metals in an urban watershed were detailed in a 1992 study in Santa Clara Valley (SCV study; Woodward Clyde, 1994), an urban center located in the San Jose area near San Francisco, California. In 1997 the SCV study results were largely modified to include several more years of water quality data (Woodward-Clyde, 1997). Specifically the SCV study was performed to identify major sources of metals found in the South San Francisco Bay. Major sources of several metals, including copper, lead, and zinc, were identified and a percentage of the total annual load for each metal was attributed to each major source.

An investigation of similar detail to the SCV study has not been performed in the San Diego area. However, since both San Diego and Santa Clara are large urban centers on the west coast, some general knowledge from the SCV study can be applied to Chollas Creek. Furthermore, the SCV study estimated the nearly same magnitude of metal load per acre as did the Chollas Creek Watershed model: copper was 0.030 and 0.033 pounds per acre (lb/acre), respectively; lead was 0.026 and 0.032 lb/acre, respectively; and zinc was 0.155 and 0.186, respectively.[21] Table 5.6 list sources that comprised the top five sources of loading to South San Francisco Bay for each metal.

[21] Chollas Creek has an estimated 16,000 acres. The area draining to South San Francisco Bay has an estimated 298,000 acres. The estimate from Chollas Creek was converted to total metal concentrations by conversion factors 0.96, 0.791 and 0.978, for copper, lead and zinc, respectively.

TABLE 5.6. Top five metal sources in urban runoff, in decreasing order (SCV, 1997)

Constituent	Top Metal Sources
Copper	Brake pads, POTWs*, Natural erosion, Reservoir releases, Water supply/corrosion
Lead	Tailpipe emissions, Natural erosion, Brake pads, Reservoir releases, POTWs
Zinc	POTWs, Tires, Natural erosion, Industry with metal processes, Brake pads

*POTWs – publicly owned treatment works.

Publicly owned treatment works (POTWs) were the only identified point sources in the SCV study. All other sources were considered nonpoint sources. It is important to emphasize that POTWs, or any other point sources besides the MS4, are not present in the Chollas Creek Watershed. The Chollas Creek source analysis and the SCV study also differ in that there are no reservoirs used for potable water in the Chollas Creek Watershed. Figures 5.7 through 5.9 show the relative amounts of copper, lead, and zinc contributions for the SCV study when sources from POTWs and reservoir releases are not considered. Automotive sources are thought to be a significant source of all three metals, including brake pads, tailpipe emissions and tire-wear. Industries that have processes that expose metal to stormwater, water supply and corrosion and illegal dumping, especially of motor oil, are also sources that should be mitigated to help lower metal sources to Chollas Creek.

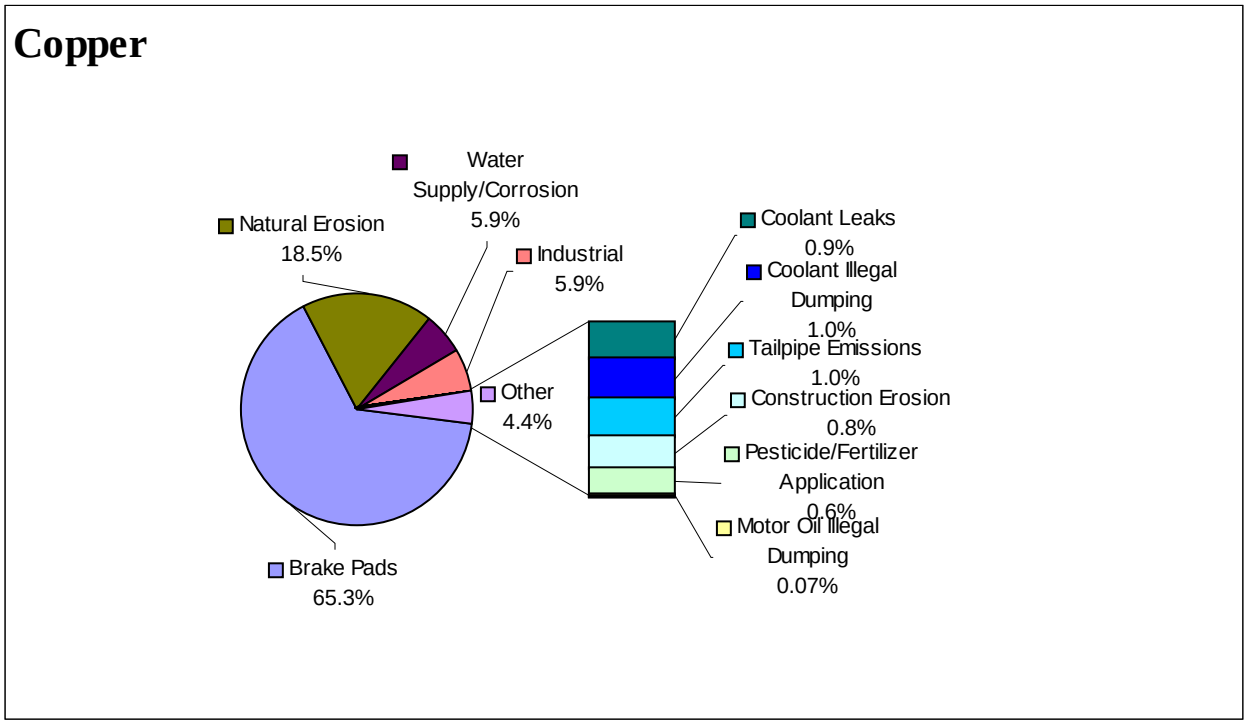

FIGURE 5.7. Relative amounts of copper loading in SCV, adjusted to omit sources from POTWs, reservoir releases and natural erosion. (Woodward Clyde, 1997)

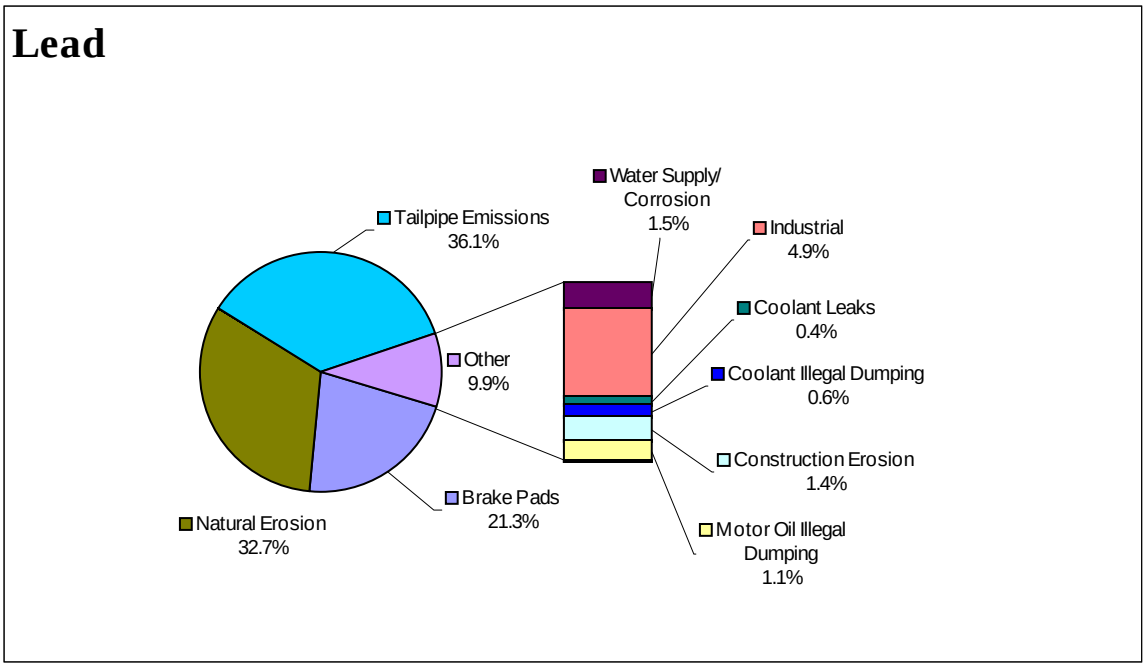

FIGURE 5.8. Relative amounts of lead loading in SCV, adjusted to omit sources from POTWs, reservoir releases and natural erosion. (Woodward Clyde, 1997)

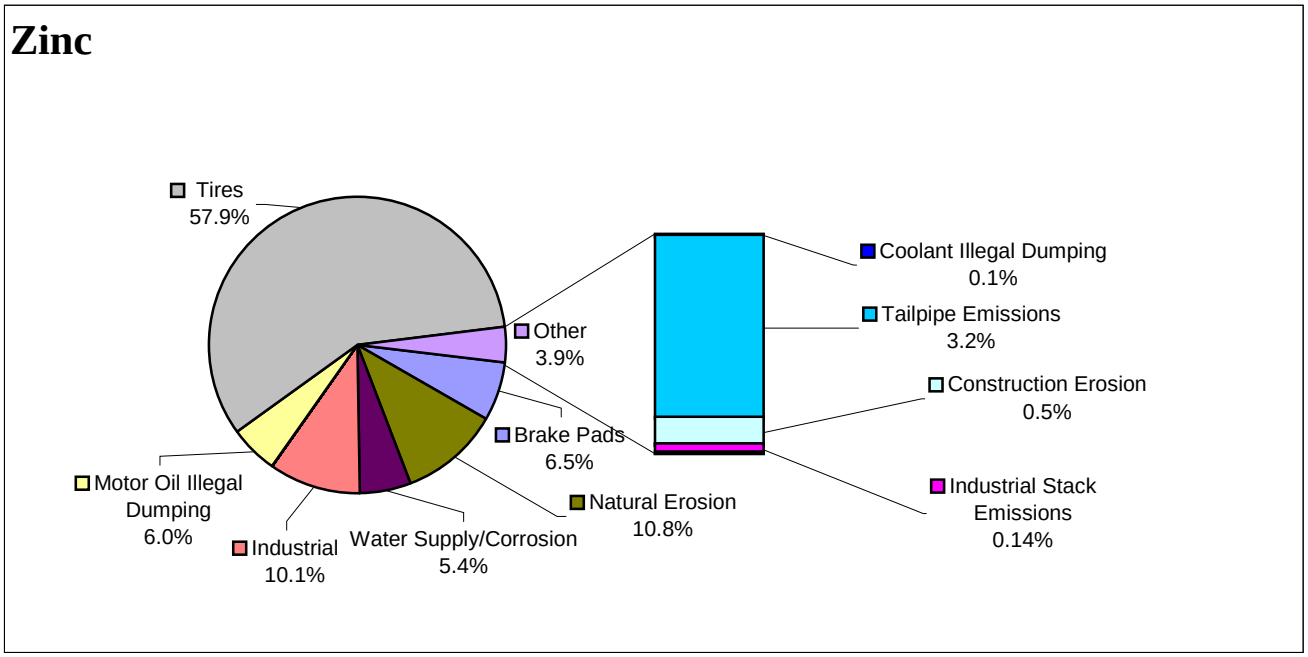

FIGURE 5.9. Relative amounts of zinc loading in SCV, adjusted to omit sources from POTWs, reservoir releases and natural erosion. (Woodward Clyde, 1997)

5.3.2 Other Studies

In addition to the SCV study, other studies in urban areas, although less extensive, have also identified many of the same sources of metals in urban runoff, further confirming them as potential sources in Chollas Creek. The USEPA (1993) and Sansalone, et al. (1997) listed many of the sources identified in the SCV study as well as new ones. Table 5.7 summarizes the following sources of copper, lead, and zinc in urban runoff (USEPA 1993; Sansalone, et al. 1997). Furthermore, Muschack (1990) identified metal sources in urban runoff from Germany that included automotive exhaust gases, tire abrasion particles, brake lining abrasion dust, lubricating oils and greases and abrasion of roadways. Also, investigations in Fresno (Brown and Caldwell, 1984) and in Santa Monica (Stolzenbach, et al. 2001), California, researched the deposition rates of atmospheric metal loads from industrial and tailpipe emissions as sources.

TABLE 5.7. Anthropogenic constituents in runoff from urban pavement. (modified from USEPA 1993)

Constituent	Primary Source
Copper	Metal plating, bearing and bushing wear, moving engine parts, brake lining wear, fungicides, insecticides
Lead	Automotive emissions, tire wear (lead oxide filler material), lubricating oil and grease, bearing wear, brake lining wear, engine wear
Zinc	Tire wear (filler material and accelerator in vulcanization process as zinc oxide 0.73%), motor oil (stabilizing additive), grease, metal plating erosion, engine wear

Source: (USEPA, 1993)

Again, general conclusions about metal sources in Chollas Creek can be made based on the similarity of the identified sources of metals in urban runoff from different areas as shown in the studies discussed above: if the major sources of metals in urban runoff were similar for different urban areas a reasonable assumption is that the same sources are present in the Chollas Creek Watershed as well. More information is needed to confirm this assumption or to quantify the amount of contributions from the different sources. The next two sections discuss potential sources from both outside and inside the Chollas Creek Watershed and confirm that many of the sources of metals in urban runoff seen in other urban areas are present in the Chollas Creek Watershed.

5.4 General Urban Runoff Sources: Background, Anthropogenic and Water Supply

The previous section identified various sources that can contribute metals[22] to urban runoff. Obviously, most of these sources cannot be pinpointed to a specific model land use category found in Section 4.2. Most sources can be ascribed to numerous land use practices and even to activity found throughout the area that encompasses a watershed. For example, atmospheric deposition may be from cars driving throughout the Chollas Creek Watershed, from equipment operating at industrial facilities within the Chollas Creek Watershed and from industrial stack emissions from facilities outside of the Chollas Creek Watershed. The sources that are found throughout the regional area are

[22] All measurements are of total metals, unless otherwise denoted as dissolved metals. TABLE 4.3 provides appropriate total to dissolved conversion factors.

addressed in this section: background, atmospheric deposition, groundwater, sediment and water supply. Background, as defined in this report, is solely the natural level of metals that would go to Chollas Creek without any influence from humans and because of this, background can also be considered a portion of the four other categories. Anthropogenic sources, as defined in this report, are from human activities throughout an area that cannot be pinpointed to a certain area, or in this case the Chollas Creek Watershed. Also, water supply is addressed in this section, because the water supply for the Chollas Creek Watershed comes from outside sources.

These categorized sources most likely enter Chollas Creek directly or indirectly through the MS4 system. As mentioned before, nonpoint sources to Chollas Creek would most likely enter through the MS4 system and thus, would become a point source. Because of this and lack of data to prove otherwise, any nonpoint source that goes directly into Chollas Creek is assumed to be comparatively insignificant. Data limitation also prevents any specific estimation of loading from these sources. Direct atmospheric deposition may be revealed as a significant source once data become available. However, other urban runoff studies have made some estimates that may provide insight into these potential nonpoint sources. The model-estimates, in a general way, capture these sources because initial land use parameters were developed from other urban studies with similar anthropogenic sources. Furthermore, the model was calibrated to observed metal concentrations in Chollas Creek, which would inherently account for all anthropogenic sources.

5.4.1 Background

Metals occur naturally and cycle by biogeochemical processes throughout the environment. Consequently, of the total metals that may be present in Chollas Creek, a fraction are likely to be from natural sources. There are no background data available for Chollas Creek and an actual quantification of background is not possible given the currently available data. However, model estimates and local reservoir data were examined in order to try to get some insight on natural background sources in the Chollas Creek Watershed.

Generally speaking, open space land uses are assumed to represent natural states of slope and vegetative cover and surface runoff from open space could account for background sources of metals. Approximately 9.73 percent of the Chollas Creek Watershed is designated as open space; however, this area likely does not represent a pristine land use. Surrounding development, urban-sourced atmospheric deposition, prior grading and non-native and invasive species all are likely to effect metal build-up and wash-off rates and surface water infiltration rates in these open spaces. Influences like these should increase metal export rates by increasing metal build-up and surface water velocity and thus, would result in higher metal concentrations than natural background. However, even with these influences, the model estimated the potential load of each metal from the open space land use to be 0.0 percent of the total existing load for each metal. According to the model, the relative contribution of metals from open space land use and thus from background, appears to be insignificant in comparison to loadings from other land uses.

Because data do not exist to determine actual background metal concentrations in Chollas Creek, data from a local reservoir were reviewed. Depending on their location and the source of water, reservoirs should theoretically contain close to background concentrations of heavy metals, because they collect surface runoff. Total metal concentrations were obtained from the City of San Diego Water Department for the Morena Reservoir between 1997 and 2003. The Morena Reservoir was chosen because it does not receive imported water and its watershed, the Cottonwood watershed, is a mainly undeveloped watershed: approximately 90 percent is undeveloped, 1 percent is residential and 8% is the Cleveland National Forest (City of San Diego, 2003). The average concentration for copper, lead, and zinc was 4.0 µg/L, 1.3 µg/L and 3.1 µg/L, respectively. Further, removing an outlier of 61.7 µg/L in the year 2000 from the data set, the average copper concentration is 1.65 µg/L.[23] These concentrations represent the initial metal load available to a treatment plant and subsequently to the Chollas Creek Watershed.

