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 2009–2010 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 2009–2010 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 2009–2010 storm season and the long-term pattern of rainfall observed in downtown Los Angeles at Station 716, Ducommun Street. During the 2009–2010 storm season, October was wetter than the 139-year average for this month. No rainfall was recorded in November. The rainfall in December was approximately the same as the average rainfall for this month for this location. Rainfall was above average in January 2010, average in February, and much lower than average in March. In general, the seasonal pattern of rainfall was consistent with historical records, with highest rainfall occurring from December 2009 through February 2010.
2. Figure 4-2 illustrates that the total annual rainfall during the 2009–2010 storm season in downtown Los Angeles. Annual rainfall for this monitoring season was approximately 10% lower than the 139-year average annual rainfall of 15.5 inches.

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

Hydrographs are provided for all monitoring station events for which flow-weighted composite samples were collected during the 2009–2010 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 of the MES and tributary stations is summarized in tables 4-2.1 and 4-2.2, respectively. The number of sampling events where toxicity was assessed is summarized by site 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.

All 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 three 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, all analyses performed were based on 24-hour composite samples or instantaneous grab samples. Therefore, only comparisons to acute water quality objectives were made.

Two categories of water quality objectives were identified (i.e., Category 1 and Category 2). Category 1 water quality objectives (see table below) are those for which there is no uncertainty regarding the applicable objectives or the implementation with respect to frequency and duration. Category 2 water quality objectives are those for which there is uncertainty regarding the applicability of the beneficial use (e.g., the conditional use of municipal water supply), or there is uncertainty regarding implementation of the objective (e.g., four-day averaging periods).

In the table below, numeric objectives listed as ranges are calculated values based on site-specific conditions. Ammonia concentrations 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 concentrations were calculated using measure hardness and procedures set forth in the CTR.

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 are included in Category 2 and were not used to compare against monitoring results from stormwater and urban runoff discharges.

Some constituents have chronic water quality objectives, which are based on four-day average exposures. Each measurement of this program is either based on a grab sample or a 24-hour composite sample. Therefore, chronic objectives are also included in Category 2 and are not used for comparison of monitoring data to water quality objectives.

Category 1 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	100
Cyanide	mg/L	CTR	0.022	0.022	0.022	0.022	0.022	0.022	0.022
Dissolved arsenic	µg/L	CTR	340	340	340	340	340	340	340
DO	mg/L	Basin Plan	5	5	5	5	5	5	5
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

Constituent	Units	Water Quality Objective Source	Station ID						
			S01	S02	S10	S13	S14	S28	S29
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	300
Total dissolved solids (TDS)	mg/L	Basin Plan	NA	2,000	1,500	NA	750	NA	1,000
Toxaphene	µg/L	CTR	0.73	0.73	0.73	0.73	NA	0.73	0.73

MPN = most probable number
NA = not applicable

Category 1 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
Dissolved arsenic	µg/L	CTR	340	340	340	340	340	340
DO	mg/L	Basin Plan	5	5	5	5	5	5
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
Toxaphene	µg/L	CTR	0.73	0.73	0.73	0.73	0.73	0.73

This subsection summarizes the constituents that did not meet Category 1 water quality objectives at MES sampled during the 2009–2010 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 SWRCB website (SWRCB, 2003).

The storm events to which the suspension applied in 2009–2010 are identified in the exceedance summary for each drainage. Measurements above the fecal coliform water quality objective were not highlighted for those events. At times, fecal coliform concentrations did not meet water quality objectives during wet weather in some of the less developed watersheds or during dry weather in highly urbanized watersheds as well as in some less developed watersheds.

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 site, 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 MPN/100mL and the REC-2 water quality objective (non-contact recreation) is 4,000 MPN/100 mL. The recreational beneficial use varies by site 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	REC-1	REC-2	Applicable Fecal Coliform WQO (MPN/100 mL)
S01	Ballona Creek		X	4,000
S02	Malibu Creek	X		400
S10	Los Angeles River	X		400
S13	Coyote Creek	X		400
S14	San Gabriel River	X		400
S28	Dominguez Channel		X	4,000
S29	Santa Clara River	X		400
TS19	Project No. 1232		X	4,000
TS20	PD 669		X	4,000
TS21	Project Nos. 5246 & 74		X	4,000
TS22	PD 21 - Hollypark Drain		X	4,000
TS23	D.D.I. 8		X	4,000
TS24	Dominguez Channel at 116'th St.		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 Category 1 water quality objectives at the Ballona Creek MES (Ballona Creek) during the 2009–2010 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 2009–10Event13, 2009–10Event15, 2009–10Event16, 2009–10Event19, 2009–10Event21, 2009–10Event24, and 2009–10Event 32. Based on this assessment, all of the wet weather events met the fecal coliform water quality objective.

