4.0 RESULTS, ANALYSES, AND RECOMMENDATIONS

This section describes the results and data analysis and includes a discussion of probable constituent sources and recommendations for the 2012-2013 Monitoring Program.

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 2012-2013 storm season differ in comparison to previous storm seasons?

This management question is answered in the following two ways:

1. Figure 4-1 is a comparison of the total monthly rainfall for the 2012-2013 storm season and the long-term pattern of rainfall observed in downtown Los Angeles at Station 716, Ducommun Street. During the 2012-2013 storm season, rainfall each month was generally less than the historic monthly averages. The only exceptions were October 2012, December 2012, and May 2013 when rainfall totals were slightly greater than the historic averages for those months. In November 2012, the rainfall total was slightly less than the historic November average. In January, February, and March 2013, rainfall totals were much less than historic averages for those months. In January 2013, rainfall was approximately one third of the historic average. February and March 2013 were drier, with rainfall of less than 5% and less than 25% of the historic averages for those months, respectively. The months of January and February are historically the wettest months. In general, the seasonal pattern of rainfall in 2012-2013 differed from the historic pattern, with the highest rainfall occurring in November, December, and January.
2. Figure 4-2 illustrates that the total annual rainfall during the 2012-2013 storm season in downtown Los Angeles was approximately 6.92 inches. Annual rainfall for this monitoring season was approximately 45% of the 141-year average annual rainfall of 15.48 inches.

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 2012-2013 Monitoring Season (Appendix A). Each hydrograph includes the known times of the first and last composite sample aliquot collection, 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 LACFCD met the requirement to compare results 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 are 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 the magnitude. Aquatic life objectives established in the 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 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., one-hour exposure) or chronic (i.e., four-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.

Some constituents have chronic water quality objectives, which are based on four-day average exposures. The chronic water quality objectives are applicable only to events with durations of four days or longer. All events during the 2012-2013 monitoring year were less than four days in length; therefore, chronic objectives are not used for comparison of monitoring data to water quality objectives.

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.

Chronic Water Quality Standards 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	.001	.001	.001	.001	.001	.001	.001
Chloride	mg/L	Basin Plan	NA	500	150	NA	150	NA	150
Cyanide	mg/L	CTR	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052
Dieldrin	µg/L	CTR	0.056	0.056	0.056	0.056	0.056	0.056	0.056
Dissolved arsenic	µg/L	CTR	150	150	150	150	150	150	150
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	0.056	0.056	0.056	0.056	0.056	0.056	0.056
beta-Endosulfan	µg/L	CTR	0.056	0.056	0.056	0.056	0.056	0.056	0.056
Endrin	µg/L	CTR	0.036	0.036	0.036	0.036	0.036	0.036	0.036
Heptachlor	µg/L	CTR	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038
Heptachlor epoxide	µg/L	CTR	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038
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	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002

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

Chronic 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	.001	.001	.001	.001	.001	.001
Chloride	mg/L	Basin Plan	500	500	500	500	500	500
Cyanide	mg/L	CTR	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052
Dieldrin	µg/L	CTR	0.056	0.056	0.056	0.056	0.056	0.056
Dissolved arsenic	µg/L	CTR	150	150	150	150	150	150
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	0.056	0.056	0.056	0.056	0.056	0.056
beta-Endosulfan	µg/L	CTR	0.056	0.056	0.056	0.056	0.056	0.056
Endrin	µg/L	CTR	0.036	0.036	0.036	0.036	0.036	0.036
Heptachlor	µg/L	CTR	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038
Heptachlor epoxide	µg/L	CTR	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038
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	2000	2000	2000	2000	2000	2000
Toxaphene	µg/L	CTR	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002

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 sampled during the 2012-2013 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 as detailed in the Basin Plan Amendment – Resolution

No. 2003-010 (High-Flow Suspension of Recreational Uses), adopted November 2, 2004. Details about the amendment are presented on the State Water Resources Control Board (SWRCB) website (SWRCB, 2003).

The storm events for which the suspension applied in 2012-2013 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. 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
NA = not applicable.
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 constituents that did not meet applicable water quality objectives at the Ballona Creek MES during the 2012-2013 Wet Weather Monitoring Season is presented in Table 4-4.1 and Figure 4-3.1.

E. coli was above the water quality objective of 576 MPN/100 mL during all six events monitored for bacteria. *E. coli* concentrations ranged from 10,120 to 61,310 MPN/100 mL. 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 events 2012-13Event06 and 2012-13Event14.

Dissolved copper concentrations were above the hardness-based water quality objective for all seven of the wet weather samples collected at Ballona Creek. Dissolved copper concentrations varied from 11.6 to 139 micrograms per liter (µg/L). Hardness values ranged from 40 to 160 mg/L (Table 4-4.1).

Dissolved zinc concentrations were above the hardness-based water quality objective for all of the wet weather samples collected at Ballona Creek except the sample from 2012-13Event08. Dissolved zinc concentrations at Ballona Creek ranged from 69.6 to 770 µg/L (Table 4-4.1).

All other applicable water quality objectives in Ballona Creek were met during the 2012-2013 Wet Weather Monitoring Season.

4.2.2.2 Malibu Creek (S02)

A summary of constituents that did not meet applicable water quality objectives at the Malibu Creek MES during the 2012–2013 Wet Weather Monitoring Season is presented in Table 4-4.2 and Figure 4-3.2.

E. coli bacteria concentrations were above the applicable water quality objective (i.e., 235 MPN/100 mL) during three of the five sampled storm events in Malibu Creek (2012-13Event14, 2012-13Event15, and 2012-13Event18; Figure 4-3.2). Values ranged from 96 to 3,500 MPN/100 mL. Malibu Creek is not subject to the wet weather suspension of the REC-1 beneficial use.

Sulfate did not meet the watershed-specific water quality objective of 500 mg/L in all six of the wet weather samples collected in Malibu Creek (Table 4-4.2). Sulfate ranged from 508 to 1,030 mg/L over the six storm events.

TDS was greater than the water quality objective of 2000 mg/L in one of the six wet weather samples (2012-13Event05). TDS values ranged from 1,220 to 2,130 mg/L over the six storm events.

All other applicable water quality objectives in Malibu Creek were met during the 2012-2013 Wet Weather Monitoring Season.

4.2.2.3 Los Angeles River (S10)

A summary of constituents that did not meet applicable water quality objectives at the Los Angeles River MES during the 2012-2013 Wet Weather Monitoring Season is presented in Table 4-4.3 and Figure 4-3.3.

E. coli concentrations were above the water quality objective of 235 MPN/100 mL during all seven storm events monitored for bacteria. *E. coli* concentrations ranged from 8,130 to 57,300 MPN/100 mL. 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 2012-13Event04, 2012-13Event06, or 2012-13Event14. Based on this assessment, four of the seven wet weather events analyzed for bacteria (2012-13Event07, 2012-13Event08, 2012-13Event11, and 2012-13Event15) did not meet the *E. coli* water quality objective (Table 4-4.3 and Figure 4-3.3).

pH was not within the water quality objective range of 6.5–8.5 pH units for one of the eight wet weather samples collected at Los Angeles River (Table 4-4.3). The water sample collected during 2012-13Event04 had a pH value slightly below the lower limit of the water quality objective range.

Dissolved copper concentrations were above the hardness-based water quality objective for all eight wet weather samples (Figure 4-3.3). Dissolved copper concentrations at Los Angeles River ranged from 19.4 to 77.2 μg/L. Hardness values ranged from 40 to 200 mg/L (Table 4-3.3).

Dissolved lead was above the hardness-based water quality objective for one of the eight wet weather samples (2012-13Event04; Figure 4-3.3). Dissolved lead concentrations ranged from 7.75 to 70.0 μg/L (Table 4-3.3).

