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ANNUAL STORMWATER MONITORING REPORT

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LOS ANGELES COUNTY
2013-2014 Annual Stormwater Monitoring

Final Report

December 2014

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ACRONYMS

ABC	Aquatic Bioassay Consulting Laboratories, Inc.
ACWM	Los Angeles County Department of Agricultural Commissioner Weights and Measures
ADA	Americans with Disabilities Act
Basin Plan	Water Quality Control Plan for the Los Angeles Region
BMP	best management practice
BOD	biochemical oxygen demand
CDPH	California Department of Public Health
CIMP	coordinated integrated monitoring program
COC	chain-of-custody
COD	chemical oxygen demand
CTR	California Toxics Rule
DNQ	detected not quantified
DO	dissolved oxygen
EC	effective concentration
ELAP	Environmental Laboratory Accreditation Program
EPA	U.S. Environmental Protection Agency
FSID	field sample identification
IC	inhibitory concentration
LACFCD	Los Angeles County Flood Control District
LADPW	Los Angeles County Department of Public Works
LARWQCB	Los Angeles Regional Water Quality Control Board
MBAS	methylene blue active substance
MCL	maximum contaminant level
MDL	method detection limit
MES	mass emission station
mg/L	milligrams per liter
mL	milliliter
ML	minimum level
MPN	most probable number
MS4	municipal separate storm sewer system
MTBE	methyl tertiary butyl ether
NA	not applicable
ND	not detected
NO_2	nitrite
NO_3	nitrate
NOEC	no-observed-effect concentrations
NPDES	National Pollutant Discharge Elimination System
PCB	polychlorinated biphenyl
2001 Permit	2001 Los Angeles County Municipal Stormwater Permit
2012 Permit	2012 Los Angeles County Municipal Stormwater Permit
pH	hydrogen ion concentration
QA	quality assurance
QC	quality control
REC	recreational
RL	reporting limit

SCCWRP	Southern California Coastal Water Research Project
SOP	standard operating procedure
SQMP	Stormwater Quality Management Program
SWAMP	Surface Water Ambient Monitoring Program
TDS	total dissolved solids
TIE	toxicity identification evaluation
TMDL	Total Maximum Daily Load
TOC	total organic carbon
TKN	total Kjeldahl nitrogen
TPH	total petroleum hydrocarbons
TSS	total suspended solids
TU	toxicity unit
µg/L	micrograms per liter
USACE	U.S. Army Corps of Engineers
USGS	United States Geological Survey
VSS	volatile suspended solid
WESTON®	Weston Solutions, Inc.
WQO	water quality objective

CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted.

Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of a fine and imprisonment for knowing violations.

Executed on the 15 day of December 2014,

at ALHAMBRA, CA.

Angela George
Assistant Deputy Director
Watershed Management Division

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ADA INFORMATION

Upon 72 hours' notice, the County of Los Angeles Department of Public Works (Public Works) can provide program information and publications in alternate formats or make other accommodations for people with disabilities. In addition, program documents are available at the Public Works main office in Alhambra (900 S. Fremont Avenue), which is accessible to individuals with disabilities. To request accommodations ONLY, or for more Americans with Disabilities Act (ADA) information, please contact the Public Works departmental ADA Coordinator at (626) 458-4081 or TTY (626) 282-7829, Monday through Thursday, from 7:00 a.m. to 5:45 p.m.

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DISCLAIMER

The comparisons to Water Quality Standards are made pursuant to the 2001 Permit's Monitoring and Reporting Program requirements and are for information only.

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EXECUTIVE SUMMARY

ES.1 Introduction

On November 8, 2012, the Los Angeles Regional Water Quality Control Board (LARWQCB) adopted a new National Pollutant Discharge Elimination System (NPDES) municipal separate storm sewer system (MS4) Permit, Order R4-2012-0175 (2012 Permit), for the coastal watersheds of Los Angeles County. This monitoring report is submitted pursuant to the Monitoring and Reporting Program for the 2012 Permit, attached as Exhibit E to that permit. In accordance with the 2012 permit, permittees are required to develop a new monitoring program. In doing so, each permittee may choose to develop an Integrated Monitoring Program (IMP) or Coordinated Integrated Monitoring Program (CIMP) through which it will meet its monitoring obligations. The County of Los Angeles and the Los Angeles County Flood Control District (LACFCD) have chosen to participate in the development of CIMPs for their respective watersheds. The CIMPs were submitted to the Regional Board on or before June 30, 2014. The County and the LACFCD are currently awaiting approval of these CIMPs.

Section IV.C.8 of the Monitoring Program provides that the monitoring requirements pursuant to Order No. 0-182 (2001 Permit), Monitoring and Reporting Program CI 6948, and approved Total Maximum Daily Load (TMDL) monitoring programs shall remain in effect until the Executive Officer approves the IMPs and CIMPs. Accordingly, for the past monitoring year, monitoring has been conducted under the protocols set forth in that order and those plans. This report sets forth those results.

ES.1.1 Core Monitoring Program

Pursuant to the protocol set forth in the 2001 Monitoring Program, monitoring was conducted at seven mass emission stations (MES) (i.e., Ballona Creek (S01), Malibu Creek (S02), Los Angeles River (S10), Coyote Creek (S13), San Gabriel River (S14), Dominguez Channel (S28), and Santa Clara River (S29)). The 2001Monitoring Program also provided that tributaries shall be monitored to identify sub-watersheds where stormwater discharges and non-stormwater (dry weather) discharges are causing or contributing to exceedances of water quality standards, and to prioritize drainage and sub-drainage areas requiring management actions. During the 2013-2014 monitoring year, sampling was continued at six tributary monitoring stations in the Malibu Creek Watershed. The tributaries monitored included Upper Las Virgenes Creek (TS25), Cheseboro Canyon (TS26), Lower Lindero Creek (TS27), Medea Creek (TS28), Liberty Canyon Channel (TS29), and PD 728 at Foxfield Drive (TS30).

Trash monitoring was also conducted at MES to identify areas impaired for trash. Visual observations of trash were made, and at least one photograph was taken at each MES after the first storm event and at least three additional storm events, with the exception of Santa Clara MES (only two additional storms were monitored) and Malibu Creek MES (only one additional storm was monitored). Trash monitoring was also conducted in the Ballona Creek and Los Angeles River watersheds (described in Appendices I and J, respectively).

In addition, the City of Los Angeles monitored shoreline stations to evaluate the impacts of urban runoff on coastal receiving waters and beneficial uses and performed an annual assessment

of shoreline water quality data. The City of Los Angeles's assessment is included as Appendix D of this monitoring report.

ES.1.2 Regional Monitoring

The LACFCD has participated in regional monitoring programs, including estuary sampling (Bight '03, Bight '08, and Bight '13), which evaluated estuarine habitats for sediment chemistry, sediment toxicity, and benthic infaunal community health. Results are posted on the Southern California Coastal Water Research Project (SCCWRP) website as they become available.

Bioassessment was also conducted to help assess the biological integrity of a waterbody and to help determine potential sources of biological impairment, where they may exist. A total of 20 sampling stations representing the six major watersheds were selected to represent the diverse environments of the Los Angeles region. The final report for the most recent year of the Bioassessment Monitoring Program (i.e., 2013) is included in Appendix H.

ES.1 Summary of Methodology

The core monitoring program was conducted in compliance with the monitoring protocols set forth by the 2001 Permit and the Stormwater Quality Management Program (SQMP). Water quality samples were collected from seven watersheds and analyzed as part of the 2013–2014 Monitoring Program. The seven watersheds included Ballona Creek, Malibu Creek, Los Angeles River, Coyote Creek, San Gabriel River, Dominguez Channel, and Santa Clara River. Collection and analysis of stormwater runoff during wet weather conditions and ambient (dry) weather runoff were performed at MES and tributary locations.

Sample collection was required at MES locations for a minimum of three storm events (including the first storm event of the season) and two dry events. Due to the dry conditions that prevailed during the 2013-2014 monitoring season, only two samples were collected during wet weather at the Malibu Creek MES (S02) and only one dry weather sample was collected at the San Gabriel River MES (S14).

At the tributary stations located in the Malibu Creek Watershed, sample collection was required for a minimum of four storm events (including the first storm event of the season) and one dry event. Due to the dry conditions, only two samples were collected during wet weather at each of tributary stations (TS25, TS26, TS27, TS28, TS29, and TS30). Insufficient sample was collected to complete all chemical analyses during the first wet weather event at each of the tributary stations except Medea Creek (TS28) and Liberty Canyon (TS29) due to equipment malfunction. Stormwater samples and ambient water samples were analyzed in accordance with the 2001 Permit requirements for chemical constituents, indicator bacteria, and toxicity to bioassay test organisms.

ES.2.1 Precipitation and Flow Monitoring

Precipitation monitoring was conducted at or near each MES using the various automatic rain gauges that LACFCD operates throughout Los Angeles County. Existing gauges near the

monitored watersheds were also used in stormwater runoff calculations and were essential in developing runoff characteristics for these watersheds.

Because the monitoring program required flow-weighted composites for many constituents, flow monitoring equipment was used to trigger the automated samplers. Flows were determined from water elevation measurements.

ES.2.2 MES and Tributary Wet and Dry Weather Sampling

During the 2013-2014 monitoring season, analyses of stormwater samples consisted of field measurements, grab samples, and composite samples. Field measurements included temperature and pH at all stations. Grab samples were collected during the initial portion of the storm event (i.e., on the rising limb of the hydrograph) and were analyzed for indicator bacteria and conventional pollutants. Composite samples consisted of a mixed sample created by combining a series aliquots of specific volume collected at specific flow-volume intervals. Flow-weighted composite storm samples were obtained using an automated sampler at all stations except Santa Clara MES, where composite samples were obtained by sampling discretely from the river at 20-minute intervals for the first three hours of the storm (or the duration of the storm if it was less than three hours). The discrete samples were then mixed in the laboratory in proportion to the estimated flow rates. Composite samples were analyzed for conventional constituents, general minerals, nutrients, metals, semivolatile organics, base neutral, chlorinated pesticides, polychlorinated biphenyls (PCBs), organophosphate pesticides, and herbicides. Water column toxicity analyses were performed during two wet weather events for composite samples collected at the MES. In addition, storm events resulting in at least 0.25 inch of rainfall were monitored for total suspended solids (TSS) at all MES equipped with automatic samplers.

Dry weather sampling methods were similar, except samples were collected as time-weighted composites over a 24-hour period.

Quality assurance (QA)/quality control (QC) is an essential component of the monitoring program. All QA/QC procedures were followed for training of field personnel; labeling of bottles; chain of custody; sampling equipment setup; and sample collection, transport, and analysis.

ES.2 Summary of Monitoring Results

The 2001 Monitoring Program consisted of core monitoring, regional monitoring, and special studies. The core monitoring program included the following elements:

- Mass emission monitoring.
- Water column toxicity monitoring.
- Tributary monitoring.
- Shoreline monitoring.
- Trash monitoring.

ES.3.1 Mass Emission Monitoring

Based on results of the mass emission monitoring, the following three water quality analyses were conducted:

- A comparison to applicable water quality standards.
- An analysis of pollutant loads and trends.
- An evaluation of the correlation between constituents of concern and TSS.

Monitoring results were compared to water quality indicators based on water quality objectives (WQOs) established in the Water Quality Control Plan for the Los Angeles Region (Basin Plan) and the California Toxics Rule (CTR), 40 CFR Part 131. The Basin Plan is designed to enhance water quality and to protect the beneficial uses of all regional waters. The CTR promulgates criteria for priority toxic pollutants in the State of California for inland surface waters and enclosed bays and estuaries.

A summary of the constituents that did not meet applicable WQOs at MES for at least one event is presented in the table below.

Summary of Constituents that Did Not Meet Water Quality Objectives at Mass Emission Stations during 2013-2014 for One or More Events

Mass Emission Station/Watershed	Wet	Dry
Ballona Creek (S01)[1,2,3]	*E. coli*, dissolved copper, dissolved zinc, dissolved lead, DO	NA
Malibu Creek (S02)	*E. coli*	DO
Los Angeles River (S10)[1,2,3]	*E. coli*, cyanide, pH, dissolved copper, dissolved zinc	pH
Coyote Creek (S13)[2,3]	*E. coli*, pH, dissolved copper, dissolved zinc	*E. coli*
San Gabriel River (S14)[2,3]	*E. coli*, DO	DO, chloride
Dominguez Channel (S28)[1,2,3]	*E. coli*, DO, pH, Dissolved copper, Dissolved zinc	*E. coli*
Santa Clara River (S29)	*E. coli*	DO

NA – all applicable water quality objectives were met.
DO – dissolved oxygen
[1]More urbanized watersheds.
[2]Subject to the bacteria water quality objective high-flow suspension (LARWQCB, 2003).
[3]The high flow suspension did not apply to Ballona Creek during 2013-14Event09, 2013-14Event10, 2013-14Event12, and 2013-14Event15; to Los Angeles River during 2013-14Event09 and 2013-14Event12; to Coyote Creek during 2013-14Event09, 2013-14Event10, and 2013-14Event12; to San Gabriel River during 2013-14Event15; and to Dominguez Channel during 2013-14Event09, 2013-14Event10, 2013-14Event12, and 2013-14Event15.

ES.3.2 Water Column Toxicity Analysis

Water column toxicity monitoring was performed at all MES. In total, four samples were analyzed for toxicity at each station (i.e., two wet weather samples and two dry weather samples). The only exception was San Gabriel River (S14), where only one dry weather sample was collected due to the absence of flow during the first dry weather monitoring event.

One freshwater species (water flea) and one marine species (sea urchin) were used for toxicity testing. The water flea, *Ceriodaphnia dubia*, was used in chronic seven-day reproduction and survival bioassays. The sea urchin, *Strongylocentrotus purpuratus*, was used in chronic fertilization bioassays.

During wet weather, bioassay tests exposing *C. dubia* to wet weather effluent samples from each of the seven MES indicated that no toxicity to *C. dubia* survival or reproduction was observed for both events. Toxicity tests measuring *S. purpuratus* fertilization in exposures to wet weather effluent samples from all seven MES indicated that no toxicity to *S. purpuratus* fertilization was observed in the test samples.

During dry weather, bioassay tests exposing *C. dubia* to dry weather effluent samples from each MES indicated that slight toxicity to *C. dubia* reproduction was observed in dry weather samples collected from Malibu Creek. A toxicity identification evaluation (TIE) was not necessary. Toxicity tests measuring *S. purpuratus* fertilization in exposures to dry weather effluent samples from each MES indicated that no toxicity to slight toxicity to *S. purpuratus* fertilization was observed in the test samples. All of the inhibitory concentration (IC) values (IC_{25} and IC_{50}) were greater than 100% test substance, the no-observed-effect concentrations (NOEC) values ranged from 50 to 100% test substance, and the toxicity units (TUs) were less than 1.

ES.3.3 Tributary Monitoring

The 2001 Monitoring Program provided that there shall be tributary monitoring in an attempt to identify sub-watersheds where stormwater discharges are causing or contributing to exceedances of water quality standards and to prioritize drainage and sub-drainage areas that need management actions. A summary of the constituents that did not meet applicable WQOs at tributary stations for at least one event is presented in the table below.

Summary of Constituents That Did Not Meet Water Quality Objectives at Tributary Stations during 2013-2014 for One or More Events

Tributary/Sub-Watershed	Wet	Dry
Upper Las Virgenes Creek (TS25)	*E. coli*	*E. coli*, sulfate, TDS
Cheseboro Canyon (TS26)	*E. coli*, dissolved copper, dissolved zinc	*E. coli*, DO, sulfate, TDS
Lower Lindero Creek (TS27)	*E. coli*	*E. coli*, DO, sulfate, TDS
Medea Creek (TS28)	*E. coli*, sulfate	Sulfate, TDS
Liberty Canyon Channel (TS29)	*E. coli*, dissolved copper	*E. coli*, DO, sulfate, dissolved copper
PD 728 at Foxfield Dr. (TS30)	*E. coli*	*E. coli*, sulfate

DO – dissolved oxygen
TDS – total dissolved solids.

ES.3.4 Correlations to Total Suspended Solids

A Spearman's Rank Test was used to determine whether a significant positive or negative correlation existed between analyte results and TSS concentrations at each MES, with the exception of the Malibu Creek MES, during wet weather conditions. Too few samples were collected at Malibu Creek MES and at the tributary stations to allow for analysis of correlations. Additionally, the findings from the San Gabriel and Santa Clara MES locations should be considered in the context of the small sample size (n=3) during the 2013-2014 monitoring season. A summary of constituents found to have correlations to TSS concentrations is presented in the following table. Priority constituents (those constituents that did not meet WQOs in one or more monitoring events) are marked with an asterisk.

