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 2010-2011 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 2010-2011 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 2010-2011 storm season and the long-term pattern of rainfall observed in downtown Los Angeles at Station 716, Ducommun Street. During the 2010-2011 storm season, rainfall in October and November was approximately the same as the average rainfall. Rainfall was over three times greater than average in December of 2010. January was drier than average and rainfall in February, March, and May 2011 was approximately the same as the average for these months in this location. There was no rainfall in April 2011. In general, the seasonal pattern of rainfall was consistent with historical records, with the highest rainfall occurring from December 2010 through March 2011.
2. Figure 4-2 illustrates that the total annual rainfall during the 2010-2011 storm season in downtown Los Angeles was 17.66 inches. Annual rainfall for this monitoring season was approximately 13% higher than the 139-year average annual rainfall of 15.6 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 2010-2011 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. In most cases, 100% of the monitored storms were captured, 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 4-2.1 and 4-2.2, 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. 24-hour composite samples were used for dry weather analyses. Comparisons to acute water quality objectives were made for all samples except for those collected during storm water monitoring 2010-11Event08 which was conducted over a four day period, and therefore the chronic water quality objectives were used in the analysis.

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 upon temperature and pH and were calculated using measured pH and Table 3-1 (COLD) and Table 3-2 (WARM) of the Basin Plan, assuming a temperature of 25 °C (for COLD) and 20 °C (for WARM). 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 only applicable to event 2010-11Event08. Therefore, chronic objectives are used for comparison of monitoring data to water quality objectives only for 2010-11Event08.

Some constituents have water quality objectives based on municipal water supply (MUN), which is a conditional beneficial use in all monitored watersheds. For this reason, the water quality objectives applicable to MUN were not used to compare against monitoring results from stormwater and urban runoff discharges.

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
DO	mg/L	Basin Plan	5	5	5	5	5	5	5
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
Fecal coliforms	MPN/ 100mL	Basin Plan	4,000	400	400	400	400	4,000	400
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	NA	0.73	0.73

MPN = most probable number.
NA = not applicable.

Acute Water Quality Standards at Tributary Stations

Constituent	Units	Water Quality Objective Source	Station ID					
			TS19	TS20	TS21	TS22	TS23	TS24
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	NA	NA	NA	NA	NA	NA
Cyanide	mg/L	CTR	0.022	0.022	0.022	0.022	0.022	0.022
Dieldrin	µg/L	CTR	0.24	0.25	0.24	0.24	0.24	0.24
Dissolved arsenic	µg/L	CTR	340	340	340	340	340	340
DO	mg/L	Basin Plan	5	5	5	5	5	5
alpha-Endolsulfan	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
Fecal coliforms	MPN/100mL	Basin Plan	4,000	4,000	4,000	4,000	4,000	4,000
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	NA	NA	NA	NA	NA	NA
Total Dissolved Solids (TDS)	mg/L	Basin Plan	NA	NA	NA	NA	NA	NA
Toxaphene	µg/L	CTR	0.73	0.73	0.73	0.73	0.73	0.73

MPN = most probable number.
NA = not applicable.

Chronic Water Quality Standards at MES Stations

Constituent	Units	Water Quality Objective Source	Station ID						
			S01	S02	S10	S13	S14	S28	S29
4-4'-DDT	µg/L	CTR	0.001	0.001	0.001	0.001	0.001	0.001	0.001
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	5	5	5	5	5	5
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
Fecal coliforms	MPN/ 100mL	Basin Plan	4,000	400	400	400	400	4,000	400
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

Chronic Water Quality Standards at Tributary Stations

Constituent	Units	Water Quality Objective Source	Station ID					
			TS19	TS20	TS21	TS22	TS23	TS24
4-4'-DDT	µg/L	CTR	0.001	0.001	0.001	0.001	0.001	0.001
Chloride	mg/L	Basin Plan	NA	NA	NA	NA	NA	NA
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
alpha-Endolsulfan	µg/L	CTR	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056
beta-Endosulfan	µg/L	CTR	0.0056	0.0056	0.0056	0.0056	0.0056	0.0056
Endrin	µg/L	CTR	0.036	0.036	0.036	0.036	0.036	0.036
Fecal coliforms	MPN/100mL	Basin Plan	4,000	4,000	4,000	4,000	4,000	4,000
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	NA	NA	NA	NA	NA	NA
Selenium, Total	µg/L	CTR	5	5	5	5	5	5
Total Dissolved Solids (TDS)	mg/L	Basin Plan	NA	NA	NA	NA	NA	NA
Toxaphene	µg/L	CTR	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002

This subsection summarizes the constituents that did not meet applicable water quality objectives at MES sampled during the 2010-2011 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.

A suspension of the fecal coliform water quality objective 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 on the amendment can be found at the State Water Resources Control Board (SWRCB) website (SWRCB, 2003).

The storm events for which the suspension applied in 2010-2011 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 fecal coliform water quality objective were not highlighted for these events.

When water quality objectives were not met, qualifiers provided by the analytical laboratory are identified. The following laboratory analytical qualifiers are noted on data review:

- Detected not quantified (DNQ).
- Not detected (ND).
- Quantity not sufficient (QNS).

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). Results reported with the qualifier of QNS indicate that the sample volume was not of sufficient size to complete the analysis. 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 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 recreational (REC) beneficial use designation at each station. The REC-1 water quality objective (water contact recreation – full immersion) for fecal coliforms is 400 most probable number (MPN)/100 mL and the REC-2 water quality objective (non-contact recreation) is 4,000 MPN/100 mL. The recreational beneficial use varies by station among the watersheds monitored, as summarized in the table below.

Summary of REC-1 and REC-2 Beneficial Uses and Applicable Fecal Coliform Water Quality Objectives

Station ID	Station Name	High Flow Suspension	REC-1	REC-2	Applicable Fecal Coliform WQO (MPN/100 mL)
S01	Ballona Creek	X		X	4,000
S02	Malibu Creek		X		400
S10	Los Angeles River	X	X		400
S13	Coyote Creek	X	X		400
S14	San Gabriel River	X	X		400
S28	Dominguez Channel	X		X	4,000
S29	Santa Clara River		X		400
TS19	Project No. 1232	X		X	4,000
TS20	PD 669	X		X	4,000
TS21	Project Nos. 5246 & 74	X		X	4,000
TS22	PD 21 – Holly Park Drain	X		X	4,000
TS23	D.D.I. 8	X		X	4,000
TS24	Dominguez Channel at 116th St.	X		X	4,000

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 2010-2011 Wet Weather Monitoring Season is presented in Table 4-4.1 and Figure 4-3.1.

During wet weather high-flow periods, Ballona Creek is subject to a suspension of the REC-2 beneficial use (i.e., non-contact recreation). Due to this suspension, fecal coliform concentrations above 4,000 MPN/100 mL are not highlighted for events 2010-11Event03 and 2010-11Event8. Based on this assessment, the fecal coliform WQO for REC-2 beneficial uses was not met during three of the five events.

Dissolved zinc concentrations were above the hardness-based water quality objective for three of the four wet weather samples collected at Ballona Creek (Figure 4-3.1). Dissolved zinc concentrations at Ballona Creek varied widely, ranging from 0.5-199 µg/L, whereas hardness values varied moderately, from 45 – 375 mg/L.

The pH value was not within the water quality objective range of 6.5-8.5 pH units for one of the four wet weather samples collected at Ballona Creek (Table 4-4.1). The water sample collected during 2010-11Event03 had a pH value of 8.79, which was slightly above the water quality objective of between 6.5 and 8.5 pH units. The measured pH was slightly acidic during the other three storm events, ranging from 6.75–6.94 pH units.

All other applicable water quality objectives in Ballona Creek were met during the 2010-2011 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 2010–2011 Wet Weather Monitoring Season is presented in Table 4-4.2 and Figure 4-3.2.