Dissolved zinc concentrations were above the hardness-based water quality objective for all wet weather samples except the sample collected during 2012-13Event08 (Figure 4-3.3). Dissolved zinc concentrations ranged from 117 to 665 μg/L (Table 4-3.3).

All other applicable water quality objectives in Los Angeles River were met during the 2012-2013 Wet Weather Monitoring Season.

4.2.2.4 Coyote Creek (S13)

A summary of constituents that did not meet applicable water quality objectives at the Coyote Creek MES during the 2012-2013 Wet Weather Monitoring Season is presented in Table 4-4.4 and Figure 4-3.4.

E. coli concentrations were above the water quality objective of 235 MPN/100 mL during all six storm events monitored for bacteria. *E. coli* concentrations ranged from 4,410 to 29,090 MPN/100 mL. 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 2012-13Event07 or 2012-13Event14. Based on this assessment, four of the six wet weather events analyzed for bacteria (2012-13Event06, 2012-13Event08, 2012-13Event11, and 2012-13Event15) did not meet the *E. coli* water quality objective (Table 4-4.4 and Figure 4-3.4).

The dissolved copper concentration was above the hardness-based water quality objective for four of the eight wet weather samples collected at Coyote Creek (2012-113Event05, 2012-13Event06, 2012-13Event14, and 2012-13Event15; Figure 4-3.4). Dissolved copper concentrations ranged from 10.0 to 52.7 μg/L, whereas hardness ranged from 60 to 230 mg/L (Table 4-4.4).

The dissolved zinc concentration was above the hardness-based water quality objective for four of the eight wet weather samples collected at Coyote Creek (2012-113Event05, 2012-13Event06, 2012-13Event07, and 2012-13Event14; Figure 4-3.4). Dissolved zinc concentrations ranged from 57.0 to 1,120 μg/L (Table 4-4.4).

All other applicable water quality objectives in Coyote Creek were met during the 2012-2013 Wet Weather Monitoring Season.

4.2.2.5 San Gabriel River (S14)

A summary of constituents that did not meet applicable water quality objectives at the San Gabriel River MES during the 2012-2013 Wet Weather Monitoring Season is presented in Table 4-4.5 and Figure 4-3.5.

E. coli concentrations were above the water quality objective of 235 MPN/100 mL during all five storm events monitored for bacteria. *E. coli* concentrations ranged from 1,842 to 127,400 MPN/100 mL. 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 2012-13Event07, 2012-13Event08, or 2012-13Event14. Based on this assessment, two of the five wet weather events (2012-13Event04 and 2012-13Event15) did not meet the *E. coli* water quality objective (Figure 4-3.5).

Cyanide concentrations were above the water quality objective of 0.022 mg/L during one storm event at San Gabriel River (2012-13Event07; Figure 4-3.5). Cyanide concentrations ranged from non-detect to 0.031 mg/L.

pH was not within the water quality objective range of 6.5–8.5 pH units for one of the five wet weather samples collected at San Gabriel River (Table 4-4.5). The water sample collected during 2012-13Event05 had a pH value slightly above the upper limit of the water quality objective range.

The dissolved copper concentration was above the hardness-based water quality objective for two of the five wet weather samples from San Gabriel River (2012-13Event04 and 2012-13Event14; Figure 4-3.5). Dissolved copper concentrations ranged from 8.53 to 32.7 μg/L, whereas hardness ranged from 90 to 210 mg/L (Table 4-4.5).

The dissolved zinc concentration was above the hardness-based water quality objective for one of the five wet weather samples from San Gabriel River (2012-13Event04; Figure 4-3.5). Dissolved zinc concentrations ranged from 69.9 to 286 μg/L (Table 4-4.5).

All other applicable water quality objectives in San Gabriel River were met during the 2012-2013 Wet Weather Monitoring Season.

4.2.2.6 Dominguez Channel (S28)

A summary of constituents that did not meet applicable water quality objectives at the Dominguez Channel MES during the 2012-2013 Wet Weather Monitoring Season is presented in Table 4-4.6 and Figure 4-3.6.

E. coli concentrations were above the water quality objective of 235 MPN/100 mL during all seven storm events monitored for bacteria. *E. coli* concentrations ranged from 2,419 to 34,500 MPN/100 mL. 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 2012-13Event04, 2012-13Event06 or 2012-13Event14. Based on this assessment, four of the seven wet weather events analyzed for bacteria (2012-13Event07, 2012-13Event08, 2012-13Event11, and 2012-13Event15) did not meet the *E. coli* water quality objective (Table 4-4.6 and Figure 4-3.6).

Cyanide concentrations were above the water quality objective of 0.022 mg/L during one storm event at Dominguez Channel (2012-13Event07; Figure 4-3.6). Cyanide concentrations ranged from non-detect to 0.041 mg/L.

pH was not within the water quality objective range of 6.5–8.5 pH units for one of the eight wet weather samples collected at Dominguez Channel (Table 4-4.5). The water sample collected during 2012-13Event14 had a pH value slightly below the lower limit of the water quality objective range.

Dissolved copper concentrations were above the hardness-based water quality objective for all eight wet weather samples at Dominguez Channel (Figure 4-3.6). Dissolved copper concentrations varied moderately and ranged from 25.3 to 163 μg/L, whereas hardness ranged from 30 to 165 mg/L (Table 4-4.6).

Dissolved zinc concentrations were also above the hardness-based water quality objective for all eight wet weather samples at Dominguez Channel (Figure 4-3.6). Dissolved zinc concentrations ranged from 108 to 1510 μg/L (Table 4-4.6).

All other applicable water quality objectives in Dominguez Channel were met during the 2012-2013 Wet Weather Monitoring Season.

4.2.2.7 Santa Clara River (S29)

A summary of constituents that did not meet applicable water quality objectives at the Santa Clara River MES during the 2012-2013 Wet Weather Monitoring Season is presented in Table 4-4.7 and Figure 4-3.7.

E. coli bacteria concentrations were above the applicable water quality objective (i.e., 235 MPN/100 mL) during each of the four sampled storm events in Santa Clara River (Figure 4-3.7). Values ranged from 1,700 to 54,000 MPN/100 mL (Table 4-4.7). Santa Clara River is not subject to the wet weather suspension of the REC-1 beneficial use.

All other applicable water quality objectives in Santa Clara River were met during the 2012-2013 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 2012-2013 Wet Weather Monitoring Season is presented in Table 4-5.1 and Figure 4-4.1.

E. coli bacteria concentrations were above the applicable water quality objective (i.e., 235 MPN/100 mL) during each of the five wet weather events monitored for bacteria. Values ranged from 1,700 to 7,660 MPN/100 mL. Malibu Creek tributaries are not subject to a high-flow suspension of the REC-1 beneficial use (Table 4-5.1 and Figure 4-4.1).

The sulfate concentration was above the water quality objective of 500 mg/L for one of the six monitored wet weather events (2012-13Event05). Sulfate concentrations ranged from 140 to 721 mg/L (Table 4-5.1).

All other applicable water quality objectives at Upper Las Virgenes Creek were met during the 2012-2013 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 2012-2013 Wet Weather Monitoring Season is presented in Table 4-5.2 and Figure 4-4.2.

E. coli bacteria concentrations were above the applicable water quality objective (i.e., 235 MPN/100 mL) during each of the five wet weather events monitored for bacteria. Values ranged from 272 to 5,400 MPN/100 mL (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.

The sulfate concentration was above the water quality objective of 500 mg/L for one of the seven monitored wet weather events (2012-13Event07). Sulfate concentrations ranged from 95 to 1,040 mg/L (Table 4-5.2).

The TDS concentration was slightly above the water quality objective of 2,000 mg/L for one of the six storms monitored for TDS (2012-13Event07). Concentrations ranged from 230 to 2,140 mg/L (Table 4-5.2).