Dissolved copper concentrations were above the hardness-based water quality objective during two of the four monitored wet weather storm events at Ballona Creek (Figure 4-3.1). Dissolved copper concentrations at Ballona Creek varied moderately, ranging from 8.77–19.6 µg/L, whereas hardness varied widely, ranging from 50–1260 mg/L. Dissolved copper concentrations did not meet site-specific water quality objectives during the two storm events (i.e., 2009–10Event16 and 2009–10Event19) that had the lowest hardness values.

The value for pH was not within the water quality objective range of 6.5–8.5 pH units during one of the four monitored storm events at Ballona Creek (Table 4-4.1). The water sample collected during 2009–10Event15 had a pH value of 6.42, which was slightly below the water quality objective of between 6.5 and 8.5 pH units. The measured pH was slightly acidic during each of the storm events, ranging from 6.42–7.03 pH units.

Nitrite did not meet the water quality objective of 1.0 mg/L for one of the four monitored storm events in Ballona Creek during the 2009–2010 Wet Weather Monitoring Season (Table 4-4.1). The water sample collected during 2009–10Event15 had a nitrite concentration of 1.17 mg/L, which was slightly above the water quality objective.

All other Category 1 water quality objectives in Ballona Creek were met during the 2009–2010 Wet Weather Monitoring Season.

4.2.2.2 Malibu Creek (S02)

A summary of constituents that did not meet Category 1 water quality objectives at the Malibu Creek MES (Malibu Creek) during the 2009–2010 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 two of the four 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.

Sulfate did not meet the watershed-specific water quality objective of 500 mg/L in two of the four wet weather events sampled in Malibu Creek. Sulfate ranged from 360–800 mg/L over the four storm events and was measured above the water quality objective during 2009–10Event13 and 2009–10Event15.

All other Category 1 water quality objectives in Malibu Creek were met during the 2009–2010 Wet Weather Monitoring Season.

4.2.2.3 Los Angeles River (S10)

A summary of constituents that did not meet Category 1 water quality objectives at the Los Angeles River MES (Los Angeles River) during the 2009–2010 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 events 2009–10Event19, 2009–10Event21, 2009–10Event24, and 2009–10Event32. Based on this assessment, two of the four wet weather events did not meet the fecal coliform water quality objective.

Dissolved copper concentrations were above the hardness-based water quality objective during two of the four monitored wet weather storm events at Los Angeles River (Figure 4-3.3). Dissolved copper concentrations varied moderately, ranging from 6.06–15.6 µg/L, whereas hardness ranged from 50–90 mg/L.

The value for pH was not within the water quality objective range of 6.5–8.5 pH units during one of the four monitored storm events at Los Angeles River (Table 4-4.3). The water sample collected during 2009–10Event15 had a pH value of 6.41, which was slightly outside of the water quality objective range.

All other Category 1 water quality objectives in Los Angeles River were met during the 2009–2010 Wet Weather Monitoring Season.

4.2.2.4 Coyote Creek (S13)

A summary of constituents that did not meet Category 1 water quality objectives at the Coyote Creek MES during the 2009–2010 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 events 2009–10Event13, 2009–10Event15, 2009–10Event16, 2009–10Event19, 2009–10Event21, 2009–10Event22, and 2009–10Event32. Based on this assessment, all of the wet weather events met the fecal coliform water quality objective.

The dissolved copper concentration was above the hardness-based water quality objective during one of the four monitored wet weather storm events at Coyote Creek (Figure 4-3.4). Dissolved copper concentrations varied moderately, ranging from 4.37–10.8 μg/L, whereas hardness ranged from 40–110 mg/L.

All other Category 1 water quality objectives in Coyote Creek were met during the 2009–2010 Wet Weather Monitoring Season.

4.2.2.5 San Gabriel River (S14)

A summary of constituents that did not meet Category 1 water quality objectives at the San Gabriel River MES during the 2009–2010 Wet Weather Monitoring Season is presented in Table 4-4.5 and Figure 4-3.5.