Correlations Between Constituents and TSS at Mass Emission Stations

Mass Emission/Watershed	Wet	
	Positively Correlated with TSS	Negatively Correlated with TSS
Ballona Creek (S01)	Dissolved lead*, Lead	Dissolved antimony, Kjeldahl N
Malibu Creek (S02)[1]	NA	NA
Los Angeles River (S10)	Selenium[2]	None
Coyote Creek (S13)	None	None
San Gabriel River (S14)[3]	Arsenic, chromium, copper, dissolved aluminum, dissolved arsenic, dissolved iron, dissolved lead, dissolved zinc, lead, nickel, turbidity, VSS, zinc	Alkalinity, BOD, chloride, *E. coli**, fecal enterococcus, fecal streptococcus, hardness, nitrite-N, pH, specific conductance, sulfate, TDS, TOC
Dominguez Channel (S28)	2-4-D[2], MBAS	Ammonia, NH_3-N
Santa Clara River (S29)[3]	Aluminum, antimony, barium, COD, chromium, copper, dissolved aluminum, dissolved antimony, dissolved chromium, dissolved copper, dissolved iron, dissolved lead, dissolved zinc, iron, lead, nickel, nitrate (NO_3), nitrate-N, nitrite-N, total phosphorus, TOC, turbidity, VSS, zinc	Alkalinity, chloride, hardness, sulfate, TDS

* Priority constituent.
[1] Too few wet weather events to perform correlation analyses.
[2] Significant with p value of <0.10 rather than <0.05.
[3] Likely correlations; too few wet weather events for confirmation.
TDS = total dissolved solids.
TOC = total organic carbon.
VSS = volatile suspended solids.
BOD = biochemical oxygen demand.
COD = chemical oxygen demand.
MBAS = methylene blue active substances
NA = not applicable.

ES.3.5 Wet Weather and Dry Weather Constituent Loads for Each Mass Emission Station

Constituent loads were calculated to determine whether there was a relationship between storm event size and the total load for a given constituent. During wet weather, calculated loads varied between stations and storm events. First-flush loading signatures (i.e., higher loads during the first monitored storm of the season than would be expected based on rainfall totals) were observed for at least one constituent at the following five of the seven MES locations: Ballona Creek, Los Angeles River, Coyote Creek, Dominguez Channel, and Santa Clara River. Rainfall totals were much higher during 2013-14Event13, the event during which the greatest loads were

observed at all MES, compared to the other wet weather events. Rainfall totals during 2013-14Event13 ranged from 1.84 to 5.20 inches, whereas the rainfall totals during the other events, including the first flush, were all under 1 inch.

During dry weather, constituent loads varied between stations and between sampling events. In general, the highest variability was observed in *E. coli* loads and TSS loads, which were generally higher during the first dry event compared to the second. TSS loads were much greater at Los Angeles River during both dry weather events than at any of the other MES. Overall, constituent loads were lower at Santa Clara River MES than at other MES.

ES.3.6 Total Suspended Solids Trend Analysis

TSS concentrations from 2000 to 2014 were evaluated separately for wet and dry weather at each MES. The summary table below presents the method used for trend evaluation and the statistical trend information on TSS data collected at each MES over the past 14 years.

Trend Analysis of Wet Weather Total Suspended Solids Concentrations at Mass Emission Stations from 2000–2014

Station	p-value	Method	Trend
Ballona Creek at Sawtelle (S01)	0.498	Mann-Kendall	Not significant
Malibu Creek at Piuma (S02)	0.069	Regression	Not significant
Los Angeles River at Wardlow (S10)	0.806	Regression	Not significant
Coyote Creek at Spring (S13)	0.428	Mann-Kendall	Not significant
San Gabriel River (S14)	**0.019**	Regression	Significant decreasing
Dominguez Channel at Artesia (S28)	0.116	Mann-Kendall	Not significant
Santa Clara River (S29)	**0.001**	Mann-Kendall	Significant decreasing

Bold text indicates significant trend with p value <0.05.

Trend Analysis of Dry Weather Total Suspended Solids Concentrations at Mass Emission Stations from 2000–2014

Station	p-value	Method	Trend
Ballona Creek at Sawtelle (S01)	0.631	Regression	Not significant
Malibu Creek at Piuma (S02)	0.051	Regression	Not significant
Los Angeles River at Wardlow (S10)	0.600	Regression	Not significant
Coyote Creek at Spring (S13)	0.451	Regression	Not significant
San Gabriel River (S14)	0.274	Regression	Not significant
Dominguez Channel at Artesia (S28)	0.688	Regression	Not significant
Santa Clara River (S29)	**0.005**	Mann-Kendall	Significant decreasing

Bold text indicates significant trend.

ES.3.7 Trash Monitoring

The 2001 Permit required a minimum of one photograph at each MES after the first storm event and three additional storm events per year. During the 2013-2014 monitoring season, visual observations of trash were made and at least one photograph was taken at each MES after the first storm event. In addition, photographs were taken at each MES after at least three additional storm events, with the exceptions of the Malibu Creek MES, which was only monitored during one additional storm event, and the Santa Clara MES, which was monitored during two additional storm events.

ES.4 Recommendations

On November 8, 2012, the LARWQCB adopted a new NPDES MS4 Permit (Order R4-2012-0175) for the coastal watersheds of Los Angeles County. The 2012 Permit, which became effective on December 28, 2012, provides a watershed management approach to address water quality protection. Under the 2012 Permit monitoring protocols, the 2001 Permit Monitoring and Reporting Program will continue until the IMPs and CIMPs submitted by the Watershed Management Groups throughout the Los Angeles Basin are approved by the Executive Officer of the LARWQCB. Due to the timing of the approval of CIMPs, MES monitoring will be conducted during the 2014-2015 monitoring season in accordance with the protocols of the 2001 Permit.

The 2001 Permit Monitoring and Reporting Program included provisions for tributary monitoring in sub-watersheds where stormwater discharges and non-stormwater (dry weather) discharges are causing or contributing to exceedances of water quality standards, and to prioritize drainage and sub-drainage areas requiring management actions. The 2012 Permit does not require tributary monitoring. However, monitoring in the tributaries will be continued until CIMPs submitted by the Watershed Management Groups are approved by the LARWQCB.

It is recommended that the field monitoring of DO and pH continue to be incorporated into in the monitoring program. DO measurements in samples may be impacted through sample handling and transportation, and sampling guidelines generally call for the measurement of DO as soon as possible after sampling. It is possible that the change in DO levels between the field and the laboratory may cause or contribute to observed DO readings outside the water quality objective range. Measuring pH in the field may limit effects of water hardness and alkalinity on changes to the pH levels measured in the analytical laboratory.

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1.0 INTRODUCTION

1.1 Monitoring Program Status

The 1994–1995 storm season was the first in which stormwater monitoring was required under the 1990 Los Angeles County National Pollutant Discharge Elimination System (NPDES) Municipal Stormwater Permit (No. CA0061654). Automated and manual sampling was conducted to characterize stormwater quality and quantity during the 1994–1995 and 1995–1996 seasons.

The 1996–1997 season was the first storm season in which stormwater monitoring was conducted under the 1996 Municipal Stormwater Permit (No. CAS614001). Under the 1996 Municipal Stormwater Permit, the Monitoring Program scope was expanded to incorporate additional data collection through the mass emission, land use, and critical source monitoring programs as well as new pilot studies (e.g., wide channel and low-flow analyses).

Under the 2001 Permit adopted on December 13, 2001, land use and critical source elements were eliminated from the Monitoring and Reporting Program, and the Program focused on core monitoring, regional monitoring, and three special studies. As a result of the varying compliance dates for each element, only mass emission, water column toxicity, and shoreline monitoring under the core Monitoring Program were addressed in the 2001–2002 Monitoring Report.

The 2002–2003 through 2011-2012 monitoring reports addressed the following programs and associated elements under the 2001 Permit:

- Core Monitoring Program – mass emission, tributary, water column toxicity, shoreline, and trash monitoring.
- Regional Monitoring Program – estuary sampling and bioassessment.
- Special studies – the results of three special studies.

An Integrated Receiving Water Impacts Report, prepared in 2004–2005, also incorporated the results, analysis, and progress of the previously mentioned monitoring programs. The report also assessed trends from 1994–2005. Annual stormwater monitoring reports are presented on the Los Angeles County Department of Public Works (LADPW) website:

http://dpw.lacounty.gov/wmd/NPDES/report_directory.cfm.

The 2012 Permit took effect on December 28, 2012. Given the timing, the 2012-2013 monitoring was conducted pursuant to the protocols under the 2001 monitoring program.

The information summarized in this *2013-2014 Annual Stormwater Monitoring Report* covers the monitoring period from June 1, 2013 to May 30, 2014.

1.1.1 Core Monitoring

1.1.1.1 Mass Emission Monitoring

Monitoring was conducted at seven mass emission monitoring stations (i.e., Ballona Creek (S01), Malibu Creek (S02), Los Angeles River (S10), Coyote Creek (S13), San Gabriel River (S14), Dominguez Channel (S28), and Santa Clara River (S29)) during the 2013–2014 reporting period. Mass emission stations (MES) capture runoff from major county watersheds that generally have heterogeneous land use. All MES, except the Santa Clara River station, are equipped with automated samplers, including integral flow meters for flow-composited sample collection.

Sampling at the Santa Clara River MES began during the 2002–2003 storm season. At this station, samples were collected manually, and flow-weighted composite samples were primarily produced using flow estimates obtained by monitoring staff.

The 2001 Monitoring Program specified annual monitoring of a minimum of three wet weather events, including the first storm event of the year. During the 2013-2014 monitoring year, a minimum of three wet weather events were monitored at all the MES, with the exception of Malibu Creek MES due to the especially dry conditions during this season. Grab samples were collected during five storm events at Ballona Creek and Dominguez Channel; during four storm events at Los Angeles River and Coyote Creek; during three storm events at San Gabriel River and Santa Clara River; and during two storm events at Malibu Creek. Grab samples were analyzed for conventional pollutants and bacteria.

Composite samples were collected during four storm events at Ballona Creek, Los Angeles River, Coyote Creek, and Dominguez Channel; during three storm events at San Gabriel River and Santa Clara River; and during two storm events at Malibu Creek. Composite samples were flow-weighted and were analyzed for general minerals, nutrients, metals, semivolatile organics, base neutral, chlorinated pesticides, polychlorinated biphenyls (PCBs), organophosphate pesticides, and herbicides. In addition, composite samples from two storm events at each MES were analyzed for toxicity as described in Section 1.1.1.2. Three additional storms were monitored, for a total of seven storms, for total suspended solids (TSS) analysis at Coyote Creek. An additional two storms were monitored, for a total of five storms, for TSS at San Gabriel River. An additional two storms were monitored, for a total of six storms at Los Angeles River. One additional storm was monitored, for a total of six storms, for TSS at Dominguez Channel. No additional storms were monitored for TSS at Ballona Creek, Malibu Creek, or Santa Clara River.

Two dry weather monitoring events were conducted at each MES, except at San Gabriel River, where only one dry weather monitoring event was possible due to dry conditions (no flow). Grab samples were collected and analyzed for conventional pollutants and bacteria during both dry weather monitoring events. Composite samples were also collected for all dry weather events and were analyzed for TSS, general minerals, nutrients, metals, semivolatile organics, base neutral, chlorinated pesticides, PCBs, organophosphate pesticides, and herbicides.

Appendix K – Table of Monitoring Events presents the dates of the wet and dry weather sampling events.

1.1.1.2 Water Column Toxicity Monitoring

The 2001 Monitoring Program provided that mass emission samples shall be analyzed for toxicity during two dry weather events and during two storm events, including the first storm of the year. Composite samples were taken at each MES for toxicity analyses. During the 2013-2014 monitoring year, samples from two wet weather events were analyzed at each MES. Samples from two dry weather events were also analyzed at each MES, with the exception of San Gabriel River, where only one dry weather sample was collected due to dry conditions.

1.1.1.3 Tributary Monitoring

The 2001 Monitoring Program provided that tributaries shall be monitored to identify sub-watersheds where stormwater discharges and non-stormwater (dry weather) discharges are causing or contributing to exceedances of water quality standards, and to prioritize drainage and sub-drainage areas requiring management actions.

During the 2013-2014 monitoring year, sampling was continued at six tributary monitoring stations in the Malibu Creek Watershed. The tributaries monitored included Upper Las Virgenes Creek (TS25), Cheseboro Canyon (TS26), Lower Lindero Creek (TS27), Medea Creek (TS28), Liberty Canyon Channel (TS29), and PD 728 at Foxfield Drive (TS30). Sampling at these tributary stations began in the 2011-2012 monitoring year. The 2001 Monitoring Program specified a minimum of four storm events at each tributary station shall be monitored, including the first storm event of the year. Due to the dry conditions prevalent in the 2013-2014 monitoring year, grab samples were taken from each tributary location during two storm events. Grab samples were analyzed for conventional pollutants and bacteria.

Flow-weighted composite samples were also collected at each tributary station. Composite samples were collected during two storm events, including the first wet weather event at Medea Creek (TS28) and Liberty Canyon (TS29). Composite samples were the first wet weather event due to equipment malfunction. Composite samples were collected during one wet weather event at Upper Las Virgenes Creek (TS25), Cheseboro Canyon (TS26), Lower Lindero Creek (TS27) and PD 728 (TS30). Composite samples were analyzed for TSS, general minerals, nutrients, metals, semivolatile organics, base neutral, chlorinated pesticides, PCBs, organophosphate pesticides, and herbicides.

Two dry weather monitoring events were conducted at each of the tributary stations. During both dry weather monitoring events, one grab sample was collected from each tributary station and analyzed for conventional pollutants and bacteria. Composite samples were also collected at each tributary station during the dry weather events and analyzed for general minerals, heavy metals, semi-volatiles, TSS, and pesticides (Appendix K).

1.1.1.4 Shoreline Monitoring

The 2001 Monitoring and Reporting Program required the City of Los Angeles to monitor shoreline stations to evaluate the impacts to coastal receiving waters and loss of beneficial uses that result from stormwater/urban runoff. Per the 2001 Monitoring and Reporting Program, the Shoreline Monitoring program consisted of sampling and indicator bacteria analysis of 18 water quality stations along the Pacific Ocean Shoreline within Santa Monica Bay. In addition, the

2001 Permit required that the City of Los Angeles perform an annual assessment of shoreline water quality data and submit these data to the Los Angeles County Flood Control District (LACFCD) for inclusion in the monitoring report. The City of Los Angeles's assessment is included as Appendix D of this monitoring report.

1.1.1.5 Trash Monitoring

In accordance with the protocols of the 2001 Monitoring and Reporting Program, visual observations of trash were made, and at least one photograph was taken at each MES after the first storm event and at least three additional storm events, with the exception of Santa Clara MES (two additional storm events) and Malibu Creek MES (one additional storm event).

The 2001 Monitoring and Reporting Program required Permittees in the Ballona Creek and Los Angeles River watersheds to capture and quantify trash. The results of this activity are described in Appendices I and J, respectively.

1.1.2 Regional Monitoring

The 2001 Monitoring and Reporting Program required the LACFCD to participate in regional monitoring programs. The regional programs include bioassessment, which is summarized below in Subsection 1.2.2.2.

1.1.2.1 Estuary Sampling

The LACFCD has participated in the coastal ecology committee of the Bight '03 project coordinated by the Southern California Coastal Water Research Project (SCCWRP). The goal of this study was to supplement the regional monitoring of the Southern California Bight estuarine habitats by sampling estuaries for sediment chemistry, sediment toxicity, and benthic infaunal communities and to determine the spatial extent of potential impacts from stormwater discharges. All reports pertinent to the Bight '03 Project have been completed by SCCWRP and were released on the SCCWRP website during the summer of 2007 (http://www.sccwrp.org/Documents/BightDocuments/Bight03Documents/Bight03AssessmentReports.aspx).

The Los Angeles County Department of Beaches & Harbors, the Los Angeles County Sanitation Districts, and the Los Angeles Department of Water and Power participated in the coastal ecology committee of the Bight '08 project coordinated by SCCWRP. Estuarine habitats were sampled for sediment chemistry, sediment toxicity, and benthic infaunal communities. Reports have been completed by SCCWRP and were released on the SCCRWP website (http://www.sccwrp.org/Documents/BightDocuments/Bight08Documents/Bight08AssessmentReports.aspx).

The Los Angeles County Sanitation District participated in the contaminant impact assessment (formerly coastal ecology) committee of the Bight '13 project coordinated by SCCWRP. Sampling was conducted over the summer of 2013. As in previous Bight studies, estuarine habitats were sampled for sediment chemistry, sediment toxicity, and benthic infaunal communities. Preliminary findings will be posted on the SCCWRP website as they become available. Planning documents are currently available for review

(http://www.sccwrp.org/Documents/BightDocuments/Bight13Documents/Bight13PlanningDocuments.aspx).