All other applicable water quality objectives at Cheseboro Canyon were met during the 2012-2013 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 2012-2013 Wet Weather Monitoring Season is presented in Table 4-5.3 and Figure 4-4.3.

E. coli bacteria concentrations were above the applicable water quality objective (i.e., 235 MPN/100 mL) during each of the five wet weather events monitored for bacteria. Values ranged from 1,134 to 9,200 MPN/100 mL (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.

Sulfate concentrations were above the water quality objective of 500 mg/L for two of the six wet weather events (2012-13Event06 and 2012-13Event07). Sulfate concentrations at Lower Lindero Creek ranged from 300 to 616 mg/L (Table 4-5.3).

The dissolved copper concentration was above the hardness-based water quality objective for one of the six wet weather samples at Lower Lindero Creek (2012-13Event05; Figure 4-4.3). Dissolved copper concentrations ranged from 2.71 to 79.8 μg/L, and hardness ranged from 360 to 720 mg/L (Table 4-5.3).

All other applicable water quality objectives at Lower Lindero Creek were met during the 2012-2013 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 2012-2013 Wet Weather Monitoring Season is presented in Table 4-5.4 and Figure 4-4.4.

E. coli bacteria concentrations were above the applicable water quality objective (i.e., 235 MPN/100 mL) during each of the five wet weather events monitored for bacteria. Values ranged from 2,014 to 35,000 MPN/100 mL (Figure 4-4.4). Malibu Creek tributaries are not subject to a suspension of the REC-1 beneficial use (Table 4-5.4).

The sulfate concentration was above the water quality objective of 500 mg/L for two of the seven monitored wet weather events (2012-13Event06 and 2012-13Event17). Sulfate concentrations ranged from 260 to 541 mg/L (Table 4-5.4).

All other applicable water quality objectives at Medea Creek were met during the 2012-2013 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 2012-2013 Wet Weather Monitoring Season is presented in Table 4-5.5 and Figure 4-4.5.

E. coli bacteria concentrations were above the applicable water quality objective (i.e., 235 MPN/100 mL) during each of the five wet weather events monitored for bacteria at Liberty Canyon Channel. Values ranged from 985 to 92,000 MPN/100 mL (Table 4-5.5 and Figure 4-4.5). Malibu Creek tributaries are not subject to a suspension of the REC-1 beneficial use.

pH was not within the water quality objective range of 6.5–8.5 pH units for one of the six wet weather samples collected at Liberty Canyon Channel (Table 4-5.5). The water sample collected during 2012-13Event05 had a pH value slightly above the upper limit of the water quality objective range.

The sulfate concentration was above the water quality objective of 500 mg/L for one of the six monitored wet weather events at Liberty Canyon Channel (2012-13Event07). Sulfate concentrations ranged from 43.8 to 796 mg/L (Table 4-5.5).

The dissolved copper concentration was above the hardness-based water quality objective for two of the six wet weather samples at Liberty Canyon Channel (Figure 4-4.5). The dissolved copper concentrations ranged from 8.73 to 157 µg/L, and hardness varied from 38 to 220 mg/L (Table 4-5.5).

The dissolved zinc concentration was above the hardness-based water quality objective for one of the six monitored wet weather storm events at Liberty Canyon Channel (Figure 4-4.5). Dissolved zinc concentrations ranged from 10.6 to 440 µg/L (Table 4-5.5).

All other applicable water quality objectives at Liberty Canyon Channel were met during the 2012-2013 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 2012-2013 Wet Weather Monitoring Season is presented in Table 4-5.6 and Figure 4-4.6.

E. coli bacteria concentrations were above the applicable water quality objective (i.e., 235 MPN/100 mL) during each of the five monitored wet weather events at the PD 728 at Foxfield Drive Tributary Station. Values ranged from 1,006 to 16,000 MPN/100 mL (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 2012-2013 Wet Weather Monitoring Season.

4.2.4 Mass Emission Stations During Dry Weather

4.2.4.1 Ballona Creek (S01)

A summary of constituents that did not meet applicable water quality objectives at the Ballona Creek MES during the 2012-2013 Dry Weather Monitoring Season is presented in Table 4-4.1 and Figure 4-5.1

E. coli was the only constituent that did not meet the applicable water quality objective (i.e., 576 MPN/100 mL) at Ballona Creek. *E. coli* concentrations ranged from 19 to 770 MPN/100 mL and were above the water quality objective during one of the two monitored dry weather events.

All other applicable water quality objectives in Ballona Creek were met during the 2012-2013 Dry Weather Monitoring Season.

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 2012-2013 Dry Weather Monitoring Season is presented in Table 4-4.2 and Figure 4-5.2.

The pH value was not within the water quality objective range of 6.5-8.5 pH units during one of the two dry weather events at Malibu Creek (Figure 4-5.2). pH values ranged from 6.17 to 6.60 (Table 4-4.2).

Sulfate concentrations did not meet the water quality objective of 500 mg/L during both of the monitored dry weather events in Malibu Creek (Figure 4-5.2). Sulfate concentrations ranged from 590 to 1090 mg/L (Table 4-4.2).

The concentration of TDS was above the water quality objective of 2,000 mg/L during one of the two monitored dry weather events. TDS concentrations ranged from 1,440 to 2,340 mg/L (Table 4-4.2).

All other applicable water quality objectives in Malibu Creek were met during the 2012-2013 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 2012-2013 Dry Weather Monitoring Season is presented in Table 4-4.3 and Figure 4-5.3.

E. coli did not meet the applicable water quality objective (i.e., 235 MPN/100 mL) during one of the two monitored dry weather events. *E. coli* concentrations ranged from 46 to 959 MPN/100 mL (Table 4-4.3).

Cyanide was above the water quality objective of 0.022 mg/L during one of the two monitored dry weather events. Cyanide concentrations ranged from 0.015 to 0.026 mg/L (Table 4-4.3).

The pH value was not within the water quality objective range of 6.5–8.5 pH units during one of the two dry weather events at Los Angeles River (Figure 4-5.3). pH values ranged from 7.35 to 8.68 (Table 4-4.3).

All other applicable water quality objectives in Los Angeles River were met during the 2012-2013 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 2012-2013 Dry Weather Monitoring Season is presented in Table 4-4.4 and Figure 4-5.4.

E. coli did not meet the applicable water quality objective (i.e., 235 MPN/100 mL) during one of the two monitored dry weather events. *E. coli* concentrations ranged from 173 to 1,124 MPN/100 mL (Table 4-4.4).

All other applicable water quality objectives at the Coyote Creek MES were met during the 2012-2013 Dry Weather Monitoring Season (Table 4-4.4).

4.2.4.5 San Gabriel River (S14)

No dry weather samples were collected at San Gabriel River due to dry conditions (no flow).

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 2012-2013 Dry Weather Monitoring Season is presented in Table 4-4.6 and Figure 4-5.6.

E. coli did not meet the applicable water quality objective (i.e., 235 MPN/100 mL) during both of the two monitored dry weather events. *E. coli* concentrations ranged from 393 to 816 MPN/100 mL (Table 4-4.6).

Cyanide was above the water quality objective of 0.022 mg/L during one of the two monitored dry weather events. Cyanide concentrations ranged from 0.015 to 0.026 mg/L (Table 4-4.6).

The pH value was not within the water quality objective range of 6.5–8.5 pH units during one of the two dry weather events at Dominguez Channel (Figure 4-5.6). pH values ranged from 6.19 to 6.87 (Table 4-4.6).

All other applicable water quality objectives in Dominguez Channel were met during the 2012-2013 Dry Weather Monitoring Season.

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 2012-2013 Dry Weather Monitoring Season is presented in Table 4-4.7 and Figure 4-5.7.