Fecal coliform bacteria concentrations were above the applicable water quality objective (i.e., 400 MPN/100 mL) during three of the five sampled storm events in Malibu Creek (Figure 4-3.2). Malibu Creek is not subject to the wet weather suspension of the REC-1 beneficial use.

Cyanide did not meet the water quality objective of 0.022 mg/L in one of the five wet weather events sampled in Malibu Creek (Figure 4-3.2). Cyanide ranged from 0.0025 - 0.042 mg/L over the five storm events and was measured above the water quality objective during 2010-2011Event03.

The value for pH was not within the water quality objective range for one of the four wet weather samples collected (Table 4-4.2). The range for pH varied from 6.48-8.16 with the one exceedance occurring during 2010-2011Event03.

Sulfate did not meet the watershed-specific water quality objective of 500 mg/L in three of the four wet weather samples collected in Malibu Creek (Figure 4-3.2). Sulfate ranged from 244–880 mg/L over the four storm events.

All other applicable water quality objectives in Malibu Creek were met during the 2010-2011 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 2010-2011 Wet Weather Monitoring Season is presented in Table 4-4.3 and Figure 4-3.3.

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). Due to this suspension, fecal coliform concentrations above 400 MPN/100 mL are not highlighted for 2010-2011Event08. Based on this assessment, four of the five wet weather events did not meet the fecal coliform water quality objective (Figure 4-3.3).

The value for pH was not within the water quality objective range of 6.5–8.5 pH units for one of the four wet weather samples at Los Angeles River (Table 4-4.3). The water sample collected during 2010-2011Event08 had a pH value of 6.23, which was slightly outside of the water quality objective range.

Cyanide exceeded the water quality objective for one of the five sampled storms (Figure 4-3.3). Cyanide ranged from 0.0025-0.036 mg/L over the five storm events and was measured above the water quality objective during 2010-11Event03.

Dissolved zinc concentrations were above the hardness-based water quality objective for all four wet weather samples (Figure 4-3.3). Dissolved zinc concentrations at Los Angeles River ranged from 12 -346 μg/L. Hardness values ranged from 45-140 mg/L.

All other applicable water quality objectives in Los Angeles River were met during the 2010-2011 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 2010-2011 Wet Weather Monitoring Season is presented in Table 4-4.4 and Figure 4-3.4.

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). Due to this suspension, fecal coliform concentrations above 400 MPN/100 mL are not highlighted for event 2010-11Event08. Based on this assessment, fecal coliform exceeded the water quality objective in four of the five monitored wet weather events (Figure 4-3.4).

The value for pH was not within the water quality objective range of 6.5–8.5 pH units for two of the four samples at Coyote Creek (Figure 4-3.4). The water samples collected during 2010-11Event08 and 2010-11Event14 had a pH value of 6.34 and 6.41 respectively, which were slightly outside of the water quality objective range.

The dissolved zinc concentration was above the hardness-based water quality objective for all four wet weather samples collected at Coyote Creek (Figure 4-3.4). Dissolved zinc concentrations varied moderately, ranging from 115-500 μg/L, whereas hardness ranged from 50-170 mg/L.

All other applicable water quality objectives in Coyote Creek were met during the 2010-2011 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 2010-2011 Wet Weather Monitoring Season is presented in Table 4-4.5 and Figure 4-3.5. Samples were not collected at San Gabriel River MES during 2010-11Event03 due to lack of flow.

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). Due to this suspension, fecal coliform concentrations above 400 MPN/100 mL are not highlighted for events 2010-11Event06, 2010-11Event08, and 2010-11Event14. Based on this assessment, one of the four wet weather events exceeded the fecal coliform water quality objective, 2010-2011Event04.

The value for pH was not within the water quality objective range of 6.5–8.5 pH units for two of the three samples at San Gabriel River. The water samples collected during 2010-11Event08 and 2010-11Event14 had a pH value of 6.34 and 6.48 respectively, which were slightly outside of the water quality objective range.

All other applicable water quality objectives in San Gabriel River were met during the 2010-2011 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 2010-2011 Wet Weather Monitoring Season is presented in Table 4-4.6 and Figure 4-3.6.

During wet weather high-flow periods, Dominguez Channel is subject to a suspension of the REC-2 beneficial use (i.e., non-contact recreation). Due to this suspension, fecal coliform concentrations above 4,000 MPN/100 mL are not highlighted for event 2010-11Event08. Based on this assessment, four of the five wet weather events exceeded the fecal coliform water quality objective.

The dissolved copper concentration was above the hardness-based water quality objective for two of the four wet weather samples at Dominguez Channel (Figure 4-3.6). Dissolved copper concentrations ranged from 0.25-76.2 μg/L, whereas hardness ranged from 30-115 mg/L.

The dissolved zinc concentration was above the hardness-based water quality objective for three of the four wet weather samples at Dominguez Channel (Figure 4-3.6). Dissolved zinc concentrations ranged from 118-492 μg/L.

All other applicable water quality objectives in Dominguez Channel were met during the 2010-2011 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 2010-2011 Wet Weather Monitoring Season is presented in Table 4-4.7 and Figure 4-3.7.

Fecal coliform bacteria concentrations were above the applicable water quality objective (i.e., 400 MPN/100 mL) during each of the five sampled storm events in Santa Clara River (Figure 4-3.7). Santa Clara River is not subject to the wet weather suspension of the REC-1 beneficial use.

The pH value was not within the water quality objective range of 6.5–8.5 pH units for one of the four samples at Santa Clara River. The water sample collected during 2010-11Event14 had a pH value of 6.21, which was outside of the water quality objective range.

The dissolved zinc concentration was above the hardness-based water quality objective during one of the four monitored wet weather storm events at Santa Clara River (Figure 4-3.7). Dissolved zinc concentrations during 2010-11Event14 were 173 µg/L.

All other applicable water quality objectives in Santa Clara River were met during the 2010-2011 Wet Weather Monitoring Season.

4.2.3 Tributary Stations During Wet Weather

4.2.3.1 Project No. 1232 (TS19)

A summary of the constituents that did not meet applicable water quality objectives at the Project No. 1232 Tributary Station (TS19) during the 2010-2011 Wet Weather Monitoring Season is presented in Table 4-5.1 and Figure 4-4.1.

During wet weather high-flow periods, Dominguez Channel tributaries are subject to a suspension of the REC-2 beneficial use (i.e., non-contact water recreation) in accordance with the “tributary rule” of the Basin Plan. Due to this suspension, fecal coliform concentrations above 4,000 MPN/100 mL are not highlighted for events 2010-11Event08 and 2010-11Event15. Based on this assessment, four of the six wet weather events exceeded the fecal coliform water quality objective.

Cyanide did not meet the water quality objective of 0.022 mg/L in one of the six wet weather events sampled in Project No. 1232. Cyanide ranged from 0.0025 - 0.07 mg/L over the six storm events and was measured above the water quality objective during 2010-11Event06.

The pH value was not within the water quality objective range of 6.5–8.5 pH units for three of five wet weather samples at Project No. 1232 (Table 4-5.1). The water samples collected during 2010–11Event08, 2010-11Event14, and 2010-11Event15 had pH values slightly below the lower limit of the water quality objective range.

The dissolved copper concentration was above the hardness-based water quality objective for one of the five wet weather samples at Project No. 1232 (Figure 4-4.1), event 2010-11Event03. Dissolved copper concentrations ranged from 0.25-51.9 µg/L, and hardness ranged from 30-165 mg/L. Dissolved copper concentrations at Project No. 1232 were comparable to those measured in Dominguez Channel.

The dissolved lead concentration was above the hardness-based water quality objective for three of the five wet weather samples at Project No. 1232 (Figure 4-4.1). Dissolved lead concentrations ranged from 8.04-46.1 µg/L.