1.1.2.2 Bioassessment

Bioassessment monitoring was conducted to help assess the biological integrity of a waterbody and to help determine potential sources of biological impairment, where they may exist. A series of metrics or indices are used to characterize the streambed biological community as well as the physical habitat of a station. These metrics can be compared with those found at reference stations to help determine the potential for anthropogenic influences on the biological community. The LACFCD typically performs annual Los Angeles County stream bioassessments in June or July during early summer baseline conditions. Sampling stations are located throughout each of the six major watersheds and were selected to represent the diverse environments of the Los Angeles region. Table 1-1 lists the sampling station locations, and Figure 1-1 shows the geographical location of the sampling stations. In 2013, bioassessment monitoring was conducted at 20 stations – four in the San Gabriel River watershed, six in the Los Angeles River watershed, one in the Dominguez Channel watershed, five in the Santa Monica Bay watershed, and four in the Santa Clara River watershed. The final report for the most recent year of the Bioassessment Monitoring Program (i.e., 2013) is included in Appendix H.

Laboratory methods in 2013 incorporated a new Surface Water Ambient Monitoring Program (SWAMP) laboratory standard operating procedure (SOP). The sampling and analysis for the 2013 survey was performed using the same protocols as in the 2009–2012 surveys, with the exception of this SWAMP laboratory protocol.

1.1.3 Special Studies

The 2012 Permit's monitoring program requires each permittee to conduct the special studies required in an effective Total Maximum Daily Load (TMDL) or an approved applicable TMDL Monitoring Plan.

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2.0 STATION DESCRIPTIONS

MES were established and monitored throughout the LACFCD in an effort to characterize the water quality of the channels and streams. Tributary stations were selected to characterize the water quality of channels and streams in the subwatersheds.

2.1 Mass Emission Station Selection

During the 2013-2014 monitoring year, the LACFCD monitored seven MES, including Ballona Creek, Malibu Creek, Los Angeles River, Coyote Creek, San Gabriel River, Dominguez Channel, and Santa Clara River. The collective drainage area from the seven MES encompasses approximately 2,060 square miles.

Four of the MES locations installed under the original 1990 Municipal Stormwater Permit were retained under the 1996 and the 2001 Municipal Stormwater Permits, including Ballona Creek (S01), Malibu Creek (S02), Los Angeles River (S10), and San Gabriel River (S14). The Coyote Creek (S13) MES was monitored under the 1990, 1996, and 2001 Municipal Stormwater Permits; however, monitoring was not required under the 1996 Municipal Stormwater Permit. Monitoring began at the Dominguez Channel (S28) MES during the 2001–2002 season, and sampling at the Santa Clara (S29) MES began during the 2002–2003 season.

2.2 Mass Emission Station Monitoring Locations and Drainage Areas

Figure 2-1 provides an overview of the study area, showing all MES monitoring locations. Table 2-1a indicates the dominant land use associated with each monitoring station and the total drainage area.

The following subsections present descriptions of the seven MES locations, including Ballona Creek, Malibu Creek, Los Angeles River, Coyote Creek, San Gabriel River, Dominguez Channel, and Santa Clara River. Figures 2-2 through 2-8 show the location of each monitoring station along with a description of its land use.

Ballona Creek Monitoring Station (S01)

The Ballona Creek monitoring station is located in the creek at the existing stream gauge station (i.e., Stream Gauge F38C-R) between Sawtelle Boulevard and Sepulveda Boulevard in the City of Los Angeles and was chosen to avoid tidal influences. The upstream tributary watershed of Ballona Creek is 88.8 square miles. The entire Ballona Creek Watershed is 127.1 square miles. Ballona Creek is a concrete-lined trapezoidal channel at the gauging station. This station is shown in the Thomas Guide, page 672, G-4 (Rand McNally, 2010).

Malibu Creek Monitoring Station (S02)

The Malibu Creek monitoring station is located in the creek at the existing stream gauge station (i.e., Stream Gauge F130-9-R) near Malibu Canyon Road, south of Piuma Road. The tributary

watershed to Malibu Creek at this location is 104.9 square miles, and the entire Malibu Creek Watershed is 109.9 square miles. This station is shown in the Thomas Guide, page 628, H-1.

Los Angeles River Monitoring Station (S10)

The Los Angeles River monitoring station is located in the river at the existing stream gauge station (i.e., Stream Gauge F319-R) between Willow Street and Wardlow Road in the City of Long Beach and was chosen to avoid tidal influences. The river is a concrete-lined trapezoidal channel at this station. The total upstream tributary drainage area for the Los Angeles River is 825 square miles. This river is the largest watershed outlet to the Pacific Ocean in the Los Angeles County Coastal watershed. This station is shown in the Thomas Guide, page 795, C-1.

Coyote Creek Monitoring Station (S13)

The Coyote Creek monitoring station is located in the creek at the existing U.S. Army Corps of Engineers (USACE) stream gauge station (i.e., Stream Gauge F354-R) below Spring Street in the lower San Gabriel River Watershed. Monitoring at this station assists in determining the mass loading for the San Gabriel River Watershed. The upstream tributary area is 150 square miles and extends into Orange County. The station was chosen to avoid backwater effects from the San Gabriel River to ensure that all water being sampled is from Coyote Creek only. Coyote Creek is a concrete-lined trapezoidal channel at this location. The Coyote Creek MES location has been an active stream gauging station since 1963. This station is shown in the Thomas Guide, page 796, H-2.

San Gabriel River Monitoring Station (S14)

The San Gabriel River monitoring station is located in the river at a historic stream gauge station (i.e., Stream Gauge F263C-R), below San Gabriel River Parkway in Pico Rivera. The upstream tributary area is 450 square miles at this location. The San Gabriel River has a grouted rock-concrete stabilizer along the western levee and a natural section on the eastern side. Flow measurement and water sampling are conducted in the grouted rock area along the western levee of the river. The length of the concrete stabilizer is nearly 70 ft. The San Gabriel River MES location has been an active stream gauging station since 1968. This station is shown in the Thomas Guide, page 676, J-2.

Dominguez Channel Monitoring Station (S28)

The Dominguez Channel monitoring station is located in the channel at Dominguez Channel and Artesia Boulevard in the City of Torrance and was chosen to avoid tidal influence. Flow at this station is measured by the flow meter attached to the auto sampler. The upstream tributary area is 33 square miles. The Dominguez Channel monitoring station is located in a concrete-lined rectangular channel. This station is shown in the Thomas Guide, page 733, H-7.

Santa Clara River Monitoring Station (S29)

The Santa Clara monitoring station is located in the river at the Santa Clara River and the Old Road in Santa Clarita. The Santa Clara River is primarily a soft bottom channel, which makes accurate flow monitoring extremely difficult. This location was originally chosen because flow monitoring was possible from the existing United States Geological Survey (USGS) 11108000 Santa Clara River near Saugus, California, Stream Gauging Station. Currently, the LADPW Water Resources Division operates a real-time stream gauging station at the station. The flow

gauging operation has been subject to shifting river conditions in recent years. The upstream tributary area is approximately 411 square miles. This station is shown in the Thomas Guide, page 4550, C-2.

2.3 Tributary Station Selection

The six tributary monitoring stations monitored during the 2013-2014 monitoring year were selected to collect water quality data from subwatersheds in the Malibu Canyon Watershed Management Area. These stations were established in accordance with the 2001 Municipal Stormwater Permit Monitoring program. Monitoring of the Malibu Canyon Watershed tributary stations began in the 2011-2012 monitoring year.

2.4 Tributary Monitoring Locations and Drainage Areas

Figure 2-9 is an overview of the study area showing all the tributary monitoring stations. Table 2-1b contains the dominant land uses for each station.

Descriptions of the six tributary monitoring stations monitored for the 2013-2014 Monitoring Season, are presented in the following subsections. Stations were identified using four alphanumeric digits, Upper Las Virgenes Creek (TS25), Cheseboro Canyon (TS26), Lower Lindero Creek (TS27), Medea Creek (TS28), Liberty Canyon Channel (TS29), and PD 728 at Foxfield Drive (TS30). Figures 2-10 through 2-15 show the location of each tributary monitoring station.

Upper Las Virgenes Creek (TS25)

The Upper Las Virgenes Creek Tributary monitoring station is located in the creek, south of Parkmor Road, east of the intersection with La Virgenes Road (County Highway N1) in the City of Calabasas. The upstream tributary watershed area is approximately 5,795 acres. This station is shown in the Thomas Guide, page 558, H-3.

Cheseboro Canyon (TS26)

The Cheseboro Canyon Tributary monitoring station is located in the creek, south of Agoura Road to the southwest of the intersection of Agoura Road and Cornell Road in the City of Agoura Hills. The upstream tributary watershed area is approximately 5,346 acres. This station is shown in the Thomas Guide, page 558, A-6.

Lower Lindero Creek (TS27)

The Lower Lindero Creek Tributary monitoring station is located in the creek, south of Agoura Rd to the west of Kanan Road (County Highway N9) in the City of Agoura Hills. The upstream tributary watershed area is approximately 4,160 acres. This station is shown in the Thomas Guide, page 557, J-6.

Medea Creek (TS28)

The Medea Creek Tributary monitoring station is located in the creek, south of Agoura Road to the southwest of the intersection of Agoura Road and Cornell Road in the City of Agoura Hills.

The upstream tributary watershed area is approximately 4,091 acres. This station is shown in the Thomas Guide, page 558, A-6.

Liberty Canyon Channel (TS29)

The Liberty Canyon Channel Tributary monitoring station is located in the channel, east of Liberty Canyon Road, south of the intersection with Park Vista Road in the City of Agoura Hills. The upstream tributary watershed area is approximately 905 acres. This station is shown in the Thomas Guide, page 588, E-1.

PD 728 at Foxfield Drive (TS30)

Tributary monitoring station PD 728 is located in the channel, south of Lindero Canyon Road east of Foxfield Drive, in the City of Westlake Village. The upstream tributary watershed area of this station is approximately 1,789 acres. This station is shown in the Thomas Guide, page 557, C-7.

3.0 METHODS

This section describes the field and laboratory methods used to implement the 2013-2014 Monitoring Program.

The core monitoring program was conducted in compliance with the monitoring protocols set forth by the 2001 Permit's monitoring program. Water quality samples were collected from seven watersheds. The seven watersheds included Ballona Creek, Malibu Creek, Los Angeles River, Coyote Creek, San Gabriel River, Dominguez Channel, and Santa Clara River. Collection and analysis of stormwater runoff during wet weather conditions and ambient (dry) weather runoff were performed at the MES and tributary locations.

The 2001 Permit's monitoring program required sample collection at MES locations for a minimum of three storm events (including the first storm event of the season) and two dry events. Due to the dry conditions that prevailed during the 2013-2014 season, only two samples were collected during wet weather at the Malibu Creek MES (S02) and only one dry weather sample was collected at the San Gabriel River MES (S14).

At the tributary stations located in the Malibu Creek Watershed, sample collection was required under the 2001 monitoring program for a minimum of four storm events (including the first storm event of the season) and one dry event. Due to the dry conditions, only two samples were collected during wet weather at each of tributary stations (TS25, TS26, TS27, TS28, TS29, and TS30). Insufficient sample was collected to complete all chemical analyses during the first wet weather event at each of the tributary stations except Medea Creek (TS28) and Liberty Canyon (TS29) due to equipment malfunction. Stormwater samples and dry weather samples were analyzed for chemical constituents, indicator bacteria, and toxicity to bioassay test organisms.

3.1 Precipitation and Flow Monitoring

3.1.1 Precipitation Monitoring

Precipitation monitoring was conducted at or near each MES using the various automatic rain gauges that LACFCD operates throughout Los Angeles County. A minimum of one automatic tipping bucket (intensity measuring) rain gauge was located nearby or within the tributary watershed for each MES. In some cases, large watersheds used multiple rain gauges to accurately characterize the rainfall. Existing gauges near the monitored watersheds were also used in stormwater runoff calculations and are essential in developing runoff characteristics for these watersheds.

3.1.2 Flow Monitoring

Because the monitoring program requires flow-weighted composites for many constituents, flow monitoring equipment was used to trigger the automated samplers. Flows were determined from water elevation measurements as described below.

The water elevation of an open channel was measured by the stage monitoring equipment, and the flow rate was derived from a previously established site-specific rating table or calculated

with an equation (e.g., Manning's Equation). The LACFCD uses rating tables generated from open channel, cross-section analysis and upstream/downstream flow characteristics. Previous flow measurement efforts indicated that all stations require multiple events to gather the data necessary for calibration of the measurement devices. The automatic samplers used pressure transducers as the stage measurement device. At the Santa Clara MES, the leaf technique was employed to measure stream discharge. Stadia rods were used to measure depth, whereas stream velocity was estimated by timing floating objects as they traveled between rods set a fixed distance apart.

3.2 Wet Weather and Dry Weather Monitoring

3.2.1 Wet Weather Sample Collection Methods

During the 2013-2014 monitoring season, analyses of stormwater samples consisted of field measurements, grab samples, and composite samples in accordance with the methods described below.

Field Measurements – Field measurements, which included pH, dissolved oxygen (DO), conductivity, turbidity, and temperature, were conducted using calibrated YSI or similar meters at the Malibu MES and its tributary stations.

Grab Sample - A grab sample is a discrete, individual sample taken within a short period of time, usually less than 15 minutes. This method is used to collect samples for constituents not amenable to composite sampling due to short holding times and specific collection or preservation needs. Grab samples were analyzed for indicator bacteria and for conventional pollutants.

Grab Sample Constituents	
Conventional Constituents/Parameters	**Indicator Bacteria**
▪ Oil & grease ▪ Total phenols ▪ Cyanide ▪ Dissolved oxygen (DO) ▪ pH ▪ Total petroleum hydrocarbons (TPH) ▪ Methyl tertiary butyl ether (MTBE) ▪ 2-Chloroethyl vinyl ether	▪ Total coliforms ▪ Fecal coliforms ▪ Fecal streptococci ▪ Fecal enterococci ▪ *E. coli*

Analytical methods, detection limits, and holding times for these constituents are provided in Table 3-1.

Grab samples were collected during the initial portion of the storm event (i.e., on the rising limb of the hydrograph), placed on ice, and taken directly to the laboratory. Samples were collected from the horizontal and vertical center of the channel if possible and kept clear from uncharacteristic floating debris. Because oil and grease and other petroleum hydrocarbons tend

to float, oil and grease grab samples were collected at the air–water interface unless flows did not allow for the safe collection of samples. In these cases, grab samples were collected using the automated samplers. Bacteria samples were collected in a sterile sample bottle and then placed on ice for transport to the laboratory for analysis within 8 hours of collection.

Composite Sample - A composite sample is a mixed or combined sample created by combining a series of discrete samples (aliquots) of specific volume, collected at specific flow-volume intervals. Composite sampling is ideally conducted over the duration of the storm or other monitoring event. Composite samples were analyzed for 150 constituents, including conventional constituents, general minerals, nutrients, metals, semivolatile organics, base neutral, chlorinated pesticides, polychlorinated biphenyls (PCBs), organophosphate pesticides, and herbicides. In addition, all storm events resulting in at least 0.25 inch of rainfall were monitored for total suspended solids (TSS) at all MES equipped with automatic samplers. The additional TSS analysis was not conducted where manual sampling was required (Santa Clara River MES). Additionally, samples from the MES were analyzed for toxicity as described in Section 3.3.1.

Composite Sample Constituents	
▪ General ▪ Nutrients ▪ Metals ▪ Semivolatile organics ▪ Base/neutral	▪ Chlorinated pesticides ▪ Polychlorinated biphenyls ▪ Organophosphate pesticides ▪ Herbicides

Specific composite analytes, analytical methods, detection limits, and holding times for these constituents are provided in Table 3-1.

Most flow-weighted composite storm samples were obtained using an automated sampler programmed to collect samples at flow-paced intervals. Because it is not feasible to install an automatic sampler at the Santa Clara River station, composite samples were obtained at this location by sampling discretely from the river at 20-minute intervals for the first three hours of the storm (or the duration of the storm if it was less than three hours). The discrete samples were then mixed in the laboratory in proportion to the estimated flow rates (i.e., a flow-weighted composite).

During the storm season, the automated samplers were programmed to start automatically when the water level in the channel or storm drain exceeded a minimum predetermined level above base flow or prevailing pre-storm flow. This practice was developed based on years of monitoring experience in local watersheds. It was particularly useful when automated samplers needed to be reset to capture storms occurring a little over 24 hours apart and it was not possible to wait for flows to return to base flow conditions.

A sample was collected each time a set volume of water had passed the monitoring point. This volume is referred to as the pacing volume or trigger volume. Samples were stored in glass containers within the sampler. An 8-liter minimum sample volume was required to conduct the necessary laboratory analyses. The automated sampler was deactivated by field personnel within 48 hours after the end of each storm event. Samples were retrieved from the automated samplers

as soon as possible to meet laboratory analysis holding time requirements. As samples were collected, rainfall discrete sample times and runoff data were logged and stored for transfer to the office.

3.2.2 Dry Weather Sample Collection Methods

Dry weather monitoring protocols were similar to those used for wet weather monitoring, except that samples were collected as time-weighted composites over a 24-hour period, and automated samplers were programmed to start at a specified time.