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 2009–10Event13, 2009–10Event15, 2009–10Event16, 2009–10Event19, 2009–10Event21, 2009–10Event22, 2009–10Event24, 2009–10Event26, and 2009–10Event32. Based on this assessment, all of the wet weather events met the fecal coliform water quality objective.

The dissolved zinc concentration was above the hardness-based water quality objective during one of the four monitored wet weather storm events at San Gabriel River (Figure 4-3.5). Dissolved zinc concentrations ranged from 28.3–44.6 μg/L, and hardness ranged from 30–160 mg/L. The storm event that had the lowest hardness value (2009–10Event19) did not meet the water quality objective for dissolved zinc.

All other Category 1 water quality objectives in San Gabriel River were met during the 2009–2010 Wet Weather Monitoring Season.

4.2.2.6 Dominguez Channel (S28)

A summary of constituents that did not meet Category 1 water quality objectives at the Dominguez Channel MES during the 2009–2010 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 events 2009–10Event13, 2009–10Event15, 2009–10Event16, 2009–10Event19, 2009–10Event21, 2009–10Event24, and 2009–10Event32. Based on this assessment, all of the wet weather events met the fecal coliform water quality objective.

The dissolved copper concentration was above the hardness-based water quality objective during each of the four monitored wet weather storm events at Dominguez Channel (Figure 4-3.6). Dissolved copper concentrations varied moderately, ranging from 11.0–21.4 µg/L, whereas hardness ranged from 30–70 mg/L.

The dissolved zinc concentration was above the hardness-based water quality objective during each of the four monitored wet weather storm events at Dominguez Channel (Figure 4-3.6). Dissolved zinc concentrations ranged from 98.2–121 µg/L.

The value for pH was not within the water quality objective range of 6.5–8.5 pH units during two of the four monitored storm events at Dominguez Channel (Table 4-4.6). The water samples collected during 2009–10Event15 and 2009–10Event16 had pH values of 6.35 and 6.48, respectively, which were outside of the water quality objective range.

All other Category 1 water quality objectives in Dominguez Channel were met during the 2009–2010 Wet Weather Monitoring Season.

4.2.2.7 Santa Clara River (S29)

A summary of constituents that did not meet Category 1 water quality objectives at the Santa Clara River MES during the 2009–2010 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 four 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.

All other Category 1 water quality objectives in Santa Clara River were met during the 2009–2010 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 Category 1 water quality objectives at the Project No. 1232 Tributary Station (TS19) during the 2009–2010 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-1 beneficial use (i.e., water contact recreation – full immersion) and REC-2 beneficial use (i.e., non-contact water recreation) in accordance with the "tributary rule" of the Basin Plan. Based on this assessment, all of the wet weather events met the fecal coliform water quality objective.

The dissolved copper concentration was above the hardness-based water quality objective during three of the five monitored wet weather storm events at Project No. 1232 (Figure 4-4.1). Dissolved copper concentrations ranged from 7.78–17.2 µg/L, and hardness ranged from 50–210 mg/L. Dissolved copper concentrations at Project No. 1232 were comparable to those measured in Dominguez Channel.

The dissolved zinc concentration was above the hardness-based water quality objective during four of the five monitored wet weather storm events at Project No. 1232 (Figure 4-4.1). Dissolved zinc concentrations ranged from 81.1–175 µg/L. Dissolved zinc concentrations at Project No. 1232 were comparable to those measured in Dominguez Channel.

All other Category 1 water quality objectives at Project No. 1232 were met during the 2009–2010 Wet Weather Monitoring Season.

4.2.3.2 PD 669 (TS20)

A summary of the constituents that did not meet Category 1 water quality objectives at the PD 669 Tributary Station (TS20) during the 2009–2010 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-1 beneficial use (i.e., water contact recreation – full immersion) and REC-2 beneficial use (i.e., non-contact water recreation) in accordance with the "tributary rule" of the Basin Plan. Based on this assessment, all of the wet weather events met the fecal coliform water quality objective.

The dissolved copper concentration was above the hardness-based water quality objective during one of the five monitored wet weather storm events at PD 669 (Figure 4-4.2). Dissolved copper concentrations ranged from 5.09–15.7 µg/L, and hardness ranged from 50–390 mg/L. Generally, dissolved copper concentrations at PD 669 were slightly lower than those measured in Dominguez Channel.