The dissolved zinc concentration was above the hardness-based water quality objective for all five wet weather samples at Project No. 1232 (Figure 4-4.1). Dissolved zinc concentrations ranged from 150-745 µg/L. Dissolved zinc concentrations at Project No. 1232 were comparable to those measured in Dominguez Channel.

All other applicable water quality objectives at Project No. 1232 were met during the 2010-2011 Wet Weather Monitoring Season.

4.2.3.2 **PD 669 (TS20)**

A summary of the constituents that did not meet applicable water quality objectives at the PD 669 Tributary Station (TS20) during the 2010-2011 Wet Weather Monitoring Season is presented in Table 4-5.2 and Figure 4-4.2.

During wet weather high-flow periods, Dominguez Channel tributaries are subject to a suspension of the REC-2 beneficial use (i.e., non-contact water recreation) in accordance with the "tributary rule" of the Basin Plan. Due to this suspension, fecal coliform concentrations above 4,000 MPN/100 mL are not highlighted for event 2010-11Event08 and 2010-11Event15. Based on this assessment, four of the six wet weather events exceeded the fecal coliform water quality objective.

Cyanide did not meet the water quality objective of 0.022 mg/L in one of the six wet weather events sampled at PD 669. Cyanide ranged from 0.0025 - 0.036 mg/L over the six storm events and was measured above the water quality objective during 2010-11Event06.

The value for pH was not within the water quality objective range of 6.5–8.5 pH units for four of five wet weather samples at PD 669 (Table 4-5.2). pH values ranged from 6.1-8.56 pH units.

The dissolved copper concentration was above the hardness-based water quality objective for one of the five wet weather samples at PD 669 (Figure 4-4.2). Dissolved copper concentrations ranged from 0.25-68.1 μg/L, and hardness ranged from 60-330 mg/L. Generally, dissolved copper concentrations at PD 669 were consistent with those measured in Dominguez Channel.

The dissolved zinc concentration was above the hardness-based water quality objective for three of the five wet weather samples at PD 669 (Figure 4-4.2). Dissolved zinc concentrations ranged from 76.4-870 μg/L.

4.2.3.3 **Project Nos. 5246 & 74 (TS21)**

A summary of the constituents that did not meet applicable water quality objectives at the Project Nos. 5246 and 74 Tributary Station (TS21) during the 2010-2011 Wet Weather Monitoring Season is presented in Table 4-5.3 and Figure 4-4.3.

During wet weather high-flow periods, Dominguez Channel tributaries are subject to a suspension of the REC-2 beneficial use (i.e., non-contact water recreation) in accordance with the "tributary rule" of the Basin Plan. Due to this suspension, fecal coliform concentrations above 4,000 MPN/100 mL are not highlighted for events 2010-11Event08 and 2010-11Event15. Based on this assessment, four of the six wet weather events exceeded the fecal coliform water quality objective.

The dissolved copper concentration was above the hardness-based water quality objective for one of the five wet weather samples at Project Nos. 5246 and 74 (Figure 4-4.3), 2010-11Event03. Dissolved copper concentrations ranged from 0.25-71.1 μg/L, and hardness ranged from 30-150 mg/L. Dissolved copper concentrations at Project Nos. 5246 and 74 were comparable to those measured in Dominguez Channel.

The dissolved lead concentration was above the hardness-based water quality objective for one of the five wet weather samples (Figure 4-4.3). Dissolved lead concentrations ranged from 7.95-56.5 μg/L.

The dissolved zinc concentration was above the hardness-based water quality objective for all five wet weather samples at Project Nos. 5246 and 74 (Figure 4-4.3). Dissolved zinc concentrations ranged from 144-815 μg/L. Generally, dissolved zinc concentrations were comparable to those measured in Dominguez Channel, with the exception of the highest level of 815 mg/L detected during event 2010-11Event03.

The pH value was not within the water quality objective range of 6.5–8.5 pH units for two of five wet weather samples at Project Nos. 5246 and 74 (Table 4-5.3). The water sample collected during events 2010-11Event14 and 2010-11Event15 had pH values of 6.41 and 6.16, which were below the lower limit of the water quality objective range.

Dissolved oxygen levels were below the water quality objective of 5 mg/L for one of six wet weather samples at Project Nos. 5246 and 74 (Table 4-5.3), during event 2010-11Event06.

All other applicable water quality objectives at Project Nos. 5246 and 74 were met during the 2010-2011 Wet Weather Monitoring Season.

4.2.3.4 ***PD 21-Hollypark Drain (TS22)***

A summary of the constituents that did not meet applicable water quality objectives at the PD 21-Hollypark Drain Tributary Station (TS22) during the 2010-2011 Wet Weather Monitoring Season is presented in Table 4-5.4 and Figure 4-4.4.

During wet weather high-flow periods, Dominguez Channel tributaries are subject to a suspension of the REC-2 beneficial use (i.e., non-contact water recreation) in accordance with the "tributary rule" of the Basin Plan. Due to this suspension, fecal coliform concentrations above 4,000 MPN/100 mL are not highlighted for events 2010-11Event08 and 2010-11Event15. Based on this assessment, three of the six wet weather events exceeded the fecal coliform water quality objective.

The dissolved copper concentration was above the hardness-based water quality objective for one of the five wet weather samples at PD 21-Hollypark Drain (Figure 4-4.4), during event 2010-11Event03. Dissolved copper concentrations ranged from 0.25-54.1 μg/L. Hardness ranged from 30-105 mg/L. Dissolved copper concentrations at PD 21-Hollypark Drain were somewhat lower than those measured in Dominguez Channel.

The dissolved lead concentration was above the hardness-based water quality objective for one of the five wet weather samples (Figure 4-4.3). Dissolved lead concentrations ranged from 0.1-47.6 μg/L.

The dissolved zinc concentration was above the hardness-based water quality objective for four of the five wet weather samples at PD 21-Hollypark Drain (Figure 4-4.4). Dissolved zinc concentrations ranged from 53.1-640 µg/L. Generally, dissolved zinc concentrations at PD 21-Hollypark Drain were similar to those measured in Dominguez Channel.

The value for pH was not within the water quality objective range of 6.5–8.5 pH units during three of five monitored storm events at PD 21-Hollypark Drain (Table 4-5.4). The water samples collected during 2010-11Event03, 2010-11Event08, and 2010-11Event14 were below the lower limit of the water quality objective range.

All other applicable water quality objectives at PD 21-Hollypark Drain were met during the 2010-2011 Wet Weather Monitoring Season.

4.2.3.5 ***D.D.I. 8 (TS23)***

A summary of the constituents that did not meet applicable water quality objectives at the D.D.I. 8 Tributary Station (TS23) during the 2010-2011 Wet Weather Monitoring Season is presented in Table 4-5.5 and Figure 4-4.5.

During wet weather high-flow periods, Dominguez Channel tributaries are subject to a suspension of the REC-2 beneficial use (i.e., non-contact water recreation) in accordance with the “tributary rule” of the Basin Plan. Due to this suspension, fecal coliform concentrations above 4,000 MPN/100 mL are not highlighted for events 210-11Event08 and 2010-11Event15. Based on this assessment, three of the six wet weather events exceeded the fecal coliform water quality objective.

The dissolved copper concentration was above the hardness-based water quality objective for one of the five wet weather samples at D.D.I. 8 (Figure 4-4.5). The dissolved copper concentration during event 2010-11Event03 was 76.9 µg/L and hardness ranged from 20 –85 mg/L. Dissolved copper concentrations at D.D.I. 8 were similar to those measured in Dominguez Channel.

The dissolved lead concentration was above the hardness-based water quality objective for one of the five wet weather samples at D.D.I. 8 (Figure 4-4.5), during event 2010-11Event03. Dissolved lead concentrations ranged from 6.16-43 µg/L.