3.2.3 Field Quality Assurance / Quality Control

Quality assurance (QA)/quality control (QC) is an essential component of the monitoring program. *Evaluation of Analytes and QA/QC Specifications for Monitoring Program* (Woodward-Clyde, 1996) describes the procedures used for bottle labeling, chain-of-custody (COC) tracking, sampler equipment checkout and setup, sample collection, field blanks to assess field contamination, field duplicate samples, and transportation to the laboratory. An important part of the QA/QC plan is the continued education of field personnel. Field personnel were trained from the onset and were informed regarding new or revised stormwater sampling techniques on a continual basis. Field personnel also evaluated the field activities required by the QA/QC plan, and the plan was updated if necessary. Accurate data were obtained by proper monitoring station setup, water sample collection, sample transport, and laboratory analyses.

QA/QC for sampling processes included proper collection of the samples to minimize the possibility of contamination. Samples were collected in clean sample bottles, sterilized by the laboratory. Sampling personnel were trained according to the field sampling SOPs. Additionally, the field staff was made aware of the significance of the project's detection limits and the requirement to avoid contamination of samples.

3.2.3.1 Field Setup Procedures

Automated field sampling stations were at fixed locations, with the sampler placed on a public road or flood control right-of-way. Inspection of visible hoses and cables was performed to ensure proper working conditions according to the station design. Inspection of the intake tube, pressure transducer, and auxiliary pump was performed during daylight hours in normal (i.e., non-storm) conditions.

For stormwater sample collection, the automated samplers were programmed prior to the event based upon weather forecast information. The automated samplers were checked at the beginning of the storm to ensure proper working conditions and to determine whether flow composite samples were being collected properly. Grab samples were taken during the rising limb of the hydrograph.

For dry weather, following the initial sample collection, field staff prepared the sampler to collect subsequent samples (dry weather mode) until the entire set had been completed for that station. Manual samples were generally collected by field staff at the time they pre-programmed the auto sampler to begin collecting at each station. Dry weather collection techniques were similarly performed for both grab samples and 24-hour composite samples.

When a complete set of samples had been collected for a given event, the bottles were removed from the sampler and packed with ice and foam insulation inside individually marked ice chests. COC forms were completed by field staff before transporting the samples to the laboratory. Under no circumstances were samples removed from the ice chest during transportation from the field to the laboratory.

3.2.3.2 Bottle Preparation

A minimum of three sets of bottles were prepared for each monitoring station so that change-outs could be made quickly between closely occurring storms. Bottle labels included the following information:

- LACFCD's Field Sample Identification (FSID) number.
- Station (site) number.
- Station (site) name.
- Laboratory analysis requested.
- Date (written at time of sampling).

Bottles were cleaned at the laboratory prior to use, labeled, and stored in sets. Each station was provided with the same number, type, and size bottles for each rotation, unless special grab samples were required. Clean composite sample bottles with sterile stoppers were placed in the automated sampler when samples were collected. This practice ensured readiness for the next storm event. All bottles not in use at the time of sampling were stored in clean dry conditions for later use. Composite sample bottles were limited to a maximum of 2.5 gallons each, to ensure ease of handling.

3.2.3.3 Chain-of-Custody Procedure

COC procedures (Woodward-Clyde, 1996) were used for all samples throughout the collection, transport, and analytical process. Samples were considered to be in custody if they were: (1) in the custodian's possession or view (2) retained in a secured place (under lock) with restricted access, or (3) placed in a container and secured with an official seal to prevent the sample from being reached without breaking the seal. COC records, field logbooks, and field tracking forms were the principal documents used to identify samples and to document possession. The COC procedures were initiated during sample collection. A COC record was provided with each sample or group of samples. Each person with sample custody signed the form and ensured the samples were not left unattended unless properly secured. Documentation of sample handling and custody included the following:

- Bottle label information (i.e., the LACFCD FSID number, station [site] number, station [site] name, laboratory analysis requested, and date [written at time of sampling]).
- Time (written at time of sampling).
- Number of bottles.
- Temperature of sample.
- Sampler(s), laboratory and sampler/courier signatures, and time(s) sample(s) changed possession (completed upon sample transfer(s)).

3.2.3.4 New Zealand Mud Snails

Due to concern about the spread of New Zealand Mud Snails, additional decontamination of monitoring equipment between Malibu MES and tributary monitoring stations was conducted. A designated set of sampling equipment (exclusive of temperature and pH field meters) was used for each of the stations in the Malibu watershed (Malibu MES and tributary stations), and was decontaminated before and after each event. Decontamination procedures as described by the California Department of Fish and Game (Hosea and Finlayson, 2005) were employed and included immersion of sampling equipment in Sparquat 256.

Field meters utilize sensitive osmotic membranes for use in measurement of pH. Therefore, the use of freezing or Sparquat 256 as a decontamination method was not employed. Field meters were visually inspected after use at each location; and all snails, mud, algae, and debris were removed. The meters were then thoroughly rinsed on-site with tap water and allowed to dry completely. Visual inspection of the field meters was completed prior to departure from the station and before use at the next monitoring location.

3.3 Laboratory Analyses

The 2001 Permit specified a suite of analyses and associated minimum levels (MLs) for samples collected at the MES and tributary locations, as detailed in Table 3-1. The laboratory methods used for analyzing stormwater samples are approved by the California Department of Public Health (CDPH) and conform to EPA-approved methods.

The Los Angeles County Department of Agricultural Commissioner Weights and Measures (ACWM) Environmental Toxicology Laboratory provides water quality laboratory and related services to LACFCD. The ACWM Laboratory is state certified to perform the water quality analyses and maintains a laboratory analysis program that includes QA/QC protocols consistent with the monitoring program. The ACWM subcontracts toxicity testing with Aquatic Bioassay Consulting Laboratories, Inc. (ABC) of Ventura, California. This laboratory is accredited by the State of California's Environmental Laboratory Accreditation Program (ELAP; certificate number 1907) for whole effluent toxicity of wastewater testing as well as for other types of analyses.

Several storm events were monitored with the assistance of an environmental consulting firm, Weston Solutions, Inc. (WESTON®). Grab and composite samples collected by WESTON were sent to ACWM. Toxicity samples collected by WESTON were analyzed by ABC Laboratories.

3.3.1 Toxicity Analysis

Toxicity testing was performed on flow-weighted composite samples collected from the MES locations concurrently with the water chemistry analyses during two wet weather events. Toxicity testing was also performed on time-weighted composite samples during two dry weather events at the MES locations, with the exception of San Gabriel River MES, where one dry weather sample was collected due to the dry conditions.

Toxicity testing is an effective tool for assessing the potential impact of complex mixtures of unknown pollutants on aquatic life in receiving waters. Rather than performing chemical analysis on a sample for a host of compounds potentially toxic to aquatic life, toxicity testing provides a direct measure of the toxicity of the sample to laboratory test organisms. Interactions among the complex mixture of chemicals and physical constituents inherent to environmental samples can lead to additive or antagonistic effects, potentially causing an individual compound to become either more or less toxic than it would be if it were isolated. Although the potential effects of these interactions cannot be derived from simple chemical measurements, they are directly accounted for in toxicity tests. If toxicity is identified in a given sample, toxicity identification evaluations (TIEs) can be used to help characterize and identify the constituent(s) responsible for the toxicity. Toxicity testing can provide information on both potential short-term (i.e., acute) effects as well as longer-term (i.e., chronic) effects.

Toxicity analysis was performed using the following methods:

- *Ceriodaphnia dubia* 7-day (chronic) survival and reproduction tests.
- *Strongylocentrotus purpuratus* (sea urchin) (chronic) fertilization test.

The tests were performed using multiple sample concentrations ranging from 0% (N-control) to 100%, such that the desired toxicity endpoints could be adequately observed. Based on the endpoints of reproduction and survival, the no-observed-effect concentrations (NOEC), inhibitory concentrations (IC), effective concentrations (EC), and toxicity units (TU) were calculated and reported for each test. Toxicity units are calculated by dividing 100 by the calculated median test response value (e.g., IC_{50}). The *C. dubia* and *S. purpuratus* tests were conducted under guidelines prescribed in *Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms* (EPA, 2002) and *Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to West Coast Marine and Estuarine Organisms* (EPA, 1995), respectively. Water quality measurements (i.e., temperature, pH, DO, conductivity, salinity, hardness, and alkalinity) were recorded for each sample at the beginning and throughout each test. These measurements were performed to ensure that there were no large variations in water quality, which can affect the accuracy of the toxicity tests.

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4.0 RESULTS, ANALYSES, AND RECOMMENDATIONS

This section describes the results and data analysis and includes a discussion of probable constituent sources and recommendations.

4.1 Hydrology – Precipitation and Flow

4.1.1 Analysis of Precipitation and Flow Data and a Discussion of the Hydrographs

This subsection discusses the precipitation and flow data and the hydrologic analysis of the monitoring area. Precipitation data and hydrographs can be used to address the following management question:

How did the 2013-2014 storm season differ in comparison to previous storm seasons?

This management question is answered in the following two ways:

1. Figure 4-1 illustrates total precipitation by storm season, observed in downtown Los Angeles at Station 716, Ducommun Street. The total annual rainfall during the 2013-2014 storm season in downtown Los Angeles was less than half of the 142-year average annual rainfall and was the driest storm season since the 2006-2007 storm season.

2. Figure 4-2 is a comparison of the total monthly rainfall for the 2013-2014 storm season and the long-term pattern of rainfall observed in downtown Los Angeles at Station 716, Ducommun Street. During the 2013-2014 storm season, rainfall was less than the 142-year historic rainfall average for every month. The month of January, historically the wettest month, was the driest winter month during the 2013-2014 monitoring year. The historic seasonal pattern of rainfall includes an increase in precipitation in October, November, and December that peaks in January and February before decreasing during March, April, and May. The seasonal pattern observed for the 2013-2014 monitoring year differed from the historic pattern, due to the dry conditions observed in December and January.

4.1.2 Hydrographs for Monitoring Stations

Hydrographs are provided for all monitoring station events for which flow-weighted composite samples were collected during the 2013-2014 monitoring season (Appendix A). Each hydrograph includes the known times of the composite sample aliquot collection, including the first and last aliquots, sample volume interval, runoff volume, and percent of storm sampled. A summary of the hydrologic data for the MES is provided in Table 4-1.

The hydrographs and composite sampling start and end times can be used to address the following management question:

What percentage and what portion of the storm event were sampled?

This question is answered by examining the hydrographs (Appendix A). Each hydrograph contains the percent of the storm that was sampled and the first and last composite samples, which provides a visual representation of the sampled portion of the storm, in most cases.

To the extent possible, the initial portion of the event was sampled, rather than the tailing end of the hydrographs. Good faith effort was made to capture composite samples most representative of the full duration of each monitored storm event. In general, the monitored storm events did meet this goal, suggesting that the water quality results are an accurate representation of the storm events.

4.2 Stormwater Quality

4.2.1 Comparison to Water Quality Objectives

The monitoring results were compared to applicable water quality standards by evaluating and compiling a list of applicable numeric water quality objectives and by comparing results measured to the applicable objectives. The number of wet weather and dry weather sampling events at each MES and tributary station is summarized in Tables 4-2a and 4-2b, respectively. The number of sampling events where toxicity was assessed is summarized by station in Table 4-3.

This subsection addresses the following key management question:

What constituents were measured at concentrations that do not meet water quality objectives?

Water quality standards consist of defined beneficial uses of water, and numeric or narrative water quality objectives used to evaluate whether beneficial uses are protected. Numeric water quality objectives are expressed in the following terms:

- Magnitude – Defined as the threshold concentration at which beneficial uses are threatened or impaired.
- Frequency – Defined as the number of exceedances of threshold concentrations in a given time period that indicates impairment.
- Duration – Defined as the length of time the ecosystem is exposed to concentrations above the threshold.

Analyses that compare measurements to objectives consider magnitude. Aquatic life objectives established in the California Toxics Rule (CTR) also allow an exceedance frequency of no more than once every 3 years (EPA, 2000). Human-health-based objectives, such as mercury in the CTR or maximum contaminant levels (MCLs) cited in the Water Quality Control Plan for the Los Angeles Region (Basin Plan), do not specify an exceedance frequency.

The duration for many aquatic life objectives (e.g., WARM and COLD) is usually expressed as acute (i.e., 1-hour exposure) or chronic (i.e., 4-day exposure). Some objectives (e.g., ammonia) are expressed as 30-day averages, or other averaging periods. Some objectives (e.g., human health criteria in the CTR) are expressed as instantaneous thresholds. For this assessment, analyses performed were based on instantaneous grab samples or composite samples. For dry weather analyses, 24-hour composite samples were used. Comparisons to acute water quality objectives were made for all samples.

Applicable water quality objectives (see tables below) are those for which there is no uncertainty regarding the applicable objectives or the implementation with respect to frequency and duration.

In Tables 4-4 and Table 4-5, numeric objectives listed as ranges are calculated values based on sample-specific conditions. Ammonia water quality objectives are sample-specific, based on pH, and were calculated using measured pH and Table 3-1 of the Basin Plan. Dissolved metals water quality objectives are sample-specific and were calculated using measured hardness and procedures set forth in the CTR. Pentachlorophenol water quality objectives are sample-specific and were calculated based upon pH values and procedures set forth in the CTR.

Water quality objectives that are not sample specific are summarized in the tables below.

Acute Water Quality Objectives at Mass Emission Stations

Constituent	Units	Water Quality Objective Source	Station ID						
			S01	S02	S10	S13	S14	S28	S29
4-4'-DDT	µg/L	CTR	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Aldrin	µg/L	CTR	3	3	3	3	3	3	3
Chloride	mg/L	Basin Plan	NA	500	150	NA	150	NA	150
Cyanide	mg/L	CTR	0.022	0.022	0.022	0.022	0.022	0.022	0.022
Dieldrin	µg/L	CTR	0.24	0.24	0.24	0.24	0.24	0.24	0.24
Dissolved arsenic	µg/L	CTR	340	340	340	340	340	340	340
Dissolved oxygen (DO)	mg/L	Basin Plan	5	7	5	5	5	5	5
E. coli	MPN/ 100 mL	Basin Plan	576	235	235	235	235	235	235
alpha-Endosulfan	µg/L	CTR	0.22	0.22	0.22	0.22	0.22	0.22	0.22
beta-Endosulfan	µg/L	CTR	0.22	0.22	0.22	0.22	0.22	0.22	0.22
Endrin	µg/L	CTR	0.086	0.086	0.086	0.086	0.086	0.086	0.086
gamma-BHC (lindane)	µg/L	CTR	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Heptachlor	µg/L	CTR	0.52	0.52	0.52	0.52	0.52	0.52	0.52
Heptachlor epoxide	µg/L	CTR	0.52	0.52	0.52	0.52	0.52	0.52	0.52
Nitrate (NO_3)	mg/L	Basin Plan	45	45	45	45	45	45	45
Nitrate-N	mg/L	Basin Plan	10	10	10	10	10	10	10
Nitrite-N	mg/L	Basin Plan	1	1	1	1	1	1	1
pH	pH units	Basin Plan	6.5–8.5	6.5–8.5	6.5–8.5	6.5–8.5	6.5–8.5	6.5–8.5	6.5–8.5
Sulfate	mg/L	Basin Plan	NA	500	350	NA	300	NA	600
Total dissolved solids (TDS)	mg/L	Basin Plan	NA	2,000	1,500	NA	750	NA	1,200
Toxaphene	µg/L	CTR	0.73	0.73	0.73	0.73	0.73	0.73	0.73

µg/L = microgram per liter.
mg/L = milligram per liter.
mL = milliliter.
MPN = most probable number.
NA = not applicable.
CTR = California Toxics Rule.

Acute Water Quality Standards at Tributary Stations

Constituent	Units	Water Quality Objective Source	Station ID					
			TS25	TS26	TS27	TS28	TS29	TS30
4-4'-DDT	µg/L	CTR	1.1	1.1	1.1	1.1	1.1	1.1
Aldrin	µg/L	CTR	3	3	3	3	3	3
Chloride	mg/L	Basin Plan	500	500	500	500	500	500
Cyanide	mg/L	CTR	0.022	0.022	0.022	0.022	0.022	0.022
Dieldrin	µg/L	CTR	0.24	0.24	0.24	0.24	0.24	0.24
Dissolved arsenic	µg/L	CTR	340	340	340	340	340	340
Dissolved Oxygen (DO)	mg/L	Basin Plan	5	5	5	5	5	5
E. coli	MPN/100 mL	Basin Plan	235	235	235	235	235	235
alpha-Endosulfan	µg/L	CTR	0.22	0.22	0.22	0.22	0.22	0.22
beta-Endosulfan	µg/L	CTR	0.22	0.22	0.22	0.22	0.22	0.22
Endrin	µg/L	CTR	0.086	0.086	0.086	0.086	0.086	0.086
gamma-BHC (lindane)	µg/L	CTR	0.95	0.95	0.95	0.95	0.95	0.95
Heptachlor	µg/L	CTR	0.52	0.52	0.52	0.52	0.52	0.52
Heptachlor epoxide	µg/L	CTR	0.52	0.52	0.52	0.52	0.52	0.52
Nitrate (NO_3)	mg/L	Basin Plan	45	45	45	45	45	45
Nitrate-N	mg/L	Basin Plan	10	10	10	10	10	10
Nitrite-N	mg/L	Basin Plan	1	1	1	1	1	1
pH	pH units	Basin Plan	6.5–8.5	6.5–8.5	6.5–8.5	6.5–8.5	6.5–8.5	6.5–8.5
Sulfate	mg/L	Basin Plan	500	500	500	500	500	500
Total Dissolved Solids (TDS)	mg/L	Basin Plan	2,000	2,000	2,000	2,000	2,000	2,000
Toxaphene	µg/L	CTR	0.73	0.73	0.73	0.73	0.73	0.73

µg/L = microgram per liter.
mg/L = milligram per liter.
mL = milliliter.
MPN = most probable number.
CTR = California Toxics Rule.