5.4.2 Atmospheric Deposition

Atmospheric deposition is another potential source of metals to Chollas Creek. Atmospheric emissions from both stationary point sources (e.g. industrial) and mobile sources, including emissions from both diesel-fueled and unleaded-fueled vehicles, enter the water bodies via direct and indirect deposition. These emissions affect rainfall and also cause settling of particulates during dry weather (Woodward-Clyde, 1992). Direct atmospheric deposition results from both wet and dry deposition directly to the surface of the water body. Indirect atmospheric deposition occurs when dissolved metals enter the watershed that drains to Chollas Creek and is therefore a component of urban runoff carried by the MS4. Topographic characteristics make indirect deposition the major component of atmospheric sources, relative to the direct deposition that may land on the surface area of Chollas Creek. Some information on atmospheric deposition follows from other urban studies. However, more site-specific information is needed to properly quantify either the direct or indirect deposition. If data are available at a future time, they may be used to further refine this analysis.

Atmospheric deposition rates of trace metals have been investigated in limited studies in California. In one Southern California study, atmospheric deposition of metals was calculated for Santa Monica Bay and the Santa Monica Bay watershed (Stolzenbach et al., 2001). Copper, lead, and zinc atmospheric deposition rates were determined through a combination of direct and indirect methods to determine contaminant loading. Researchers found that atmospheric deposition, primarily through daily dry deposition, was a significant contributor of nonpoint source pollutant loading to Santa Monica Bay.

The SCV study, previously discussed, also evaluated contributions of copper, lead, and zinc due to atmospheric emissions of particulates both from stationary and mobile sources. The study found that atmospheric emissions of copper from vehicle exhaust was largely due to diesel-fueled vehicles (Woodward-Clyde 1992) and was approximately 1 percent of the total copper load. Also, the SCV study found the largest source of lead was from tailpipe emissions and that, although it was not a top zinc source, atmospheric

[23] Nondetects were considered as on half of the DL for statistical purposes.

emissions of zinc in SCV from vehicle exhaust were largely due to both diesel fuel and unleaded fuel exhaust (Woodward-Clyde 1992). Zinc was also the only metal of the three that had industrial stack emissions as a source.

Deposition rates determined for Fresno, California may give a rough understanding of atmospheric lead loads to Chollas Creek. The dry weather lead deposition rate for Fresno was obtained from studies by the National Urban Runoff Program (NURP) and determined to be 2.22 milligrams per meter squared per month for lead (Brown and Caldwell 1984). If these results were directly applied to the Chollas Creek Watershed[24] roughly 1,740,000 g/year total metals would be the estimated load. However, this value should only be used for an illustrative purpose: Fresno and San Diego differ in climate, population, etc. Also, the reformulated gasoline (RFG) program and the Clean Air Act as amended in 1990 have since prohibited the introduction of gasoline containing lead or lead additives for commercial use as a motor vehicle fuel. The latter point suggests the lead deposition is less now than in 1984.

In fact, since the SCV and Fresno studies were performed, the USEPA has implemented the RFG program in 17 cities across the country, including San Diego, to reduce emissions of toxic pollutants (including metals) and smog forming pollutants from automobiles. Phase I of the RFG program was implemented in 1995 and Phase II began January 1, 2000. The state of California implemented its own RFG program effective in 1996 that met USEPA's Phase II requirements. Therefore, metal emissions from automobiles are expected to be less than those determined in the SCV and Fresno studies, but emissions will not decrease further with the recent implementation of Phase II since California has been meeting the Phase II requirements since 1996. Although the RFG program does not impact diesel fuel, which contributes the largest amount of metals, the effects of the program may still be measurable.

Again, because information on atmospheric deposition of metals to the San Diego Region is not currently available, more research is needed to characterize this source of loading. Perhaps in the future the model developed for Santa Monica Bay (Stolzenbach *et al.,* 2001) could be adapted to local conditions and combined with atmospheric concentrations of metals for San Diego County. At this time however, a reasonable assumption is that Chollas Creek receives significant amounts of copper, lead, and zinc from indirect deposition. These sources must travel through the MS4 to reach Chollas Creek and thus have already been accounted for. On the other hand, direct atmospheric deposition of metals is assumed to be relatively insignificant to Chollas Creek compared to other sources, in part due to the small surface area of the creek.

5.4.3 Sediment

Chollas Creek sediment likely contains metals that could become a source in a more static system. However, Chollas Creek is a highly dynamic system that ranges from low flow (dry) during the summer to high velocity and high volume flows during and shortly after storm conditions. This leads to short residence times for any sediment and associated metals within the creek. The available data support this idea (see Problem

[24] The Chollas Creek Watershed is estimated to be 6.59×10^7 meters squared.

Statement). Therefore, sediment is assumed to not reside in Chollas Creek long enough to allow metal concentrations to build to high enough levels that the sediment becomes a source to the creek.

5.4.4 Groundwater

Groundwater flows may be another source of metals to Chollas Creek. Subterranean flows may seep directly through the creek bed or surface at other points within the watershed. There are portions of Chollas Creek that are lined with concrete that forms a barrier to groundwater flow into the creek. Also there are portions of Chollas Creek were water is present even during long periods of dry weather. However, groundwater flows and their contribution to Chollas Creek are poorly characterized. Groundwater may contain naturally occurring dissolved metals concentrations, or enriched concentrations from overlying metals contaminated soils that contribute to exceedances of metals water quality objectives in Chollas Creek. Groundwater discharges to storm drains or directly to the creek provide an uninterrupted pathway for dissolved metals to reach Chollas Creek. Therefore, any discharges of groundwater in the Chollas Creek watershed are considered a source of metals and will need to be regulated.

5.4.5 Water Supply

In the San Diego Region sparse rainfall requires that approximately 90 percent of water demand be met with imported water, mostly from the Colorado River. The remainder of the water supply comes from treated runoff that is collected in reservoirs (City of San Diego, 2004). In the Chollas Creek Watershed, supply water is transported in from two treatment plants (Alvarado and Otay), which process water directly from reservoirs Murray, San Vicente, El Capitan and Otay. (None of which are located in the Chollas Creek Watershed.) The SCV study concluded that water supply was a metal source for copper, lead, and zinc, which included corrosion inhibitors, algae inhibitors and corrosion of distribution infrastructure. These sources will be discussed in this subsection as they apply to Chollas Creek.

To summarize the SCV study, several pathways were found through which tap water can eventually reach surface and ground waters, including car washing, irrigation, building and sidewalk cleaning, system overflows and hydrant flushing (Woodward-Clyde 1997). The study also estimated the amount of tap water that potentially reaches surface and ground waters and multiplied that amount by the estimated concentration of metal in tap water. Copper in the water supply was attributed to both the amount found in the source water (largely influenced by algaecide application) as well as the amount that leached into the potable water from corrosion of copper piping. Also, a large portion of the zinc loading from water was attributed to the addition of zinc orthophosphate, a corrosion inhibitor, to potable water. Other sources of zinc from the water supply included corrosion of plumbing and source water. Reservoir releases were also a significant source of all three metals in the SCV study.

5.4.5.1 Reservoir Contributions – Releases and Algaecide

There are no drinking water reservoirs within the Chollas Creek Watershed. The Chollas Reservoir is no longer an active drinking supply and drains such a small watershed that

overflows seem unlikely. Furthermore, the lake is maintained at a level to prevent spills; only normal leakage from the dam into a nearby canyon occurs to prevent the dam from breaking. No spills have been recorded since the concrete dam was built several decades ago (Chaffin pers. comm., January 2005). Therefore, reservoir releases are not considered a significant source of copper in Chollas Creek.

The algaecide copper sulfate, a potential source of copper, is applied infrequently and in small, strategic amounts in Metropolitan Water District (MWD) reservoirs (Wang pers. comm., January 2005), minimizing the amount of copper in the potable water supply from the MWD. In San Diego, no copper sulfate has been added to any of the reservoirs in the last five years except for the Miramar Reservoir, which is not located in the Chollas Creek Watershed and does not supply the plant that services the Chollas Creek Watershed population. Further, either the Alvarado or Otay Treatment Plants would treat the reservoir water before it would reach the Chollas Creek Watershed. Therefore algaecides used in the potable water supply in San Diego are assumed not to be a significant source of copper.

5.4.5.2 Treatment Plant Contributions and Corrosion Inhibitors

The San Diego Water Department does not add any corrosion inhibitors that contain heavy metals to the water supply; only sodium hydroxide is added for pH control (Chaffin pers. comm., January 2005). The pH is maintained at 8.2, which results in the water being slightly scale forming, thus reducing the amount of heavy metal corrosion in the piping. Therefore corrosion inhibitors used in the potable water supply in San Diego are assumed not to be a significant source of zinc.

The MWD, which manages the three San Diego plants including Alvarado and Otay, indicated that its effluent water generally has copper concentrations below the detection limit of 10 micrograms per liter (µg/L) (Wang pers. comm., January 2005). In addition, in 2003 the City of San Diego reported (City of San Diego, 2003) low average concentrations of copper, lead, and zinc (Table 5.8).

TABLE 5.8. Average metal concentration of treatment plant effluent in 2003.

Treatment Plant	Copper (µg/L)	Lead (µg/L)	Zinc (µg/L)
Alvarado	3.9	<2	<8
Otay	ND	<2	<8

Because the treatment plants' effluents have little detectable copper, lead, and zinc, it is concluded that water supply, up to the time it leaves the plant as effluent, is an insignificant contributor of these metals to the Chollas Creek Watershed.

5.4.5.3 Infrastructure Contributors – Water Supply from "Tap"

Corrosion of copper piping in San Diego, however, is considered a significant source of copper. In 1999 the City of San Diego performed a lead and copper household monitoring study on more than fifty homes, to measure copper and lead concentrations in household tap water (Brannian, pers. comm., July 2000). The first liter of tap water collected was after six to twelve hours of non-use of household water. The average

copper concentration for the homes was 180.7 μg/L and the average lead concentration from household taps was 2.6 μg/L. Since the copper concentrations coming from the three plants are below 50 μg/L and more likely near 10 μg/L since MWD effluent is at that level, copper plumbing corrosion in residential homes seems to add a relatively significant amount of copper, 130 μg/L to 170 μg/L, to the potable water supply. Conversely, lead concentrations coming from the three plants are below 5 μg/L and lead sources due to plumbing corrosion, seem to be very insignificant if any at all. Also, the City of San Diego does not use lead piping in its utilities, except for plumbing fixtures (City of San Diego, 2004). No results from the 1999 household monitoring study are currently available for zinc. However, more recently the 2002 City of San Diego Water Department Consumer Confidence Report (City of San Diego, 2002) reported copper sampling results at 0.346 milligrams per liter (mg/L) or 346 μg/L, lead sampling results at less that 5 μg/L and zinc sampling results at less than 50 μg/L. The 346 μg/L copper level was reported as the 90th percentile concentration.

For illustrative purposes, consider typical per capita water usage to be 65 gallons per day (Metcalf and Eddy 1991). If the population of the watershed was roughly 300,000 (SANDAG, 1999), the total water usage in the watershed would be about 20 million gallons per day (MGD). Approximately 50 percent (10 MGD) of water used will reach the wastewater system and of the remaining amount, 10 percent will reach the creek (1.0 MGD) (Woodward Clyde 1992). Since corrosion of copper piping contributes roughly 170 μg/L of copper (the more conservative estimate) and 2.6 μg/L of lead to the water supply, this source contributes approximately 235,000 g/year (100 percent of the modeled typical year) and 3,600 g/year (2 percent of the modeled typical year) to the Chollas Creek Watershed, respectively.

Although this estimate does not exactly match model estimates (likely due to differences in time, inherent uncertainties in methodology and physical interactions when potable water travels across the watershed), it does highlight the fact that a significant amount of copper may be entering Chollas Creek as urban runoff simply from the drinking water supply, which most likely results from piping infrastructure.

5.5 Urban Runoff Sources from Chollas Creek Land Use Activities

This section supplies additional detail on the land use practices that may contribute metals to Chollas Creek. The information here is gathered from the studies mentioned in section 5.3 and can be applicable to different land uses. For example, residential land use sources include application and disposal of household products such as pesticides, fertilizers, paints and maintenance and construction activities, such as remodeling, building and cleaning roofs and gutters. Some of these sources may also result from land uses such as commercial/institutional and open recreation (golf courses/cemeteries). At this time, quantitative data are not readily available to support an estimate of the loads potentially contributed by each of these sources. In the future, if data are available, adjustments to this source analysis could be made. Also, the sources of metals are not limited those listed here. These are sources that, because of other studies, are known to commonly contribute metals to urban runoff.

5.5.1 Operating Automobiles

Automotive sources (other than emissions, which were discussed in section 5.4.2) include maintenance and operation activities for automobiles and trucks, such as wear and tear on tires and brake pads and spills and leaks of fluids such as motor oil, coolants, etc. Copper and zinc are also released through the abrasion of roadways (Muschack 1990).

Brake pad wear is likely a significant urban nonpoint source of copper in Chollas Creek and to a lesser extent a source of lead and zinc. The SCV study calculated that the typical amount of copper released from a single car due to break-pad wear was 7.23 g/26,000 miles (Woodward-Clyde 1992). Brake pad wear may also be a significant source of lead and zinc in urban runoff (Sansalone 1997). Supporting information on how much copper is contained in brakes and brake equipment is also available from the Brake Pad Partnership Program's Brake Manufacturers Council Product Environmental Committee Report. Information on how much copper (or lead and zinc) ends up on the roadways and into stormwater sewers is currently not available (Connick, 2004).

Tire wear was the second largest contributor of zinc in the 1997 SCV study. Woodward-Clyde (1992) also estimated that the typical amount of zinc released per vehicle due to tire wear was 43.04 g/40,000 miles. In addition, Sansalone, et al, also found that tire wear is a potential source of copper and lead in urban runoff (1997). There are currently very limited data on how tire wear affects urban runoff, however the Rubber Manufacturer's Association is currently assisting in the data search for tire-wear emissions.

Also according to the SCV study, copper, lead, and zinc are all found in motor oil and coolants for automobiles and can potentially affect urban runoff as leaks, spills or illegal dumping. Motor oil accounts for a larger percentage of zinc's total estimated load than for copper or lead, and although relatively less significant compared to other sources, coolant was an identified source for all three metals. Coolant contains an approximate copper concentration of 76 µg/g and motor oil contains a zinc concentration of 1,060 µg/g (Shaheen 1975). In San Diego, contributions from automotive coolant leaks, coolant dumping, oil dumping and oil leaks were assumed to be less significant relative to other sources since the San Diego and the Santa Clara Valley are similar in demographics.

5.5.2 Illegal Sources

As mentioned above copper, lead, and zinc contributions from automotive coolant dumping and oil dumping are possible in the Chollas Creek Watershed. However, this TMDL will not consider allocations for dumping of coolants and motor oil into the MS4 system because dumping is illegal. Similarly, copper, lead, and zinc loads periodically occur as a result of sewage spills. All loads from sewage spills (also illegal) are assumed to receive a 100 percent reduction for implementation of the TMDL through the enforcement of existing permits.

5.5.3 Industrial Facilities

Industrial sources may also be a significant source of copper, lead, and zinc in Chollas Creek, especially facilities that handle, process, or store metals that may be exposed to rainfall. These facilities would be included in both the heavy industry and light industry land use model categories. WDRs for San Diego County municipal dischargers require municipalities, including the City of San Diego, to identify industries that threaten water quality and to require these facilities to test for and manage pollutants that are likely to reach stormwater. Further, the Industrial Storm Water General NPDES WDRs Order 97-0003-DWQ (General Industrial NPDES Requirements) is an order that regulates discharges in Chollas Creek that are associated with ten broad categories of industrial activities.

The 1992 SCV study identified industries with potential to allow metals to enter stormwater discharges and was based on professional knowledge of processes that result in metals being exposed to stormwater. Table 5.9 shows the industries that were prioritized as having the highest likelihood to discharge quantities of metals in stormwater. Because of the similarities between Santa Clara and San Diego, any of the same industries in the Chollas Creek Watershed are likely to be potential metal contributors.