The dissolved zinc concentration was above the hardness-based water quality objective during one of the five monitored wet weather storm events at PD 669 (Figure 4-4.2). Dissolved zinc concentrations ranged from 44.3–140 µg/L and were comparable to those measured in Dominguez Channel.

4.2.3.3 Project Nos. 5246 & 74 (TS21)

A summary of the constituents that did not meet Category 1 water quality objectives at the Project Nos. 5246 and 74 Tributary Station (TS21) during the 2009–2010 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-1 beneficial use (i.e., water contact recreation – full immersion) and REC-2 beneficial use (i.e., non-contact water recreation) in accordance with the “tributary rule” of the Basin Plan. Based on this assessment, all of the wet weather events met the fecal coliform water quality objective.

The dissolved copper concentration was above the hardness-based water quality objective during each of the five monitored wet weather storm events at Project Nos. 5246 and 74 (Figure 4-4.3). Dissolved copper concentrations ranged from 11.3–21.4 µg/L, and hardness ranged from 30–80 mg/L. Dissolved copper concentrations at Project No. 1232 were comparable to those measured in Dominguez Channel.

The dissolved zinc concentration was above the hardness-based water quality objective during four of the five monitored wet weather storm events at Project Nos. 5246 and 74 (Figure 4-4.3). Dissolved zinc concentrations ranged from 62.3–163 µg/L. Dissolved zinc concentrations at Project No. 1232 were comparable 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 one of five monitored storm events at Project Nos. 5246 and 74 (Table 4-5.3). The water sample collected during 2009–10Event15 had a pH value of 6.47, which was slightly below the lower limit of the water quality objective range.

All other Category 1 water quality objectives at Project Nos. 5246 and 74 were met during the 2009–2010 Wet Weather Monitoring Season.

4.2.3.4 PD 21-Hollypark Drain (TS22)

A summary of the constituents that did not meet Category 1 water quality objectives at the PD 21-Hollypark Drain Tributary Station (TS22) during the 2009–2010 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-1 beneficial use (i.e., water contact recreation – full immersion) and REC-2 beneficial use (i.e., non-contact water recreation) in accordance with the “tributary rule” of the Basin Plan. Based on this assessment, all of the wet weather events met the fecal coliform water quality objective.

The dissolved copper concentration was above the hardness-based water quality objective during three of the five monitored wet weather storm events at PD 21-Hollypark Drain (Figure 4-4.4). Dissolved copper concentrations ranged from 6.07–11.4 µg/L, and hardness ranged from 40–120 mg/L. Dissolved copper concentrations at PD 21-Hollypark Drain were somewhat lower than those measured in Dominguez Channel.

The dissolved zinc concentration was above the hardness-based water quality objective during three of the five monitored wet weather storm events at PD 21-Hollypark Drain (Figure 4-4.4). Dissolved zinc concentrations ranged from 34.8–105 µg/L. Generally, dissolved zinc concentrations at PD 21-Hollypark Drain were slightly lower than 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 one of five monitored storm events at PD 21-Hollypark Drain (Table 4-5.4). The water sample collected during 2009–10Event15 had a pH value of 6.39, which was slightly below the lower limit of the water quality objective range.

The cyanide concentration was above the water quality objective during one the five monitored wet weather storm events at PD 21-Hollypark Drain. All other Category 1 water quality objectives at PD 21-Hollypark Drain were met during the 2009–2010 Wet Weather Monitoring Season.

4.2.3.5 D.D.I. 8 (TS23)

A summary of the constituents that did not meet Category 1 water quality objectives at the D.D.I. 8 Tributary Station (TS23) during the 2009–2010 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-1 beneficial use (i.e., water contact recreation – full immersion) and REC-2 beneficial use (i.e., non-contact water recreation) in accordance with the “tributary rule” of the Basin Plan. Based on this assessment, all of the wet weather events met the fecal coliform water quality objective.

The dissolved copper 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 copper concentrations ranged from 11.3–35.8 µg/L, and hardness ranged from 20–60 mg/L. Dissolved copper concentrations at D.D.I. 8 were slightly or moderately higher than 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 D.D.I. 8 (Figure 4-4.5). Dissolved zinc concentrations ranged from 94.4–278 µg/L. Generally, dissolved zinc concentrations at D.D.I. 8 were slightly or moderately higher than 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 one of five monitored storm events at D.D.I. 8 (Table 4-5.5). The water sample collected during

2009–10Event15 had a pH value of 6.28, which was slightly below the lower limit of the water quality objective range.