The dissolved zinc concentration was above the hardness-based water quality objective during each of the five monitored wet weather storm events at D.D.I. 8 (Figure 4-4.5). Dissolved zinc concentrations ranged from 98.5-515 µg/L. Generally, dissolved zinc concentrations at D.D.I. 8 were similar to those measured in Dominguez Channel.

The pH value was not within the water quality objective range of 6.5–8.5 pH units for two of five wet weather samples at D.D.I. 8 (Table 4-5.5). The water sample collected during 2010-11Event06 had a pH value of 9.29, which is above the upper limit of the water quality objective range. The water sample collected during 2010-11Event15 had a pH value of 6.27, which is below the lower limit of the water quality objective range.

All other applicable water quality objectives at D.D.I. 8 were met during the 2010-2011 Wet Weather Monitoring Season.

4.2.3.6 Dominguez Channel at 116th Street (TS24)

A summary of the constituents that did not meet applicable water quality objectives at the Dominguez Channel at 116th Street Tributary Station (TS24) during the 2010-2011 Wet Weather Monitoring Season is presented in Table 4-5.6 and Figure 4-4.6.

During wet weather high-flow periods, Dominguez Channel tributaries are subject to a suspension of the REC-2 beneficial use (i.e., non-contact water recreation) in accordance with the “tributary rule” of the Basin Plan. Due to this suspension, fecal coliform concentrations above 4,000 MPN/100 mL are not highlighted for events 2010-11Event08 and 2010-11Event15. Based on this assessment, two of the six wet weather events exceeded the fecal coliform water quality objective.

The dissolved copper concentration was above the hardness-based water quality objective for three of the five wet weather samples at Dominguez Channel at 116th Street (Figure 4-4.6). Dissolved copper concentrations ranged from 0.25-53.9 μg/L, and hardness ranged from 25-100 mg/L. Dissolved copper concentrations at Dominguez Channel at 116th Street were similar to those measured in Dominguez Channel.

The dissolved zinc concentration was above the hardness-based water quality objective during each of the five monitored wet weather storm events at Dominguez Channel at 116th Street (Figure 4-4.6). Dissolved zinc concentrations ranged from 204-372 μg/L. Generally, dissolved zinc concentrations at Dominguez Channel at 116th Street were similar to those measured in Dominguez Channel.

The pH value was not within the water quality objective range of 6.5–8.5 pH units during one of five monitored storm events at the Dominguez Channel at 116th Street Tributary Station (Table 4-5.6). The water sample collected during 2010-11Event15 had a pH value of 6.24, which is below the lower limit of the water quality objective range.

All other applicable water quality objectives at Dominguez Channel at 116th Street were met during the 2010-2011 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 2010-2011 Dry Weather Monitoring Season is presented in Table 4-4.1 and Figure 4-5.1

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 monitoring events at Ballona Creek (Figure 4-5.1). The water samples collected during 2010-11Event02 had pH values of 8.6, which is slightly above the water quality objective range.

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 2010-2011 Dry Weather Monitoring Season is presented in Table 4-4.2 and Figure 4-5.2.

Fecal coliform bacteria concentrations were above the applicable water quality objective (i.e., 400 MPN/100 mL) for one of the two dry weather sampling events in Malibu Creek (Figure 4-5.2). The fecal coliform concentration for 2010-11Event02 was 5,000 MPN/100 mL.

Sulfate concentrations did not meet the water quality objective during one of the two monitored dry weather events in Malibu Creek (Figure 4-5.2). The sulfate concentration of 800 mg/L during 2010-11Event02 was above the 500 mg/L water quality objective.

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 2010-2011 Dry Weather Monitoring Season is presented in Table 4-4.3 and Figure 4-5.3.

Fecal coliform bacteria concentrations were above the applicable water quality objective (i.e., 400 MPN/100 mL) for one of the two dry weather sampling events at Los Angeles River (Figure 4-5.3). The fecal coliform concentration for 2010-11Event02 was 300,000 MPN/100 mL.

The pH value was not within the water quality objective range of 6.5–8.5 pH units during each of the two dry weather monitoring events at Los Angeles River (Table 4-5.3). The water samples collected for 2010-11Event02 and 2010-11Event13 had pH values of 8.97 and 8.65, respectively, which were above the water quality objective range.

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 2010-2011 Dry Weather Monitoring Season is presented in Table 4-4.4 and Figure 4-5.4.

Fecal coliform bacteria concentrations were above the applicable water quality objective (i.e., 400 MPN/100 mL) during one of the two dry weather sampling events in Coyote Creek (Figure 4-5.4). Fecal coliform concentrations ranged from 230-16,000 MPN/100 mL.

4.2.4.5 San Gabriel River (S14)

All applicable water quality objectives at San Gabriel River MES were met during the 2010-2011 Dry Weather Monitoring Season.

4.2.4.6 Dominguez Channel (S28)

A summary of constituents that did not meet applicable water quality objectives at the Dominguez Channel MES during the 2010-2011 Dry Weather Monitoring Season is presented in Table 4-4.6 and Figure 4-5.6.

The fecal coliform bacteria concentration was above the applicable water quality objective (i.e., 4000 MPN/100 mL) during one of the two dry weather sampling events in Dominguez Channel (Figure 4-5.6), during event 2010-11Event02. Fecal coliform concentrations ranged from 40-240,000 MPN/100 mL over the two events.

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 monitoring events at Dominguez Channel (Table 4-4.6), during event 2010-11Event02. The water samples collected during both events were slightly basic with the pH values ranging from 8.41-8.89 over the two events.

4.2.4.7 *Santa Clara River (S29)*

All applicable water quality objectives at the Santa Clara River MES were met during the 2010-2011 Dry Weather Monitoring Season.

4.2.5 Tributary Stations during Dry Weather

4.2.5.1 *Project No. 1232 (TS19)*

A summary of the constituents that did not meet applicable water quality objectives at Project No. 1232 Tributary Station (TS24) during the 2010-2011 Dry Weather Monitoring Season is presented in Table 4-5.1 and Figure 4-6.1.

The fecal coliform bacteria concentration was above the applicable water quality objective (i.e., 4,000 MPN/100 mL) during one of the two dry weather sampling events in Project No. 1232 (Figure 4-6.1). Fecal coliform concentrations ranged from 500-5000 MPN/100 mL over the two events.

The pH value was not within the water quality objective range of 6.5–8.5 pH units during each of the two dry weather monitoring events at Project No. 1232 (Table 4-5.1). The water samples collected during both events had a pH value of 8.59, which is slightly outside of the water quality objective range.

4.2.5.2 *PD 669 (TS20)*

A summary of the constituents that did not meet applicable water quality objectives at PD 669 Tributary Station (TS24) during the 2010-2011 Dry Weather Monitoring Season is presented in Table 4-5.2 and Figure 4-6.2.

The fecal coliform bacteria concentration was above the applicable water quality objective (i.e., 4,000 MPN/100 mL) during one of the two sampled events in PD 669 (Figure 4-6.2). Fecal coliform concentrations ranged from 1,300-30,000 MPN/100 mL over the two events with the exceedance occurring during event 2010-11Event02.

The dissolved copper concentration was above the hardness-based water quality objective during one of the two dry weather sampling events at PD 669 Tributary Station (Figure 4-6.2). Dissolved copper concentrations ranged from 0.25-51.2 μg/L, and hardness ranged from 1930-1970 mg/L.

4.2.5.3 Project Nos. 5246 & 74 (TS21)

A summary of constituents that did not meet applicable water quality objectives at the Project Nos. 5246 & 74 Tributary Station (TS21) during 2010-2011 dry weather monitoring is presented in Table 4-5.3 and Figure 4-6.3.