TABLE 5.9. Industries with highest likelihood to discharge metals to stormwater. (SCV, 1992)

Industry	Standard Industrial Classification (SIC) Code
Mining of Miscellaneous Metal Ores	1099
Metal Plating	3471
Boat Building and Repairing	373
Industrial Machinery	355 and 356
Trucking	4212, 4213 and 4214
Metal Scrap Industry	5093
Metal Scrap Industry Combined With Used Auto Parts Sales	5015
Automotive Repair, Include Automobile Renting And Leasing	751, 7538 and 7539
Galvanizing And Metal Coating	3479

Particular industries in the Chollas Creek Watershed that may be contributing a significant amount of metals is the auto wrecking/dismantling facilities and scrap metal recycling facilities (Standard Industrial Classification [SIC] 5015 and 5093, respectively). A report completed by Sustainable Conservation in San Francisco has also identified auto wrecking/dismantling facilities and scrap metal recycling facilities as two industries that contribute metals to stormwater runoff (O'Brien, 2000). A review of discharge reports was conducted for auto wrecking/dismantling shops and scrap metal recycling facilities in the Chollas Creek Watershed and only three of approximately twenty-two facilities tested for copper, lead, and zinc in their stormwater runoff. Notably, all three facilities had fairly high concentrations of metals in their discharge. Among the three facilities, copper ranged from 72 to 500 μg/L, lead ranged from 42 to 690 μg/L and zinc ranged from 260 to 1,000 μg/L in runoff from the facilities.

5.5.4 Pesticides

Pesticides were also identified as a potential source of copper and zinc in Chollas Creek, although the SCV study only discussed copper as a source. The 2002 DPR annual report was reviewed for pesticide use in San Diego County. All applications of pesticides that contain copper or zinc are identified and listed in Table 5.10, except for applications that would not correspond with the land uses at Chollas Creek. For example, agricultural pesticide application was not given. Moreover, DPR does not report residential, or nonprofessional, use of pesticides (DPR, 2002) and according to a survey most residents in the Chollas Creek Watershed apply pesticides themselves, as opposed to hiring a professional (Willen, 2002). Only a percentage of the pesticide amount shown in Table 5.10 is actually copper or zinc and there is not enough information to quantify the actual amount of copper or zinc that would reach a water body in the San Diego County. (Chollas Creek is approximately 0.6 percent of the total area in San Diego County)[25]

TABLE 5.10. Pounds of chemicals containing copper and zinc applied in San Diego County in 2002 as reported to DPR.

Active Ingredient of Pesticide	Pounds of Chemical Applied in San Diego County	Active Ingredient of Pesticide	Pounds of Chemical Applied in San Diego County
Copper	5693	Copper 8-Quinolinoleate	10
Copper Ammonium Complex	304	Copper Sulfate (Anhydrous)	0.3
Copper Carbonate, Basic	819	Copper Sulfate (Basic)	20
Copper Ethanolamine Complexes, Mixed	182	Copper Sulfate (Pentahydrate)	2904
Copper Ethlenediamine Complex	14	Zinc Oxide	3366
Copper Hydroxide	6	Zinc Phosphide	66
Copper Naphthenate	1394	Zinc Sulfate	3
Copper Oxide (ous)	376		

Reference: (DPR Website, 2002 Report)
The chart excludes copper and zinc pesticides used in nurseries.

5.5.5 Wood Preservatives

Wood preservatives are actually pesticides that protect wood against attack by fungi, bacteria, or insects. The active ingredients found in wood preservatives may include copper or zinc. Preservatives of this sort are injected into the wood before purchase (pressure-treated wood) or applied by the user. If wood-preservative chemicals are incorporated into a paint or stain, that product is considered a pesticide and is regulated under the DPR. Wood preservatives in residential, commercial and industrial areas could also be a contributor of copper to Chollas Creek

5.5.6 Construction

Construction erosion is a potential source of metals in Chollas Creek. In California, dischargers whose projects disturb one or more acres of soil or whose projects disturb less than one acre but are part of a larger common plan of development that in total

[25] The Chollas Creek Watershed is estimated to be about 6.59 x 10^7 meters squared. According to California State Association of Counties in 2002 San Diego County is estimated to be 4,281 square miles.

disturbs one or more acres, are required to obtain coverage under the General NPDES WDRs for Discharges of Stormwater Associated with Construction Activity (Construction General NPDES WDRs, Order No. 99-08-DWQ). Construction activities regulated under these WDRs include clearing, grading and disturbances to the ground such as stockpiling or excavation. The Storm Water Construction Notice of Intent (NOI) database can be reviewed at any time to identify current construction projects underway, according to zip code, city and waste disposal identification (WDID) number. The land use percentage of land under development is estimated to be about 0.33 percent of the Chollas Creek Watershed.

5.5.7 Galvanized Metals

Galvanized chain-link fences may also contribute zinc to urban runoff. There are extensive stretches of chain-link fencing along roadways in the Chollas Creek Watershed. However, there are no known studies on the amount of zinc contributed by fencing. Zinc loads from this potential source would be estimated if relevant data become available at a later date. Also galvanized roofing materials and gutters have been found to contribute 153 µg/L and 363 µg/L of zinc to urban runoff, respectively (Woodward-Clyde, 1992).

5.5.8 Paint

A study conducted in Kentucky by the U.S. Department of Energy (Kszos, et. al., 2004) found that paint used on metal cylinders was causing toxicity to C*eriodaphnia dubia* in stormwater. Further investigation revealed that zinc was the causative agent. Similar paints are likely to be used in the Chollas Creek Watershed and should be considered as a likely source of zinc. Data are currently unavailable to quantify this potential load in the Chollas Creek Watershed. However, the SCV study estimated that residential paints contributed less than 1 percent of the total zinc load. In San Diego, contributions from residential paints are also assumed to be relatively less significant compared to other potential sources since the cities are similar in demographics.

5.5.9 Landfill

Special consideration must be paid to groundwater flows through former and active landfills and any former burn ash areas because of the increased likelihood that these areas may contribute significant amounts of metals to groundwater. There are currently no active landfills in the Chollas Creek Watershed, as indicated by the land use model results, or former burn sites. There is however a closed landfill, South Chollas Landfill, which sits adjacent to and apparently down gradient of, the Chollas Creek Reservoir in subwatershed 19022. The landfill is regulated under General WDR Order No. 97-11[26] and is required to address groundwater contamination concerns.

The landfill was closed in 1981 and annual monitoring data have been available since 1987. Samples were analyzed for copper, lead, and zinc, however, only until January 1997. The San Diego Basin Plan does not designate any beneficial uses for the groundwater in the 908.20 hydrologic area. Subsequently, the Basin Plan does not list WQSs applicable to the groundwater under the South Chollas Landfill. Furthermore,

[26] Order No. 97-11, *General Waste Discharge Requirements for Post-Closure Maintenance of Inactive Nonhazardous Waste Landfills within the San Diego Region.*

since hardness analyses were not performed, comparison of metal concentrations to surface water CTR criteria is not possible. The ultimate fate of groundwater at the most down gradient well at the landfill is unknown. Local geology may bring the water to the surface such that leachate would reach Chollas Creek as surface flow and come under the jurisdiction of the MS4. Also, the Chollas Creek Reservoir may be impacting groundwater through artificial recharge, which has caused higher groundwater levels in the vicinity of the landfill site. Reservoir leakage could be passing through the closed landfill and carrying metals and other pollutants down to the creek. However, the available data do not allow for reservoir leakage to be quantified.

Until further information is available, the South Chollas Landfill and the Chollas Reservoir are considered only as potential sources of metals to Chollas Creek. This designation has no bearing on the load and waste load allocations of this TMDL but is useful information when considering metal loading reduction scenarios. If the landfill is determined to be a source of metals, appropriate corrective actions will be required of the discharger responsible for the landfill to be consistent with the allocations of this TMDL.

5.6 Summary of Sources

Modeling efforts (Appendix D) have identified freeways and commercial/ institutional land uses as having the highest relative loading contributions of copper, lead, and zinc to Chollas Creek. Together, these two land uses account for over 75 percent of the predicted metal loadings. The model gives an estimate of the magnitude and location of copper, lead, and zinc in the Chollas Creek watered. Additionally, other watershed studies outside Chollas Creek have identified individual sources of copper, lead, and zinc likely to be present in the Chollas Creek Watershed, including many aspects of automobile operations, water supply systems, pesticides, industrial metal recyclers and other suspected significant sources to Chollas Creek.

More data are needed to better understand the impacts these suspected sources have on concentrations of copper, lead, and zinc in Chollas Creek. Additional information is needed to properly populate the watershed model to more accurately describe dry weather loadings. Local data are also needed to quantify other sources and should be collected under Order No. R9-2007-0001 (as amended) to be consistent with the load and wasteload allocations of this TMDL. The San Diego Water Board may also use its authority under the California Water Code to require the collection and reporting of the necessary information. However, the current modeling efforts effectively quantify and identify the land uses that are considered to be the biggest contributors of copper, lead, and zinc to Chollas Creek. The land uses and subwatersheds that contribute more than the others may be targeted during implementation planning and load reduction scenarios. Furthermore, the specific suspected sources of metals, as identified in watershed studies from other regions, will be helpful in targeting practices that may be amenable to load reduction scenarios.

6 Linkage Analysis

The TMDL technical report must estimate total assimilative capacity (loading capacity) of Chollas Creek for the metals and describe the relationship between Numeric Targets and identified metal sources [40 CFR 130.7 (d) and 40 CFR 130.2 (i) and (f)]. Collectively, these requirements are termed the linkage analysis and provide the necessary quantitative link between the TMDL and attainment of WQSs.

The total assimilative capacity, or loading capacity, is the maximum amount of pollutant that a water body can assimilate while maintaining WQSs. The loading capacity is also a function of different hydrodynamic processes that affect the environmental fate and transport of dissolved metals as they move through the system. At Chollas Creek, the loading capacity for each metal is estimated to be equal to its respective Numeric Target. Per the Numeric Target's basis on CTR (see Numeric Target section), these loading capacities will attain WQSs, because the Numeric Targets are at a minimum to be protective of aquatic life and are thus conservatively considered the total loading capacity for Chollas Creek. Also, because the loading capacity is equated to the Numeric Target, the hydrodynamic processes are not quantified. In-stream processes, such as binding to organic material, are thought to only decrease the dissolved metals' concentration in Chollas Creek and are, thus, considered an implicit MOS. Table 6.1 presents the loading capacities for the dissolved metals copper, lead, and zinc.

TABLE 6.1. Dissolved metals loading capacities for acute and chronic conditions.

Metal	Loading Capacity for Acute Conditions – One-Hour Average[1]	Loading Capacity for Chronic Conditions – Four-Day Average[1]
Copper	(0.96) * {e^ [0.9422 * ln (hardness) - 1.700]}	(0.96) * {e^[0.8545 * ln (hardness) - 1.702]}
Lead	[1.46203 – 0.145712 * ln (hardness)] * {e^ [1.273 * ln (hardness) - 1.460]}	[1.46203 – 0.145712 * ln (hardness)] * {e^[{1.273 * ln (hardness)} - 4.705]}
Zinc	(0.978) * {e^ [0.8473 * ln (hardness) + 0.884]}	(0.986) * {e^[0.8473 * ln (hardness) + 0.884]}

The natural log and exponential functions are represented as "ln" and "e", respectively.
[1] These equations are also the numeric targets and CTR WQOs.

These loading capacities, which are equal to the Numeric Targets, will apply to the entirety of Chollas Creek and during all times of the year. Each of the land uses identified in the Source Analysis portion of this TMDL will not be allowed to have runoff that causes in-stream waters to exceed these concentrations. Further more, all other sources of copper, lead, and zinc to Chollas Creek will be expected to not cause the creek to exceed these loading capacities. Once these capacities are achieved, it is expected that Chollas Creek copper, lead, and zinc concentrations will be protective of the creek's beneficial uses.

A concentration-based approach was chosen to link the Numeric Targets with the largest identified metal source -- urban runoff. This approach is considered more appropriate

than a mass-based approach, because not only does it take into account the dynamic nature of urban runoff, which is greatly affected by stormwater, but it also accommodates the dynamic nature of freshwater systems that have a myriad of flow and hardness conditions. Metals concentrations are also generally easier to monitor; however, hardness measurements will also be needed and sampling will need to be done in accordance with Table 4.2.

In addition, a mass-based approach would be more sensitive to concerns of accumulated bottom sediment in fresh water bodies and down stream sediment toxicity. However, as discussed in the Source Analysis (section 5), sediment is not considered a source of metals due to the nature of Chollas Creek and due to low sediment toxicity results. In addition, downstream sediment toxicity is to be addressed in a separate TMDL once adequate data are collected and applicable models are developed for the Chollas Creek Watershed.

7 Margin of Safety

The TMDL must contain a MOS to account for uncertainty in the analysis. The MOS for Chollas Creek is explicit as well as implicit. The explicit MOS was calculated by taking 10 percent of the total loading capacity as generated from the CTR equation, using the currently sampled hardness concentration. This 10 percent amount is essentially reserved: It is not available for waste load allocation or load allocation and therefore makes these allocations smaller and thus, more protective. For example, if the CTR equation, using the currently sampled hardness concentration, calculated a loading capacity of 106 kg Cu/L, then 10 percent or 11 (kg Cu/L) would be allocated to the MOS. Therefore, the waste load allocation and load allocation together would have to be equal to 95 kg Cu/L/year (106 kg Cu/L minus 11 kg Cu/L). This reservation is to account for (1) uncertainty associated with the calculations in the source analysis and linkage analysis, (2) any difference between total metal concentrations and dissolved[27] or assumed bioavailable, metal concentrations and (3) the uncertain effects that default, or non site-specific, CTR values had on the TMDL loading capacity.[28]

Using actual hardness values in the CTR equation in order to calculate TMDLs is an implicit MOS. The other alternative was to use an estimated hardness value from a model, a flow-correlation, or an average from past data. Because past data were very limited, an estimated hardness would in itself have a great amount of uncertainty and this uncertainty would be incorporated into the TMDL concentration if an estimated hardness would be used in the CTR equation. Also, although not an MOS by definition, the derivation of the CTR's criteria maximum concentration (CMC) takes safety into account, because it divides the Final Acute Value, determined from laboratory acute toxicity concentrations, by a safety factor of two (Stephan, 1985). In summary, staying as close as possible to the CTR definition gives assurance that the TMDL is a conservative, defendable value.

Another implicit MOS is not allowing for metal interactions with anions and negatively charged sites on particulates when calculating the loading capacity and allocations. Theoretically, an increase in bioavailability from these types of chemical interactions in water would only take place in waters with low pH levels. The increased aqueous acidity (low pH levels) would yield higher levels of free metal ions and thereby increase bioavailability to aquatic organisms. Such low pH levels in ambient waters are more likely to be observed in areas of high acid rain; these low pH conditions are not likely in San Diego. Therefore, metal interactions with negatively charged anions and particles within the water are assumed to only decrease bioavailability. Not allowing for this interaction makes the TMDL concentration more conservative.

---

[27] Although dissolved concentration is the most appropriate value to use for metals [40 CFR 131], any additional concern is addressed by the 10 percent MOS.

[28] The 10 percent MOS helps account for any additional uncertainties in calculating the Load and Waste Load Calculations due to use of the CTR default conversion factors and water effect ratio. Although CTR's guidance was strictly followed (when there is not enough site-specific data default values are used) there may remain a chance that if the data were available, these site-specific values would result in a more stringent TMDL concentration than the default values. Additional studies may also be preformed in the future to create site-specific values (Appendix H).

8 TMDL and Allocations

The TMDL must be less than or equal to the loading capacity after taking into account allocations to all sources. The TMDL is the combination of a total wasteload allocation (WLA) that allocates loadings for point sources, a total load allocation (LA) that allocates loadings for nonpoint sources and background sources and a MOS that may either explicitly reserve an allocation for or implicitly account for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. In this TMDL, 10 percent of the load is reserved for an MOS, or not allocated to sources, in order to account for identified uncertainties in the TMDL in addition to conservative assumptions made in the TMDL analysis (Margin of Safety Section).

In TMDL development, allowable WLA and LA from pollutant sources that cumulatively amount to no more than the TMDL must be established; this provides the basis to establish water quality-based controls. TMDLs can be expressed on a mass loading basis (e.g., grams of pollutant per year) or as a concentration in accordance with provisions in federal regulations [40 CFR 130.2(l)]. In addition, TMDLs and associated WLA and LA must be expressed in quantitative terms [40 CFR 130.2 (e-i) and 40 CFR 130.7 (c)]. For Chollas Creek, the WLAs and LAs and consequently the TMDL, are expressed as a concentration. This decision was made based on the concentration-based approach and quantitative linkage analysis. (See section 6.0, Linkage Analysis) In addition, the concentration-based TMDL will account for any future point or nonpoint sources, because any future sources will also be required to be below the same concentration.