All other Category 1 water quality objectives at D.D.I. 8 were met during the 2009–2010 Wet Weather Monitoring Season.

4.2.3.6 Dominguez Channel at 116th Street (TS24)

A summary of the constituents that did not meet Category 1 water quality objectives at the Dominguez Channel at 116th Street Tributary Station (TS24) during the 2009–2010 Wet Weather Monitoring Season is presented in Table 4-5.6 and Figure 4-4.6.

During wet weather high flow periods, Dominguez Channel and its tributaries are subject to a suspension of the REC-1 beneficial use (i.e., water contact recreation – full immersion) and REC-2 beneficial use (i.e., non-contact water recreation) in accordance with the “tributary rule” of the Basin Plan. Based on this assessment, all of the wet weather events met the fecal coliform water quality objective.

The dissolved copper 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 copper concentrations ranged from 13.7–80.6 µg/L, and hardness ranged from 20–60 mg/L. Dissolved copper concentrations at Dominguez Channel at 116th Street were substantially higher than those measured in Dominguez Channel.

The dissolved zinc concentration was above the hardness-based water quality objective during three of the five monitored wet weather storm events at Dominguez Channel at 116th Street (Figure 4-4.6). Dissolved zinc concentrations ranged from 63.5–501 µg/L. Generally, dissolved zinc concentrations at Dominguez Channel at 116th Street were several times higher than those measured in Dominguez Channel.

All other Category 1 water quality objectives at Dominguez Channel at 116th Street were met during the 2009–2010 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 Category 1 water quality objectives at the Ballona Creek MES during the 2009–2010 Dry Weather Monitoring Season is presented in Table 4-4.1 and Figure 4-5.1

The value for pH was not within the water quality objective range of 6.5–8.5 pH units during two of the four dry weather monitoring events at Ballona Creek (Figure 4-5.1). The water samples collected during 2009–10Event12 and 2009–10Event28 had pH values of 8.51 and 8.66, respectively, which were outside of the water quality objective range.

4.2.4.2 Malibu Creek (S02)

A summary of constituents that did not meet Category 1 water quality objectives at the Malibu Creek MES during the 2009–2010 Dry Weather Monitoring Season is presented in Table 4-4.2 and Figure 4.5.2.

Sulfate did not meet the water quality objective during two of the four monitored dry weather events in Malibu Creek (Figure 4-5.2). Sulfate concentrations ranged from 401–749 mg/L over the four events. The sulfate concentrations of 712–749 mg/L during 2009–10Event02 and 2009–10Event12 were above the 500 mg/L water quality objective.

TDS did not meet the applicable water quality objective in one of the four dry weather events in Malibu Creek (Figure 4-5.2). The sulfate concentration during 2009–10Event02 was slightly above the 2000 mg/L water quality objective.

4.2.4.3 Los Angeles River (S10)

A summary of constituents that did not meet Category 1 water quality objectives at the Los Angeles River MES during the 2009–2010 Dry Weather Monitoring Season is presented in Table 4-4.3 and Figure 4-5.3.

The value for pH was not within the water quality objective range of 6.5–8.5 pH units during two of the four dry weather monitoring events at Los Angeles River (Table 4-5.3). The water samples collected during 2009–10Event02, 2009–10Event14, and 2009–10Event28 had pH values of 9.25, 8.54, and 9.45, respectively, which were outside of the water quality objective range.

The cyanide concentration was above the water quality objective during one of four wet weather monitoring events.

4.2.4.4 Coyote Creek (S13)

A summary of constituents that did not meet Category 1 water quality objectives at the Coyote Creek MES during the 2009–2010 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 three of the four sampled storm events in Coyote Creek (Figure 4-5.4). Fecal coliform concentrations ranged from 300–9,000 MPN/100 mL.

The value for pH was not within the water quality objective range of 6.5–8.5 pH units during one of the four dry weather monitoring events at Coyote Creek (Table 4-4.4). The water sample collected during 2009–10Event28 had a pH value of 8.58, which was outside of the water quality objective range.

The cyanide concentration was above the water quality objective during one of four wet weather monitoring events.

4.2.4.5 San Gabriel River (S14)

A summary of constituents that did not meet Category 1 water quality objectives at the San Gabriel River MES during the 2009–2010 Dry Weather Monitoring Season is presented in Table 4-4.5 and Figure 4-5.5.