The pH value was not within the water quality objective range of 6.5–8.5 pH units during one of the two dry weather events at Dominguez Channel (Figure 4-5.7). pH values ranged from 6.36 to 7.56 (Table 4-4.7).

All other applicable water quality objectives at the Santa Clara River MES were met during the 2012-2013 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 2012-2013 Dry Weather Monitoring Season is presented in Table 4-5.1 and Figure 4-6.1.

The *E. coli* bacteria concentration was above the applicable water quality objective (i.e., 235 MPN/100 mL) during both of the dry weather sampling events in Upper Las Virgenes Creek (Figure 4-6.1). *E. coli* concentrations ranged from 435 to 1,259 MPN/100 mL over the two events (Table 4-5.1).

The sulfate concentration was above the water quality objective of 500 mg/L for both of the dry weather events at Upper Las Virgenes Creek (Figure 4-6.1). Sulfate concentrations ranged from 993 to 1,350 mg/L (Table 4-5.1).

The concentration of TDS was above the water quality objective of 2,000 during the one monitored dry weather event at Upper Las Virgenes Creek (Figure 4-6.1). The TDS concentration was 2,750 mg/L (Table 4-5.1).

All other applicable water quality objectives in Upper Las Virgenes Creek were met during the 2012-2013 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 2012-2013 Dry Weather Monitoring Season is presented in Table 4-5.2 and Figure 4-6.2.

The *E. coli* bacteria concentration was above the applicable water quality objective (i.e., 235 MPN/100 mL) during both of the sampled events in Cheseboro Canyon (Figure 4-6.2). *E. coli* concentrations ranged from 387 to 2,110 MPN/100 mL over the two events (Table 4-5.2).

The sulfate concentration was above the water quality objective of 500 mg/L during both dry weather events at Cheseboro Canyon (Figure 4-6.2). Sulfate concentrations ranged from 1,450 to 1,600 mg/L (Table 4-5.2).

The concentration of TDS was above the water quality objective of 2,000 during both dry weather events at Cheseboro Canyon (Figure 4-6.2). The TDS concentration ranged from 2,890 to 3,360 mg/L (Table 4-5.2).

All other applicable water quality objectives in Cheseboro Canyon were met during the 2012-2013 Dry Weather Monitoring Season.

4.2.5.3 Lower Lindero Creek (TS27)

A summary of constituents that did not meet applicable water quality objectives at the Lower Lindero Creek Tributary Station (TS27) during the 2012-2013 dry weather monitoring is presented in Table 4-5.3 and Figure 4-6.3.

The *E. coli* bacteria concentration was above the applicable water quality objective (i.e., 235 MPN/100 mL) during both of the dry weather sampling events at the Lower Lindero Creek Tributary Station (Figure 4-6.3). *E. coli* concentrations ranged from 683 to 6,570 MPN/100 mL over the two events (Table 4-5.3).

The sulfate concentration was above the water quality objective of 500 mg/L for both of the dry weather events at Lower Lindero Creek (Figure 4-6.3). Sulfate concentrations ranged from 738 to 862 mg/L over the two events (Table 4-5.3).

All other applicable water quality objectives in Lower Lindero Creek were met during the 2012-2013 Dry Weather Monitoring Season.

4.2.5.4 Medea Creek (TS28)

A summary of constituents that did not meet applicable water quality objectives at the Medea Creek Tributary Station (TS28) during the 2012-2013 dry weather monitoring is presented in Table 4-5.4 and Figure 4-6.4.

The *E. coli* bacteria concentration was above the applicable water quality objective (i.e., 235 MPN/100 mL) during one of the two dry weather sampling events at the Medea Creek Tributary Station (Figure 4-6.4). *E. coli* concentrations ranged from 189 to 579 MPN/100 mL over the two events (Table 4-5.4).

The sulfate concentration was above the water quality objective of 500 mg/L for both of the dry weather events at Medea Creek (Figure 4-6.4). Sulfate concentrations ranged from 1,040 to 1,220 mg/L (Table 4-5.4).

The TDS concentration was above the water quality objective of 2,000 mg/L for both of the dry weather events at Medea Creek (Figure 4-6.4). TDS concentrations ranged from 2,390 to 2,690 mg/L (Table 4-5.4).

All other applicable water quality objectives in Medea Creek were met during the 2012-2013 Dry Weather Monitoring Season.

4.2.5.5 Liberty Canyon Channel (TS29)

A summary of constituents that did not meet applicable water quality objectives at the Liberty Canyon Channel Tributary Station (TS29) during the 2012-2013 dry weather monitoring is presented in Table 4-5.5 and Figure 4-6.5.

The *E. coli* bacteria concentration was above the applicable water quality objective (i.e., 235 MPN/100 mL) during both of the sampled events in Liberty Canyon Channel (Figure 4-6.5). The *E. coli* concentrations ranged from 14,830 to 19,863 MPN/100 mL (Table 4-5.5).

Cyanide was above the water quality objective of 0.022 mg/L during one of the two monitored dry weather events. Cyanide concentrations ranged from 0.0025 to 0.043 mg/L (Table 4-5.5).

The sulfate concentration was above the water quality objective of 500 mg/L during both of the dry weather events (Figure 4-6.5). Sulfate concentrations ranged from 669 to 954 mg/L (Table 4-5.5).

The TDS concentration was above the water quality objective of 2,000 mg/L during one of the two dry weather events at Liberty Canyon Channel (Figure 4-6.5). TDS concentrations ranged from 1,570 to 2,030 mg/L over the two events (Table 4-5.5).

The dissolved cadmium concentration was above the hardness-based water quality objective during one of the two dry weather monitoring events at Liberty Canyon Channel (Figure 4-6.5). Dissolved cadmium concentrations ranged from 3.25 to 21.0 μg/L. Hardness values ranged from 740 to 980 mg/L (Table 4-5.5).

Dissolved copper concentrations were above the hardness-based water quality objective during both of the dry weather events at Liberty Canyon Channel (Figure 4-6.5). Dissolved copper concentrations ranged from 217 to 235 μg/L over the two events (Table 4-5.5).

All other applicable water quality objectives in Liberty Canyon Channel were met during the 2012-2013 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 2012-2013 dry weather monitoring is presented in Table 4-5.6 and Figure 4-6.6.

The *E. coli* bacteria concentration was above the applicable water quality objective (i.e., 235 MPN/100 mL) during one of the two dry weather events at PD 728 at Foxfield Drive (Figure 4-6.6). *E. coli* concentrations ranged from 63 to 631 MPN/ 100 mL (Table 4-5.6).

The sulfate concentration was above the water quality objective of 500 mg/L during both of the dry weather events at PD 728 at Foxfield Drive (Figure 4-6.6). Concentrations of sulfate ranged from 548 to 612 mg/L over the two events (Table 4-5.6).

All other applicable water quality objectives in PD 728 at Foxfield Drive were met during the 2012-2013 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 is presented in this subsection.

4.2.6.1 Mass Emission Stations

At the MES located in urbanized watersheds (i.e., Ballona Creek, Los Angeles River, and Dominguez Channel), dissolved copper did not meet the water quality objectives during all of the monitored wet weather events. In addition, dissolved zinc did not meet water quality objectives during all monitored wet weather events at Dominguez Channel and during all but one event at Ballona Creek and Los Angeles River. Indicator bacteria were also above water quality objectives at all three urbanized MES. *E. coli* was above the water quality objectives during four of six wet weather events monitored for bacteria at Ballona Creek. *E. coli* was above the water quality objective during four of seven events at Los Angeles River and Dominguez Channel. At Los Angeles River, pH and dissolved lead also did not meet water quality objectives during one wet weather event. At Dominguez Channel, pH and cyanide also did not meet water quality objectives during one event.