Mass-based TMDLs typically are described by the following equation:

$$TMDL_{mass} = \Sigma\ WLAs + \Sigma\ LAs + MOS$$

However, in concentration-based TMDLs, the allocations are not additive. Additionally, the allocation concentrations for point sources (WLAs), and nonpoint and background sources (LAs) will be equivalent for each metal. Thus, only one term is needed in the equation for the allocations. Because significant nonpoint sources and background sources were not identified in the Chollas Creek watershed, the WLA term was retained in the equation and the LA term dropped. The MOS also is not additive in concentration-based TMDLs. As described previously, the MOS is incorporated into the WLAs, rather than added to them. This reduces the equation to:

$$TMDLs_{conc} = WLAs$$

The explicit MOS reserves 10 percent of the allocation and is incorporated into the WLAs by setting them equal to 90 percent of the loading capacity. Because the loading capacities are equal to the numeric targets, which are equal to the CTR WQOs, the TMDLs are equal to 90 percent of the CTR WQO concentrations. In other words:

CTR WQOs = Numeric Targets
Numeric Targets = Loading Capacities
WLAs = Loading Capacities * 0.9

Substituting CTR WQOs for Loading Capacity results in:

TMDLs = WLAs = CTR WQOs * 0.9

The hardness-based equations for calculating TMDL concentrations are shown in Table 8.1. The sampling requirements for calculating TMDL concentrations are given in Table 4.2.

TABLE 8.1. The Total Maximum Daily Load (TMDL) for dissolved copper, lead, and zinc for acute and chronic conditions

Metal	TMDL for Acute Conditions – One-Hour Average	TMDL for Chronic Conditions – Four-Day Average
Copper	(0.96) * {e^ [0.9422 * ln (hardness) - 1.700]}*0.9	(0.96) * {e^[0.8545 * ln (hardness) - 1.702]}*0.9
Lead	[1.46203 – 0.145712 * ln (hardness)] * {e^ [1.273 * ln (hardness) - 1.460]} * 0.9	[1.46203 – 0.145712 * ln (hardness)] * {e^[{1.273 * ln (hardness)} - 4.705]} * 0.9
Zinc	(0.978) * {e^ [0.8473 * ln (hardness) + 0.884]} * 0.9	(0.986) * {e^[0.8473 * ln (hardness) + 0.884]} * 0.9

If all copper, lead, and zinc concentrations in urban runoff to Chollas Creek meet their respective TMDL concentrations, the loading capacity of the creek should not be exceeded.

8.1 Wasteload Allocations

Federal regulations [40 CFR 130.7] require TMDLs to include individual WLAs for each point source discharge. The point sources that could affect Chollas Creek are the MS4 discharges, stormwater discharges from industrial sites, and discharges of extracted groundwater. Order No. R9-2007-0001 for San Diego County covers the entire Chollas Creek Watershed, including the creek itself and regulates all wet and dry weather runoff that enters the creek through the stormwater conveyance system. All other existing WDR orders applicable to regulating metal sources regulate discharges that reach Chollas Creek directly through the MS4 system. For example, the stormwater WDR order for Caltrans (Order No. 99-06-DWQ) regulates freeway runoff that flows into the MS4 system. A full list of the existing WDR orders applicable to this TMDL is discussed in the Source Analysis section (section 5.0). All point source discharges to Chollas Creek are expected to achieve this WLA.

Modeling results, also discussed in the Source Analysis section, demonstrate the possible land use specific and sub-watershed specific contributions of copper, lead, and zinc. However because this WLA is concentration-based it will apply to each land use and each sub-watershed at all times and will not be specific to any land use or sub-watershed.

Therefore, the model predictions of the relative metal contribution from each category will be useful in targeting problem areas during implementation.

8.2 Load Allocations

The LAs are assigned to nonpoint sources and natural background sources in the watershed. Background sources can include air deposition of metals in the watershed and any groundwater contributions. Because of the regulatory definition of the MS4 system, all source (point and nonpoint sources) contributions of metals to Chollas Creek come via the MS4 and are therefore accounted for in the allocation assigned to the MS4s. The only other possible sources that may end up directly in Chollas Creek would be direct air deposition and groundwater, which may or may not include anthropogenic sources. As discussed in the Source Analysis section, these two sources are not considered significant at this time. These sources may be re-evaluated at a future date if any additional data become available. Currently, the sources contributing to the LAs not accounted for in the WLA assigned to the MS4s are considered to be relatively insignificant. Thus, in the TMDL calculation, the LAs are equal to zero, and the TMDL calculations are equal to the WLAs.

9 Seasonal Variations and Critical Conditions

In accordance with federal regulations [40 CFR 130.7(c)], a TMDL must consider seasonal variations and critical conditions (e.g. stream flows, pollutant loadings and other water quality parameters). A flow-based approach was used for the Chollas Creek Metals TMDL, and defines critical conditions solely based on freshwater flow rates regardless of season. No matter the time of year or situation, toxicity allocations that are based on the CTR equations will be required throughout all segments of Chollas Creek and therefore, by definition, will always be protective of aquatic life.

Furthermore, the flow-based approach is appropriate because the main sources of metal accumulation in the Chollas Creek Watershed are non-seasonal (e.g. automobile wear, exhaust emissions, industry contributions). Urban runoff, which is the main mechanism by which these accumulated metals reach Chollas Creek, can occur in both dry and wet weather. As explained previously, urban runoff is a combination of non-stormwater flows (e.g. car washing, lawn watering) during dry weather and stormwater flows during wet weather. Because the climate in southern California can be described as dry weather most of the year and intermittent wet weather events throughout the year, wet weather and dry weather are also most easily characterized by precipitation flow rates as opposed to being characterized by season. To further address these differences, both the CMC and CCC equations are used for determining a metal's allocation in order to be protective for both acute and chronic conditions.

The allowable concentration will be determined with hardness values measured at the time of compliance. These data will provide a direct measure of any seasonal variations and/or critical conditions effects on hardness. Since hardness is an essential component of the LA and WLAs, seasonal variations and/or critical conditions will be covered by this TMDL. This method of using sampled hardness as the variable instead of an estimated hardness, will account for these effects because it is an absolute representation of current conditions and thus will account for any effects that may be caused by seasonal variations or extreme conditions. Other stream chemistry, which may or may not be a function of seasonal variations and critical conditions, were not taken into consideration as an implicit MOS and will therefore not have a bearing, with respect to seasonal variations and critical conditions, on the TMDL.

10 Legal Authority

This section presents the legal authority and regulatory framework used as a basis for assigning responsibilities to dischargers to implement and monitor compliance with the Chollas Creek Metals TMDL. The laws and policies governing point source[29] discharges are described below. Non-point source discharges are not discussed because these discharges are negligible in the Chollas Creek watershed, and did not receive load allocations or reductions. Discharger accountability for attaining metals wasteload allocations is established. The legal authority and regulatory framework is described in terms of the following:

- Controllable water quality factors;
- Regulatory background; and
- Persons accountable for point source discharges

10.1 Controllable Water Quality Factors

The Chollas Creek watershed lies within the Pueblo 908.00 Hydrologic Unit. The vast majority of metals are transported from sources to Chollas Creek from wet and dry weather runoff generated from human habitation and land use practices, and to a lesser extent, direct atmospheric deposition. Construction, maintenance, and operation of state-owned highways are also sources of metal discharges to Chollas Creek. These metal discharges result from controllable water quality factors which are defined as those actions, conditions, or circumstances resulting from man's activities that may influence the quality of the waters of the state and that may be reasonably controlled. This TMDL project establishes wasteload allocations for these controllable discharges.

10.2 Regulatory Background

CWA section 402 establishes the NPDES Program to regulate the ‘‘discharge of a pollutant,’’ other than dredged or fill materials, from a ‘‘point source’’ into ‘‘waters of the U.S.”[30] Under section 402, discharges of pollutants to waters of the U.S. are authorized by obtaining and complying with NPDES permits. These permits commonly contain effluent limitations consisting of either Technology Based Effluent Limitations (TBELs) or Water Quality Based Effluent Limitation (WQBELs). TBELs represent the degree of control that can be achieved by point sources using various levels of pollution control technology that are defined by the USEPA for various categories of discharges and implemented on a nation-wide basis.

---

[29] The term ‘‘point source’’ is defined in Clean Water Act section 502(6) to mean any discernible, 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, or vessel or other floating craft, from which pollutants are or may be discharged. This term does not include agricultural storm water discharges and return flows from irrigated agriculture.

[30] See federal regulations [40 CFR section 122.2(c)(e)]. The USEPA has interpreted “waters of the United States” to include “intrastate lakes, rivers, streams (including intermittent streams) . . . the use, degradation, or destruction of which would affect or could affect interstate or foreign commerce,” and “tributaries of [those] waters.” Chollas Creek is a water of the United States.

TBELs may not be sufficient to ensure that water quality standards will be attained in receiving waters. In such cases, NPDES regulations require the San Diego Water Board to develop WQBELs that derive from and comply with all applicable WQSs. If necessary to achieve compliance with the applicable WQSs, NPDES requirements must contain WQBELs more stringent than the applicable TBELs [CWA 303 (b)(1)(c)] [40 CFR 122.44(d)(1)]. WQBELs may be expressed as numeric effluent limitations or as BMP development, implementation and revision requirements. Numeric effluent limitations require monitoring to assess load reductions while non-numeric s provisions, such as BMP programs, require progress reports on BMP implementation and efficacy.

In California, state Waste Discharge Requirements (WDRs) for discharges of pollutants from point sources to navigable waters of the U.S. that implement federal NPDES regulations serve in lieu of federal NPDES permits. Such WDRs are issued by the state pursuant to independent state authority (not authority delegated by the USEPA or derived from the Clean Water Act).[31]

Within each TMDL, a "wasteload allocation"[32] is determined which is the maximum amount of a pollutant that may be contributed to a waterbody by "point source" discharges of the pollutant in order to attain and maintain WQOs. WDRs implementing NPDES regulations must include conditions that are consistent with the assumptions and requirements of the wasteload allocation. The principle regulatory means of implementing TMDLs for point source discharges regulated under these types of WDRs are:

- Allocate the total wasteload allocation calculated for point source facilities among each individual NPDES point source facility that is discharging the pollutant that needs to be controlled;

- Evaluate whether the effluent limitations or conditions within the WDRs implementing NPDES regulations are consistent with the wasteload allocations. If not, incorporate WQBELs that are consistent with the wasteload allocations into the WDRs[33] or otherwise revise the WDRs to make them consistent with the assumptions and requirements of the TMDL wasteload allocations.[34] A time schedule to achieve

[31] Pursuant to Chapter 5.5 of the Porter-Cologne Act, in order to avoid the issuance by the USEPA of separate and duplicative NPDES permits for discharges in California that would be subject to the Clean Water Act, the State's WDRs for such discharges implement the NPDES regulations and entail enforcement provisions that reflect the penalties imposed by the Clean Water Act for violation of NPDES permits issued by the USEPA.

[32] See federal regulations [40 CFR section 130.2(h)]. A wasteload allocation is the portion of the receiving water's loading capacity that is allocated to one of its existing or future point sources of pollution.

[33] In the case of WDRs implementing NPDES regulations, WQBELs may include best management practices that evidence shows are consistent with the wasteload allocation.

[34] See federal regulations [40 CFR section 122.44(d)(1)(vii)(B)]. NPDES water quality-based effluent limitations must be consistent with the assumptions and requirements of any available TMDL wasteload allocation. The regulations do not require the WQBELs to be identical to the wasteload allocation. The regulations leave open the possibility that the San Diego Water Board could determine that fact-specific circumstances render something other than literal incorporation of the wasteload allocation to be consistent

compliance should also be incorporated into the WDRs in instances where the discharger is unable to immediately comply with the required wasteload reductions;

- Mandate discharger compliance with the wasteload allocations in accordance with the terms and conditions of the revised WDRs;

- Implement a monitoring and/or modeling plan designed to measure the effectiveness of the controls implementing the wasteload allocations and the progress the waterbody is making toward attaining WQOs; and

- Establish criteria to determine that substantial progress toward attaining water quality standards is being made and if not, the criteria for determining whether the TMDLs or wasteload allocations need to be revised.

10.3 Persons Responsible for Point Source Discharges

For Chollas Creek, all metal loading essentially comes to the creek through the MS4s within the watershed. MS4 discharges are point source discharges because they are released from channelized, discrete conveyance pipe systems and outfalls. Background loads and loads from air deposition are negligible compared to the loads delivered from the MS4s as discussed in section 5. Discharges from MS4s to navigable waters of the U.S. are considered to be point source discharges and are regulated in California through the issuance of WDRs that implement NPDES regulations. Persons owning and/or operating MS4s tributary to Chollas Creek include Caltrans, the cities of San Diego, Lemon Grove, and La Mesa, San Diego County, the San Diego Unified Port District, and the Navy.

The following discussion describes the persons responsible for actual or potential MS4 point source discharges of metals to the Chollas Creek watershed. These dischargers have specific roles and responsibilities assigned to them for achieving compliance with the metals wasteload allocations described in section 11.0, Implementation Plan.

10.4 California Department of Transportation

Caltrans is responsible for the design, construction, maintenance, and operation of the California State Highway System, including the portion of the Interstate Highway System within the state's boundaries. The roads and highways operated by Caltrans are legally defined as MS4s and discharges of pollutants from Caltrans MS4s to waters of the U.S., such as Chollas Creek, constitute a point source discharge that is subject to regulation under WDRs implementing federal NPDES regulations.

---

with the TMDL assumptions and requirements. The rationale for such a finding could include a trade amongst dischargers of portions of their load or wasteload allocations, performance of an offset program that is approved by the San Diego Water Board, or any number of other considerations bearing on facts applicable to the circumstances of the specific discharger.

Discharges of storm water from the Caltrans owned right-of-ways, properties, facilities, and activities, including storm water management activities in construction, maintenance, and operation of state-owned highways are regulated under Order No. 99-06-DWQ.[35] Caltrans is responsible, under the terms and conditions of these WDRs, for ensuring that its operations do not contribute to violations of water quality objectives in Chollas Creek.

Caltrans is a point source discharger of metals to Chollas Creek. Caltrans discharges storm water runoff containing metals from Interstates-5, 15 and 805 freeway surfaces, and State Highway 94 freeway surfaces and adjacent land areas via a storm drain system. Stormwater runoff from highways can contain pollutants, including metals, from vehicle exhaust and atmospheric deposition. These discharges are contributing to the exceedances of the metals water quality objectives in Chollas Creek.

10.5 Cities of San Diego, Lemon Grove, and La Mesa, San Diego County, and the San Diego Unified Port District

The Municipal Dischargers discharge urban runoff to Chollas Creek via MS4s that are regulated under WDRs prescribed in Order No. R9-2007-0001.[36] Under the terms and conditions of this Order, the Municipal Dischargers are responsible for controlling all storm and non-storm water flows (i.e., urban runoff) that are transported through their respective MS4s to surface waters.

The Municipal Dischargers are point source dischargers of metals to Chollas Creek. Metals are present in stormwater and urban runoff from commercial/industrial and transportation land use activities within these jurisdictions. Metal-laden stormwater and urban runoff are discharged to Chollas Creek via the MS4s. These discharges are contributing to the exceedances of the metals water quality objectives in Chollas Creek.

10.6 U.S. Navy

There is a small portion of the Chollas Creek watershed, immediately adjacent to San Diego Bay, which is under the jurisdiction of the Navy. Naval Station San Diego west of Harbor Drive[37] appears to drain directly to San Diego Bay, and if so, does not contribute metals to Chollas Creek. However, east of Harbor Drive, facility MS4s discharge into Chollas Creek.

---

[35] *Order No. 99-06-DWQ, NPDES No. CAS000003, National Pollutant Discharge Elimination System (NPDES) Permit Statewide Storm Water Permit and Waste Discharge Requirements (WDRs) for the State of California, Department of Transportation (Caltrans).*

[36] Order No. R9-2007-0001, *Waste Discharge Requirements for Discharges of Urban Runoff from the Municipal Separate Storm Sewer Systems Draining the Watersheds of the County of San Diego, the Incorporated Cities of San Diego County, and the San Diego Unified Port District*, NPDES No. CAS0108758

[37] These lands are regulated under Order No. R9-2003-0265, NPDES Permit No. CA0107867, *Waste Discharge Requirements for U.S. Navy Graving Dock Located at Naval Station San Diego* and Order No. R9-2002-0169, NPDES Permit No. CA0109169, *Waste Discharge Requirements for U.S. Navy Base San Diego*.

A statewide order prescribing general WDRs for discharges from small MS4s[38] regulates urban runoff not covered by the San Diego Water Board's phase I MS4 WDRs (Order No. R9-2007-0001), including discharges from MS4s on military bases. The Navy's discharge from its MS4 into Chollas Creek can be regulated by enrolling this facility under the statewide order.