Fecal coliform bacteria concentrations were above the applicable water quality objective (i.e., 400 MPN/100 mL) during two of the four sampled storm events in San Gabriel River (Figure 4-5.5). Fecal coliform concentrations ranged from 230–800 MPN/100 mL.

The Basin Plan chloride water quality objective of 150 mg/L was not met during one of the four dry weather events monitored (Figure 4-5.5). The chloride concentration was 161 mg/L during 2009–10Event12.

Sulfate did not meet the water quality objective during one of the four monitored dry weather events in San Gabriel River (Figure 4-5.5). Sulfate concentrations ranged from 117–443 mg/L over the four events. The sulfate concentrations of 443 mg/L during 2009–10Event02 was above the 300 mg/L water quality objective.

The cyanide concentration was above the water quality objective during one of four wet weather monitoring events.

4.2.4.6 Dominguez Channel (S28)

A summary of constituents that did not meet Category 1 water quality objectives at the Dominguez Channel MES during the 2009–2010 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., 400 MPN/100 mL) during one of the four sampled storm events in Dominguez Channel (Figure 4-5.6). Fecal coliform concentrations ranged from 300–13,000 MPN/100 mL over the four events.

The value for pH was not within the water quality objective range of 6.5–8.5 pH units during one of the four dry weather monitoring events at Dominguez Channel (Table 4-4.6). The water samples collected during 2009–10Event12 and 2009–10Event28 had pH values of 8.59 and 8.83, respectively, which were outside of the water quality objective range.

4.2.4.7 Santa Clara River (S29)

A summary of constituents that did not meet Category 1 water quality objectives at the Santa Clara River MES during the 2009–2010 Dry Weather Monitoring Season is presented in Table 4-4.7 and Figure 4-5.7.

The fecal coliform bacteria concentration was above the applicable water quality objective (i.e., 400 MPN/100 mL) during one of the four sampled storm events in Santa Clara River (Figure 4-5.7). Fecal coliform concentrations ranged from less than 20–2,400 MPN/100 mL over the four events.

The chloride concentration was above the applicable water quality objective during three of four wet weather monitoring events.

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 Category 1 water quality objectives at Project No. 1232 Tributary Station (TS24) during the 2009–2010 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 four sampled storm events in Project No. 1232 (Figure 4-6.1). Fecal coliform concentrations ranged from 230–900,000 MPN/100 mL over the four events.

The value for pH was not within the water quality objective range of 6.5–8.5 pH units during two of the four dry weather monitoring events at Project No. 1232 (Table 4-5.1). The water samples collected during 2009–10Event14 and 2009–10Event28 had pH values of 8.84 and 8.91, respectively, which were outside of the water quality objective range.

Ammonia did not meet the water quality objective during one of the four dry weather monitoring events at Project No. 1232 (Table 4-5.1). The water sample collected during 2009–10Event02 had an ammonia concentration of 5.17 mg/L, which was outside of the pH-based water quality objective of 3.9 mg/L.

4.2.5.2 PD 669 (TS20)

A summary of the constituents that did not meet Category 1 water quality objectives at PD 669 Tributary Station (TS24) during the 2009–2010 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 four sampled storm events in PD 669 (Figure 4-6.2). Fecal coliform concentrations ranged from 500–24,000 MPN/100 mL over the four events.

The value for pH was not within the water quality objective range of 6.5–8.5 pH units during three of the four dry weather monitoring events at PD 669 (Table 4-5.2). The water samples collected during 2009–10Event02, 2009–10Event14, and 2009–10Event28 had pH values of 8.55, 8.59, and 8.79, respectively, which were outside of the water quality objective range.

The cyanide concentration was above the applicable water quality objective for cyanide during one of the four dry weather monitoring events.

4.2.5.3 Project Nos. 5246 & 74 (TS21)

A summary of constituents that did not meet Category 1 water quality objectives at the Project Nos. 5246 & 74 Tributary Station (TS21) during the 2009–2010 dry weather sampling is presented in Table 4-5.3 and Figure 4-6.3.

The value for pH was not within the water quality objective range of 6.5–8.5 pH units during three of the four dry weather monitoring events at Project Nos. 5246 & 74 (Table 4-5.3). The water samples collected during 2009–10Event02, 2009–10Event12, and 2009–10Event28 had pH values of 8.63, 8.95, and 9.16, respectively, which were outside of the water quality objective range.