During dry weather conditions, *E. coli* bacteria were above water quality objectives during both dry weather events at one of the three urbanized watershed MES (Dominguez Channel) and during one dry weather event at both of the other urbanized watershed MES (Ballona Creek and Los Angeles River). Cyanide and pH were also measured outside of water quality objectives during one event at two of the three urbanized watershed MES (Los Angeles River and Dominguez Channel).

Among the four less urbanized watersheds (i.e., Malibu Creek, Coyote Creek, San Gabriel River, and Santa Clara River), indicator bacteria concentrations were above water quality objectives. At Malibu Creek, where the high-flow suspension of the bacteria water quality objective does not apply, *E. coli* was above the water quality objective during three of five wet weather events. At Coyote Creek, *E. coli* concentrations were above the water quality objective during four of six wet weather events; and at San Gabriel River, *E. coli* was above the water quality objective during two of five wet weather events. At Santa Clara River, where the high-flow suspension of the bacteria water quality objective does not apply, *E. coli* was above the water quality objective during all four monitored wet weather events. In addition, TDS was above the water quality objective during one event and sulfate was above the water quality objective during all monitored wet weather events at Malibu Creek. At Coyote Creek, dissolved copper and dissolved zinc were each above the water quality objectives during four of eight wet weather events. At San Gabriel River, cyanide, pH, and dissolved zinc were each above the water quality objectives during one wet weather event and dissolved copper was above the water quality objective during two of five events. At Santa Clara River, no additional constituents other than *E. coli* were above water quality objectives.

As for the four less urbanized watersheds, during dry weather monitoring *E. coli* was above the water quality objective during one of the dry weather monitoring events at Coyote Creek MES. San Gabriel River was not sampled due to dry conditions (no flow). At the other two MES in less urbanized watersheds (Malibu Creek and Santa Clara River), pH was outside of the water quality objective range during one event. In addition, sulfate was above the water quality objective during both events, and TDS was above the water quality objective during one event at the Malibu Creek MES. The results are summarized in the table below.

Summary of Constituents that Did Not Meet Water Quality Objectives at Mass Emission Stations during 2012-2013 for One or More Events

Mass Emission Station/Watershed	Wet	Dry
Ballona Creek (S01)[1,2,3]	*E. coli* Dissolved zinc Dissolved copper	*E. coli*
Malibu Creek (S02)	*E. coli* Sulfate TDS	pH Sulfate TDS
Los Angeles River (S10)[1,2,3]	*E. coli* pH Dissolved copper Dissolved lead Dissolved zinc	*E. coli* Cyanide pH
Coyote Creek (S13)[2,3]	*E. coli* Dissolved copper Dissolved zinc	*E. coli*
San Gabriel River (S14)[2,3]	*E. coli* Cyanide pH Dissolved copper Dissolved zinc	Not sampled (no flow)
Dominguez Channel (S28)[1,2,3]	*E. coli* Cyanide pH Dissolved copper Dissolved zinc	*E. coli* Cyanide pH
Santa Clara River (S29)	*E. coli*	pH

TDS – total dissolved solids.

[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 2012-13Event05, 2012-13Event07, 2012-13Event08, 2012-2013Event11, and 2012-13Event15; to Los Angeles River during 2012-13Event05, 2012-13Event07, 2012-13Event08, 2012-13Event11, and 2021-13Event15; to Coyote Creek during 2012-13Event04, 2012-13Event05, 2012-13Event06, 2012-13Event08, 2012-13Event11, and 2012-13Event15; to San Gabriel River during 2012-13Event04, 2012-13Event05, and 2012-13Event15; and to Dominguez Channel during 2012-13Event05, 2012-13 Event07, 2012-13Event08, 2012-13Event11, and 2012-13Event15.

4.2.6.2 Tributary Monitoring Stations

This subsection summarizes the constituents that were measured above Basin Plan water quality objectives at the tributary monitoring stations during the 2012–2013 Monitoring Season.

During wet weather, *E. coli* concentrations were above the water quality objective during all monitored wet weather events at all six tributary stations. In addition, similar to results observed at the Malibu Creek MES, sulfate exceeded the water quality objectives at five of the six stations (Upper Las Virgenes, Cheseboro Canyon, Lower Lindero Creek, Medea Creek, and Liberty Canyon Channel) during at least one monitored wet weather event. TDS was above the water quality objective during one wet weather event at Cheseboro Canyon, pH and dissolved zinc did not meet the water quality objectives during one event at Liberty Canyon Channel, and dissolved copper concentrations were above the water quality objective during one event at Lower Lindero Creek and during two events at Liberty Canyon Channel. There were no wet weather exceedances for pH, dissolved copper, or dissolved zinc at the Malibu Creek MES.

During dry weather, *E. coli* and sulfate did not meet the water quality objectives for at least one monitored dry weather event at each of the tributary stations. In addition, TDS was above the water quality objective during at least one of the two dry weather events at all stations except Lower Lindero Creek and PD 728 at Foxfield Drive. Sulfate and TDS, but not *E. coli* concentrations, also exceeded water quality objectives at the Malibu Creek MES. At Liberty Canyon Channel, cyanide and dissolved cadmium were each above water quality objectives during one dry weather event, and dissolved copper was greater than the hardness-based water quality objective during both monitored dry weather events. There were no dry weather cyanide or metals exceedances at the Malibu Creek MES. The results are summarized in the table below.

Summary of Constituents That Did Not Meet Water Quality Objectives at Tributary Stations during 2012-2013 for One or More Events

Tributary/Sub-Watershed	Wet	Dry
Upper Las Virgenes Creek (TS25)	*E. coli* Sulfate	*E. coli* Sulfate TDS
Cheseboro Canyon (TS26)	*E. coli* Sulfate TDS	*E. coli* Sulfate TDS
Lower Lindero Creek (TS27)	*E. coli* Sulfate Dissolved copper	*E. coli* Sulfate
Medea Creek (TS28)	*E. coli* Sulfate	*E. coli* Sulfate TDS
Liberty Canyon Channel (TS29)	*E. coli* pH Sulfate Dissolved copper Dissolved zinc	*E. coli* Cyanide Sulfate TDS Dissolved cadmium 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 and at each tributary station during wet and dry weather conditions. The TSS concentrations from composite samples collected during dry weather and 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 Figures 4-7 through 4-8.

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 in this case). 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 of occurring randomly (there is a 95% confidence that this result did not occur by chance).

4.3.1 Priority Constituents and Correlation 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. Positive correlations between TSS and metal priority constituents were observed at two of the seven watersheds. At San Gabriel River, dissolved zinc was correlated positively with TSS and at Dominguez Channel, dissolved copper was correlated positively with TSS. The results of the correlation analysis are summarized in the table below.

At Ballona Creek, volatile suspended solids (VSS), was positively correlated with TSS. At Malibu Creek, chromium was positively correlated with TSS. At Los Angeles River, no constituents were positively correlated with TSS. At Coyote Creek, alkalinity, aluminum, barium, chromium, dissolved chromium, dissolved lead, dissolved nickel, *E. coli*, hardness, iron, lead, nickel, TDS, and VSS were positively correlated with TSS. At San Gabriel River, aluminum, barium, biochemical oxygen demand (BOD), cadmium, chromium, copper, dissolved aluminum, dissolved iron, dissolved lead, dissolved nickel, dissolved zinc (a priority constituent, as mentioned above), fecal streptococcus, iron, lead, nickel, VSS, and zinc were positively correlated with TSS. At Dominguez Channel, dissolved copper (a priority constituent, as mentioned above), dissolved phosphorus, total phosphorus, and VSS were positively correlated with TSS. At Santa Clara River, aluminum, ammonia, chemical oxygen demand (COD), chromium, dissolved iron, iron, lead, NH_3-N, silver, turbidity, and VSS were positively correlated with TSS.

Negative correlations with TSS were found at Los Angeles River MES for total coliform and turbidity and at Santa Clara River for dissolved arsenic.