The fecal coliform bacteria concentration was above the applicable water quality objective (i.e., 4,000 MPN/100 mL) during each of the two dry weather sampling events at the Project Nos. 5246 & 74 Tributary Station (Figure 4-6.5). Fecal coliform concentrations ranged from 9,000-50,000 MPN/100 mL over the two events.

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 monitoring events at Project Nos. 5246 & 74 (Table 4-5.3). The water sample collected during 2010-11Event02 had a pH value of 8.91, which is outside of the water quality objective range.

4.2.5.4 PD 21-Hollypark Drain (TS22)

A summary of constituents that did not meet applicable water quality objectives at the PD 21-Hollypark Drain Tributary Station (TS22) during 2010-2011 dry weather monitoring is presented in Table 4-5.4 and Figure 4-6.4.

The value for pH was not within the water quality objective range of 6.5–8.5 pH units during one of the two dry weather monitoring events at PD 21-Hollypark Drain (Table 4-5.4). The water sample collected during 2010-11Event02 had a pH value of 9.1, which is outside of the water quality objective range.

4.2.5.5 D.D.I. 8 (TS23)

A summary of constituents that did not meet applicable water quality objectives at the D.D.I. 8 Tributary Station (TS23) during 2010-2011 dry weather monitoring is presented in Table 4-5.5 and Figure 4-6.5.

The fecal coliform bacteria concentration was above the applicable water quality objective (i.e., 4,000 MPN/100 mL) during one of the two sampled events in D.D.I. 8 (Figure 4-6.5). The fecal coliform concentration during event 2010-11Event02 was 50,000 MPN/100 mL.

The pH value was not within the water quality objective range of 6.5–8.5 pH units during each of the two dry weather monitoring events at D.D.I. 8 (Figure 4-6.5). The pH values at this station ranged from 8.99-9.52 pH units.

Ammonia levels exceeded the water quality objective for one of the two dry weather sampling events, 2010-11Event13. Ammonia concentrations ranged from 0.46 mg/L – 1.33 mg/L over the two events.

The dissolved zinc concentration was above the hardness-based water quality objective during one of the two dry weather monitoring events at the D.D.I 8 Tributary Station (Figure 4-6.5).

Dissolved zinc concentrations ranged from 51.6-173 µg/L. Hardness values ranged from 140-190 mg/L.

4.2.5.6 Dominguez Channel at 116th Street (TS24)

A summary of constituents that did not meet applicable water quality objectives at the Dominguez Channel at 116th Street Tributary Station (TS24) during 2010-2011 dry weather monitoring is presented in Table 4-5.6 and Figure 4-6.6.

The value for pH was not within the water quality objective range of 6.5–8.5 pH units during one of the two dry weather monitoring events at Dominguez Channel at 116th Street (Table 4-5.6). The pH value was 8.93 during 2010–11Event13.

The dissolved copper concentration was above the hardness-based water quality objective during one of the two dry weather sampling events at Dominguez Channel at 116th Street (Figure 4-6.6). The dissolved copper concentration was 201 µg/L during 2010-11Event02. Hardness values ranged from 140-145 mg/L.

The dissolved zinc concentration was above the hardness-based water quality objective during one of the two dry weather sampling events at Dominguez Channel at 116th Street (Figure 4-6.6). The dissolved zinc concentration was 1720 µg/L during 2010-11Event02.

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 zinc did not meet the water quality objective during at least three of the four wet weather monitoring events. Fecal coliform did not meet the water quality objective for at least three of five wet weather samples taken. pH values were outside the water quality objective range for one of four storms at both Ballona Creek and Los Angeles River. Cyanide levels were above the water quality objective for one storm at Los Angeles River. At the Dominguez Channel MES, dissolved copper exceeded the water quality objective for two of the four wet weather events.

During dry weather conditions, pH was measured above water quality objectives during at least one sampling event at each of the urbanized watershed stations. Fecal coliform concentrations were also measured above water quality objectives during one dry weather event each at Dominguez Channel and Los Angeles River.

Among the four less urbanized watersheds (i.e., Malibu Creek, Coyote Creek, San Gabriel River, and Santa Clara River), fecal coliform concentrations were above water quality objectives during all five events monitored at Santa Clara River, four of the five monitored at Coyote Creek, three of the five monitored at Malibu Creek, and at one of the four monitored at San Gabriel River. At all four of the less urbanized watersheds, pH values were outside of the water quality objective range for at least one of the wet weather samples taken, with two samples not meeting the objective at both Coyote Creek and San Gabriel River. In Coyote Creek, dissolved zinc levels exceeded the water quality objective in all four wet weather samples and in the Santa Clara River, dissolved zinc levels exceeded during one event. Malibu Creek had exceedances in three of the four wet weather samples taken for both sulfate. Cyanide levels in Malibu Creek were above the water quality objective for one of the five wet weather samples collected.

During dry weather monitoring, two of the four less urbanized watersheds, San Gabriel River and Santa Clara River met all applicable water quality objectives. In both Malibu Creek and Coyote Creek, fecal coliform exceeded the water quality objective during one of the two dry weather monitoring samples. In Malibu Creek, sulfate concentrations exceeded the water quality objective for one of the four dry weather samples. The results are summarized in the table below.

Summary of Constituents that Did Not Meet Water Quality Objectives at Mass Emission Stations during 2010-2011 for One or More Events

Mass Emission/Watershed	Wet	Dry
Ballona Creek (S01)[1]	Fecal coliforms[2] pH[3] Dissolved zinc	pH[3]
Malibu Creek (S02)	Fecal coliforms Cyanide pH[3] Sulfate	Fecal coliforms Sulfate
Los Angeles River (S10)[1]	Fecal coliforms[2] pH[3] Dissolved zinc Cyanide	Fecal coliforms pH[3]
Coyote Creek (S13)	Fecal coliforms[2] pH[3] Dissolved Zinc	Fecal coliforms
San Gabriel River (S14)	Fecal coliforms[2] pH[3]	
Dominguez Channel (S28)[1]	Fecal coliforms[2] Dissolved copper Dissolved zinc	Fecal coliforms pH[3]
Santa Clara River (S29)	Fecal coliforms pH[3] Dissolved zinc	

[1]More urbanized watersheds.
[2]Subject to the fecal coliform water quality objective high-flow suspension (LARWQCB, 2003).
3 pH was evaluated outside of holding time

4.2.6.2 Tributary Monitoring Stations

This subsection summarizes the constituents that were measured above applicable water quality objectives at the tributary monitoring stations during the 2010-2011 Monitoring Season. During wet weather, dissolved zinc concentrations were above the water quality objectives at all tributary stations for at least three wet weather events. Fecal coliform concentrations were above the water quality objective in at least two events, at all the tributary stations. Dissolved copper did not meet the water quality objective during at least one storm event at each station. The pH values also did not meet the water quality objective for any of the tributary stations for at least one storm. At TS19, TS21, TS22, and TS23, dissolved lead concentrations did not meet the water quality objective for at least one storm event. At TS19 and TS20, cyanide concentrations exceeded the water quality objective for one storm. Dissolved oxygen was below the water quality objective for one storm at TS21.

During dry weather, pH did not meet water quality objectives in at least one event at all tributary stations, with the exception of TS20. Fecal coliform concentrations did not meet objectives in at least one event at TS19, TS20, TS21, and TS23. Dissolved zinc concentrations did not meet water quality objectives for one dry weather event each for TS23 and TS24 while dissolved copper did not meet the water quality objectives for one event each at TS20 and TS24. Ammonia concentrations did not meet the water quality objective for one dry weather event at TS23. The results are summarized in the table below.