10.7 Persons Discharging Stormwater Regulated Under Statewide General NPDES WDRs

Industrial facilities, construction sites, and utility vaults generate stormwater that can be discharged to Chollas Creek via the MS4s. Stormwater discharges from industrial facilities, construction sites, and utility vaults in the Chollas Creek watershed are regulated under statewide general NPDES WDRs prescribed in Order No. 99-08-DWQ, Order No. 99-08-DWQ, and Order No. 2001-11-DWQ, respectively.[39]

Stormwater discharges from industrial sites in Chollas Creek watershed may contain dissolved metals concentrations that contribute to exceedances of metals water quality objectives in Chollas Creek. Therefore, Chollas Creek watershed enrollees under the Industrial Stormwater WDRs are responsible for potential MS4 point source discharges of metals to Chollas Creek.

The principal pollutants of concern for construction site stormwater discharges are sediment and total suspended solids, however, air-deposited metals, and metals deposited from equipment operation can wash off construction sites in stormwater and be discharged to the MS4s. Therefore, Chollas Creek watershed enrollees under the Construction Stormwater WDRs are responsible for potential MS4 point source discharges of metals to Chollas Creek

For utility vault discharges, the principal pollutants of concern are total suspended solids, oil and grease. Utility vaults are typically located beneath sidewalks rather than roads. Storm water leaking into a utility vault from a sidewalk is not likely to contain significant metals concentrations because of the lack of contact between sidewalks and cars. However, air deposited metals can be washed off into utility vaults and groundwater seeping into a utility vault may contain elevated levels of metals. Nonetheless, a WLA is not assigned to these discharges because they make up an extremely small volume of

[38] State Water Board Water Quality Order No. 2003-0005-DWQ, NPDES General Permit No. CAS000004, *Waste Discharge Requirements for Storm Water Discharges from Small Municipal Separate Storm Sewer Systems*.

[39] Order No. 97-03-DWQ NPDES No. CAS 000001, *Waste Discharge Requirements for Discharges of Storm Water Associated with Industrial Activities Excluding Construction Activities*. Active enrollees in the Chollas Creek watershed include A to Z Auto Dismantling, IMS Recycling Services, Mini Trucks and Cars, Trolley Auto Parts, Able Auto Wrecking, Pacific Coast Recycling- Always Recycling.
Order No. 99-08-DWQ NPDES No. CAS 000002 General Construction Storm Water WDRs.
Order No. 2001-11-DWQ NPDES No. CAG 99002 General Utility Vault WDRs.

water discharged, and the WDRs regulating these discharges prohibit the discharges from violating water quality objectives in the receiving water.

10.8 Persons Discharging Groundwater Regulated Under San Diego Water Board General NPDES WDRs

Groundwater discharges from dewatering sites can be discharged to Chollas Creek via the MS4s. These discharges are regulated under San Diego Water Board general NPDES WDRs prescribed in Order No. 2000-90[40] and Order No. 2001-96.[41] Groundwater discharges may contain naturally occurring dissolved metals concentrations, or enriched concentrations from overlying metals contaminated soils that contribute to exceedances of metals water quality objectives in Chollas Creek. Both orders contain numeric effluent limitations for copper, lead, and zinc that are equivalent to the CTR WQOs. At this time, there are no enrollees discharging extracted groundwater to MS4s in the Chollas Creek watershed. However, copper, lead, and zinc wasteload reductions for groundwater dewatering will be required in the event that future groundwater dewatering dischargers apply for coverage under Orders No. 2000-90 and No. 2001-96 to ensure that water quality standards are attained and maintained in Chollas Creek.

10.9 Persons Discharging Hydrostatic Test Water Regulated under San Diego Water Board General NPDES WDRs

Hydrostatic test water discharges to the MS4s can contain dissolved copper, lead, and zinc. These discharges are regulated under San Diego Water Board general NPDES WDRs prescribed in Order No. R9-2002-0020. A WLA is not assigned to these discharges because they make up an extremely small volume of water discharged, and the WDRs regulating these discharges contain a requirement that the discharger provide data and information to be used by the San Diego Water Board to determine whether the proposed discharge may cause, have a reasonable potential to cause, or contribute to an excursion above any applicable priority pollutant, criterion or objective. If so, an effluent limitation may be required for the pollutant.

10.10 School Districts

In addition to the Navy, other owners and operators of small MS4s in the Chollas Creek Watershed include the school districts of Lemon Grove, La Mesa, and San Diego. These facilities are classified under the institutional land use category, which is associated with the highest copper and lead loading, and second highest zinc loading of all the land uses in the Chollas Creek Watershed. The correlation between institutional land uses and high

[40] Order No. 2000-90, NPDES Permit No. CAG919001, *General Waste Discharge Requirements for Temporary Groundwater Extraction and Similar Waste Discharges to San Diego Bay and Storm Drains or Other Conveyance Systems Tributary Thereto* or subsequent superceding NPDES renewal orders.
[41] Order No. 2001-90, NPDES No. CAG19001, *General Waste Discharge Requirements for Temporary Groundwater Extraction and Similar Waste Discharges to San Diego Bay and Storm Drains or other Conveyance Systems Tributary Thereto.*

metals loading may be because parking lots constitute a significant portion of this land use. A statewide order prescribing general WDRs for discharges from small MS4s[42] regulates urban runoff not covered by the San Diego Water Board's phase I MS4 WDRs (Order No. R9-2007-0001), including discharges from MS4s on school property. The school districts' discharges from their MS4 into Chollas Creek can be regulated by enrolling these facilities under the statewide order.

[42] State Water Board Water Quality Order No. 2003-0005-DWQ, NPDES General Permit No. CAS000004, *Waste Discharge Requirements for Storm Water Discharges from Small Municipal Separate Storm Sewer Systems*.

11 Implementation Plan

This Chapter describes the actions necessary to implement the TMDL to attain and maintain copper, lead, and zinc WQOs in Chollas Creek. The plan describes implementation responsibilities assigned to cooperating agencies and dischargers and describes the schedule and key milestones for the actions to be taken. A monitoring strategy to assess the success of this implementation plan is presented in section 12, Implementation Monitoring Plan.

The goal of the Implementation Plan is to ensure that Chollas Creek does not exceed CTR WQOs[43] for copper, lead, and zinc at all times and in all points of the creek. Since nonpoint source discharges to the creek are considered negligible, compliance with the TMDL will be accomplished by ensuring that all point source discharges meet the WLAs as set forth in section 8 of this Technical Report. Applicable WDRs will be revised to incorporate WLAs to ensure that the discharges comply with the WLAs and do not contribute to an exceedance of the WQOs in Chollas Creek

11.1 Regulatory Authority for Implementation Plans

TMDL implementation plans are not directly required under federal law; however federal policy is that TMDLs should include implementation plans. CWA section 303 [40 CFR 130] authorizes USEPA to require implementation plans for TMDLs. Although current USEPA regulations implementing section 303 do not now require states to include implementation plans for TMDLs, regulations are likely to be revised in the future to do so. USEPA regulations [40 CFR 130.6] do require states to incorporate TMDLs in the State Water Quality Management Plans (Basin Plans) along with adequate implementation measures to implement all aspects of the plan (including the TMDLs). USEPA policy is that states must include implementation plans as an element of TMDL Basin Plan amendments submitted to EPA for approval.[44]

TMDL implementation plans are required under state law. Basin plans must have a program of implementation to achieve WQOs.[45] The implementation program must include a description of actions that are necessary to achieve the objectives, a time schedule for these actions, and a description of surveillance to determine compliance with the WQOs.[46] State law requires that a TMDL include an implementation plan because the TMDL normally is, in essence, an interpretation or refinement of an existing water quality objective. The TMDLs and WLAs must be incorporated into the Basin Plan.[47] Because the TMDL supplements, interprets, or refines existing WQOs, state law requires a program of implementation.

---

[43] [40 CFR 131.38(b)(2)]
[44] See *Guidance for Developing TMDLs in California,* USEPA Region 9, (January 7, 2000), Page 11.
[45] See Water Code section 13050(j). A "Water quality control plan" or "Basin Plan" consists of a designation or establishment for the waters within a specified area of all of the following: (1) Beneficial uses to be protected, (2) Water quality objectives and (3) A program of implementation needed for achieving water quality objectives.
[46] See Water Code section 13242.
[47] See Clean Water Act section 303(e).

11.2 Implementation Plan Objectives

The specific objectives of this Implementation Plan are as follows:

1. Amend the different statewide and San Diego Water Board orders that regulate point source discharges to Chollas Creek to require that urban runoff discharges from MS4s achieve the WLAs set forth in section 11.3 below;

2. Establish mechanisms to track BMP implementation, monitor BMP effectiveness in achieving the WLAs in urban runoff discharges to and from MS4s, assess success in achieving TMDL objectives and milestones, and report on TMDL program effectiveness in attaining the copper, lead, and zinc water quality objectives in Chollas Creek.

3. Establish a time schedule for meeting the WLAs of this TMDL project. The schedule will establish an interim milestone that is to be achieved until the WLAs are achieved.

4. Identify the regulatory authority under which the San Diego Water Board will direct the NPDES dischargers to initiate the elements of the implementation plan. This will only be required if the relevant WDRs are not modified to incorporate wasteload allocations in a timely manner.

5. Identify the persons responsible for meeting the WLAs in urban runoff discharged to Chollas Creek.

11.3 Waste Load Allocations and Responsible Persons

The WLAs must be met in specified point source waste discharges, which are or can be subject to regulation through NPDES WDRs, and which drain to Chollas Creek. The Chollas Creek metals WLAs are expressed as concentrations equal to 90 percent of the loading capacities for the three metals. The loading capacities are equal to the hardness based CTR maximum (acute) and continuous (chronic) criteria for copper, lead, and zinc. Setting the WLAs equal to ninety percent of the loading capacity provides the explicit MOS. Because the toxicity of dissolved metals varies with hardness, the CTR criteria are expressed as the equations in Table 11.1 below. Background sources and nonpoint sources of metals were insignificant. Therefore, this TMDL has no LAs.

TABLE 11.1 The Wasteload Allocations for dissolved copper, lead, and zinc for acute and chronic conditions

Metal	WLA for Acute Conditions – One-Hour Average = Loading Capacity* MOS	WLA for Chronic Conditions – Four-Day Average =Loading Capacity*MOS
Copper	(0.96) * {e^ [0.9422 * ln (hardness) - 1.700]}*0.9	(0.96) * {e^[0.8545 * ln (hardness) - 1.702]}*0.9
Lead	[1.46203 – 0.145712 * ln (hardness)] * {e^ [1.273 * ln (hardness) - 1.460]} * 0.9	[1.46203 – 0.145712 * ln (hardness)] * {e^[{1.273 * ln (hardness)} - 4.705]} * 0.9
Zinc	(0.978) * {e^ [0.8473 * ln (hardness) + 0.884]} * 0.9	(0.986) * {e^[0.8473 * ln (hardness) + 0.884]} * 0.9

Persons whose discharges contribute to the exceedance of WQOs for copper, lead, and zinc in Chollas Creek (as discussed in section 10) will be required to meet the WLA hardness dependant concentrations. The Municipal Dischargers and Caltrans are responsible for meeting the WLAs in their urban runoff because they own or operate MS4s that discharge copper, lead, and zinc to Chollas Creek. The Navy facility, Naval Station San Diego, has MS4s that drain directly to Chollas Creek. The Navy is responsible for meeting the WLAs in its MS4 urban runoff discharges to Chollas Creek.

Persons enrolled in the statewide General Industrial WDRs (State Water Board Order No. 99-08-DWQ) will be also be required to meet the WLAs in their regulated discharges to Chollas Creek. At this time, there are no persons enrolled in the general WDRs for Groundwater Extraction Discharges to San Diego Bay and Tributaries (San Diego Water Board Order No. 2001-90).

11.4 Interim Goals for Achieving Wasteload Allocations

The purpose of these TMDLs is to attain and maintain the applicable WQOs in Chollas Creek through mandated wasteload reductions of pollutants in point sources discharging to the creek. The TMDL requires dischargers to improve water quality conditions in the Chollas Creek receiving water by achieving wasteload reductions in their discharges. The copper, lead, and zinc TMDLs shall be implemented with a monitoring component to determine the effectiveness of each phase and guide the selection of BMPs.

Concentrations of metals in urban runoff shall only be allowed to exceed the WLAs by a certain percentage for the first nineteen years after initiation of this TMDL. Allowable concentrations shall decrease to the amounts indicated in Table 11.2 by the times indicated. For example, if the measured hardness ten years after initiation of this TMDL project dictates the WLA for copper in urban runoff is 10 µg/l, the maximum allowable measured copper concentration would be 12.0 µg/L. The phases require loading reductions in two steps through the use of expanded or better tailored BMPs to achieve the ultimate goal of attaining and maintaining compliance with copper, lead, and zinc water quality objectives. By the end of the twentieth year after initiation of this TMDL, the WLAs of this TMDL shall be met. This will ensure that copper, lead, and zinc water quality objectives are being met at all locations in the creek during all times of the year.

TABLE 11.2 Interim goals for achieving Wasteload Allocations

	Allowable Exceedance of the WLAs (allowable percentage above)		
Compliance Year	**Copper**	**Lead**	**Zinc**
1	100%	100%	100%
10	20%	20%	20%
20	0%	0%	0%

Compliance with the interim goals in this schedule can be assessed by showing that dissolved metals concentrations in the receiving water exceed the WQOs for copper, lead, and zinc by no more than the allowable exceedances for WLAs shown in Table 11.2. Regulated groundwater discharges to Chollas Creek must meet the WLAs at the initiation of the discharge. No schedule to meet interim goals will be allowed in the case of groundwater discharges.

Dischargers are expected to implement metal reduction BMPs during the first year of this TMDL, with all necessary metal load reductions being achieved within twenty years. The first ten years will require the bulk of the metal load reduction, while the remaining ten years provide for adequate construction and implementation time for potential structural BMPs, to achieve the full (100 percent) metal load reduction. As described in Appendix I section 8.4, this compliance schedule of 20 years requires comprehensive BMP planning for all pollutants impairing Chollas Creek, including coordination with all TMDLs and all other water quality project requirements within the Chollas Creek watershed.

11.5 San Diego Water Board Actions

This section describes the actions that the San Diego Water Board will take to implement the TMDL. WDRs that implement federal NPDES regulations must be made consistent with the assumptions and requirements of the WLA. NPDES WDRs must contain water quality based effluent limitations (WQBELs) consistent with the WLAs but not necessarily the strict equivalent of the WLAs. WQBELs can be numeric, non-numeric, or both. Non-numeric effluent limitations typically are a program of expanded or better-tailored BMPs. USEPA expects that most WQBELs for NPDES-regulated municipal discharges will be in the form of BMPs, and that numeric limitations will be used only in rare instances.[48] WQBELs can be incorporated into new WDRs, or into existing WDRs by reissuing or revising these WDRs. The following paragraphs describe regulatory actions that are appropriate for regulating discharges of metals and ensuring compliance with TMDL provisions.

NPDES requirements (individual and general requirements) should be issued, revised, or reissued "as expeditiously as practicable" to incorporate WQBELs derived from the TMDL wasteload allocation. As "expeditiously as practicable" means the following:

[48] EPA Memorandum entitled “Establishing Total Maximum Daily Load (TMDL) Wasteload Allocations (WLAs) for Storm Water Sources and NPDES Permit Requirements Based on Those WLAs,” dated November 22, 2002.

(1) New Facilities. For facilities receiving a NPDES WDRs for the first time, "as expeditiously as practicable" means that the San Diego Water Board issues the NPDES WDRs that implements the WLA upon the initiation of the discharge.

(2) Facilities Currently Regulated. For facilities currently regulated under NPDES WDRs, "as expeditiously as practicable" means that:

(i)The San Diego Water Board should consider revision of the NPDES WDRs during its 5 year term, prior to expiration, in accordance with the applicable NPDES reopening provisions, taking into account factors such as available NPDES resources, staff and budget constraints, and other competing priorities.

(ii) In the event the San Diego Water Board cannot consider modification following the five-year term expiration of the NPDES WDRs, the San Diego Water Board will reissue the NPDES WDRs implementing the WLA at the end of its five-year term. Please see Table 11.3 for more details.

1. Caltrans MS4 Discharges

This point source discharge is subject to NPDES WDRs under statewide Order No. 99-06-DWQ.[49] NPDES WDRs shall be issued, reissued, or revised to include WQBELs consistent with the assumptions and requirements of the WLAs described in Table 11.1. The WQBELs may include 1) numeric effluent limitations consistent with the WLAs; 2) a program of expanded or better tailored BMPs consistent with the WLAs; or 3) some combination of both. The WDRs shall also include:

a. The schedule of compliance applicable to MS4 discharges into Chollas Creek described in Table 11.2.

b. A requirement to implement an iterative BMP approach of expanded or better-tailored BMPs to attain the WLAs in Table 11.1 in accordance with the compliance schedule in Table 11.2 of this Technical Report.

c. A requirement to submit annual progress reports to the San Diego Water Board on the progress in attaining the WLAs in urban runoff discharges and WQOs in Chollas Creek. The reports shall be due on April 1 of each year and shall be incorporated within the report required by section 2, Program Management of Order No. 99-06. Reporting shall continue on an annual basis until the metals WQOs are attained and maintained in Chollas Creek. Please see Table 11.3 for more details.