Many constituents have a strong binding affinity for sediment particles in stormwater effluent, particularly bacteria, metals, organics, and total organic carbon (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. Additional, more tailored monitoring programs and studies will be developed pursuant to the new MS4 permit (Order No. R4-2012-0175 adopted by the LARWQCB on November 8, 2012).

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)	VSS	None
Malibu Creek (S02)	Chromium	None
Los Angeles River (S10)	None	Total coliform, Turbidity
Coyote Creek (S13)	Alkalinity, Aluminum, Barium, Chromium, Dissolved chromium, Dissolved lead, Dissolved nickel, *E. coli*, Hardness, Iron, Lead, Nickel, TDS, VSS	None
San Gabriel River (S14)	Aluminum, Barium, BOD, Cadmium, Chromium, Copper, Dissolved aluminum, Dissolved iron, Dissolved lead, Dissolved nickel, Dissolved zinc, Fecal streptococcus, Iron, Lead, Nickel, VSS, Zinc	None
Dominguez Channel (S28)	Dissolved copper, Dissolved phosphorus, Total phosphorus, VSS	None
Santa Clara River (S29)	Aluminum, Ammonia, COD, Chromium, Dissolved iron, Iron, Lead, NH_3-N, Silver, Turbidity, VSS	Dissolved arsenic

TDS = total dissolved solids.
VSS = volatile suspended solids.
BOD = biochemical oxygen demand.
COD = chemical oxygen demand.

Wet Weather – Tributary Stations

Only one correlation was found between TSS and priority constituents at tributary stations (those that did not meet water quality objectives at tributary stations for one or more events). At Liberty Canyon Channel, the priority constituent *E. coli* was positively correlated with TSS.

At Upper Las Virgenes Creek, BOD, cadmium, dissolved cadmium, and VSS were positively correlated with TSS. At Cheseboro Canyon, aluminum, ammonia, antimony, cadmium, dissolved aluminum, dissolved cadmium, dissolved iron, dissolved lead, iron, lead, VSS, and zinc were positively correlated with TSS. At Lower Lindero Creek, aluminum, antimony, barium, cadmium, chromium, copper, dissolved aluminum, dissolved cadmium, iron, lead, methylene blue active substance (MBAS), nickel, VSS, and zinc were positively correlated with TSS. At Medea Creek, arsenic, nickel, and TOC were positively correlated with TSS. At Liberty Canyon Channel, aluminum, BOD, cadmium, *E. coli* (a priority constituent, as mentioned above), fecal coliform, iron, lead, silver, and VSS were positively correlated with TSS. At PD 728 at Foxfield Drive, dissolved barium, dissolved cadmium, and pH were positively correlated with TSS.

A negative correlation with TSS was found only at Liberty Canyon Channel, where dissolved selenium was negatively correlated with TSS.

Correlations Between Constituents and Total Suspended Solids at Tributary Stations

Tributary Station/Watershed	Wet	
	Positively Correlated with TSS	Negatively Correlated with TSS
Upper Las Virgenes Creek (TS25)	BOD, Cadmium, Dissolved cadmium, VSS	None
Cheseboro Canyon (TS26)	Aluminum, Ammonia, Antimony, Cadmium, Dissolved aluminum, Dissolved cadmium, Dissolved iron, Dissolved lead, Iron, Lead, VSS, Zinc	None
Lower Lindero Creek (TS27)	Aluminum, Antimony, Barium, Cadmium, Chromium, Copper, Dissolved aluminum, Dissolved cadmium, Iron, Lead, MBAS, Nickel, VSS, Zinc	None
Medea Creek (TS28)	Arsenic, Nickel, TOC	None
Liberty Canyon Channel (TS29)	Aluminum, BOD, Cadmium, *E. coli*, Fecal coliform, Iron, Lead, Silver, VSS	Dissolved selenium
PD 728 at Foxfield Drive (TS30)	Dissolved barium, Dissolved cadmium, pH	None

BOD = biochemical oxygen demand.
VSS = volatile suspended solids.
MBAS = methylene blue active substances.
TOC = total organic carbon.

4.3.2 Watershed Load Analysis

Constituent loads at each MES were calculated for storm events that occurred during the 2012-2013 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 (2012-13Event03) and April (2012-13Event20) 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. Event 2012-13Event03 (October 9, 2012) and 2012-13Event20 (April 8, 2013) at each MES and tributary station were used to calculate dry weather low-flow estimations for each of the watersheds. 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 three of the seven MES locations: Ballona Creek MES, Los Angeles River MES, and San Gabriel River MES.

During dry weather, constituent loads varied between stations and among sampling events. In general, the highest variability was observed in nutrient loads and TSS loads. 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 substantially lower at Santa Clara River MES than at all 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 of the MES. These constituents were chosen because of their prevalence in stormwater runoff.

Ballona Creek (S01)

The wet weather events with the highest rainfall totals at Ballona Creek MES were 2012-13Event06 (0.83 inches), and 2012-13Event14 (0.70 inches). Rainfall totals for the other five wet weather events monitored at Ballona Creek MES ranged from 0.12 to 0.43 inches. During 2012-13Event06 and 2012-13Event14, loads for *E. coli,* nitrate, total phosphorus, TPH, TKN, TDS, dissolved chromium, copper, and zinc were all among the highest observed at Ballona Creek during the 2012-2013 wet weather season. TSS loads were highest during 2012-13Event11 (0.43 inches of rainfall). Nutrient, dissolved chromium, copper, and zinc loads were also relatively high compared to other events for 2012-13Event05 (the first flush at Ballona Creek, with 0.2 inches of rainfall), which is indicative of a first-flush loading signature for these constituents.

Dry weather loads at Ballona Creek were higher during the first event (2012–13Event03) than the second event (2012-13Event20) for *E. coli*, nutrients, TDS, TSS, copper, and zinc, whereas while loads for TPH and dissolved chromium were greater during the second dry weather event. Loads varied between the two events, with the highest variability observed for nutrients, *E. coli*, and TSS. The *E. coli* load during 2012-13Event03 was more than 38 times greater than during 2012-13Event20. The TSS load during 2012-13Event03 was more than 21 times greater than during 2012-13Event20. The event volumes for the two dry weather events were similar (68.5 and 71.2 acre feet, respectively).

Malibu Creek (S02)

The wet weather event with the highest rainfall total at Malibu Creek MES was 2012-13Event14 (1.03 inches). Three other monitored wet weather events also produced close to three-quarters of an inch of rain 2012-13Event05, 2012-13Event06, 2012-13Event18, and 2012-13Event15 (0.87, 0.90, 0.83 and 0.71 inches, respectively). Rainfall during 2021-13Event07 was much lower at only 0.28 inches. During 2012-13Event14, loads for *E. coli*, TDS, TPH, TSS, and metals were among the highest observed at Malibu Creek MES during the 2012-2013 wet weather season. Nutrient loads during 2012-13Event14 were not among the highest observed at Malibu Creek. TKN loads were highest during 2012-13Event15 and 2012-13Event18; nitrate loads were highest during 2012-13Event06 and 2012-13Event07; and total phosphorus loads were highest during 2012-13Event07 and 2012-13Event15. The greatest TSS loads observed were during 2012-13Event14 and 2012-13Event18. No first-flush loading signatures were observed in assessing loads at Malibu Creek MES.

Dry weather loads in Malibu Creek were higher during the second event (2012-13Event20) than during the first event (2012-13Event03) for *E. coli*, TKN, nitrate, total phosphorus, TPH, and dissolved chromium, and copper. Loads were higher during the first event for zinc, TDS, and TSS. Loads varied between the two events with the highest variability observed for nitrate, which was several hundred times greater during 2012-13Event20 than during 2012-13Event03. The dissolved chromium load was ten times greater, and loads for total phosphorus and TKN were approximately six to seven times greater during the second dry weather event compared to the first. TSS was approximately six times greater during the first dry weather event compared to the second. Loads for *E. coli*, TDS, TPH, copper, and zinc were similar between the two dry weather events. The event volume for the second dry weather event (2012-12Event03) was approximately 1.3 times the volume for the first dry weather event (2012-13Event20).