Summary of Constituents That Did Not Meet Water Quality Objectives at Tributary Stations During 2010-2011 for One or More Events

Tributary/Sub-Watershed	Wet	Dry
Project No. 1232 (TS19)	Fecal coliforms Cyanide pH[1] Dissolved copper Dissolved lead Dissolved zinc	Fecal coliforms pH[1]
PD 669 (TS20)	Fecal coliforms Cyanide pH[1] Dissolved copper Dissolved zinc	Fecal coliforms Dissolved copper
Project Nos. 5246 & 74 (TS21)	Fecal coliforms Dissolved Oxygen pH[1] Dissolved copper Dissolved lead Dissolved zinc	Fecal coliforms pH[1]
PD 21-Hollypark Drain (TS22)	Fecal coliforms pH[1] Dissolved copper Dissolved lead Dissolved zinc	pH[1]
D.D.I. 8 (TS23)	Fecal coliforms pH[1] Dissolved copper Dissolved lead Dissolved zinc	Fecal coliforms pH[1] Ammonia Dissolved zinc
Dominguez Channel at 116th Street (TS24)	Fecal coliforms pH[1] Dissolved copper Dissolved zinc	pH[1] Dissolved copper Dissolved zinc

1 pH was evaluated outside of holding time

4.3 Correlation Analysis

A Spearman's Rank Test was used to determine if 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 on Figures 4-7 through 4-10.

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. The results of the correlation analysis are summarized in the table below. In Ballona Creek, Malibu Creek, and Santa Clara River, aluminum and zinc were positively correlated with TSS. Aluminum was also positively correlated with TSS in the San Gabriel River. Dissolved aluminum was positively correlated with TSS in Malibu Creek, San Gabriel River, and Santa Clara River. Volatile suspended solids (VSS) was positively correlated with TSS in Ballona Creek, Coyote Creek, and Dominguez Channel. Dissolved iron and iron were positively correlated with TSS in Los Angeles River, San Gabriel River, and Santa Clara River, whereas dissolved iron was positively correlated with TSS in Malibu Creek. In Coyote Creek, additional positive correlations with TSS were found with biochemical oxygen demand (BOD), chemical oxygen demand (COD), dissolved lead, lead, dissolved zinc, and dissolved arsenic. Lead was also positively correlated with TSS in San Gabriel River while ammonia, BOD, NH3 as N, and VSS were negatively correlated with TSS for this MES. In Los Angeles River, additional positive correlations with TSS were found with cyanide, nickel, and chromium.

Negative correlations with TSS were found in Santa Clara River for alkalinity as $CaCO_3$, chloride, fluoride, hardness, specific conductance, TDS, and pH. In Ballona Creek, COD was negatively correlated with TSS, while in Malibu Creek, BOD and chloride were negatively correlated with TSS.

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 very small data set and may not be representative of true conditions during a storm. This is especially true of the data set for San Gabriel River. Analysis of a larger data set would help determine the validity of these correlations.

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)	Ammonia, VSS, zinc	COD
Malibu Creek (S02)	Aluminum, dissolved aluminum, dissolved iron, zinc	BOD, Chloride
Los Angeles River (S10)	Cyanide, dissolved iron, iron, nickel, chromium	None
Coyote Creek (S13)	BOD, COD, dissolved lead, dissolved zinc, lead, VSS, zinc, dissolved arsenic	None
San Gabriel River (S14)[1]	Aluminum, dissolved aluminum, dissolved iron, iron, lead	Ammonia, BOD, NH3 as N, VSS
Dominguez Channel (S28)	VSS	None
Santa Clara River (S29)	Aluminum, dissolved aluminum, dissolved iron, iron, zinc	Alkalinity as $CaCO_3$, chloride, fluoride, hardness as $CaCO_3$, specific conductance, sulfate, TDS, pH

[1]Likely correlations shown, sample size too small for definitive determination.

Wet Weather – Tributary Stations

Several priority constituents (those that did not meet water quality objectives at tributary stations for one or more events) were found to have positive correlations with TSS during wet weather. At TS20, TS21, TS22, and TS23, dissolved zinc is a priority constituent and was found to positively correlate with TSS at all of these stations. Additionally, dissolved lead was positively correlated with TSS at TS22 and TS23, stations where dissolved lead is a priority constituent.

Other positive correlations include aluminum and dissolved aluminum at TS20, TS22, and TS23. Additionally, dissolved aluminum was also positively correlated with TSS at TS21. Dissolved iron and iron were positively correlated with TSS at TS22, and TS23, whereas dissolved iron was also positively correlated with TSS at TS20 and TS24. Chromium, lead, and zinc were positively correlated with TSS at TS22 and TS23, whereas lead was positively correlated with TSS at TS24 and zinc was positively correlated with TSS at TS20. In TS20, TS21 and TS22 VSS was positively correlated with TSS. Nickel was also positively correlated with TSS in TS21. In TS20, NH3 as N was positively correlated with TSS, whereas in TS23, nitrate (NO_3) and nitrate as N were positively correlated with TSS along with antimony. The only correlations with TSS for TS19 were positive correlations with COD and glyphosate. The only negative correlation with TSS in any of the tributary stations occurred with cyanide in TS24.

Correlations Between Constituents and Total Suspended Solids at Tributary Stations

Tributary Station/Watershed	Wet	
	Positively Correlated with TSS	Negatively Correlated with TSS
Project No. 1232 (TS19)	COD, glyphosate	None
PD 669 (TS20)	Ammonia, dissolved aluminum, dissolved iron, dissolved zinc, NH3 as N, VSS, zinc	None
Project Nos. 5246 & 74 (TS21)	Dissolved aluminum, dissolved zinc, VSS, nickel	None
PD 21-Hollypark Drain (TS22)	Aluminum, dissolved aluminum, dissolved iron, dissolved lead, dissolved zinc, iron, lead, VSS, zinc, chromium	None
D.D.I. 8 (TS23)	Aluminum, BOD, dissolved aluminum, dissolved iron, dissolved lead, dissolved zinc, iron, lead, nitrate (NO_3), nitrate as N, zinc, chromium, antimony	None
Dominguez Channel at 116th Street (TS24)	Dissolved iron, lead	Cyanide

4.3.2 Watershed Load Analysis

The LACFCD collected and analyzed TSS samples at all MES equipped with automated samplers for storm events of at least 0.25 inch of total rainfall. These storms were not exclusive of the storms monitored for the entire analyte list. Several storms were also manually sampled for TSS at the Santa Clara MES, although this sampling was not required. 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. An estimate of the total constituent loads for each MES is shown in Table 4-9.

Sample loads were calculated using the following equation:

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

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 September (2010-11Event02) and January (2010-11Event13) at all stations. Volumes used in the calculation are included in Table 4-9. Concentration units were µg/L, mg/L, or MPN/100 mL. The 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 at each MES were calculated for four storm events that occurred during the 2010-2011 Wet Weather Monitoring Season. Constituent loads were calculated to determine whether there was a relationship between storm event size and the total load for a given constituent. Event 2010-11Event02 (September 21 through September 22, 2010) and 2010-11Event13 (January 24 through January 25, 2011) at each MES and Tributary station were used to calculate dry weather low-flow estimations for each of the watersheds.

For discussion purposes, a limited constituent list comprised of 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)

Rainfall totals during 2010–11Event08 (4.28 inches) were substantially higher than rainfall totals during the other three monitored storm events (0.64 inch or less) at Ballona Creek. As a result, constituent loads were approximately 4 or more times higher during 2010–11Event08 than they were during 2010–11Event03, 2010–11Event06, or 2010–11Event14. No first-flush loading signatures were observed in assessing the loads of nitrate, total phosphorus, TPH, TKN, TDS, TSS, dissolved chromium, copper, or zinc at Malibu Creek.