This subsection summarizes the constituents that did not meet applicable water quality objectives at MES and tributary stations sampled during the 2013-2014 Monitoring Program. Results are grouped by wet weather or dry weather, and by watershed. Specific results are available in Appendix B for all stations and sampling events.

Basin Plan Amendment – Resolution No. R10-005 (Update of the Bacteria Objectives for Freshwaters Designated for Water Contact Recreation) adopted December 5, 2011, removed the fecal coliform water quality objectives for the recreation (REC) beneficial uses REC-1 and LREC-1.

A suspension of the recreational beneficial uses (REC-1 and REC-2) and of the associated bacteria water quality objectives is applied in some urban watersheds during wet weather storm events greater than 0.5 inch over 24 hours. The High Flow Suspension only applies to concrete lined engineered channels; as detailed in the Basin Plan Amendment – Resolution No. 2003-010 (High-Flow Suspension of Recreational Uses), adopted November 2, 2004 (Los Angeles Regional Water Quality Control Board (LARWQCB), 2003).

The storm events for which the high flow suspension applied in 2013-2014 are identified in the exceedance summary for each drainage area as well as in Table 4-1, Summary of Hydrologic Data for Mass Emissions Stations. The high-flow suspension was applied at one or more of the MES during four storms events monitored during the 2013-2014 season. Measurements above the bacteria water quality objective were not highlighted for these events.

The following laboratory analytical qualifiers are noted on data review:

- Detected not quantified (DNQ).
- Not detected (ND).

Values reported as ND are below the method detection limit (MDL). Values reported with the qualifier of DNQ indicate that the result was between the MDL and the reporting limit (RL). In this analysis, reported values higher than the water quality objective are not discounted based on the three qualifiers above. Rather, the qualifiers are provided so that decision-makers can understand the reliability of data used to assess any impairment and can identify whether improved analytical methods are warranted.

A summary of the water quality monitoring data is presented in Table 4-4 and Table 4-5 for the MES and tributary stations, respectively. Figures 4-3.1 through 4-6.6 provide a graphical summary of water quality data for all MES and tributary stations, respectively. Wet weather monitoring data are shown on Figures 4-3.1 through 4-4.6, and dry weather monitoring data are shown on Figures 4-5.1 through 4-6.6. For each station, the constituents are represented as the ratio of the concentration measured during the monitoring event to the applicable water quality objective. For instance, if the total dissolved solids (TDS) concentration for a given storm was 2,000 milligrams per liter (mg/L) and the water quality objective was 2,000 mg/L at that location, then the ratio would be 1 on the graph.

Water quality objectives for indicator bacteria are based on the REC beneficial use designation at each station. Since the adoption of Resolution R10-005 in 2011, the REC-1 water quality objective (water contact recreation – full immersion) for bacteria is 235 most probable number (MPN)/100 milliliters (mL) of *E. coli*, and the LREC-1 (limited contact recreation) water quality objective for bacteria is 576 MPN/100 mL of *E. coli*. The REC-2 water quality objective (non-contact recreation) of 4,000 MPN/100 mL of fecal coliform applies to waters that are not also designated for water contact recreation (REC-1). The table below summarizes the recreational beneficial uses by station among the watersheds monitored.

Summary of Recreational Beneficial Uses and Applicable Bacteria Water Quality Objectives

Station ID	Station Name	High Flow Suspension	REC-1	LREC-1	REC-2	Applicable *E. coli* WQO (MPN/100 mL)
S01	Ballona Creek	X	P*	E	E	576
S02	Malibu Creek		E		E	235
S10	Los Angeles River	X	E		E	235
S13	Coyote Creek	X	P		I	235
S14	San Gabriel River	X	E		E	235
S28	Dominguez Channel	X	P		E	235
S29	Santa Clara River		E		E	235
TS25	Upper Las Virgenes		E		E	235
TS26	Cheseboro Canyon		E		E	235
TS27	Lower Lindero Creek		I		I	235
TS28	Medea Creek		E		E	235
TS29	Liberty Canyon Channel		E		E	235
TS30	PD 728		I		I	235

*- The REC-1 use designation does not apply to recreational activities associated with the swimmable goal or the associated bacteriological objectives.
E- Existing beneficial use
P – Potential beneficial use
I – Intermittent beneficial use
WQO = water quality objective.
MPN = most probable number.
mL = milliliter.

4.2.2 Mass Emission Stations During Wet Weather

4.2.2.1 Ballona Creek (S01)

A summary of the constituents that did not meet applicable water quality objectives at the Ballona Creek MES during the 2013-2014 Wet Weather Monitoring Season is presented in Table 4-4.1 and Figure 4-3.1.

E. coli concentrations ranged from 6,310 to 47,200 MPN/100 mL and were above the water quality objective of 576 MPN/100 mL during all five events monitored for bacteria. During wet weather high-flow periods, Ballona Creek is subject to a suspension of the LREC-1 beneficial use (i.e., limited contact recreation). As a result of this suspension, *E. coli* concentrations above

576 MPN/100 mL are not highlighted for 2013-14Event13. Based on this assessment, four of the five wet weather events analyzed for bacteria (2013-2014Event09, 2013-14Event10, 2013-14Event12, and 2013-14Event15) did not meet the *E. coli* water quality objective (Table 4-4.1 and Figure 4-3.1).

Several metals were above their corresponding hardness-based water quality objectives for at least one wet weather sample collected at Ballona Creek (Table 4-4.1). Dissolved copper concentrations ranged from 48.4 to 94.7 micrograms per liter (μg/L) and were above the water quality objective for all four of the wet weather samples collected at Ballona Creek. Dissolved zinc was also above the hardness-based water quality objective for all four wet weather samples, with concentrations ranging from 284 to 535 μg/L. Dissolved lead concentrations ranged from 23.5 to 47.8 μg/L, and one of the four concentrations (2013-14Event13) was above the hardness-based water quality objective. Hardness values for samples collected during wet weather at Ballona Creek ranged from 45 to 235 mg/L.

Dissolved oxygen concentrations ranged from 4.62 to 9.8, and one of the five values (2013-14Event15) was below the water quality objective of 5 mg/L.

All other applicable water quality objectives in Ballona Creek were met during the 2013-2014 Wet Weather Monitoring Season.

4.2.2.2 Malibu Creek (S02)

A summary of the constituents that did not meet applicable water quality objectives at the Malibu Creek MES during the 2013–2014 Wet Weather Monitoring Season is presented in Table 4-4.2 and Figure 4-3.2.

E. coli bacteria concentrations ranged from 214 to 677 MPN/100 mL, and one of the two values (2013-14Event13) was above the applicable water quality objective of 235 MPN/100 mL. Malibu Creek is not subject to the wet weather suspension of the REC-1 beneficial use.

All other applicable water quality objectives in Malibu Creek were met during the 2013-2014 Wet Weather Monitoring Season.

4.2.2.3 Los Angeles River (S10)

A summary of the constituents that did not meet applicable water quality objectives at the Los Angeles River MES during the 2013-2014 Wet Weather Monitoring Season is presented in Table 4-4.3 and Figure 4-3.3.

E. coli concentrations ranged from 3,255 to 137,600 MPN/100 mL and were above the water quality objective of 235 MPN/100 mL during all four storm events monitored for bacteria at Los Angeles River. During wet weather high-flow periods, Los Angeles River is subject to a suspension of the REC-1 beneficial use (i.e., water contact recreation – full immersion). As a result of this suspension, *E. coli* concentrations above 235 MPN/100 mL are not highlighted for 2013-14Event10 or 2013-14Event13. Based on this assessment, two of the four wet weather events analyzed for bacteria (2013-14Event09 and 2013-14Event12) did not meet the *E. coli* water quality objective (Table 4-4.3 and Figure 4-3.3).

Cyanide concentrations ranged from 0.0025 to 0.03 mg/L, and one of the four values (2013-14Event09) was above the water quality objective of 0.022 mg/L (Table 4-4.3).

pH was outside of the water quality objective range of 6.5–8.5 pH units for one of the four wet weather samples collected at Los Angeles River (Table 4-4.3). The water sample collected during 2013-14Event10 had a pH value of 6.45, slightly below the lower limit of the water quality objective range.

Dissolved copper concentrations ranged from 24.2 to 92 µg/L and were above the hardness-based water quality objective for all four of the wet weather samples collected at Los Angeles River. Dissolved zinc was also above the hardness-based water quality objective for all four wet weather samples, with concentrations ranging from 117 to 988 µg/L. Hardness values for samples collected during wet weather at Los Angeles River ranged from 50 to 170 mg/L (Table 4-4.3).

All other applicable water quality objectives in Los Angeles River were met during the 2013-2014 Wet Weather Monitoring Season.

4.2.2.4 Coyote Creek (S13)

A summary of the constituents that did not meet applicable water quality objectives at the Coyote Creek MES during the 2013-2014 Wet Weather Monitoring Season is presented in Table 4-4.4 and Figure 4-3.4.

E. coli concentrations ranged from 6,130 to 40,400 MPN/100 mL and were above the water quality objective of 235 MPN/100 mL during all four storm events monitored for bacteria at Coyote Creek. During wet weather high-flow periods, Coyote Creek is subject to a suspension of the REC-1 beneficial use (i.e., water contact recreation – full immersion). As a result of this suspension, *E. coli* concentrations above 235 MPN/100 mL are not highlighted for 2013-14Event13. Based on this assessment, three of the four wet weather events analyzed for bacteria (2013-2014Event09, 2013-14Event10, and 2013-14Event12) did not meet the *E. coli* water quality objective (Table 4-4.4 and Figure 4-3.4).

pH was outside of the water quality objective range of 6.5–8.5 pH units for one of the four wet weather samples collected at Coyote Creek (Table 4-4.4). The water sample collected during 2013-14Event10 had a pH value of 6.41, slightly below the lower limit of the water quality objective range.

Dissolved copper concentrations ranged from 24.9 to 72.8 µg/L and were above the hardness-based water quality objective for all four of the wet weather samples collected at Coyote Creek. Dissolved zinc was also above the hardness-based water quality objective for all four wet weather samples, with concentrations ranging from 145 to 765 µg/L. Hardness values for samples collected during wet weather at Coyote Creek ranged from 45 to 220 mg/L (Table 4-4.4).

All other applicable water quality objectives in Coyote Creek were met during the 2013-2014 Wet Weather Monitoring Season.

4.2.2.5 San Gabriel River (S14)

A summary of the constituents that did not meet applicable water quality objectives at the San Gabriel River MES during the 2013-2014 Wet Weather Monitoring Season is presented in Table 4-4.5 and Figure 4-3.5.

E. coli concentrations ranged from 6,131 to 14,670 MPN/100 mL and were above the water quality objective of 235 MPN/100 mL during all three storm events monitored for bacteria at San Gabriel River. During wet weather high-flow periods, San Gabriel River is subject to a suspension of the REC-1 beneficial use (i.e., water contact recreation – full immersion). As a result of this suspension, *E. coli* concentrations above 235 MPN/100 mL are not highlighted for events 2013-14Event09 or 2013-14Event13. Based on this assessment, one of the three wet weather events (2013-14Event15) did not meet the *E. coli* water quality objective (Figure 4-3.5).

Dissolved oxygen concentrations ranged from 4.4 to 10.9, and one of the three values (2013-14Event15) was below the water quality objective of 5 mg/L (Table 4-4.5).

All other applicable water quality objectives in San Gabriel River were met during the 2013-2014 Wet Weather Monitoring Season.

4.2.2.6 Dominguez Channel (S28)

A summary of the constituents that did not meet applicable water quality objectives at the Dominguez Channel MES during the 2013-2014 Wet Weather Monitoring Season is presented in Table 4-4.6 and Figure 4-3.6.

E. coli concentrations ranged from 6,770 to 33,600 MPN/100 mL and were above the water quality objective of 235 MPN/100 mL during all five storm events monitored for bacteria at Dominguez Channel. During wet weather high-flow periods, Dominguez Channel is subject to a suspension of the REC-1 beneficial use (i.e., water contact recreation – full immersion). As a result of this suspension, *E. coli* concentrations above 235 MPN/100 mL are not highlighted for 2013-14Event13. Based on this assessment, four of the five wet weather events analyzed for bacteria (2013-14Event09, 2013-14Event10, 2013-14Event12, and 2013-14Event15) did not meet the *E. coli* water quality objective (Table 4-4.6 and Figure 4-3.6).

Dissolved oxygen concentrations ranged from 4.35 to 10.4, and one of the five values (2013-14Event15) was below the water quality objective of 5 mg/L (Table 4-4.6).

pH was outside of the water quality objective range of 6.5–8.5 pH units for one of the four wet weather samples analyzed for general constituents at Dominguez Channel (Table 4-4.6). The water sample collected during 2013-14Event10 had a pH value of 6.33, slightly below the lower limit of the water quality objective range.

Dissolved copper concentrations ranged from 34.9 to 69.2 μg/L and were above the hardness-based water quality objective for all four of the wet weather samples collected at Dominguez

Channel. Dissolved zinc was also above the hardness-based water quality objective for all four wet weather samples, with concentrations ranging from 218 to 600 µg/L. Hardness values for samples collected during wet weather at Dominguez Channel ranged from 50 to 190 mg/L (Table 4-4.6).

All other applicable water quality objectives in Dominguez Channel were met during the 2013-2014 Wet Weather Monitoring Season.

4.2.2.7 Santa Clara River (S29)

A summary of the constituents that did not meet applicable water quality objectives at the Santa Clara River MES during the 2013-2014 Wet Weather Monitoring Season is presented in Table 4-4.7 and Figure 4-3.7.

E. coli bacteria concentrations ranged from 260 to 4,130 MPN/100 mL and were above the applicable water quality objective of 235 MPN/100 mL during all three of the sampled storm events at Santa Clara River (Table 4-4.7). Santa Clara River is not subject to the wet weather high-flow suspension of the REC-1 beneficial use.

All other applicable water quality objectives in Santa Clara River were met during the 2013-2014 Wet Weather Monitoring Season.

4.2.3 Tributary Stations During Wet Weather

4.2.3.1 Upper Las Virgenes Creek (TS25)

A summary of the constituents that did not meet applicable water quality objectives at the Upper Las Virgenes Creek Tributary Station (TS25) during the 2013-2014 Wet Weather Monitoring Season is presented in Table 4-5.1 and Figure 4-4.1.

E. coli bacteria concentrations ranged from 7,270 to 14,136 MPN/100 mL and were above the applicable water quality objective of 235 MPN/100 mL during both wet weather events monitored for bacteria (Table 4-5.1 and Figure 4-4.1). Malibu Creek tributaries are not subject to a high-flow suspension of the REC-1 beneficial use.

All other applicable water quality objectives at Upper Las Virgenes Creek were met during the 2013-2014 Wet Weather Monitoring Season.

4.2.3.2 Cheseboro Canyon (TS26)

A summary of the constituents that did not meet applicable water quality objectives at the Cheseboro Canyon Tributary Station (TS26) during the 2013-2014 Wet Weather Monitoring Season is presented in Table 4-5.2 and Figure 4-4.2.

E. coli bacteria concentrations ranged from 1,580 to 13,960 MPN/100 mL and were above the applicable water quality objective of 235 MPN/100 mL during both wet weather events monitored for bacteria (Table 4-5.2 and Figure 4-4.2). Malibu Creek tributaries are not subject to a high-flow suspension of the REC-1 beneficial use.

Dissolved metals were measured during one wet weather event (2013-14Event13) at Cheseboro Canyon. The dissolved copper concentration was 19.9 µg/L, which was above the hardness-based water quality objective of 16.6 µg/L. Dissolved zinc was also above the hardness-based water quality objective for the wet weather sample, with a concentration of 151 µg/L. The hardness value for the sample collected during wet weather at Cheseboro Canyon was 125 mg/L (Table 4-5.2).

All other applicable water quality objectives at Cheseboro Canyon were met during the 2013-2014 Wet Weather Monitoring Season.

4.2.3.3 Lower Lindero Creek (TS27)

A summary of the constituents that did not meet applicable water quality objectives at the Lower Lindero Creek Tributary Station (TS27) during the 2013-2014 Wet Weather Monitoring Season is presented in Table 4-5.3 and Figure 4-4.3.