4.2.5.4 PD 21-Hollypark Drain (TS22)

A summary of constituents that did not meet Category 1 water quality objectives at the PD 21-Hollypark Drain Tributary Station (TS22) during the 2009–2010 dry weather sampling 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 three of the four dry weather monitoring events at PD 21-Hollypark Drain (Table 4-5.4). The water samples collected during 2009–10Event02, 2009–10Event12, and 2009–10Event14 had pH values of 8.81, 8.81, and 8.94, respectively, which were outside of the water quality objective range.

4.2.5.5 D.D.I. 8 (TS23)

A summary of constituents that did not meet Category 1 water quality objectives at the D.D.I. 8 Tributary Station (TS23) during the 2009–2010 dry weather sampling 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 four sampled storm events in D.D.I. 8 (Figure 4-6.5). Fecal coliform concentrations ranged from 230–24,000 MPN/100 mL over the four events.

The value for pH was not within the water quality objective range of 6.5–8.5 pH units during each of the four dry weather monitoring events at D.D.I. 8 (Figure 4-6.5). The pH values at this site ranged from 8.66–9.36 pH units.

4.2.5.6 Dominguez Channel at 116th Street (TS24)

A summary of constituents that did not meet Category 1 water quality objectives at the Dominguez Channel at 116th Street Tributary Station (TS24) during the 2009–2010 dry weather sampling is presented in Table 4-5.6 and Figure 4-6.6.

Fecal coliform bacteria at Dominguez Channel at 116th Street did not meet the applicable water quality objective (i.e., 4,000 MPN/100 mL) in one of the four events sampled during dry weather in (Figure 4-6.6). Fecal coliform concentrations ranged from less than 20–16,000 MPN/100 mL over the four events.

The value for pH was not within the water quality objective range of 6.5–8.5 pH units during one of the four dry weather monitoring events at Dominguez Channel at 116th Street (Table 4-5.6). The pH value was 8.9 during 2009–10Event12.

The dissolved copper concentration was above the hardness-based water quality objective during two of the five monitored dry weather events at Dominguez Channel at 116th Street (Figure

4-6.6). Dissolved copper concentrations ranged from 9.46–100 μg/L, and hardness ranged from 170–310 mg/L.

The dissolved zinc concentration was above the hardness-based water quality objective during one of the five monitored wet weather storm events at Dominguez Channel at 116th Street (Figure 4-6.6). Dissolved zinc concentrations ranged from 22–322 μg/L.

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 and pH did not meet water quality objectives during at least one wet weather monitoring event. Fecal coliform concentrations were above the water quality objective during two storm events at the Los Angeles River MES. Nitrite and dissolved zinc were measured above water quality objectives in Ballona Creek and Dominguez Channel, respectively, during one storm event. The cyanide concentration was above the water quality objective during one storm event each in the Ballona Creek, Los Angeles River, and Dominguez Channel stations.

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 at Dominguez Channel. The cyanide concentration was above the water quality objective during one sampling event in the Los Angeles River.

Among the four less urbanized watersheds (i.e., Malibu Creek, Coyote Creek, San Gabriel River and Santa Clara River), fecal coliform and sulfate concentrations during wet weather were above water quality objectives at Malibu Creek during two storm events. Dissolved copper and cyanide concentrations were above water quality objectives during one wet weather event in Coyote Creek. In the San Gabriel River, the dissolved zinc and cyanide concentrations were above the water quality objective during one wet weather sampling event. In the Santa Clara River, fecal coliform concentrations were above water quality objectives during one sampling event.

Among the four less urbanized watersheds during dry weather monitoring, sulfate and TDS were above water quality objectives during one dry weather sampling event in Malibu Creek. In Coyote Creek, fecal coliforms concentrations were above the water quality objective during three dry weather events and pH and cyanide concentrations were above the water quality objective during one event. In the San Gabriel River, fecal coliform concentrations were above the water quality objective during two dry weather events and chloride, sulfate, and cyanide did not meet water quality objectives during one event. In the Santa Clara River, fecal coliform concentrations were above the water quality objectives during one dry weather event and chloride concentrations were above the water quality objectives in three events. The results are summarized in the table below.