Los Angeles River (S10)

The highest rainfall total at the Los Angeles River MES occurred during the first storm event of the season, 2012-2013Event04 (0.77 inches). Rainfall totals during 2012-13Event06, 2012-13Event11, and 2012-13Event14 were similar (0.51, 0.43, and 0.63 inches, respectively). Rainfall amounts during the remaining wet weather events, 2012-13Event05, 2012-13Event07, 2012-13Event08 and 2012-13Event15, were much lower (0.20, 0.20, 0.08, and 0.16 inches, respectively). During 2012-13Event04, loads for *E. coli*, nutrients, dissolved chromium, copper, and zinc were among the highest observed at Los Angeles River MES during the 2012-13 wet weather season. TSS and TDS loads were greatest during 2012-13Event05, whereas TPH loads were highest during 2012-13Event14. First-flush loading signatures were observed for zinc and copper at Los Angeles River MES.

Dry weather loads for *E. coli*, nitrate, TSS, total phosphorus, and zinc were higher during the first dry weather event (2012-13Event03). Loads for TKN, TDS, TPH, dissolved chromium, and copper were greater during the second dry weather event (2012-13Event20). The highest variability between the two dry weather events was observed in *E. coli* loads, which were approximately 18 times greater during the first dry weather event. Event volumes were similar during both of the dry weather events (413.9 and 456.1 acre feet, respectively).

Coyote Creek (S13)
At Coyote Creek MES, rainfall totals were highest during 2012-13Event07 (0.71 inches). Rainfall totals were similar for 2012-13Event14, 2012-13Event06, and 2012-13Event08 (0.67, 0.55, and 0.39 inches, respectively) but were much lower during 2012-Event04, 2012-13Event05, and 2012-13Event11 (0.04, 0.08, and 0.12 inches, respectively). The first monitored wet weather event, 2012-13Event04 at Coyote Creek MES was a sporadic storm; therefore, the sample volume collected was sufficient to analyze only a portion of the composite constituent list. Grab samples were also not obtained for this event at Coyote Creek MES, nor were they collected during 2012-13Event05 due to the nature of the storm. Loads for nutrients, chromium, TSS, TPH, dissolved chromium, copper, and zinc were highest during 2012-13Event06 and 2012-13Event07, corresponding with higher rainfall totals for these storms. Loads for *E. coli* and TDS were highest during 2012-13Event08. First flush loading signatures were not observed at Coyote Creek MES.

Dry weather loads for TKN, nitrate, total phosphorus, TDS, TSS, TPH, dissolved cadmium, copper, and zinc were higher during the second dry event (2012-13Event20) compared to the first dry event (2012-13Event03). *E. coli* loads were higher during the first dry event. The greatest variability between the two dry weather events was observed for dissolved chromium and copper. Dissolved chromium loads were approximately 13 times greater during the second dry weather event, whereas copper loads were approximately 7 times greater during the second dry weather event. The event volume was approximately 5.7 times greater during the second dry weather event than during the first dry weather event.

San Gabriel River (S14)
Rainfall totals at San Gabriel River MES were highest during 2012-13Event08, and 2012-13Event14 (1.37 and 1.10 inches, respectively). Rainfall totals for 2012-13Event04, 2012-13Event05, and 2012-13Event07 were similar (0.39, 0.38, and 0.71 inches, respectively), whereas rainfall totals for 2012-13Event15 were much lower (0.08 inches) than the other monitored wet weather events at San Gabriel MES. Loads for nitrate, total phosphorus, TDS, TPH, TSS, dissolved chromium, copper, and zinc were highest during the two largest storms (2012-13Event08 and 2012-13Event14) at San Gabriel River MES. First flush loading signatures were observed for *E. coli* and TKN at San Gabriel River MES.

During both dry weather events (2012-13Event03 and 2012-13Event20), no flow was observed at San Gabriel River MES.

Dominguez Channel (S28)
Rainfall totals at Dominguez Channel MES were highest during 2012-2013Event 14, 2012-13Event04 and 2012-13Evnet06 (0.85, 0.80, 0.66 inches, respectively). Rainfall totals for the remaining five monitored wet weather events at Dominguez Channel MES ranged from 0.12 to 0.20 inches. Loads for *E. coli*, nutrients, TSS, TDS, copper and zinc were highest during 2012-13Event06, whereas loads for TP and dissolved copper were highest during 2012-13Event14. First flush loading signatures were not observed at Dominguez Channel MES.

Dry weather loads for *E. coli*, TKN, nitrate, TDS, TPH, and dissolved cadmium were all greater during the first dry weather event (2011-12Event04) compared to the second dry weather event (2011-12Event12), whereas loads for TSS, total phosphorus, copper and zinc were greater during the second dry weather event. Little variability was observed in the loads between the two events, with the greatest variability observed in loads of dissolved chromium that were approximately 3.3 times greater during the second dry weather event and in TSS loads that were approximately 2.6 times greater during the first dry weather event. The event volumes were similar for the first and second dry weather events (8.2 and 8.3 acre feet, respectively).

Santa Clara River (S29)

The rainfall total during 2012-13Event18 (0.83 inches) was more than four times higher than rainfall totals during the other three monitored wet weather events, 2012-13Event08, 2012-13Event15, and 2012-13Event17 (0.20, 0.14, and 0.12 inches, respectively). Loads for *E. coli*, nutrients, metals, TSS, TDS, and TPH were all much greater during 2012-13Event18. First flush loading signatures were not observed at Santa Clara MES. However, wet weather monitoring did not begin at Santa Clara River MES until the third storm event of the season.

Dry weather loads were relatively similar for nutrients, TDS, TPH, dissolved chromium, and copper between the two dry weather events (2012-13Event03 and 2012-13Event20). TSS loads were approximately 15 times greater during the first dry weather event (2012-13event03) than during the second dry weather event (2012-13Event20), and zinc loads were approximately five times greater during the first dry weather event. *E. coli* loads were approximately three times higher during the second dry weather event compared to the first dry weather event. Event volumes for both dry weather events were similar (1.0 and 1.1 acre feet, respectively).

4.3.3 Total Suspended Solids Trend Analysis

TSS concentrations from 2000 to 2013 were evaluated for normality and log-normal distributions separately for wet and dry weather at each MES. If the TSS concentrations were normal or log-normally distributed, then a regression analysis was used to evaluate trends. Multiple samples during each monitoring year 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 of the MES over the past 13 years. The data are shown graphically in Figures 4-13.1 through 4-13.4.

No significant trends for TSS were identified for wet weather, based on an alpha of 0.05. The TSS trend analysis of dry weather data identified one significant trend (based on an alpha of 0.05), an increasing trend in TSS at Santa Clara River MES (Table 4-11).