E. coli bacteria concentrations ranged from 4,500 to 8,130 MPN/100 mL and were above the applicable water quality objective of 235 MPN/100 mL during both of the wet weather events monitored for bacteria (Table 4-5.3 and Figure 4-4.3). Malibu Creek tributaries are not subject to a high-flow suspension of the REC-1 beneficial use.

All other applicable water quality objectives at Lower Lindero Creek were met during the 2013-2014 Wet Weather Monitoring Season.

4.2.3.4 Medea Creek (TS28)

A summary of the constituents that did not meet applicable water quality objectives at the Medea Creek Tributary Station (TS28) during the 2013-2014 Wet Weather Monitoring Season is presented in Table 4-5.4 and Figure 4-4.4.

E. coli bacteria concentrations ranged 3,448 and 14,136 MPN/100 mL and were above the applicable water quality objective of 235 MPN/100 mL during both of the wet weather events monitored for bacteria (Table 4-5.4). Malibu Creek tributaries are not subject to a suspension of the REC-1 beneficial use.

The sulfate concentration was above the water quality objective of 500 mg/L for one of the two monitored wet weather events (2013-14Event09). Sulfate concentrations ranged from 195 to 635 mg/L (Table 4-5.4).

All other applicable water quality objectives at Medea Creek were met during the 2013-2014 Wet Weather Monitoring Season.

4.2.3.5 Liberty Canyon Channel (TS29)

A summary of the constituents that did not meet applicable water quality objectives at the Liberty Canyon Channel Tributary Station (TS29) during the 2013-2014 Wet Weather Monitoring Season is presented in Table 4-5.5 and Figure 4-4.5.

E. coli bacteria concentrations ranged from 17,300 to 150,000 MPN/100 mL and were above the applicable water quality objective of 235 MPN/100 mL during both wet weather events monitored for bacteria at Liberty Canyon Channel (Table 4-5.5 and Figure 4-4.5). Malibu Creek tributaries are not subject to a suspension of the REC-1 beneficial use.

Dissolved copper concentrations ranged from 21.3 to 78.2 µg/L and were above the hardness-based water quality objective for both wet weather samples collected at Liberty Canyon Channel. Hardness values for samples collected during wet weather ranged from 160 to 175 mg/L (Table 4-5.5).

All other applicable water quality objectives at Liberty Canyon Channel were met during the 2013-2014 Wet Weather Monitoring Season.

4.2.3.6 PD 728 at Foxfield Drive (TS30)

A summary of the constituents that did not meet applicable water quality objectives at the PD 728 at Foxfield Drive Tributary Station (TS30) during the 2013-2014 Wet Weather Monitoring Season is presented in Table 4-5.6 and Figure 4-4.6.

E. coli bacteria concentrations ranged from 2,160 and 4,884 MPN/100 mL and were above the applicable water quality objective of 235 MPN/100 mL during both monitored wet weather events at the PD 728 at Foxfield Drive Tributary Station (Table 4-5.6 and Figure 4-4.6). Malibu Creek tributaries are not subject to a suspension of the REC-1 beneficial use.

All other applicable water quality objectives at PD 728 at Foxfield Drive were met during the 2013-2014 Wet Weather Monitoring Season.

4.2.4 Mass Emission Stations During Dry Weather

4.2.4.1 Ballona Creek (S01)

All applicable water quality objectives at the Ballona Creek MES were met during the 2013-2014 Dry Weather Monitoring Season (Table 4-4.1 and Figure 4-5.1).

4.2.4.2 Malibu Creek (S02)

A summary of constituents that did not meet applicable water quality objectives at the Malibu Creek MES during the 2013-2014 Dry Weather Monitoring Season is presented in Table 4-4.2 and Figure 4-5.2.

Dissolved oxygen concentrations ranged from 4.2 to 7.93, and one of the two values (2013-14Event14) was below the water quality objective of 5 mg/L (Table 4-4.2).

All other applicable water quality objectives in Malibu Creek were met during the 2013-2014 Dry Weather Monitoring Season.

4.2.4.3 Los Angeles River (S10)

A summary of constituents that did not meet applicable water quality objectives at the Los Angeles River MES during the 2013-2014 Dry Weather Monitoring Season is presented in Table 4-4.3 and Figure 4-5.3.

The pH value was outside of the water quality objective range of 6.5–8.5 pH units during both of the dry weather events at Los Angeles River (Figure 4-5.3). pH values ranged from 8.54 to 8.69 (Table 4-4.3).

All other applicable water quality objectives in the Los Angeles River were met during the 2013-2014 Dry Weather Monitoring Season.

4.2.4.4 Coyote Creek (S13)

A summary of constituents that did not meet applicable water quality objectives at the Coyote Creek MES during the 2013-2014 Dry Weather Monitoring Season is presented in Table 4-4.4 and Figure 4-5.4.

E. coli bacteria concentrations ranged from non-detect to 1,172 MPN/100 mL (2013-14Event08) which was above the applicable water quality objective of 235 MPN/100 mL (Table 4-4.4).

All other applicable water quality objectives at Coyote Creek were met during the 2013-2014 Dry Weather Monitoring Season.

4.2.4.5 San Gabriel River (S14)

A summary of constituents that did not meet applicable water quality objectives at the San Gabriel River MES during the 2013-2014 Dry Weather Monitoring Season is presented in Table 4-4.5 and Figure 4-5.5. Only one dry weather event (2013-14Event14) was sampled due to lack of flow during the first dry weather event.

The dissolved oxygen concentration at the San Gabriel River MES was 3.37, which was below the water quality objective of 5 mg/L.

Chloride was measured at 151 mg/L, which was slightly above the water quality objective of 150 mg/L (Table 4-4.5).

All other applicable water quality objectives in the San Gabriel River were met during the 2013-2014 Dry Weather Monitoring Season.

4.2.4.6 Dominguez Channel (S28)

A summary of constituents that did not meet applicable water quality objectives at the Dominguez Channel MES during the 2013-2014 Dry Weather Monitoring Season is presented in Table 4-4.6 and Figure 4-5.6.

E. coli bacteria concentrations ranged from non-detect to 886 MPN/100 mL, and one of the two values (2013-14Event08) was above the applicable water quality objective of 235 MPN/100 mL (Table 4-4.6).

All other applicable water quality objectives at Dominguez Channel were met during the 2013-2014 Dry Weather Monitoring Season. (Table 4-4.6 and Figure 4-5.6).

4.2.4.7 Santa Clara River (S29)

A summary of constituents that did not meet applicable water quality objectives at the Santa Clara River MES during the 2013-2014 Dry Weather Monitoring Season is presented in Table 4-4.7 and Figure 4-5.7.

Dissolved oxygen concentrations ranged from 3.45 to 7.58, and one of the two values (2013-14Event14) was below the water quality objective of 5 mg/L (Table 4-4.7).

All other applicable water quality objectives at the Santa Clara River MES were met during the 2013-2014 Dry Weather Monitoring Season.

4.2.5 Tributary Stations During Dry Weather

4.2.5.1 Upper Las Virgenes Creek (TS25)

A summary of the constituents that did not meet applicable water quality objectives at Upper Las Virgenes Creek (TS25) during the 2013-2014 Dry Weather Monitoring Season is presented in Table 4-5.1 and Figure 4-6.1.

E. coli bacteria concentrations ranged from non-detect to 2,850, and one of the two values (2013-14Event08) was above the applicable water quality objective of 235 MPN/100 mL (Table 4-5.1, Figure 4-6.1).

Sulfate concentrations ranged from 849 to 1,400 mg/L and were above the water quality objective of 500 mg/L for both of the dry weather events at Upper Las Virgenes Creek (Table 4-5.1, Figure 4-6.1).

Concentrations of TDS ranged from 2,290 to 2,910 mg/L and were above the water quality objective of 2,000 mg/L during both monitored dry weather events at Upper Las Virgenes Creek (Table 4-5.1, Figure 4-6.1).

All other applicable water quality objectives in Upper Las Virgenes Creek were met during the 2013-2014 Dry Weather Monitoring Season.

4.2.5.2 Cheseboro Canyon (TS26)

A summary of the constituents that did not meet applicable water quality objectives at the Cheseboro Canyon Tributary Station (TS26) during the 2013-2014 Dry Weather Monitoring Season is presented in Table 4-5.2 and Figure 4-6.2.

E. coli bacteria concentrations ranged from non-detect to 384 MPN/100 mL, and one of the two concentrations (2013-14Event08) was above the applicable water quality objective of 235 MPN/100 mL (Table 4-5.2, Figure 4-6.2).

Dissolved oxygen values ranged from 4.24 to 10.7 mg/L, and one of the two concentrations measured at Cheseboro Canyon during 2013-14Event14 was slightly below the water quality objective of 5 mg/L.

Sulfate concentrations ranged from 1,420 to 1,490 mg/L and were above the water quality objective of 500 mg/L during both dry weather events at Cheseboro Canyon (Table 4-5.2, Figure 4-6.2).

The TDS concentration was 2,990 mg/L, which is above the water quality objective of 2,000 mg/L, during both dry weather events at Cheseboro Canyon (Table 4-5.2, Figure 4-6.2).

All other applicable water quality objectives in Cheseboro Canyon were met during the 2013-2014 Dry Weather Monitoring Season.

4.2.5.3 Lower Lindero Creek (TS27)

A summary of the constituents that did not meet applicable water quality objectives at the Lower Lindero Creek Tributary Station (TS27) during the 2013-2014 dry weather monitoring is presented in Table 4-5.3 and Figure 4-6.3.

E. coli bacteria concentrations ranged from non-detect to 693 MPN/100 mL, and one of the two values (2013-14Event08) was above the applicable water quality objective of 235 MPN/100 mL (Table 4-5.3, Figure 4-6.3).

Dissolved oxygen values ranged from 4.62 to 10.5 mg/L, and one of the two concentrations measured at Lower Lindero Creek during 2013-14Event14 was slightly below the water quality objective of 5 mg/L.

Sulfate concentrations ranged from 659 to 864 and were above the water quality objective of 500 mg/L for both of the dry weather events at Lower Lindero Creek (Table 4-5.3, Figure 4-6.3).

Concentrations of TDS ranged from 1,690 to 2,040 mg/L and were above the water quality objective of 2,000 mg/L during one of the two dry weather events (2013-14Event08) at Lower Lindero Creek (Table 4-5.3, Figure 4-6.3).

All other applicable water quality objectives in Lower Lindero Creek were met during the 2013-2014 Dry Weather Monitoring Season.

4.2.5.4 Medea Creek (TS28)

A summary of the constituents that did not meet applicable water quality objectives at the Medea Creek Tributary Station (TS28) during the 2013-2014 dry weather monitoring is presented in Table 4-5.4 and Figure 4-6.4.

Sulfate concentrations ranged from 1,150 to 1,190 and were above the water quality objective of 500 mg/L for both of the dry weather events at Medea Creek (Table 4-5.4, Figure 4-6.4).

Concentrations of TDS ranged from 2,510 to 2,540 and were above the water quality objective of 2,000 mg/L for both of the dry weather events at Medea Creek (Table 4-5.4, Figure 4-6.4).

All other applicable water quality objectives in Medea Creek were met during the 2013-2014 Dry Weather Monitoring Season.

4.2.5.5 Liberty Canyon Channel (TS29)

A summary of the constituents that did not meet applicable water quality objectives at the Liberty Canyon Channel Tributary Station (TS29) during the 2013-2014 dry weather monitoring is presented in Table 4-5.5 and Figure 4-6.5.

E. coli bacteria concentrations ranged from non-detect to 2,050 MPN/100 mL, and one of the two values (2013-14Event08) was above the applicable water quality objective of 235 MPN/100 mL (Table 4-5.5, Figure 4-6.5).

Dissolved oxygen concentrations ranged from 4.63 to 10.9 mg/L, and one of the two concentrations measured at Liberty Canyon Channel during 2013-14Event14 was slightly below the water quality objective of 5 mg/L.

Sulfate concentrations ranged from 342 to 812 mg/L, and the concentration measured during one of the two events (2013-14Event14) was above the water quality objective of 500 mg/L (Table 4-5.5, Figure 4-6.5).

The dissolved copper concentration was above the hardness-based water quality objective during one of the two dry weather monitoring events (2013-14Event14) at Liberty Canyon Channel (Table 4-5.5, Figure 4-6.5). Dissolved copper concentrations ranged from 11.2 to 56.2 µg/L and hardness values ranged from 440 to 815 mg/L.

All other applicable water quality objectives in Liberty Canyon Channel were met during the 2013-2014 Dry Weather Monitoring Season.

4.2.5.6 PD 728 at Foxfield Drive (TS30)

A summary of constituents that did not meet applicable water quality objectives at the PD 728 at Foxfield Drive Tributary Station (TS30) during the 2013-2014 dry weather monitoring is presented in Table 4-5.6 and Figure 4-6.6.

E. coli bacteria concentrations ranged from non-detect to 788 MPN/100 mL, and one of the two values (2013-14Event08) was above the applicable water quality objective of 235 MPN/100 mL (Table 4-5.6, Figure 4-6.6).

Sulfate concentrations ranged from 509 to 695 mg/L and were above the water quality objective of 500 mg/L during both of the dry weather events at PD 728 at Foxfield Drive (Table 4-5.6, Figure 4-6.6).

All other applicable water quality objectives in PD 728 at Foxfield Drive were met during the 2013-2014 Dry Weather Monitoring Season.

4.2.6 Summary of Constituents That Did Not Meet Water Quality Objectives

A summary of the constituents that did not meet the water quality objectives listed in the Basin Plan at the MES and tributary stations is presented in this subsection.

4.2.6.1 Mass Emission Stations

This subsection summarizes the constituents that were measured above Basin Plan water quality objectives at the MES monitoring stations during the 2013–2014 Monitoring Season.

During wet weather, indicator bacteria did not meet water quality objectives at all seven MES. Following the application of high-flow suspensions of *E. coli* water quality objectives (where appropriate), *E. coli* was above the water quality objectives during four of five wet weather events at Ballona Creek and Dominguez Channel, three of four events at Coyote Creek, two of four events at Los Angeles River, all three events at Santa Clara River, one of three events at San Gabriel River, and one of two events at Malibu Creek.

At the MES located in urbanized watersheds (i.e., Ballona Creek, Los Angeles River, and Dominguez Channel) and at the Coyote Creek MES, dissolved copper and dissolved zinc did not meet water quality objectives during all four wet weather events. In addition, dissolved lead did not meet the water quality objective during one of the four wet weather events at Ballona Creek.

pH, dissolved oxygen, and cyanide also did not meet water quality objectives at one or more MES locations during wet weather. pH was slightly below the water quality objective range during one of four events at Los Angeles River, Coyote Creek, and Dominguez Channel. Dissolved oxygen was slightly below the water quality objective range during one of five events at Ballona Creek and Dominguez Channel, and one of three events at San Gabriel River. Cyanide did not meet the water quality objective during one of four wet weather events at Los Angeles River.

During dry weather conditions, dissolved oxygen was the analyte that most frequently did not meet water quality objectives. Dissolved oxygen was slightly below the water quality objective during the one monitored event at San Gabriel River and one of two events at Malibu Creek and Santa Clara River. *E. coli* bacteria generally met water quality objectives during dry weather with the exceptions of one dry weather event at the Coyote Creek MES and one event at the Dominguez Channel MES.

pH and chloride also did not meet water quality objectives at one MES location each during dry weather. pH was slightly above the water quality objective range during both dry events at Los Angeles River, and chloride was slightly above the water quality objective during the one monitored event at San Gabriel River.

Summary of Constituents that Did Not Meet Water Quality Objectives at Mass Emission Stations during 2013-2014 for One or More Events

Mass Emission Station/Watershed	Wet	Dry
Ballona Creek (S01)[1,2,3]	*E. coli* Dissolved copper Dissolved zinc Dissolved lead Dissolved oxygen	NA
Malibu Creek (S02)	*E. coli*	Dissolved oxygen
Los Angeles River (S10)[1,2,3]	*E. coli* Cyanide pH Dissolved copper Dissolved zinc	pH
Coyote Creek (S13)[2,3]	*E. coli* pH Dissolved copper Dissolved zinc	*E. coli*
San Gabriel River (S14)[2,3]	*E. coli* Dissolved oxygen	Dissolved oxygen Chloride
Dominguez Channel (S28)[1,2,3]	*E. coli* Dissolved oxygen pH Dissolved copper Dissolved zinc	*E. coli*
Santa Clara River (S29)	*E. coli*	Dissolved oxygen

NA – all applicable water quality objectives were met.
[1]More urbanized watersheds.
[2]Subject to the bacteria water quality objective high-flow suspension (LARWQCB, 2003).
[3]The high flow suspension did not apply to Ballona Creek during 2013-14Event09, 2013-14Event10, 2013-14Event12, and 2013-14Event15; to Los Angeles River during 2013-14Event09 and 2013-14Event12; to Coyote Creek during 2013-14Event09, 2013-14Event10, and 2013-14Event12; to San Gabriel River during 2013-14Event15; and to Dominguez Channel during 2013-14Event09, 2013-14Event10, 2013-14Event12, and 2013-14Event15.