Dry weather loads at Ballona Creek were highest during 2010–11Event13 for TKN, nitrate, TDS, and TPH. Total phosphorus, TSS, chromium, copper, and zinc were higher during 2010–11Event02. Loads varied between the two events, with the highest variability observed for TSS. The TSS load during 2010-11Event02 was four times greater than during 2010-11Event13, while other loads remained similar between the two events.

Malibu Creek (S02)

Rainfall totals during 2010–11Event08 (10.16 inches) were substantially higher than rainfall totals during the other monitored storm events (4.52 inches or less) at Malibu Creek. As a result, constituent loads were approximately 30 or more times higher during 2010–11Event08 than they were during 2010–11Event03, 2010–11Event06, or 2010–11Event14. No first-flush loading signatures were observed in assessing loads of nitrate, total phosphorus, TPH, TKN, TDS, TSS, dissolved chromium, copper, or zinc at Malibu Creek.

Dry weather loads in Malibu Creek were much higher during the second event (2010-11Event13) than during the first event (2010-11Event02). TDS loads were ten times higher during the second event, while other constituent loads were up to 200 times greater (nitrate). Base flows during the first event were approximately 1 cubic foot per second (cfs), but were approximately 17 cfs during the second dry event (January 24-25, 2010). However, many constituent loads were more than 17 times greater when comparing the two events.

Los Angeles River (S10)
Rainfall totals during 2010–11Event08 (6.40 inches) were substantially higher than rainfall totals during 2010–11Event03 (0.40 inches), 2010–11Event06 (0.28 inches), or 2010–11Event14 (0.08 inches) at Los Angeles River. As a result, all constituent loads were highest during 2010–11Event08. Loads of TKN, TDS, TSS, copper, zinc, nitrate, and total phosphorus appeared to be more closely associated with storm flow volume than a first-flush phenomenon.

Dry weather loads for TKN, nitrate, total phosphorus, TDS, TPH, TSS and zinc were higher during the second dry event (2010-11Event13), while chromium and copper loads were higher during the first event (2010-11Event02). The higher loads observed during the second dry event are likely linked to the higher base flows and mobilization of constituents by wet weather events prior to the second dry weather event.

Coyote Creek (S13)
At Coyote Creek, rainfall totals during 2010–11Event08 (4.60 inches) were substantially higher than rainfall totals during 2010–11Event03 (0.16 inches), 2010–11Event06 (0.44 inches), or 2010–11Event14 (0.20 inches). As a result, constituent loads were greater during 2010–11Event08. Total phosphorus loads, TPH, nitrate, chromium, and copper all appeared to be associated with storm flow volume as the highest loads occurred during 2010–11Event08, followed by smaller loads during 2010–11Event03 and 2010–11Event06, and the lowest loads during 2010–11Event03.

Dry weather loads for TKN, nitrate, total phosphorus, TDS, and TPH were higher during the second dry event (2010-11Event13) compared to the first dry event (2010-11Event02). TSS, chromium, copper, and zinc constituent loads were higher during the first dry event.

San Gabriel River (S14)
Rainfall totals at San Gabriel River during 2010–11Event08 (6.16 inches) were substantially higher than rainfall totals during 2010–11Event03 (not monitored), 2010–11Event06 (1.72 inches), or 2010–11Event14 (0.76 inches). As a result, constituent loads were two to ten times greater during 2010–11Event08. The first storm was not monitored (2010-11Event03) and therefore it is not known whether or not a first-flush increased loading of constituents occurred.

The second dry event (2010-11Event13) was the only dry weather event sampled in the San Gabriel River. There was insufficient flow observed during the September 2010 dry event (2010-11Event02) to carry out monitoring at this location.

Dominguez Channel (S28)
Rainfall totals during 2010–11Event08 (8.16 inches) were substantially higher than rainfall totals during 2010–11Event03 (0.28 inch), 2010–11Event06 (0.36 inch), or 2010–11Event14 (0.40 inch) at Dominguez Channel. As a result, most constituent loads were higher during 2010–11Event08. A first flush pattern was observed for some constituents if 2010-11Event08 is excluded. Nitrate, total phosphorus, TDS, TPH, TSS, and zinc were all higher during the first event (2010-11Event03) compared to the other two events when 2010-11Event08 is excluded

from the analysis. These results point toward a first-flush phenomenon at this station because rainfall amounts were lower during the first event compared to the other two events (excluding 2010-11Event08).

Dry weather monitoring loads were relatively consistent between the first and second dry events (2010-11Event02 and 2010-11Event13, respectively). In general, constituent loads were higher during the first dry event (total phosphorus, TPH, TSS, chromium, copper, and zinc). TKN, nitrate, and TDS constituent loads were higher during the second event.

Santa Clara River (S29)

Rainfall totals during 2010-11Event08 (7.56 inches) were much higher than rainfall totals during 2010-11Event03 (0.20 inch), 2010-11Event06 (0.92 inch), or 2010-11Event14 (0.52 inch) at Santa Clara River. However, the largest volume of water was observed during 2010-11Event14, and the resultant constituent loads were relatively higher for total phosphorus, TDS, TPH, TSS, dissolved chromium, dissolved copper, and dissolved zinc. Of note are the low constituent loads observed during the first wet event (2010-11Event03). The rainfall during this event was the lowest of all monitored events, yet the first-flush phenomenon was not observed.

The pattern of dry weather loads at the Santa Clara River MES was similar to the other MES, with higher constituent loading during the second event (2010-11Event13) for most constituents. Overall, constituent loads at Santa Clara River were substantially lower than all other MES.

4.3.3 Total Suspended Solids Trend Analysis

TSS concentrations from 2000 to 2011 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 11 years. The data are shown graphically on Figures 4-13.1 through 4-13.4.

Coyote Creek had the only significant wet weather trend (i.e., p-value less than 0.05) in TSS concentrations over the last 11 years. The TSS concentrations at Coyote Creek showed a negative trend, indicating that TSS concentrations have decreased significantly over time at this location. Malibu Creek (p-value = 0.055) also had a negative trend but the p-value was slightly greater than 0.05, the cutoff for significance.

No dry weather significant trends for TSS were found.

Trend Analysis of Wet Weather Total Suspended Solids Concentrations at Mass Emission Stations from 2000–2011

Station	p-value	Method	Trend
Ballona Creek at Sawtelle (S01)	0.110	Mann-Kendall	Not significant
Malibu Creek at Piuma (S02)	0.055	Regression	Not significant
Los Angeles River at Wardlow (S10)	0.670	Regression	Not significant
Coyote Creek at Spring (S13)	**0.025**	Mann-Kendall	Significant Decreasing
San Gabriel River (S14)	0.353	Regression	Not significant
Dominguez Channel at Artesia (S28)	0.156	Mann-Kendall	Not significant
Santa Clara River (S29)	0.137	Mann-Kendall	Not significant

Shading indicates significant p-value.

Trend Analysis of Dry Weather Total Suspended Solids Concentrations at Mass Emission Stations from 2000–2011

Station	p-value	Method	Trend
Ballona Creek at Sawtelle (S01)	0.605	Regression	Not significant
Malibu Creek at Piuma (S02)	0.101	Regression	Not significant
Los Angeles River at Wardlow (S10)	0.626	Regression	Not significant
Coyote Creek at Spring (S13)	0.181	Regression	Not significant
San Gabriel River (S14)	0.436	Regression	Not significant
Dominguez Channel at Artesia (S28)	0.451	Regression	Not significant
Santa Clara River (S29)	0.308	Mann-Kendall	Not significant

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). Dry weather samples were collected on September 22, 2010 (2010–11Event02), and January 25, 2011 (2010–11Event13). Wet weather samples were collected during the first rain event of the season on October 8, 2010 (2010–11Event03), and on November 22, 2010 (2010–11Event06), at all MES. 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 by Station – Wet Weather

Bioassay tests exposing *C. dubia* to wet weather effluent samples from each of the seven MES indicated that no toxicity was observed for either the survival or reproduction endpoints.