[49] Order No. 99-06-DWQ, NPDES No. CAS000003, *National Pollutant Discharge Elimination System (NPDES) Permit, Statewide Storm Water Permit, and Waste Discharge Requirements (WDRs) for the State of California, Department of Transportation (Caltrans)*, or subsequent superceding NPDES renewal Orders.

The reports should describe the BMPs being implemented by Caltrans in the Chollas Creek watershed and additional BMPs that will be implemented. The reports should describe the steps Caltrans will take to develop a long-term strategy for assessing the effectiveness of its BMPs. The long-term assessment strategy should identify specific direct and indirect measurements that it will use to track the long-term progress towards achieving the copper, lead, and zinc load reductions required under this TMDL. Methods used for assessing effectiveness should include the following or their equivalent: surveys, pollutant loading estimations, and receiving water quality monitoring. The long-term strategy should also discuss the role of monitoring data in substantiating or refining the assessment.

2. Discharges from MS4s Owned by the Cities, the County, and the Port

These point source discharges are subject to NPDES WDRs under Order No. R9-2007-0001.[50] NPDES WDRs shall be issued, reissued, or revised to include WQBELs consistent with the assumptions and requirements of the WLAs described in Table 11.1. The WQBELs may include 1) numeric effluent limitations consistent with the WLAs; 2) a program of expanded or better tailored BMPs consistent with the WLAs; or 3) some combination of both. The WDRs shall also include:

a. The schedule of compliance applicable to MS4 discharges into Chollas Creek described in Table 11.2.

b. A requirement to implement an iterative BMP approach of expanded or better-tailored BMPs to attain the WLAs in Table 11.1 in accordance with the compliance schedule in Table 11.2 of this Technical Report.

c. A requirement that the Municipal Dischargers submit annual progress reports to the San Diego Water Board on the progress in attaining the WLAs in effluent discharges and WQOs in Chollas Creek. Annual reports shall cover the period of July 1 through June 30. The reports shall be submitted to the San Diego Water Board by January 31 of the following year and shall be incorporated within the annual receiving water monitoring reports required in the Receiving Waters and Urban Runoff Monitoring Annual Report Requirements outlined in the Receiving Waters and Urban Runoff Monitoring and Report Program of Order No. R9-2007-0001. Reporting shall continue on an annual basis until the metal water quality objectives are attained and maintained in Chollas Creek. Please see Table 11.3 for more details.

The reports should describe the BMPs being implemented by the Municipal Dischargers in the Chollas Creek watershed and additional BMPs that will be

[50] Order No. 99-06-DWQ, NPDES No. CAS000003, *National Pollutant Discharge Elimination System (NPDES) Permit, Statewide Storm Water Permit, and Waste Discharge Requirements (WDRs) for the State of California, Department of Transportation (Caltrans)*, or subsequent superceding NPDES renewal Orders.

implemented. The reports should describe the steps the Municipal Dischargers will take to develop a long-term strategy for assessing the effectiveness of their BMPs. The long-term assessment strategy should identify specific direct and indirect measurements that they will use to track the long-term progress towards achieving the copper, lead, and zinc WLAs required under this TMDL Project. Methods used for assessing effectiveness should include the following or their equivalent: surveys, pollutant loading estimations, and receiving water quality monitoring. The long-term strategy should also discuss the role of monitoring data in substantiating or refining the assessment.

For copper, lead, and zinc discharges in urban runoff to or from MS4s within the Chollas Creek watershed, the Municipal Dischargers have an existing obligation under Order No. R9-2007-0001 to require increasingly stringent BMPs, pursuant to the iterative process described in Prohibitions and Receiving Water Limitation A.3.a.(1)[51] of the Order, to reduce metal discharges in the Chollas Creek watershed to the maximum extent practicable and to restore compliance with the copper, lead, and zinc components of the toxic pollutants water quality objectives.

3. Municipal Dischargers and the Navy – Amend Order No. R9-2004-0277, Chollas Creek Investigation and Monitoring Program for Diazinon and Metals

   The San Diego Water Board shall amend Order No. R9-2004-0277 (or subsequent superseding renewal orders) to include the following:

   A requirement that the Municipal Dischargers and Caltrans investigate excessive levels of metals in Chollas Creek and feasible management strategies to reduce metal loadings in Chollas Creek. The amendment will require additional monitoring to collect the data necessary to refine the watershed wash-off model to provide a more accurate estimate of the mass loads of copper, lead, and zinc leaving Chollas Creek each year. The Navy will be added to this order when it is amended to include the requirements of this TMDL Project. Please see Table 11.3 for more details.

4. Amend Orders No. 2000-90 and No. 2001-96 General WDRs for Groundwater Extraction Discharges

[51] Receiving Water Limitation A.3.a (1) provides that "[u]pon a determination by either the Copermittee or the San Diego Water Board that MS4 discharges are causing or contributing to an exceedance of an applicable water quality standard, the Copermittee shall promptly notify and thereafter submit a report to the San Diego Water Board that describes BMPs that are currently being implemented and additional BMPs that will be implemented to prevent or reduce any pollutants that are causing or contributing to the exceedance of water quality standards…"

The San Diego Water Board will amend Orders No. 2000-90,[52] and No. 2001-96[53] which regulates temporary groundwater extraction discharges to San Diego Bay and its tributaries. The existing effluent limitations for copper, lead, and zinc for extracted groundwater discharges to MS4s in the Chollas Creek watershed, and directly to Chollas Creek, will be revised to equal the WLAs of this TMDL. Regulated groundwater discharges to Chollas Creek must meet the WLAs at the initiation of the discharge. No schedule to meet interim goals will be allowed in the case of groundwater discharges. A revision of the receiving water limitations is not required since they are equal to the WQOs for metals in Chollas Creek.

5. Stormwater Discharges from Industrial Facilities

These point source discharges are subject to NPDES WDRs under Order No. 97-03-DWQ.[54] NPDES WDRs shall be issued, reissued, or revised to include requirements of the WLAs described in Table 11.1. The WQBELs may include 1) numeric effluent limitations consistent with the WLAs; 2) a program of expanded or increasing BMPs consistent with the WLAs; or 3) some combination of both. The WDRs shall also include:

a. The schedule of compliance applicable to industrial facility stormwater discharges into Chollas Creek described in Table 11.2.

b. A requirement to implement an iterative BMP approach of expanded or better-tailored BMPs to attain the WLAs in Table 11.1 in accordance with the compliance schedule in Table 11.2 of this Technical Report.

c. A requirement to submit annual progress reports to the San Diego Water Board on the progress in attaining the WLAs in effluent discharges. The reports shall be due on July 1 of each year and shall be incorporated within the annual report required by section A.14 of Order No. 97-03-DWQ. Reporting shall continue on an annual basis until the metals WQOs are attained and maintained in Chollas Creek. Please see Table 11.3 for more details.

   The report should describe the steps industrial dischargers will take to develop a long-term strategy for assessing the effectiveness of its BMPs. The long-term assessment strategy should identify specific direct and indirect measurements that it will use to track the long-term progress towards

[52] Order No. 2000-90, NPDES Permit No. CAG919001, *General Waste Discharge Requirements for Temporary Groundwater Extraction and Similar Waste Discharges to San Diego Bay and Storm Drains or Other Conveyance Systems Tributary Thereto* or subsequent superseding NPDES renewal orders.
[53] Order No. 2001-96, NPDES Permit No. CAG919002, *General Waste Discharge Requirements for Groundwater Extraction Waste Discharges from Construction, Remediation and Permanent Groundwater Extractioi Projects to Surface Waters within the San Diego Region Except for San Diego Bay* or subsequent superseding NPDES renewal orders.
[54] Order No. 97-03-DWQ, NPDES Permit No. CAS000001, *Waste Discharge Requirements for Discharges of Storm Water Associated with Industrial Activities Excluding Construction Activities* or subsequent superseding NPDES renewal orders.

achieving the copper, lead, and zinc load reductions required by this TMDL. Methods used for assessing effectiveness should include the following or their equivalent: surveys, pollutant loading estimations, and receiving water quality monitoring. The long-term strategy should also discuss the role of monitoring data in substantiating or refining the assessment.

6. Take Enforcement Actions

   The San Diego Water Board shall consider enforcement action,[55] as necessary, against any discharger failing to comply with applicable waiver conditions, WDRs, discharge prohibitions, or take enforcement action, as necessary, to control the discharge of metals to Chollas Creek, to attain compliance with the metals WLAs specified in this Technical Report, or to attain compliance with the metals WQOs. The San Diego Water Board may also terminate the applicability of waivers and issue WDRs or take other appropriate action against any discharger(s) failing to comply with the waiver conditions. Please see Table 11.3 for more details.

7. Recommend High Priority for Grant Funds

   The San Diego Water Board shall recommend that the State Water Board assign a high priority to awarding grant funding[56] for projects to implement the Chollas Creek metal TMDLs. Special emphasis will be given to projects that can achieve quantifiable metal load reductions consistent with the specific metal TMDL WLAs. Please see Table 11.3 for more details.

8. Enroll the Navy in Order No. 2003-0005-DWQ, Statewide general WDRs for Discharges from Small MS4s

   The San Diego Water Board shall require the Navy to submit a complete Report of Waste Discharge (ROWD), and shall enroll the Navy community facilities of Naval Base San Diego under Order No. 2003-0005-DWQ.[57] Alternatively, the San Diego

[55] An enforcement action is any formal or informal action taken to address an incidence of actual or threatened noncompliance with existing regulations or provisions designed to protect water quality. Potential enforcement actions include notices of violations (NOVs), notices to comply (NTCs), imposition of time schedules (TSO), issuance of cease and desist orders (CDOs) and cleanup and abatement orders (CAOs), administrative civil liability (ACL), and referral to the attorney general (AG) or district attorney (DA). The San Diego Water Board generally implements enforcement through an escalating series of actions to: (1) assist cooperative dischargers in achieving compliance; (2) compel compliance for repeat violations and recalcitrant violators; and (3) provide a disincentive for noncompliance.

[56] Order No. 99-06-DWQ, NPDES No. CAS000003, *National Pollutant Discharge Elimination System (NPDES) Permit, Statewide Storm Water Permit, and Waste Discharge Requirements (WDRs) for the State of California, Department of Transportation (Caltrans)*, or subsequent superceding NPDES renewal Orders.

[57] Order No. 99-06-DWQ, NPDES No. CAS000003, *National Pollutant Discharge Elimination System (NPDES) Permit, Statewide Storm Water Permit, and Waste Discharge Requirements (WDRs) for the State of California, Department of Transportation (Caltrans)*, or subsequent superceding NPDES renewal Orders.

Water Board could issue new WDRs to the Navy. Please see Table 11.3 for more details.

9. Construction Stormwater Discharges

These point source discharges are subject to NPDES WDRs under statewide Order No. 97-03-DWQ.[58] NPDES WDRs shall be issued, reissued, or revised to include WQBELs consistent with the assumptions and requirements of the WLAs described in Table 11.1. The WQBELs may include 1) numeric effluent limitations consistent with the WLAs; 2) a program of expanded or better tailored BMPs consistent with the WLAs; or 3) some combination of both. The WDRs shall also include:

d. The schedule of compliance applicable to industrial facility stormwater discharges into Chollas Creek described in Table 11.2.

e. A requirement to implement an iterative BMP approach of expanded or better-tailored BMPs to attain the WLAs in Table 11.1 in accordance with the compliance schedule in Table 11.2 of this Technical Report.

f. A requirement to submit annual progress reports to the San Diego Water Board on the progress in attaining the WLAs in effluent discharges. The reports shall be due on July 1 of each year and shall be incorporated within the annual report required by section A.14 of Order No. 97-03-DWQ. Reporting shall continue on an annual basis until the metals WQOs are attained and maintained in Chollas Creek. Please see Table 11.3 for more details.

   The report should describe the steps industrial dischargers will take to develop a long-term strategy for assessing the effectiveness of its BMPs. The long-term assessment strategy should identify specific direct and indirect measurements that it will use to track the long-term progress towards achieving the copper, lead, and zinc load reductions required by this TMDL. Methods used for assessing effectiveness should include the following or their equivalent: surveys, pollutant loading estimations, and receiving water quality monitoring. The long-term strategy should also discuss the role of monitoring data in substantiating or refining the assessment.

10. South Chollas Landfill

There is only one landfill in the Chollas Creek Watershed and it was closed in 1981. Order No. 97-11[59] and Addendum No. 4 require monitoring of groundwater below and near the South Chollas Landfill. The San Diego Water Board will revise this WDR to re-institute analysis for metals and begin analysis for hardness as part of the

[58] Order No. 99-08-DWQ NPDES No. CAS 000002 General Construction Storm Water WDRs or subsequent superseding NPDES renewal orders.
[59] Order No. R9-97-11, *General Waste Discharge Requirements for Post-Closure Maintenance of Inactive Nonhazardous Waste Landfills within the San Diego Region* or subsequent superseding NPDES renewal orders.

monitoring requirements. Furthermore, if the data indicate that metal concentrations are in excess of the WLAs of this TMDL, the San Diego Water Board may require additional actions. Since the landfill is down gradient from Chollas Reservoir and is up gradient from Chollas Creek, the possibility exists that groundwater recharge from the reservoir may be transporting landfill pollutants to the creek. The WDR may be revised or the San Diego Water Board may issue an investigative order (under the authority of the Water Code section 13267) to require a technical report examining this potential metals pathway to Chollas Creek. Please see Table 11.3 for more details.

11. School Districts

Order No. 2003-0005-DWQ (or superseding renewal order) identifies Phase II small MS4 dischargers and requires them to develop and implement a Stormwater Management Plan/Program with the goal of reducing the discharge of pollutants to the maximum extent practicable (MEP). In addition to the Navy, the Phase II small MS4 dischargers identified in the Chollas Creek watershed include the Lemon Grove, La Mesa, and San Diego School Districts. Currently, none of the school districts are enrolled under the general NPDES requirements.

MEP is the performance standard specified in section 402(p) of the CWA. The management programs specify what BMPs will be used to address certain program areas. The program areas include public education and outreach; illicit discharge detection and elimination; construction and post-construction; and good housekeeping for municipal operations. In general, medium and large municipalities are required to conduct chemical monitoring, though small municipalities are not.

The San Diego Water Board shall require the school districts in the Chollas Creek watershed, subject to these TMDLs, to submit Notices of Intent[60] to comply with the requirements of Order No. 2003-0005-DWQ, immediately upon adoption of these TMDLs. Once enrolled under the order, the school districts will be required to comply with the provisions of the order to reduce the discharge of copper, lead and zinc to the MEP as specified in their Stormwater Management Plans/Programs. Please see Table 11.3 for more details.

12. New Facilities

All new facilities in the Chollas Creek watershed enrolling for regulation under existing NPDES WDRs for the first time, will not be given a compliance schedule for their discharge to meet the WQBELs that implement the WLAs of this TMDL. Upon initiation of enrollment, their discharge must be in compliance with the WQBELs.

[60] The Notice of Intent, or NOI, is attachment 7 to Order No. 2003-0005-DWQ.

11.6 Compliance Schedule

The Compliance Schedule is shown in Table 11.3. This schedule includes the implementation actions of the San Diego Water Board and the dischargers discussed in the preceeding sections, the due dates for those actions, and the interim and final allowable exceedances of the WLAs.

TABLE 11.3 Compliance schedule.

Item	Implementation Action	Responsible Parties	Date
1	Effective date of Chollas Creek Metals TMDL Waste Load Allocations.	San Diego Water Board, Municipal Dischargers, Caltrans, Navy, Industrial Stormwater Dischargers, Construction Stormwater Dischargers, Landfill Stormwater Dischargers	Effective date[61]
2	Recommend High Priority for grant funds.	San Diego Water Board	Immediately after effective date
3	Submit annual Progress Report to San Diego Water Board due January 1 of each year.	Municipal Dischargers	Annually after reissue of NPDES WDRs.
4	Submit annual Progress Report to San Diego Water Board due April 1 of each year.	Caltrans	Annually after reissue of NPDES WDRs.
5	Submit annual Progress Report to San Diego Water Board due July 1 of each year.	Industrial Stormwater Dischargers	Annually after reissue of NPDES WDRs.
6	Submit annual Progress Report to San Diego Water Board due July 1 of each year.	Construction Stormwater Dischargers	Annually after reissue of NPDES WDRs.
7	Municipal NPDES WDRs shall be issued, reissued, or revised to include WQBELs consistent with the assumptions and requirements of the Chollas Creek WLAs.	San Diego Water Board	Within 5 years of effective date
8	Caltrans NPDES WDRs shall be issued, reissued, or revised to include WQBELs consistent with the assumptions and requirements of the Chollas Creek WLAs.	State Water Board	Within 5 years of effective date
9	Construction NPDES WDRs shall be issued, reissued, or revised to include WQBELs consistent with the assumptions and requirements of the Chollas Creek WLAs.	State Water Board	Within 5 years of effective date
10	Industrial NPDES WDRs shall be issued, reissued, or revised to include WQBELs consistent with the assumptions and requirements of the Chollas Creek WLAs.	State Water Board	Within 5 years of effective date
11	Amend Orders No. 2000-90, and No. 2001-96 (or superseding renewal orders) which regulates temporary groundwater extraction discharges to San Diego Bay and its tributaries to include WQBELs consistent with the assumptions and requirements of the Chollas Creek WLAs.	San Diego Water Board	Within 5 years of effective date

[61] Upon approval of by OAL.