4.2.6.2 Tributary Monitoring Stations

This subsection summarizes the constituents that were measured above the Basin Plan water quality objectives at the tributary monitoring stations during the 2013–2014 Monitoring Season.

During wet weather, *E. coli* concentrations did not meet the water quality objective during both monitored wet weather events at all six tributary stations. In addition, dissolved copper did not meet the hardness-based water quality objective during both wet weather events at Liberty Canyon Channel and one of the two events at Cheseboro Canyon. Dissolved zinc also did not meet the hardness-based water quality objective during one of two events at Cheseboro Canyon.

The only other analyte that did not meet water quality objectives during wet weather was sulfate, which was above the water quality objective during one of two wet weather events at Medea Creek. There were no sulfate exceedances during wet weather at the Malibu Creek MES.

During dry weather, *E. coli*, sulfate, and TDS were the analytes that most frequently did not meet water quality objectives. *E. coli* was above the water quality objective during one of the two dry weather events at all of the tributary stations except Medea Creek. Sulfate was above the water quality objective during both dry weather events at Upper Las Virgenes Creek, Cheseboro Canyon, Lower Lindero Creek, Medea Creek, and PD 728 at Foxfield Drive and during one of the two events at Liberty Canyon Channel. TDS also frequently did not meet water quality objectives. TDS was measured above the water quality objective during both dry weather events at Upper Las Virgenes Creek, Cheseboro Canyon, and Medea Creek and during one of the two events at Lower Lindero Creek.

The only remaining analytes that did not meet water quality objectives during dry weather were dissolved oxygen, which was slightly below the water quality objective range during one of the two events at Cheseboro Canyon, Lower Lindero Creek, and Liberty Canyon Channel, and dissolved copper, which was above the hardness-based water quality objective during one of the two dry weather events at Liberty Canyon Channel. There were no sulfate, TDS, or dissolved copper exceedances during dry weather at the Malibu Creek MES.

Summary of Constituents That Did Not Meet Water Quality Objectives at Tributary Stations during 2013-2014 for One or More Events

Tributary/Sub-Watershed	Wet	Dry
Upper Las Virgenes Creek (TS25)	*E. coli*	*E. coli* Sulfate TDS
Cheseboro Canyon (TS26)	*E. coli* Dissolved copper Dissolved zinc	*E. coli* Dissolved oxygen Sulfate TDS
Lower Lindero Creek (TS27)	*E. coli*	*E. coli* Dissolved oxygen Sulfate TDS
Medea Creek (TS28)	*E. coli* Sulfate	Sulfate TDS
Liberty Canyon Channel (TS29)	*E. coli* Dissolved copper	*E. coli* Dissolved oxygen Sulfate Dissolved copper
PD 728 at Foxfield Dr. (TS30)	*E. coli*	*E. coli* Sulfate

TDS – total dissolved solids.

4.3 Total Suspended Solids Analyses

A Spearman's Rank Test was used to determine whether a significant positive or negative correlation existed between analyte results and TSS concentrations at each MES, with the exception of the Malibu Creek MES, during wet weather conditions. Too few samples were collected at Malibu Creek MES and at the tributary stations to allow for analysis of correlations. The TSS concentrations from composite samples collected during wet weather events are summarized in Table 4-6. Other constituents analyzed that had significant correlations to TSS are detailed in Table 4-7 and discussed below. Scatter plots of selected constituents that had significant correlations with TSS are presented in Figure 4-7.

Spearman's Rank Test is a rank-based correlation that uses the ranks of the data instead of the actual sample results. This non-parametric test is employed when the data are not normally distributed. The ranks of each data set to be correlated are ordered from highest to lowest, with the highest number in each set given a rank of "1" and so on to the lowest value in each data set. The Spearman rank correlation coefficient, r_s, is then calculated using the ranks and compared to the critical r_s value. The critical r_s value is based on the number of samples and the required alpha (0.05 or 0.10). If the r_s is greater than the critical r_s, then the correlation is considered "significant," or the result has a less than 5% chance (or less than 10% if the alpha is 0.10) of occurring randomly (there is a 95% confidence that this result did not occur by chance or 90% if the alpha is 0.10).

4.3.1 Correlations to Total Suspended Solids

Wet Weather – Mass Emission Stations

Consistent relationships were not observed in correlations between TSS and priority constituents (those constituents that did not meet water quality objectives in one or more monitoring events) across MES during wet weather. Priority constituents evaluated for relationships with TSS included *E. coli*, dissolved metals (copper, zinc, and lead), and dissolved oxygen at Ballona Creek; *E coli*, cyanide, pH, and dissolved metals (copper and zinc) at Los Angeles River; *E. coli*, pH, and dissolved metals (copper and zinc) at Coyote Creek; *E. coli* and dissolved oxygen at San Gabriel River; *E. coli*, dissolved oxygen, pH, and dissolved metals (copper and zinc) at Dominguez Channel; and *E. coli* at Santa Clara River. The only positive correlation of TSS to a priority constituent was dissolved lead at Ballona Creek, and the only negative correlation to a priority constituent was *E. coli* at San Gabriel River.

Lead and dissolved lead (a priority constituent) at Ballona Creek, selenium (with a p value of < 0.10) at Los Angeles River, and 2-4-D (with a p value of < 0.10) and methylene blue active substances (MBAS) at Dominguez Channel were positively correlated with TSS. No positive correlations with TSS were observed at the Coyote Creek MES, and there were too few wet weather events at the Malibu Creek MES to perform correlation analyses. Negative correlations were also observed between TSS and constituents analyzed at MES during wet weather. Dissolved antimony and Kjeldahl nitrogen at Ballona Creek, and ammonia and NH_3-N at Dominguez Channel, were negatively correlated with TSS. No negative correlations with TSS were observed at the Los Angeles River or Coyote Creek MES, and there were too few wet weather events at the Malibu Creek MES to perform correlation analyses. The results of the correlation analyses are summarized in the table below.

The statistical findings of the correlation analysis indicated that several constituents were significantly correlated with TSS at the San Gabriel River and Santa Clara River MES locations, but these findings should be considered in the context of the small sample size (n=3) during the 2013-2014 monitoring season. At San Gabriel River, likely positive correlations with TSS included arsenic and dissolved arsenic, chromium, copper, dissolved aluminum, dissolved iron, lead and dissolved lead, zinc and dissolved zinc, nickel, turbidity, and volatile suspended solids (VSS). Likely negative correlations with TSS included alkalinity, biochemical oxygen demand (BOD), chloride, *E. coli* (a priority constituent), fecal enterococcus, fecal streptococcus, hardness, nitrite-N, pH, specific conductance, sulfate, TDS, and total organic carbon (TOC). At Santa Clara River, likely positive correlations included aluminum and dissolved aluminum, antimony and dissolved antimony, barium, chemical oxygen demand (COD), chromium and dissolved chromium, copper and dissolved copper, iron and dissolved iron, lead dissolved lead, zinc and dissolved zinc, nickel, nitrate (NO_3), nitrate-N, nitrite-N, total phosphorus, TOC, turbidity, and VSS. Likely negative correlations included alkalinity, chloride, hardness, sulfate, and TDS.

Many constituents have a strong binding affinity for sediment particles in stormwater effluent, particularly bacteria, metals, organics, and TOC. It is important to note that the correlations discussed above were based on a small data set and may not be representative of true conditions during a storm.

Correlations Between Constituents and Total Suspended Solids at Mass Emission Stations

Mass Emission/Watershed	Wet	
	Positively Correlated with TSS	Negatively Correlated with TSS
Ballona Creek (S01)	Dissolved lead*, lead	Dissolved antimony, Kjeldahl N
Malibu Creek (S02)[1]	NA	NA
Los Angeles River (S10)	Selenium[2]	None
Coyote Creek (S13)	None	None
San Gabriel River (S14)[3]	Arsenic, chromium, copper, dissolved aluminum, dissolved arsenic, dissolved iron, dissolved lead, dissolved zinc, lead, nickel, turbidity, VSS, zinc	Alkalinity, BOD, chloride, *E. coli**, fecal enterococcus, fecal streptococcus, hardness, nitrite-N, pH, specific conductance, sulfate, TDS, TOC
Dominguez Channel (S28)	2-4-D[2], MBAS	Ammonia, NH_3-N
Santa Clara River (S29)[3]	Aluminum, antimony, barium, COD, chromium, copper, dissolved aluminum, dissolved antimony, dissolved chromium, dissolved copper, dissolved iron, dissolved lead, dissolved zinc, iron, lead, nickel, nitrate (NO_3), nitrate-N, nitrite-N, total phosphorus, TOC, turbidity, VSS, zinc	Alkalinity, chloride, hardness, sulfate, TDS

* Priority constituent.
[1] Too few wet weather events to perform correlation analyses.
[2] Significant with p value of <0.10 rather than <0.05.
[3] Likely correlations; too few wet weather events for confirmation.
TDS = total dissolved solids.
TOC = total organic carbon.
VSS = volatile suspended solids.
BOD = biochemical oxygen demand.
COD = chemical oxygen demand.
MBAS = methylene blue active substances.
NA = not applicable.

4.3.2 Watershed Load Analysis

Constituent loads at each MES were calculated for storm events that occurred during the 2013-2014 Wet Weather Monitoring Season. An estimate of the total constituent loads for each MES is shown in Table 4-9. TSS loads were also calculated for storm events of at least 0.25 inch of total rainfall at all MES equipped with automated samplers. The TSS concentration for each event is shown in Table 4-6 and depicted in Figures 4-9 through 4-12. The total TSS load for each MES is shown in Table 4-8.

Sample loads were calculated using the following equation:

$$concentration\ x\ volume\ (cf)\ x\ conversion\ factor\ = load\ (pounds\ or\ MPN)$$

The sample concentration was multiplied by the volume of water sampled for each event, or in the case of the dry weather monitoring, the base flow for a 24-hour period in October (2013-14Event08) and March (2013-14Event14) at all stations. Volumes used in the calculation are included in Table 4-1. Concentration units were µg/L, mg/L, or MPN/100 mL. The unit conversion factors were 0.0000000624, 0.0000624, or 283.17, respectively.

4.3.2.1 Wet Weather and Dry Weather Constituent Loads for Each Mass Emission Station

Constituent loads were calculated to determine whether there was a relationship between storm event size and the total load for a given constituent. Calculated loads varied between stations and storm events. First-flush loading signatures (i.e., higher loads during the first monitored storm of the season than would be expected based on rainfall totals) were observed for at least one constituent at the following five of the seven MES locations: Ballona Creek MES, Los Angeles River MES, Coyote Creek MES, Dominguez Channel MES, and Santa Clara River MES. Rainfall totals were much higher during 2013-14Event13 (February 27, 2014), the event during which the greatest loads were observed at all MES, compared to the other wet weather events. Rainfall totals during 2013-14Event13 ranged from 1.84 to 5.20 inches, whereas the rainfall totals during the other events, including the first flush, were all under 1 inch.

Dry weather loads were calculated for Event 2013-14Event08 (October 15, 2013) and 2013-14Event14 (March 5, 2014) at each MES and tributary. During dry weather, constituent loads varied between stations and between sampling events. In general, the highest variability was observed in *E. coli* loads and TSS loads, which were generally higher during the first dry event compared to the second. TSS loads were much greater at Los Angeles River during both dry weather events than at any of the other MES. Overall, constituent loads were lower at Santa Clara River MES than at other MES.

For discussion purposes, a limited constituent list comprised of *E. coli*, nitrate, total phosphorus, total petroleum hydrocarbons (TPHs), total Kjeldahl nitrogen (TKN), TDS, TSS, dissolved chromium, copper, and zinc is discussed for each MES. These constituents were chosen because of their prevalence in stormwater runoff.

Ballona Creek (S01)

The wet weather event with the highest rainfall total at Ballona Creek MES was 2013-14Event13 (2.88 inches). Rainfall totals for the other four wet weather events monitored at Ballona Creek MES ranged from 0.12 to 0.31 inches. During 2013-14Event13, loads for *E. coli*, nutrients, TPH, TDS, TSS, and dissolved metals were all the highest observed at Ballona Creek during the 2013-2014 wet weather season. Nitrate, total phosphorus, and dissolved chromium loads were relatively high during the first storm event (2013-14Event09, 0.16 inch) compared to other events which is indicative of a first-flush loading signature for these constituents.

Dry weather loads at Ballona Creek were higher during the first event (2013–14Event08) than the second event (2013-14Event14) for *E. coli*, nutrients, TPH, TDS, TSS, and dissolved metals. Loads varied between the two events, with the highest variability observed for *E. coli* and TSS. The *E. coli* load during 2013-14Event08 was 776 times greater than during 2013-14Event14, and the TSS load during 2013-14Event08 was 20 times greater than during 2013-14Event14. The event volumes for the two dry weather events were 56.6 and 29.7 acre feet, respectively.

Malibu Creek (S02)

Due to the dry conditions during the 2013-2014 monitoring season, only two storm events were monitored as this station. The wet weather event with the highest rainfall total at Malibu Creek MES was 2013-14Event13 (5.12 inches). The rainfall total for the other wet weather event monitored at Malibu Creek MES (2013-14Event09) was 0.35 inches. During 2013-14Event13, loads for *E. coli*, nutrients, TPH, TDS, TSS, and dissolved metals were higher than those observed at Malibu Creek MES during the first event of the season (2013-14Event09); therefore, a first-flush loading signature was not indicated at Malibu Creek MES.

Dry weather loads in Malibu Creek were higher during the first event (2013-14Event09) than during the second event (2013-14Event13) for *E. coli* and TSS. Loads of nutrients, TPH, TDS, and dissolved metals were higher during the second event. Loads varied between the two events with the highest variability observed for dissolved zinc, which was more than 10 times greater during 2013-14Event13 than during 2013-14Event09. Loads for dissolved chromium and copper, nutrients, TDS, and TPH were about 5.5 to 8.0 times greater during 2013-14Event13 than during 2013-14Event09. Loads for *E. coli* and TSS, the two constituents with higher loads during the first event, were less variable (2.3 to 3.7 times greater during the first event). The event volumes for the dry weather events 2013-14Event08 and 2013-14Event14 were 2.6 and 21.0 acre feet, respectively.

Los Angeles River (S10)

The highest rainfall total at the Los Angeles River MES occurred during 2013-14Event13 (1.84 inches). Rainfall totals during the other five monitored events (2013-14Event09, 2013-14Event10, 2013-14Event11, 2013-14Event12, and 2013-14Event15) ranged from 0.15 to 0.51 inches. During 2013-14Event13, loads for nutrients, TPH, TDS, TSS, and dissolved metals were the highest and the load for *E. coli* among the highest observed at Los Angeles River MES during the 2013-14 wet weather season. Loads calculated for *E. coli*, nitrate, total phosphorus, TDS, TPH, TSS, dissolved chromium, and dissolved copper loads were relatively high during the first storm (2013-14Event09, 0.18 inch) compared to other events, which is indicative of a first-flush loading signature for these constituents.

Dry weather loads for *E. coli*, nitrate, TPH, TKN, TDS, TSS, dissolved metals were higher during the first event (2013-14Event09) than during the second event (2013-14Event13), whereas the load for total phosphorus was higher during the second event. Load variability was generally low (up to three times) between the two dry weather events with the exceptions of the TSS load, which was approximately eight times greater during the first dry weather event, and the *E. coli* load, which was about 700 times greater during the first dry weather event. Event volumes during dry weather events 2013-14Event08 and 2013-14Event14 were 672.0 and 383.7 acre feet, respectively.

Coyote Creek (S13)

At Coyote Creek MES, the rainfall total was highest during 2013-14Event13 (2.33 inches). Rainfall totals were similar for 2013-14Event09, 2013-14Event10, 2013-14Event12, and 2013-14Event16 (0.31, 0.23, 0.36, and 0.21 inches, respectively) but were lower during 2013-14Event11 and 2013-14Event15 (0.14 and 0.02 inches, respectively). Loads for *E. coli*, nutrients, TPH, TDS, TSS, and dissolved metals were all highest during 2013-14Event13. The second-highest loads observed for each of these constituents was during the first event of the season, 2013-14Event09, which is indicative of a first-flush loading signature.

Dry weather loads for *E. coli*, TKN, and TSS were higher during the first dry event (2013-14Event08) compared to the second dry event (2013-14Event14). Nitrate, total phosphorus, TDS, TPH, and dissolved metal loads were higher during the second dry event. Load variability was generally low (up to three times) between the two dry weather events with the exception of the *E. coli* load, which was over 1,000 times greater during the first event. Event volumes for dry weather events 2013-14Event08 and 2013-14Event14 were 11.2 and 22.5 acre feet, respectively.