Trend Analysis of Wet Weather Total Suspended Solids Concentrations at Mass Emission Stations from 2000–2013

Station	p-value	Method	Trend
Ballona Creek at Sawtelle (S01)	0.066	Mann-Kendall	Not significant
Malibu Creek at Piuma (S02)	0.072	Regression	Not significant
Los Angeles River at Wardlow (S10)	0.465	Regression	Not significant
Coyote Creek at Spring (S13)	0.245	Mann-Kendall	Not significant
San Gabriel River (S14)	0.100	Regression	Not significant
Dominguez Channel at Artesia (S28)	0.392	Mann-Kendall	Not significant
Santa Clara River (S29)	0.057	Mann-Kendall	Not significant

Trend Analysis of Dry Weather Total Suspended Solids Concentrations at Mass Emission Stations from 2000–2013

Station	p-value	Method	Trend
Ballona Creek at Sawtelle (S01)	0.700	Regression	Not significant
Malibu Creek at Piuma (S02)	0.080	Regression	Not significant
Los Angeles River at Wardlow (S10)	0.936	Regression	Not significant
Coyote Creek at Spring (S13)	0.422	Regression	Not significant
San Gabriel River (S14)	0.364	Regression	Not significant
Dominguez Channel at Artesia (S28)	0.456	Regression	Not significant
Santa Clara River (S29)	**0.028**	Mann-Kendall	Significant Increasing

4.3.4 Water Column Toxicity Analysis

Water column toxicity monitoring was performed at all MES in accordance with the Municipal Stormwater Permit. 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 dry weather samples could not be collected due to absence of flow. Wet weather samples were collected during the first rain event of the season on October 11, 2012 (2012–13Event04) for Los Angeles River (S10), San Gabriel River (S14), and Dominguez Channel (S28) and on November 30, 2012 (2012-13Event06) for Ballona Creek (S01), Malibu Creek (S02), and Coyote Creek (S13). The second wet weather samples were collected on December 13, 2012 (2012–13Event08) at all MES except Malibu Creek and on January 24, 2013 (2012-13Event14) at Malibu Creek. Dry weather samples were collected on October 9, 2012 (2012–13Event03) and April 8, 2013 (2012–13Event20) for all MES except San Gabriel River, due to dry conditions (no flow). 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, and the sea urchin, *Strongylocentrotus purpuratus*, was used in chronic fertilization bioassays.

4.3.4.1 Toxicity Results – Wet Weather

Bioassay tests exposing *C. dubia* to wet weather effluent samples from each of the seven MES indicated that toxicity to *C. dubia* survival was observed in wet weather samples collected from Ballona Creek and San Gabriel River during one event and from Los Angeles River during both events. No toxicity to *C. dubia* survival was observed at the remaining MES locations.

At Ballona Creek during 2012-13Event08, the concentration resulting in a 25% reduction in survival (LC_{25}) was 95.8%, indicating that at 95.8% concentration, a 25% reduction in survival was observed. The concentration resulting in a 50% reduction in survival (LC_{50}) was greater than 100%, the no-observed-effect concentration (NOEC) was 100%, and the toxicity unit (TU) was less than 1. A TU is defined in the NPDES Municipal Permit as 100 divided by the calculated median test response (e.g., LC_{50}). A TU value greater than or equal to 1 is considered substantially toxic and requires a Phase I TIE. Therefore, a TIE was not necessary.

At San Gabriel River during 2012-13Event04, the IC_{25}, IC_{50}, and NOEC were 50%, 85.7%, and 50.0% and the TU was greater than 1. The initial component of the TIE process is to conduct a "baseline" test to determine the final TIE test dilutions. The baseline test conducted on this sample resulted in a NOEC of 100% and a TU less than 1. The initial toxicity may have been caused by volatile compounds that dissipated to non-toxic levels prior to the baseline TIE. Therefore, the TIE was not initiated.

At Los Angeles River during 2012-13Event04, the LC_{25} and LC_{50} were 35.7 and greater than 100%, respectively. The NOEC was 100% and the TU was less than 1. Therefore, a TIE was not necessary. At Los Angeles River during 2012-13Event08, the LC_{25} and LC_{50} were 53.3 and greater than 100%, respectively. The NOEC was 100% and the TU was less than 1. Therefore, a TIE was not necessary.

Toxicity to *C. dubia* reproduction was observed in wet weather samples collected from Ballona Creek, Coyote Creek, San Gabriel River, and Dominguez Channel during one event and from Los Angeles River during both events. No toxicity to *C. dubia* reproduction was observed at the other MES locations. At Ballona Creek during 2012-13Event08, the concentration resulting in a 25% inhibition (IC_{25}) in the selected sublethal effect (e.g. reproduction) was 80.7%. The concentration resulting in a 50% inhibition of reproduction (IC_{50}) was greater than 100%, the NOEC was 100%, and the TU was less than 1. Therefore, a TIE was not necessary. At Coyote Creek during 2012-13Event06, the IC_{25} and IC_{50} were 11.99% and greater than 100%, respectively. The NOEC was 100% and the TU was less than 1. Therefore, a TIE was not necessary. At San Gabriel River during 2012-13Event04, the IC_{25} and IC_{50} were 36.1% and 51.4%, respectively. The NOEC was 100% and the TU was greater than 1. The baseline test conducted on this sample prior to the TIE resulted in a NOEC of 100% and a TU less than 1. The initial toxicity may have been caused by volatile compounds that dissipated to non-toxic levels prior to the baseline TIE. Therefore, the TIE was not initiated. At Dominguez Channel during 2012-13Event08, the IC_{25} and IC_{50} were 81.7% and greater than 100%, respectively. The NOEC was 100% and the TU was less than 1. Therefore, a TIE was not necessary. At Los Angeles River during 2012-13Event04, the IC_{25} and IC_{50} were 41.3% and greater than 100%, respectively. The NOEC was 100% and the TU was less than 1. Therefore, a TIE was not necessary. At Los Angeles River during 2012-13Event04, the IC_{25} and IC_{50} were 46.2% and greater than 100%, respectively. The NOEC was 100% and the TU was less than 1. Therefore, a TIE was not necessary.

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 IC_{25} and IC_{50} values were greater than 100% test substance, the NOEC values were 100% test substance, and the TUs were less than 1.

4.3.4.2 Toxicity Results – Dry Weather

No dry weather samples were collected at San Gabriel River (S14) due to dry conditions (no flow). Bioassay tests exposing *C. dubia* to dry weather effluent samples from each of the other six MES indicated that slight toxicity to *C. dubia* survival was observed in dry weather samples collected from Ballona Creek and Los Angeles River. At Ballona Creek during 2012-2013Event03, the IC_{25} value was 96.88, indicating that at 96.88% concentration, a 25% reduction in survival was observed. The IC_{50} value was greater than 100%, the NOEC was greater than 100%, and the TU was calculated to be less than 1. Therefore, a TIE was not necessary. At Los Angeles River during 2013-14Event03, the IC_{25} value was 84.38, indicating that at 84.38% concentration, a 25% reduction in survival was observed. The IC_{50} value was greater than 100%, the NOEC was greater than 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 of the six MES indicated that no toxicity to *S. purpuratus* fertilization was observed in any of the test samples. The IC_{25} and IC_{50} values were greater than 100% test substance and TUs were <1 for each of the MES.

4.3.5 Trash Monitoring Analysis

The Municipal Stormwater Permit requires a minimum of one photograph at each MES after the first storm event and three additional storm events per year. During the 2012-2013 monitoring season, 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, which was not monitored during the first 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.

4.3.6 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.

4.3.6.1 Indicator Bacteria

Multiple studies have found urban runoff to be a source of indicator bacteria in the 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* (Los Angeles Regional Water Quality Control Board (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 the most commonly employed BMPs may not capture the majority of the bacterial contaminant load because of the association of bacteria with small particle size.

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 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.

4.3.6.2 Copper, Lead, and Zinc

According to the report *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.

4.3.6.3 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.

4.3.6.4 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 in the 2012-2013 monitoring year were above the water quality objective range (slightly basic) and two were 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. 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 at night, as a result of increased production of carbon dioxide as algae respire at night.

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 two low pH values observed during wet weather.

4.3.6.5 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.

4.4 Recommendations

The LARWQCB adopted a new NPDES MS4 Permit (Order R4-2012-0175) on November 8, 2012. Recommendations are not included in the *2012-2013 Annual Stormwater Monitoring Report* due to adoption of the new permit and the development of new monitoring and reporting programs that will be created in accordance with the new permit requirements.

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