Item	Implementation Action	Responsible Parties	Date
12	Municipal and Navy WDR Order No. R9-2004-0277 shall amended to require additional monitoring for metals and hardness.	San Diego Water Board	Within 5 years of effective date
13	Landfill NPDES WDR Order No. 97-11 (or superseding renewal orders) shall be issued, reissued, or revised to monitor for metals and hardness.	San Diego Water Board	Within 5 years of effective date
14	Navy and all other Phase II small MS4 permittees in the Chollas Creek watershed shall be enrolled in Order No. 2003-0005-DWQ (or superseding renewal orders).	San Diego Water Board	Immediately after effective date.
15	Take enforcement actions	San Diego Water Board	As needed after effective date.
16	Meet 80% Chollas Creek Metals TMDL WLA reductions.	Municipal Dischargers, Caltrans, Navy, Industrial Stormwater Dischargers, Construction Stormwater Dischargers, Landfill Stormwater Dischargers	10 years after effective date.
17	Meet 100% Chollas Creek Metals TMDL WLA reductions.	Municipal Dischargers, Caltrans, Navy, Industrial Stormwater Dischargers, Construction Stormwater Dischargers, Landfill Stormwater Dischargers	20 years after effective date.

12 Implementation Monitoring Plan

This section describes an Implementation Monitoring Plan to assess the success of the implementation plan presented in section 10 in 1) achieving the copper, lead, and zinc wasteload allocations and 2) attaining copper, lead, and zinc water quality objectives in Chollas Creek. The plan assigns monitoring responsibilities and describes key milestones.

12.1 Regulatory Authority for Implementation Monitoring Plan

Basin Plans must have a program of implementation to achieve WQOs.[62] The implementation program must include a description of actions that are necessary to achieve WQOs, a time schedule for these actions, and a description of "surveillance" to determine compliance with the water quality objectives.[63] The term "surveillance" in a TMDL context refers to an implementation monitoring plan designed to measure the effectiveness of the TMDL point and nonpoint source control measures and the progress the waterbody is making toward attaining WQOs. Such a plan would necessarily include collection of water quality data. State law requires that a TMDL include an implementation monitoring plan because the TMDL normally is, in essence, an interpretation or refinement of an existing WQO. The TMDL must be incorporated into the Basin Plan,[64] and, because the TMDL supplements, interprets, or refines an existing WQO, state law requires an implementation monitoring plan be included to determine the success of the implementation plan measures

Water Code section 13267 provides that the San Diego Water Board can require any person who has discharged, discharges, proposes to discharge or is suspected of discharging waste to investigate, monitor, and report information. The only restriction is that the burden of preparing the reports bears a reasonable relationship to the need for and the benefits to be obtained from the reports.

Water Code section 13383 provides that the San Diego Water Board may establish monitoring requirements for any person who discharges, or proposes to discharge, pollutants to navigable waters of the U.S. Order No. R9-2004-0277, issued by the San Diego Water Board pursuant to section 13383, requires the Municipal Dischargers and Caltrans to conduct an investigation and monitoring program for diazinon, copper, lead, and zinc in Chollas Creek.

12.2 Monitoring Objectives

The specific objectives of this Implementation Monitoring Plan are as follows:

---

[62] See CWC section 13050(j). A "Water Quality Control Plan" or "Basin Plan" consists of a designation or establishment for the waters within a specified area of all of the following: (1) Beneficial uses to be protected, (2) WQOs and (3) A program of implementation needed for achieving water quality objectives.

[63] See CWC section 13242.

[64] See CWA section 303(e).

1. Establish a monitoring program for Chollas Creek and its tributaries using monitoring, sampling and analytical methods consistent with the State Water Board Surface Water Ambient Monitoring Program (SWAMP); SWAMP data quality assurance protocols; and SWAMP data management;

2. Characterize baseline conditions in Chollas Creek and its tributaries with respect to metals to place future monitoring data into perspective and document progress towards cleaner water;

3. Track changes in water quality over time in Chollas Creek and its tributaries with respect to metals and enable comparison of baseline data and TMDL project target values with conditions. Determine whether the "trajectory" of the measured water quality values points toward attainment of the copper, lead, and zinc WQOs;

4. Evaluate the effectiveness of the TMDL implementation actions over time and determine the need for revisions to improve the implementation plan;

5. Provide the monitoring data needed to verify or refine assumptions, resolve uncertainties, and improve the scientific foundation of the TMDL. This includes the metals, hardness, and flow data necessary to refine land use wash-off models to more accurately estimate copper, lead, and zinc mass loads from the Chollas Creek watershed; and

6. Provide the monitoring data needed to evaluate the overall TMDL implementation effectiveness and success in attaining copper, lead, and zinc WQOs in Chollas Creek and its tributaries.

12.3 San Diego Water Board Actions

1. Review Order No. R9-2004-0277[65] - This Order requires the Municipal Dischargers to submit monitoring program reports for copper, lead, zinc, calcium carbonate, and diazinon monitoring in Chollas Creek. The San Diego Water Board will review the Order to ensure that all elements of the Implementation Monitoring Plan for this TMDL Project are being addressed in the Order. Furthermore, the San Diego Water Board will research the data requirements to refine the watershed wash-off models to provide more accurate estimates of the mass loads of copper, lead, and zinc leaving the Chollas Creek Watershed on an annual basis. If necessary, Order No. R9-2004-0277 will be amended to include additional monitoring.

2. Amend Order No. R9-2004-0277, if Necessary, to Require Submission of Revised Monitoring and Reporting Program Plan - If the monitoring and reporting

[65] Order No. R9-2004-0277, Investigation Order issued to California Department Of Transportation and San Diego Municipal Separate Storm Sewer System Copermittees Responsible for the Discharge Of Diazinon into the Chollas Creek Watershed, San Diego, California

program ongoing in Chollas Creek is inadequate to fulfill the monitoring objectives listed is section 12.2, Order No. R9-2004-0277 shall be amended to require Caltrans and the Municipal Dischargers to prepare and submit a revised Implementation Monitoring and Reporting Program Plan containing the additional elements described in section 12.5 Implementation Monitoring Plan Elements below. Caltrans and the Municipal Dischargers shall be required to implement the revised Implementation Monitoring Plan in accordance with the revised order. The San Diego Water Board may further amend this order at any time.

12.4 Municipal Dischargers and Caltrans Actions

1. Prepare and Submit Monitoring Plan, if Required - The Municipal Dischargers and Caltrans shall collaborate to prepare and submit a revised Implementation Monitoring Plan for the Chollas Creek watershed containing the elements described in section 12.5 Implementation Monitoring Plan Elements below, upon order of the San Diego Water Board pursuant to CWC section 13383. The revised Implementation Monitoring Plan shall be modified as required by the San Diego Water Board.

2. Implement Monitoring Plan - The Municipal Dischargers and Caltrans shall implement the revised Implementation Monitoring Plan upon order of the San Diego Water Board pursuant to CWC section 13383. The San Diego Water Board may amend this order at any time.

12.5 Revised Implementation Monitoring Plan Elements

The revised Implementation Monitoring Plan shall contain the following elements:

1. The data necessary to refine the watershed wash-off models, to provide more accurate estimates of the mass loads of copper, lead, and zinc leaving the Chollas Creek Watershed on an annual basis. This is likely to include, at a minimum, measurements of calcium carbonate, copper, lead, zinc and flow during dry weather.

2. Additional dry and wet weather monitoring. The San Diego Water Board has worked with SCCWRP to identify data gaps and has collected samples as part of the development of the TMDL for metals in San Diego Bay at the mouth of Chollas Creek.

3. All monitoring shall concurrently sample for both hardness and metals. Hardness analysis will be conducted on unfiltered samples according to Standard Method 2340-B at a detection level 1 mg/L $CaCO_3$. Analysis for dissolved metals will be conducted on filtered samples using trace metal clean analytical and sampling methods. To ensure detection limits are low enough to compare to the wasteload allocations, USEPA methods 1638 and 1669 shall be used. Equivalent

methods with equal or lower detection limits may be used after approval by the San Diego Water Board.

Until Order No. R9-2004-0277 is amended, all monitoring and reporting requirements are in full force and effect. Most, if not all, of the existing requirements will be unchanged if the order is amended.

13 Environmental Analysis, Checklist, and Economic Factors

The San Diego Water Board must comply with the California Environmental Quality Act (CEQA) when amending the Basin Plan as proposed in this project to adopt TMDLs for copper, lead, and zinc in Chollas Creek. Under the CEQA, the San Diego Water Board is the Lead Agency for evaluating the environmental impacts of the reasonably foreseeable methods of compliance with the proposed TMDLs. The following section summarizes the environmental analysis conducted to fulfill the CEQA requirements. The complete Environmental Analysis, Checklist and Economic Factors are discussed in detail in Appendix I.

13.1 California Environmental Quality Act Requirements

The CEQA authorizes the Secretary of the Resources Agency to certify state regulatory programs, designed to meet the goals of the CEQA, as exempt from its requirements to prepare an Environmental Impact Report (EIR), Negative Declaration, or Initial Study. The State Water Board's and San Diego Water Board's Basin Plan amendment process is a certified regulatory program and is therefore exempt from the CEQA's requirements to prepare such documents.[66]

The State Water Board's CEQA implementation regulations[67] describe the environmental documents required for Basin Plan amendment actions. These documents consist of a written report that includes a description of the proposed activity, alternatives to the proposed activity to lesson or eliminate potentially significant environmental impacts, and identification of mitigation measures to minimize any significant adverse impacts.

The CEQA and CEQA Guidelines limit the scope to an environmental analysis of the reasonably foreseeable methods of compliance with the WLAs and LAs. The State Water Board CEQA Implementation Regulations for Certified Regulatory Programs[68] require the environmental analysis to include at least the following:

1. A brief description of the proposed activity. In this case, the proposed activity is the TMDL Basin Plan amendment.

2. Reasonable alternatives to the proposed activity.

3. Mitigation measures to minimize any significant adverse environmental impacts of the proposed activity.

Additionally, the CEQA[69] and CEQA Guidelines[70] require the following components, some of which are repetitive of the list above:

[66] 14 CCR section 15251(g) and Public Resources Code section 21080.5.
[67] 23 CCR section 3720 et seq. "Implementation of the Environmental Quality Act of 1970."
[68] Ibid.
[69] Public Resources Code section 21159(a)
[70] 14 CCR section 15187(c)

1. An analysis of the reasonably foreseeable environmental impacts of the methods of compliance.

2. An analysis of the reasonably foreseeable feasible mitigation measures relating to those impacts.

3. An analysis of reasonably foreseeable alternative means of compliance with the rule or regulation, which would avoid or eliminate the identified impacts.

Additionally, the CEQA Guidelines require the environmental analysis take into account a reasonable range of:[71]

1. Environmental factors
2. Economic factors
3. Technical factors
4. Population
5. Geographic areas
6. Specific sites

13.2 Analysis of Reasonably Foreseeable Methods of Compliance

The analysis of potential environmental impacts is based on the numerous alternative means of compliance available for controlling copper, lead, and zinc loading to Chollas Creek. The majority of metals discharged into the Chollas Creek watershed result from stormwater runoff of metals from freeway surfaces and commercial/institutional land uses. Attainment of the WLAs will be achieved through discharger implementation of structural and nonstructural control strategies designed to reduce metals loading in urban runoff. The controls evaluated in Appendix I include:

1. Education and Outreach
2. Road and Street Maintenance
3. Illicit Discharges
4. Inspections
5. Development/Enforcement of Local Ordinances
6. Vegetated Swales and Buffer Strips
7. Bioretention
8. Detention Basins
9. Retention Ponds
10. Sand Filters
11. Diversion Systems
12. Porous Pavement
13. Infiltration Systems

Structural and non-structural control strategies can be based on specific land uses, sources, or periods of a storm event. In order to comply with these TMDLs, emphasis

[71] 14 CCR section 15187(d) and Public Resources Code section 21159(c)

should be placed on Best Management Practices (BMPs) that control the sources of pollutants and on the maintenance of BMPs that remove pollutants from runoff.

13.3 Possible Environmental Impacts

The CEQA[72] and CEQA Guidelines [73] require an analysis of the reasonably foreseeable environmental impacts of the methods of compliance with the TMDL Basin Plan amendment. The Environmental Checklist identifies the potential environmental impacts associated with these methods with respect to earth, air, water, plant life, animal life, noise, light, land use, natural resources, risk of upset, population, housing, transportation, public services, energy, utilities and services systems, human health, aesthetics, recreation, and archeological/historical concerns.

From the 61 reasonably foreseeable environmental impacts identified in the checklist none were considered to be "Potentially Significant." Forty nine were considered either "Less Than Significant with Mitigation" or "Less Than Significant." Twelve were considered to have "No Impact" on the environment. See sections 4 and 5 in Appendix I for a complete discussion of the potential environmental impacts.

In addition to the potential impacts mentioned above, mandatory finding of significance regarding short-term, long-term, cumulative, and substantial impacts were evaluated. Based on this review, the San Diego Water Board concluded that the potentially significant cumulative impacts can be mitigated to less than significant levels as discussed in Appendix I.

13.4 Alternative Means of Compliance

The CEQA requires an analysis of reasonably foreseeable alternative means of compliance with the rule or regulation, which would avoid or eliminate the identified impacts.[74] The dischargers can use the structural and non-structural BMPs described in Appendix I or other structural and non-structural BMPs, to control and prevent pollution, and meet the TMDLs' required load reductions. The alternative means of compliance with the TMDLs consist of the different combinations of structural and non-structural BMPs that the dischargers might use. Since most of the adverse environmental effects are associated with the construction and installation of large scale structural BMPs, to avoid or eliminate impacts, compliance alternatives should minimize structural BMPs, maximize non-structural BMPs, and site, size, and design structural BMPs in ways to minimize environmental effects.

13.5 Reasonably Foreseeable Methods of Compliance at Specific Sites

The most reasonably foreseeable method of compliance with this Basin Plan amendment establishing TMDLs for copper, lead, and zinc is through the implementation of BMPs. The types of BMPs suitable for different specific sites in the watershed depend on the

[72] Public Resources Code section 21159(a)
[73] 14 CCR section 15187(c)
[74] 14 CCR section 15187 (c) (3)

land use at the site, particularly as it relates to population density and the amount of vehicular traffic. In open space areas, and residential areas, where vehicular traffic is lower than other land uses, non-structural BMPs alone may be adequate to reduce metals loading. Appropriate non-structural BMPs include street sweeping, development and enforcement of municipal ordinances prohibiting exposure of copper, lead, and zinc materials to stormwater, and development and enforcement of municipal ordinances prohibiting nuisance flows. However, in commercial/institutional and roadways land use areas, both structural and non-structural BMPs likely will be needed. Appropriate structural BMPs include vegetated swales and buffer strips, detention basins and retention ponds, sand filters, diversion systems, porous pavement/infiltration systems, and bioretention.

13.6 Economic Factors

The environmental analysis required by the CEQA must take into account a reasonable range of economic factors. This section contains estimates of the costs of implementing the reasonably foreseeable methods of compliance with the TMDL Basin Plan amendment. Specifically, this analysis estimates the costs of implementing the structural and non-structural BMPs which the dischargers could use to reduce copper, lead, and zinc loading to Chollas Creek in 10 percent of the watershed.

As discussed in section 7 in Appendix I, the cost estimates for non-structural BMPs ranged from $0 to $200,000. The cost estimates for treating 10 percent of the watershed with structural BMPs ranged from $960,000 to $490 million with yearly maintenance costs estimated from $10,000 to $2 million.

Implementation of these TMDLs will also entail water quality monitoring which has associated costs. Assuming that a two-person sampling team can collect samples at 5 sites per day, the total cost for one day of sampling would be $1,907.