San Gabriel River (S14)

The rainfall total at San Gabriel River MES was highest during 2013-14Event13 (5.20 inches). Rainfall totals for the remaining monitored events (2013-14Event09, 2013-14Event12, 2013-14Event15, and 2013-14Event16) were similar, ranging from 0.31 to 0.78 inches. Loads for *E. coli*, nutrients, TPH, TDS, TSS, and dissolved metals were all highest during 2013-14Event13. Constituent loads for the first monitored storm event (2013-14Event09) were similar to those for 2013-14Event09, 2013-14Event12, 2013-14Event15, and 2013-14Event16, which indicates that first-flush loading signatures were not observed at San Gabriel River MES.

Flow was only observed during one dry weather event (2013-14Event14) at San Gabriel River MES. The event volume was 59.2 acre feet.

Dominguez Channel (S28)

The rainfall total at Dominguez Channel MES was highest during 2013-14Event13 (3.20 inches). Rainfall totals for the remaining five monitored wet weather events at Dominguez Channel MES were similar, ranging from 0.25 to 0.49 inches. Loads for E. coli, nutrients, TPH, TDS, TSS, and dissolved metals were all highest during 2013-14Event13. The second-highest loads observed for TKN, nitrate, TDS, and dissolved chromium were during the first event of the season, 2013-14Event09, which is indicative of a first-flush loading signature for those constituents.

Dry weather loads for nutrients, TPH, and dissolved metals were very similar during the first event (2013-14Event09) and the second event (2013-14Event13), with slightly greater

concentrations occurring during the first event with the exception of total phosphorus. However, loads for *E. coli* and TSS were much greater during the first event. The *E. coli* load was over 1900 times greater and the TSS load was approximately 29 times greater during the first event. The event volumes were similar for dry weather events 2013-14Event08 and 2013-14Event14 (8.5 and 7.9 acre feet, respectively).

Santa Clara River (S29)

The rainfall total during 2013-14Event13 (5.16 inches) was much higher than rainfall totals during the other two monitored wet weather events, 2013-14Event09 and 2013-14Event15 (0.67 and 0.24 inches, respectively). Loads for *E. coli* and TKN were greater during the first wet event of the monitoring year (2013-14Event09), whereas loads for nitrate, total phosphorus, TSS, TDS, TPH, and dissolved metals were all much greater during the event with the greatest rainfall (2013-14Event13). First flush loading signatures were observed at Santa Clara MES for *E. coli* and TKN. In addition, loads for nitrate and TSS were greater during the first wet weather event than 2013-14Event15, which is indicative of first flush signatures for those constituents as well.

Dry weather loads for nutrients, TPH, TDS, and dissolved metals were greater during the second event (2013-14Event14) than the first (2013-14Event08), whereas loads for *E. coli* and TSS were greater during the first event. Load variability was generally low (up to 2.2 times) between the two dry weather events with the exceptions of the *E. coli* and TSS loads, which were 27.3 and 8.6 times greater during the first event, respectively. Event volumes for dry weather events 2013-14Event08 and 2013-14Event14 were 0.5 and 1.0 acre feet, respectively.

4.3.3 Total Suspended Solids Trend Analysis

TSS concentrations from 2000 to 2014 were evaluated for normality and log-normal distributions separately for wet and dry weather at each MES using the Shapiro-Wilk test. If the TSS concentrations were normal or log-normally distributed, then a regression analysis was used to evaluate trends. Multiple samples during each monitoring season were treated as replicates. If a normal or log-normal distribution was not found, then it was determined that the distribution of the data was not known. These results were evaluated for trends using the Mann-Kendall non-parametric method. The summary table below presents the method used for trend evaluation and the statistical trend information on TSS data collected at each MES over the past 14 years. The data are shown graphically in Figures 4-13.1 through 4-13.4.

Two significant trends for TSS were identified for wet weather, based on an alpha of 0.05. TSS was identified as a significantly decreasing trend at San Gabriel MES and Santa Clara River MES. The TSS trend analysis of dry weather data identified one significant trend based on an alpha of 0.05, a significantly decreasing trend in TSS at Santa Clara River MES (Table 4-11). The p values indicating significant trends are bolded in the tables below.

Trend Analysis of Wet Weather Total Suspended Solids Concentrations at Mass Emission Stations from 2000–2014

Station	p-value	Method	Trend
Ballona Creek at Sawtelle (S01)	0.498	Mann-Kendall	Not significant
Malibu Creek at Piuma (S02)	0.069	Regression	Not significant
Los Angeles River at Wardlow (S10)	0.806	Regression	Not significant
Coyote Creek at Spring (S13)	0.428	Mann-Kendall	Not significant
San Gabriel River (S14)	**0.019**	Regression	Significant Decreasing
Dominguez Channel at Artesia (S28)	0.116	Mann-Kendall	Not significant
Santa Clara River (S29)	**0.001**	Mann-Kendall	Significant Decreasing

Bold text indicates significant trend

Trend Analysis of Dry Weather Total Suspended Solids Concentrations at Mass Emission Stations from 2000–2014

Station	p-value	Method	Trend
Ballona Creek at Sawtelle (S01)	0.631	Regression	Not significant
Malibu Creek at Piuma (S02)	0.051	Regression	Not significant
Los Angeles River at Wardlow (S10)	0.600	Regression	Not significant
Coyote Creek at Spring (S13)	0.451	Regression	Not significant
San Gabriel River (S14)	0.274	Regression	Not significant
Dominguez Channel at Artesia (S28)	0.688	Regression	Not significant
Santa Clara River (S29)	**0.005**	Mann-Kendall	Significant Decreasing

Bold text indicates significant trend

4.4 Water Column Toxicity Analysis

Water column toxicity monitoring was performed at all MES. In total, four samples were analyzed for toxicity at each station (i.e., two wet weather samples and two dry weather samples). The only exception was San Gabriel River (S14), where only one dry weather sample was collected due to the absence of flow during the first dry weather monitoring event. Wet weather samples were collected during the first rain event of the season on November 21, 2013 (2013–14Event09) for all seven MES locations. The second wet weather samples were collected on February 26, 2014 (2013–14Event14) for all seven MES locations. Dry weather samples were collected on October 21, 2013 (2013–14Event08) and March 5, 2014 (2013–14Event14) for all MES except San Gabriel River; due to dry conditions (no flow) in October. The toxicity results from these samples are provided in Table 4-10a (dry weather) and Table 4-10b (wet weather).

One freshwater species (water flea) and one marine species (sea urchin) were used for toxicity testing. The water flea, *Ceriodaphnia dubia*, was used in chronic 7-day reproduction and survival bioassays. The sea urchin, *Strongylocentrotus purpuratus*, was used in chronic fertilization bioassays.

4.4.1.1 Toxicity Results – Wet Weather

Bioassay tests exposing *C. dubia* to wet weather effluent samples from each of the seven MES indicated that no toxicity to *C. dubia* survival or reproduction was observed for both events. All of the IC_{25} and IC_{50} values were greater than 100%, the NOEC values were 100%, and the TUs (100/ IC_{50}) were calculated as less than 1.

Toxicity tests measuring *S. purpuratus* fertilization in exposures to wet weather effluent samples from all seven MES indicated that no toxicity to *S. purpuratus* fertilization was observed in the test samples. All of the NOEC values were 100%, IC_{25} and IC_{50} values were greater than 100%, and the TUs were calculated as less than 1.

4.4.1.2 Toxicity Results – Dry Weather

Bioassay tests exposing *C. dubia* to dry weather effluent samples from each MES indicated that slight toxicity to *C. dubia* reproduction was observed in dry weather samples collected from Malibu Creek. During 2013-2014Event08, the concentration resulting in a 25% inhibition (IC_{25}) in the selected sublethal endpoint (e.g., reproduction) was 20%, indicating that at 20% concentration, a 25% reduction in neonate production was observed. The NOEC value was 100%, the IC_{50} value was greater than 100%, and the TU was calculated to be less than 1. Therefore, a TIE was not necessary. During 2013-14Event14, the IC_{25} value was 5.49, indicating that at 5.49% concentration, a 25% reduction in survival was observed. The IC_{50} value was greater than 100%, the NOEC was 100%, and the TU was calculated to be less than 1. Therefore, a TIE was not necessary.

Toxicity tests measuring *S. purpuratus* fertilization in exposures to dry weather effluent samples from each MES indicated that no toxicity to slight toxicity to *S. purpuratus* fertilization was observed in the test samples. All of the IC_{25} and IC_{50} values were greater than 100% test substance, the NOEC values ranged from 50 to 100% test substance, and the TUs were less than 1.

4.4.2 Trash Monitoring Analysis

During the 2013-2014 monitoring season, visual observations of trash were made, and at least one photograph was taken at each MES after the first storm event. In addition, photographs were taken at each MES after at least three additional storm events, with the exception of the Santa Clara MES, which was monitored during two additional storm events, and the Malibu Creek MES, which was monitored during one additional storm event. Photographs are presented in Appendix C. Ballona Creek Watershed and Los Angeles River Watershed Trash Compliance Monitoring Reports are presented in Appendices I and J, respectively.

4.4.3 Identification of Possible Constituent Sources

This subsection summarizes some of the key points regarding known or suspected sources of constituents that did not meet applicable water quality objectives.

4.4.3.1 Indicator Bacteria

Multiple studies have found urban runoff to be a source of indicator bacteria in the municipal separate storm sewer system (MS4). The SCCWRP conducted bacteria source identification studies of Ballona Creek, and the results were published in 2005 in the journal *Water, Air, and Soil Pollution* (Stein and Tiefenthaler, 2005). The City of Los Angeles conducted a bacteria source identification study of the Los Angeles River, and the results were published in November 2008. Both of these studies found urban runoff to be a source of indicator bacteria. According to the *Draft Total Maximum Daily Load to Reduce Bacterial Indicator Densities at Santa Monica Bay Beaches* (LARWQCB, 2001), published on November 8, 2001, urban runoff from the storm drain system may have elevated levels of indicator bacteria as a result of sanitary sewer leaks and spills, illicit connections of sanitary lines to the storm drain system, runoff from homeless encampments, illegal discharges from recreational vehicle holding tanks, and/or malfunctioning septic tanks. Fecal matter from animals, including pets, livestock, and birds, can also elevate bacteria levels. A July 2007 report by ENSR International for EPA New England Region 1, *Mitigation Measures to Address Pathogen Pollution in Surface Waters: A TMDL Implementation Guidance Manual for Massachusetts* (ENSR International, 2007) also discussed the previously mentioned sources.

Bacteria have a strong binding affinity for sediment particles in stormwater effluent. A recent study published in *Environmental Toxicology and Chemistry* examined stormwater particle size distribution in Ballona Creek (Brown et al., 2013). The study suggested that commonly employed best management practices (BMPs) designed to capture larger particles ($\geq$ 250 µm) may not capture the majority of the bacterial contaminant load because of the association of bacteria with small particles ($\leq$ 6 µm).

The report, Total Maximum Daily Loads (TMDL) for Bacteria, Malibu Creek Watershed (LARWQCB, 2004), identified surface runoff loads from residential and commercial areas as the largest source of bacteria loads in the Malibu Creek watershed during both wet and dry weather. The TMDL report also indicated that failing septic systems and birds were significant contributors to the fecal coliform loads in the watershed. Other sources of bacteria in the watershed include contributions from undeveloped areas (wildlife) and horses/livestock.

In addition to bacteria sources, certain factors can amplify bacteria concentrations by promoting bacteria growth. Organic carbon provides food for bacteria. Sunlight can kill bacteria; therefore, covered water can promote bacterial growth. Slow-moving, stagnant water also can promote bacterial growth.

4.4.3.2 Copper, Lead, and Zinc

According to the article "Regulating Copper in Urban Stormwater Runoff" (Lee and Lee, 2000), copper can come from brake pads or industrial (e.g., the textile industry) and mining sources. A metals source study is discussed in the article "Loadings of Lead, Copper, Cadmium, and Zinc in Urban Runoff from Specific Sources" (Davis et al., 2001). The study concludes that elevated levels of metals were found from urban areas, especially in highway runoff. The abstract identifies important sources, such as building siding for lead, copper, cadmium, and zinc; vehicle brake emissions for copper; and tire wear for zinc. Atmospheric deposition was also identified as an important source of cadmium, copper, and lead. Details behind those findings are presented in

the May 2005 Technical Report from SCCWRP entitled *Contributions of Trace Metals from Atmospheric Deposition to Stormwater Runoff in a Small Impervious Urban Catchment* (Sabin et al., 2005). Additionally, a historic comparison completed by SCCWRP (Sabin and Schiff, 2008) indicated atmospheric deposition sources of copper and zinc have increased near harbor and urban sites over the past 30 years.

4.4.3.3 Sulfate

Large quantities of greenish rock with amphiboles and sediment are found near the MES in the Malibu Creek Watershed. The hillside is composed primarily of what appears to be decomposed, somewhat grainy, greenish marine or lagoon sediment/glauconite and less decomposed, greenish-brown shale with clear fossils and embedded detritus. These sediments are known to be sulfur bearing. Representative field samples gathered initially had a distinct moderate sulfur (e.g., musty, rotten eggs) odor. Sulfate concentrations in the Malibu Creek Watershed can be largely attributable to the presence of eroded sulfur-rich sediment (Orton, 2011). Fungal and bacterial processes within the creek and surrounding areas may facilitate the release of sediment-bound sulfur into the water column.

Another potential sulfur source may be effluent from the nearby Tapia Water Reclamation Facility, located just upstream from the sampling station. Sulfur is used in wastewater processes such as flocculation. However, other MES close to wastewater treatment plants did not show highly elevated sulfur concentrations. Tests and/or a review of effluent reports would be necessary to determine whether effluent from the plant is a significant contributor to the raised sulfur concentrations of these waters.

4.4.3.4 pH

The pH value is a measure of the acid (or H+ ion) concentration in solutions. When the concentrations of acid and base (or OH- ion) are exactly equal, the pH is equal to 7.0. Natural rainwater has a pH of approximately 5.5 (i.e., slightly acidic). As minerals dissolve into rainwater, the pH increases because of the “buffering” effect of minerals such as calcium and magnesium carbonate. Sources that can decrease pH below the water quality objective of 6.5 include illicit discharges (e.g., swimming pools, battery acid, and other light and heavy industrial chemicals).

Two pH exceedances during the 2013-2014 monitoring year were slightly above the water quality objective range (slightly basic), and three were slightly below the water quality objective (slightly acidic). A pH above 8.5 could indicate highly mineralized waters; for example, groundwater seepages that are not as diluted, especially during dry weather. Each of the basic readings measured during the 2013-2014 monitoring year were measured during dry conditions. Common human factors that can cause high pH in surface waters include the discharge of concrete wash water, surfactants in cleaning agents, and illicit washing. Algal blooms can also cause elevated pH during the day as they use carbon dioxide for photosynthesis and decreased pH at night as they respire.

It is possible that sudden rain events can bring the pH below 6.5, if the water sampled is not heavily mineralized. This would be expected in a watershed that is mostly hardscape, with little

vegetation to provide detention or interaction with soils. The sudden influx of rainwater is the most likely explanation for the three slightly low pH values observed during wet weather.

4.4.3.5 Cyanide

Sources of cyanide include industrial operations such as manufacturing of synthetic fabrics, plastics, and metal processing or electroplating operations. Fumigation operations can also contribute to cyanide in the environment as can commercial printers and pharmaceutical manufacturers. Additionally, incomplete combustion during forest fires can also contribute a large amount of cyanide to the environment. Only one cyanide exceedance was measured during the 2013-2014 monitoring year.

4.5 Recommendations

On November 8, 2012, the LARWQCB adopted a new NPDES MS4 Permit (Order R4-2012-0175) for the coastal watersheds of Los Angeles County. The new 2012 Permit, which became effective on December 28, 2012, provides a watershed management approach to address water quality protection. Under the 2012 Permit, the protocols of the 2001 Permit Monitoring and Reporting Program are to continue to be used until the Integrated Monitoring Programs (IMPs) and Coordinated Integrated Monitoring Program (CIMPs) submitted by the Watershed Management Groups throughout the Los Angeles Basin are approved by the Executive Officer of the LARWQCB. Due to the timing of the approval of the CIMPs, MES monitoring will be conducted during the 2014-2015 monitoring season in accordance with the monitoring protocols of the 2001 monitoring program.

The 2001 Permit Monitoring and Reporting Program included provisions for tributary monitoring in sub-watersheds where stormwater discharges and non-stormwater (dry weather) discharges are causing or contributing to exceedances of water quality standards, and to prioritize drainage and sub-drainage areas requiring management actions. The 2012 permit does not require tributary monitoring. However, monitoring in the tributaries will be continued until CIMPs submitted by the Watershed Management Groups are approved by the LARWQCB.

It is recommended that the field monitoring of DO and pH continue to be incorporated into in the monitoring program. DO measurements in samples may be impacted through sample handling and transportation, and sampling guidelines generally call for the measurement of DO as soon as possible after sampling. It is possible that the change in DO levels between the field and the laboratory may cause or contribute to observed DO readings outside the water quality objective range. Measuring pH in the field may limit effects of water hardness and alkalinity on changes to the pH levels measured in the analytical laboratory.

5.0 REFERENCES

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