When the observable effect is sublethal (e.g., mean young per female), the term IC is used. For example, IC_{50} is the concentration that causes a 50% reduction in the selected sublethal biological response (e.g., reproduction). The IC_{25} and IC_{50} values were greater than 100% test substance for each of the MES wet weather samples. This indicates that the undiluted sample did not cause sublethal inhibition of reproduction in *C. dubia*.

The *C. dubia* survival and reproduction toxicity tests resulted in <1 toxicity unit (TU) for survival and <1 TU for reproduction for each of the MES. A TU is defined in the NPDES Municipal Permit as 100 divided by the calculated median test response (e.g., LC_{50} or EC_{50}). A TU value greater than or equal to 1 is considered substantially toxic and requires a Phase I TIE.

Toxicity tests measuring *S. purpuratus* fertilization in exposures to wet weather effluent samples from each of the seven 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.

4.3.4.2 Toxicity Results by Station – Dry Weather

Bioassay tests exposing *C. dubia* to dry weather effluent samples from each of the seven mass MES indicated that toxicity to *C. dubia* was observed in dry weather samples collected from the Los Angeles River MES for reproduction. The IC_{25} value was 44.03, indicating that at 44.03% concentration, a 25% reduction in reproduction was observed. However, the IC_{50} value was greater than 100% test substance and therefore the TU was calculated to be <1.

For all the other MES stations, the IC_{25} and IC_{50} values were greater than 100% test substance, indicating that no observable adverse effects to either survival or reproduction in *C. dubia* occurred in exposure to the undiluted test samples. Additionally, the TUs for each test sample in the *C. dubia* 7-day chronic bioassay were calculated to be <1.

Toxicity tests measuring *S. purpuratus* fertilization in exposures to dry weather effluent samples from each of the seven 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. Pictures can be found in Appendix C. Ballona Creek Watershed and Los Angeles River Watershed Trash Compliance Monitoring Reports can be found 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

The source of bacteria is hard to pinpoint. According to the *Draft Total Maximum Daily Load to Reduce Bacterial Indicator Densities at Santa Monica Bay Beaches* (LARWQCB, 2001), published on November 8, 2001, urban runoff from the storm drain system may have elevated levels of indicator bacteria due to sanitary sewer leaks and spills, illicit connections of sanitary lines to the storm drain system, runoff from homeless encampments, illegal discharges from recreational vehicle holding tanks, and malfunctioning septic tanks. 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) reiterated the previously mentioned sources.

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 can promote bacterial growth.

The SCCWRP has conducted bacteria source identification studies on Ballona Creek, published in 2005 in the journal *Water Air and Soil Pollution* (Stein and Tiefenthaler, 2005). The City of Los Angeles has conducted a bacteria source identification study on the Los Angeles River, published November 2008. Both of those studies confirm that there are dry weather urban runoff sources that discharge into the MS4; however, it is difficult to determine the exact sources of fecal coliform bacteria in the discharges to the MS4. The study by the City of Los Angeles also pointed out the role of bacteria re-growth and scouring of sediments with bacteria attached.

4.3.6.2 Copper 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 can be found 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).

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 mainly composed 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 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, found just upstream from the sampling station. Sulfur is used in wastewater processes such as flocculation. However, other sampling stations 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 if the Plant's effluent was 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 concentration 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).

It is also 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 low pH observed during wet weather in some of the tributary stations.

Conversely, 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 than can cause high pH in surface waters is the discharge of concrete wash water, surfactants in cleaning agents, and illicit washing. Algal blooms can also cause elevated pH at night, due to increased production of carbon dioxide as algae respire at night.

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.

Cyanide results from the past 5 years were evaluated to determine whether any patterns between events, laboratory quality control batches, monitoring years, or stations could be discerned. An Analysis of Variance (ANOVA) was run to test for differences between QA batch results, events, years, and stations. Tukey's test for paired differences was run for the ANOVA post analysis for significant ANOVAs. An alpha of 0.05 was used as the benchmark for significance.

The findings indicate that laboratory QA batch 102907 was significantly higher than all other QA batches from the years 2006-2011 (average result of 0.17 mg/L, standard error of 0.06

mg/L). The average result for this QA batch was between 1 and 69 times greater than all other average QA batch results. The results for this QA batch are shown in the following table. This finding also held true for the event ID analysis, because the event IDs match up with the QA batch identifiers exactly.

QA Batch 102907 and Event ID 2007-08Event21 Cyanide Results

Station	Event ID	Cyanide Result (mg/L)
S01	2007-08Event21	0.362
S13	2007-08Event21	0.285
S28	2007-08Event21	0.338
S02	2007-08Event21	Not Detected
S14	2007-08Event21	Not Detected
S29	2007-08Event21	0.008
DUP_ME	2007-08Event21	0.361
S10	2007-08Event21	0.024

Shaded values are all higher than water quality objective of 0.022 mg/L.

The monitoring year comparison also revealed that cyanide concentrations collected during monitoring year 2007-2008 were significantly higher than all other monitoring years included in the evaluation (shown in the following table).

Monitoring Year Average Cyanide Results

Monitoring Year	N	Average (mg/L)	Standard Error (mg/L)
2006-07	48	0.00849	0.00173
2007-08	40	0.04613	0.01598
2008-09	63	0.00555	0.00065
2009-10	65	0.01159	0.00168
2010-11	54	0.00709	0.00109

Shaded values highest compared to all other monitoring years, and higher than the water quality benchmark of 0.022 mg/L.

An ANOVA was run to test for the interaction between stations and monitoring years, but no significant results were observed.

4.4 Recommendations

The following recommendations for improving monitoring techniques are presented below.

- Monitoring for the Dominguez tributaries was extended to a third year (2010-2011) to collect more data, and therefore the recommendation from the 2009-2010 Annual Monitoring Report to monitor Malibu Creek tributaries was not implemented during the 2010-2011 period. Tributary monitoring is still recommended for Malibu Creek to distinguish between naturally occurring and anthropogenic concentrations of sulfate and other priority constituents. Tributary concentrations in developed areas of the watershed could be compared against undeveloped areas of the watershed to identify naturally occurring constituent concentrations. If no significant sulfate concentrations are detected in the developed portion of the watershed, it could be inferred that any concentrations measured above these concentrations are naturally occurring.

- A literature review of the cyanide method used for evaluation may provide interesting information about whether or not interference from other analytes is expected to affect cyanide results. In addition, the analytical method to test for total cyanide levels should be assessed and other methods proposed as necessary to determine the bioavailable fraction of cyanide in the environment.

- Sample analysis of *e. coli* is recommended for future monitoring, based on the recently adopted Resolution No. R10-005. Currently, fecal coliform are analyzed for both storm water and ambient or dry conditions at the MES. However, because bacteria standards have been changed to require *e. coli* monitoring, instead of fecal coliform, *e. coli* should replace fecal coliform and fecal coliform monitoring should be discontinued.

- The analysis of TSS and other constituents is limited to one year of monitoring data, and it is recommended that the past five to ten years of data be included in next year's evaluation to determine whether or not TSS and other monitored constituents are often correlated.

- It is recommended that pH levels should be monitored in the field to limit effects of water hardness and alkalinity on changes to the pH levels measured in the analytical laboratory. The holding time for pH is approximately 10-15 minutes, and so composite samples may be out of holding time when the sample arrives at the laboratory.

- It is recommended that an evaluation of the bioavailable fraction of dissolved metals (including the copper, lead, and zinc dissolved metals) should be estimated by using the biotic ligand model as a data evaluation exercise of available data. Because the dissolved metals water quality objectives are low, due to low hardness levels, and the toxicity results are also low, it is possible that the measured dissolved metals concentrations are not negatively impacting aquatic life.