The specific BMPs to be implemented will be chosen by the dischargers after adoption of these TMDLs. All costs are preliminary estimates since particular elements of a BMP, such as type, size, and location, would need to be developed to provide a basis for more accurate cost estimations.

13.7 Reasonable Alternatives to the Proposed Activity

The environmental analysis must include an analysis of reasonable alternatives to the proposed activity.[75] The proposed activity is a Basin Plan Amendment to incorporate TMDLs for copper, lead, and zinc in Chollas Creek. The purpose of this analysis was to determine if there is an alternative that would feasibly attain the basic objective of the rule or regulation (the proposed activity), but would lessen, avoid, or eliminate any identified impacts. The alternatives analyzed included taking no action and modifying water quality standards in Chollas Creek. In addition, two alternative time schedules for implementing load reductions to meet the TMDL were analyzed.

[75] 23 CCR section 3777

Taking no action and modifying water quality standards in Chollas Creek do not meet the objective of the TMDLs and are therefore, not feasible. Of the two compliance schedule alternatives, the longer 20-year schedule is the preferred alternative because it allows the dischargers time to choose cost effective and low-impact BMPs that are designed to remove a comprehensive suite of pollutants, not just copper, lead, and zinc. These alternative actions and time schedules are discussed in section 8 of Appendix I.

14 Necessity of Regulatory Provisions

The OAL is responsible for reviewing administrative regulations proposed by state agencies for compliance with standards set forth in California's Administrative Procedure Act, Government Code section 11340 et seq., for transmitting these regulations to the Secretary of State and for publishing regulations in the California Code of Regulations (CCR). Following State Water Board approval of this Basin Plan amendment establishing TMDLs, any regulatory portions of the amendment must be approved by OAL per Government Code section 11352. The State Water Board must include in its submittal to OAL a summary of the necessity[76] for the regulatory provision.

This Basin Plan amendment for Chollas Creek meets the "necessity standard" of Government Code section 11353(b). Amendment of the Basin Plan to establish and implement copper, lead, and zinc TMDLs in Chollas Creek is necessary because the existing water quality does not meet applicable numeric WQOs for these metals. Applicable state and federal laws require the adoption of this Basin Plan amendment and regulations as provided below.

The State and Regional Water Boards are delegated the responsibility for implementing California's Porter Cologne Water Quality Control Act and the federal CWA. Pursuant to relevant provisions of both of those acts the State and Regional Water Boards establish WQSs, including designated (beneficial) uses and criteria or objectives to protect those uses.

Section 303(d) of the CWA [33 USC section 1313(d)] requires the states to identify certain waters within their borders that are not attaining WQSs and to establish TMDLs for certain pollutants impairing those waters. USEPA regulations in Title 40 of the CFR section 130.2 provide that a TMDL is a numerical calculation of the amount of a pollutant that a water body can assimilate and still meet standards. A TMDL includes one or more numeric targets that represent attainment of the applicable standards, considering seasonal variations and a MOS, in addition to the allocation of the target or load among the various sources of the pollutant. These include WLAs for point sources and LAs for nonpoint sources and natural background. TMDLs established for impaired waters must be submitted to the USEPA for approval.

CWA section 303(e) requires that TMDLs, upon USEPA approval, be incorporated into the State's Water Quality Management Plans, along with adequate measures to implement all aspects of the TMDL. In California, these are the basin plans for the nine regions. CWC sections 13050(j) and 13242 require that basin plans have a program of implementation to achieve WQOs. The implementation program must include a description of actions that are necessary to achieve the objectives, a time schedule for these actions, and a description of surveillance to determine compliance with the

[76] "Necessity" means the record of the rulemaking proceeding demonstrates by substantial evidence the need for a regulation to effectuate the purpose of the statute, court decision, provision of law that the regulation implements, interprets, or makes, taking into account the totality of the record. For purposes of this standard, evidence includes, but is not limited to, facts, studies, and expert opinion. [Government Code section 11349(a)].

objectives. State law requires that a TMDL project include an implementation plan because TMDLs normally are, in essence, interpretations or refinements of existing WQOs. The TMDLs have to be incorporated into the Basin Plan [CWA section 303(e)], and, because the TMDLs supplement, interpret, or refine existing objectives, state law requires a program of implementation.

15 Public Participation

Public participation is an important component of TMDL development. The federal regulations [40 CFR 130.7] require that TMDL projects be subject to public review. All public hearings and public meetings have been conducted as stipulated in the regulations [40 CFR 25.5 and 40 CFR 25.6, respectively], for all programs under the CWA. Public participation was provided through four public workshops, numerous stakeholder group meetings and communications, and public presentations and participation at relevant conferences. In addition, staff contact information was provided on the San Diego Water Board's web site, along with periodically updated drafts of TMDL project documents throughout the development process. Public participation will also occur through the San Diego Water Board's Basin Plan amendment process, which includes a public workshop and formal public comment period. A chronology of public participation and major milestones is provided in Table 16.1 below:

TABLE 16.1. Public Participation Milestones

Date	Event
May 2000–Ongoing	Web Site – Information including drafts of the technical report and contact information were made available on the San Diego Water Board's web site.
August 1999	Public Workshop
December 1999	Public Workshop
May 2000	Public Workshop
March 2003	Public Workshop and CEQA Scoping Meeting
March 17, 2005	Informal Public Review
March 28, 2005	Release draft for formal Public Review
April 28, 2005	Public Workshop
May 11, 2005	Public Hearing
May 18, 2005	Informal meeting with interested parties to discuss the compliance schedule
June 29, 2005	Deliberation and adoption
July 25, 2006	Re-release draft for formal Public Review
March 9, 2007	Re-release draft for formal Public Review
April 25, 2007	Public Hearing
June 13, 2007	Public Hearing, deliberation, and adoption

16 References

Besser, J. M., W.G. Brumbaugh, T.W. May, S.E. Church and B.A. Kimball, *Bioavailability of metals in stream food webs and hazards to brook trout (Salvelinus fontinalis) in the Upper Animas River Watershed, Colorado*. Arch Environ Contam Toxicol 40 (2001), pp. 48–59.

Birch, G. F. and A. Scollen. *Heavy metals in road dust, gully pots and parkland soils in a highly urbanized sub-catchment of Port Jackson, Australia*. Australian Journal of Soil Research, 41(7): 1329 – 1342. December, 2003.

Brown and Caldwell. *Fresno Nationwide Urban Runoff Program Project, 1984*. Prepared for Fresno Metropolitan Flood Control District. May 1984. (See Appendix B, Table B2-1 in Woodward-Clyde 1992. Source Identification and Control Report, Santa Clara Valley Nonpoint Source Pollution Control Program. December 1, 1992.

Brannian, S. City of San Diego Water Department. *personal communication*, July 2000.

Buffle, J. *Complexation reactions in aquatic systems: an analytical approach*. Chichester. Ellis Horwood. 1988.

Caltrans. BMP Retrofit Pilot Program, Final Report, Report ID CTSW-RT-01-050, January 2004

Chaffin, John. Water Quality Superintendent, The City of San Diego Water Department. *personal communication*. January 2005.

City of San Diego. *Consumer Confidence Report 2001*: *Water Quality Report and Information.* The City of San Diego Water Department. San Diego, CA. February 19, 2003.

City of San Diego. *Consumer Confidence Report 2002.* The City of San Diego Water Department. San Diego, CA. 2002.

City of San Diego. *San Diego Water Department Watershed Sanitary Survey.* The City of San Diego Water Department. San Diego, CA. 2003.

City of San Diego, *San Diego Water Department Frequently Asked Questions.* The City of San Diego Water Department Website: http://www.sandiego.gov/water/quality/index.shtml#f accessed March 28, 05.

Connick, S. (Facilitator). *Copper Use Monitoring Program Results for Model Years 1998-2002*. Brake Pad Partnership Project, Sustainable Conservation. San Francisco, CA. 2004.

Department of Pesticide Regulation. *2002 Annual Pesticide Use Report Indexed by Commodity for San Diego County.* http://www.cdpr.ca.gov/docs/pur/pur02rep/comcnty/sandieo02.pdf

Desert Research Institute. *Southern California Climate Summaries*. Western Regional Climate Center. 2003.

Di Toro, D.M., H.E. Allen, H.L. Bergman, J.S. Meyer, P.R. Paqiun, and R.C. Santore. *A biotic ligand model of the acute toxicity of metals. I. Technical basis*. Environ. Tox. Chem. 20 (2001): 2383-2396. 2001.

King. A., 2002. *A Time-Series Analysis of the Bi-national Tijuana River Watershed: Using BASINS To Understand the Flow and Loading of Fecal Coliforms.* A Thesis Presented to the Faculty of San Diego State University In Partial Fulfillment of the Requirements for the Degree Master of Public Health. Spring 2002.

Kinnetic Laboratories, Incorporated. City of San Diego and Co-Permittee Stormwater Monitoring Program 1994-1995. July 1995.

Kinnetic Laboratories, Incorporated and ToxScan Incorporated. *1993-1994 City of San Diego and Co-Permittee NPDES Stormwater Monitoring Program*. July 29, 1994.

Kszos, L. A., G. W Morris, and B. K. Konetsky. *Source of Toxicity in Stormwater: Zinc from Commonly Used Paint*. Environmental Toxicology and Chemistry, Vol 23, No. 1, pp. 12-16. SETAC Press, USA. 2004.

MacDonald, DD, RS Carr, FD Calder, ER Long and CG Ingersoll. *Development and Evaluation of Sediment Quality Guidelines for Florida Coastal Waters. Ecotoxicology,* 5: 253-278. 1996.

MacDonald, DD, CG Ingersoll and T. Berger. *Development and Evaluation of Consensus-based Sediment Quality Guidelines for Freshwater Ecosystems*. Arch. Environ. Contam. Toxicol. 39: p. 20-31. 2000.

MacDonald, D.D., C.G. Ingersoll, D.E. Smorong, R.A. Lindskoog, G. Sloane and T. Biernacki. *Development and Evaluation of Numerical Sediment Quality Assessment Guidelines for Florida Inland Waters*. Technical Report. Prepared for Florida Department of Environmental Protection. January 2003.

MEC Analytical Systems, Inc. *Draft Report 2000-2001 City of San Diego and Co-Permittee NPDES Stormwater Monitoring Program, Volume 1*. June 2001.

Metcalf and Eddy. *Wastewater Engineering, Treatment, Disposal and Reuse.* Third Edition. Irwin McGraw-Hill, San Francisco, CA. 1991.

Moore, J.W. and S. Ramamoorthy. *Aromatic Hydrocarbons-Polycyclics.* Organic Chemicals in Natural Waters: Applied Monitoring and Impact Assessment. Springer-Verlag, New York, NY. p. 67-87. 1984.

Muschack, Werner. *Pollution of Street Run-off by Traffic and Local Conditions.* The Science of the Total Environment, 93: 419-431. 1990.

O'Brien, E. *Final Report to the Arco Foundation from Sustainable Conservation, Working In Urban Watersheds: Industry Analyses Auto Recycling, Scrap Processing, Tires, and Marine Paint*. January 2000.

RWQCB. *Total Maximum Daily Load for Selenium in the Lower San Joaquin River.* Regional Water Quality Control Board – Central Valley Region. August 2001.

RWQCB. *Clear Lake TMDL for Mercury Staff Report.* Regional Water Quality Control Board – Central Valley Region. February 2002.

SANDAG. *2020 Cities/County Forecast for the Chollas Hydrologic Basin (908.22).* San Diego Association of Governments. February 1999.

San Diego Water Board. *Water Quality Control Plan for the San Diego Basin (9).* San Diego, CA. 1994.

Sansalone, J. J. and S. G. Buchberger. *Partitioning and First Flush of Metals in Urban Roadway Storm Water.* Journal of Environmental Engineering, pp 134-143. 1997.

SCCWRP. Southern California Coastal Waters Research Project, *Characterization of Stormwater Toxicity in Chollas Creek, San Diego*. SCCWRP. Westminster, CA. 1999.

Schiff, K., S. Bay and C. Stransky. *Characterization of stormwater toxicity from Chollas Creek, San Diego*. In Weishberg, S. and D. Elmore (eds) Southern California Coastal Water Research Project Annual Report 1999-2000. Westminster, CA. pp 71-84. 2001.

Shaheen, D. G. *Contributions of Urban Roadway Usage to Water Pollution.* USEPA Office of Research and Development. EPA-600/2-75-004. Washington, D.C. 1975.

Smith, S.L., D.D. MacDonald, K.A. Keenleyside, C.G. Ingersoll, and J. Field. *A preliminary evaluation of sediment quality assessment values for freshwater ecosystems.* Journal of Great Lakes Research 22:624-638. 1996.

Stephan, C.E., D.I. Mount, D.J. Hansen, J.H. Gentile, G.A. Chapman, and W.A. Brungs. *Guidelines for deriving numerical national water quality criteria for the protection of aquatic organisms and their uses*. USEPA, Washington, D.C. NTIS No. PB85-227049. 1985.

Stolzenbach, R. L., C. Xiong, S. Freidlander, R. Turco, K. Schiff and L. Tiefenthaler, *Measuring and Modeling of Atmospheric Deposition on Santa Monica Bay and the Santa Monica Bay Watershed*. Final Report to the Santa Monica Bay Restoration Project. Institute of the Environment University of California, Los Angeles and the Southern California Coastal Water Research Project. Los Angeles and Westminster, CA. 2001.

State Water Board, 2004. *Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List, 2004*. State Water Resources Control Board, September 2004.

Taylor and Francis. *Fundamentals of Aquatic Toxicology, Effects, Environmental Fate, and Risk Assessment*, Second Edition. Edited by Gary M. Rand. 1995. Pages 28-29.

URS Greiner Woodward Clyde. *1998–1999 City of San Diego and Co-Permittee NPDES Stormwater Monitoring Program Report*. August 10, 1999.

URS Greiner Woodward Clyde. *1999-2000 City of San Diego and Co-Permittee NPDES Stormwater Monitoring Program Report*. August 11, 2000.

USEPA, 2000a. *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health.* EPA-822-B-00-004. Office of Water. Oct. 2000.

USEPA, 2001. *Total Maximum Daily Loads for Toxic Pollutants – San Diego Creek and Newport Bay, California.* United States Environmental Protection Agency - Region 9. June 14, 2002.

USEPA. *2003 Draft Update of Ambient Water Quality Criteria for Copper. EPA-822-R-03-026*. Office of Water. November 2003.

USEPA. California Toxics Rule [CTR]. *Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California*; Federal Registry Rule – 40 CFR Part 131. May 28, 2002.

USEPA. *Guidance for Developing TMDLs in California.* USEPA Region 9. January 7, 2000.

USEPA. *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters*. EPA-840-B-93-001c. Office of Water. United States Environmental Protection Agency. Washington, DC. January 1993.

USEPA. *Interim Guidance on the Determination and Use of the Water-Effect Ratios for Metals*. Incorporated into the Second Edition of the Water Quality Standards Handbook, Appendix L. USEPA 823-B-94-001. February 22, 1994.

USEPA. *National Menu of Best Management Practices for Stormwater-Phase II,* http://cfpub1.epa.gov/npdes/stormwater/menuofbmps/poll_10.cfm. 1999.

USEPA. *Total Maximum Daily Loads For Pollutants San Diego Creek and Newport Bay, California.* Water Division, EPA Region 9. April 2002.

USEPA. *Update of Ambient Water Quality Criteria for Cadmium*. EPA-823-B-00-007. Office of Water. April 2001.

USF&W. *Guidelines for Interpretation of the Biological Effect of Selected Constituents in Biota, Water and Sediment*. National Irrigation Water Quality Program. US Department of Interior Report. 1998.

Wang, Hsiao-Chiu. Principal Chemist, Metropolitan Water District of Southern California, *personal communication*. January 2005.

Wilen, Cheryl A. *Survey of Residential Pesticide Use in the Chollas Creek Area of San Diego County and Delhi Channel of Orange County, California*. University of California Statewide IPM Project, UC Cooperative Extension, September 2002.

Woodward-Clyde Consultants. *Source Identification and Control Report prepared for the Santa Clara Valley Nonpoint Source Pollution Control Program.* Oakland, CA. December 1, 1992.

Woodward-Clyde Consultants. 1995-1996 City of San Diego and Co-Permittee NPDES Stormwater Monitoring Program. August 9, 1996.

Woodward-Clyde Consultants. *Metals Control Measures Plan (Volume I) and Evaluation of Nine Metals of Concern (Volume II)*. Prepared for the Santa Clara Valley Nonpoint Source Pollution Control Program. Oakland, CA. February 12, 1997.

Woodward-Clyde International-Americas. 1996-1997 City of San Diego and Co-Permittee NPDES Stormwater Monitoring Program Report. August 8, 1997.

Woodward-Clyde International-Americas. 1997-1998 City of San Diego and Co-Permittee NPDES Stormwater Monitoring Program Report. August 10, 1998.