Summary of Constituents that Did Not Meet Water Quality Objectives at Mass Emission Stations during 2009–2010 for One or More Events

Mass Emission/Watershed	Wet	Dry
Ballona Creek (S01)*	pH Nitrite Dissolved copper Cyanide	pH
Malibu Creek (S02)	Fecal coliforms Sulfate	Sulfate TDS
Los Angeles River (S10)*	Fecal coliforms** pH Dissolved copper Cyanide	pH Cyanide
Coyote Creek (S13)	Dissolved copper Cyanide	Fecal coliforms pH Cyanide
San Gabriel River (S14)	Dissolved zinc Cyanide	Fecal coliforms Chloride Sulfate Cyanide
Dominguez Channel (S28)*	pH Dissolved copper Dissolved zinc Cyanide	Fecal coliforms pH
Santa Clara River (S29)	Fecal coliforms	Fecal coliforms Chloride

*More urbanized watersheds
**Two of four storms met the requirements of the high flow suspension (LARWQCB, 2003)

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 2009–2010 Monitoring Season. In general, the constituents that were above water quality objectives were similar to those found at the Dominguez Channel MES. During wet weather, dissolved copper and zinc concentrations were above the water quality objectives in at least one event at all tributary stations. At Stations TS21, TS22, and TS23, pH did not meet water quality objectives during at least one event.

During dry weather, pH did not meet water quality objectives in at least one event at all tributary stations. Fecal coliform concentrations did not meet objectives in at least one event at Stations TS19, TS20, TS23, and TS24. The ammonia concentration did not meet water quality objectives during at least one event at Station TS19 and cyanide concentrations were above the water quality objective during at least one event at Site TS20. The results are summarized in the table below.

Summary of Constituents That Did Not Meet Water Quality Objectives at Tributary Stations during 2009–2010 for One or More Events

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

4.2.7 Detection Limit Analysis

The monitoring and reporting requirements of the Permit state that constituents monitored at MES below the detection limit for 75% of the first 48 events monitored need not be further analyzed, except for annual confirmation sampling during the first storm of the wet season. A review of the data from 2001 to 2010 indicated that several constituents meet these criteria, as summarized in Appendix M. There is a substantial list of organic constituents that meet the criteria across all MES. In addition, dissolved beryllium, mercury, silver, and thallium meet the criteria across all MES, and dissolved aluminum, cadmium, chromium +6, and lead meet the criteria at several of the MES.

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 rank correlation 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 dataset 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 dataset. The spearman rank correlation coefficient, rs is then calculated using the ranks and compared to the critical rs value. The critical rs value is based on the number of samples and the required alpha (0.05 in this case). If the rs is greater than the critical rs, then the correlation is considered "significant," or the result has a less than 5% chance of occurring randomly.

4.3.1 Priority Constituents and Correlation to Total Suspended Solids

Wet Weather – Mass Emission Stations

Consistent trends 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 three most urbanized watersheds (i.e., Ballona Creek, Los Angeles River, and Dominguez Channel) did, however, have more constituents that were positively correlated with TSS than the less urbanized watersheds (i.e., Malibu Creek, Coyote Creek, San Gabriel River, Santa Clara River), as summarized in the table below. In Ballona Creek and Dominguez Channel, TDS, volatile suspended solids (VSS), and specific conductance were positively correlated with TSS, whereas in both Los Angeles River and Dominguez Channel dissolved barium was positively correlated with TSS. In the Los Angeles River, the nutrients ammonia and NH_3 as N, as well as total organic carbon (TOC) had a significant positive correlation with TSS. Bacteria, the nutrients sulfate and total Kjeldahl nitrogen (TKN), and chloride and dissolved chromium were also positively correlated with TSS in Dominguez Channel. Interestingly, fecal coliform bacteria were negatively correlated with TSS in Ballona Creek, whereas DO was negatively correlated with TSS in Dominguez Channel. Many constituents have a strong binding affinity for sediment particles in storm water effluent, particularly bacteria, metals, organics, and 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. Analysis of a larger data set would help determine the validity of these correlations.

In the less urbanized watersheds, no consistent correlations with TSS were apparent. Several metals (i.e., aluminum, barium, and dissolved chromium) were positively correlated with TSS in Malibu Creek, whereas in Coyote Creek pH and TKN had a significant positive correlation with TSS. No analytes had significant positive correlations with TSS in either the San Gabriel River or in the Santa Clara River. In the Santa Clara River, chemical oxygen demand (COD), fluoride, hardness as $CaCO_3$ specific conductance, and TDS were negatively associated with TSS.

Dry Weather – Mass Emission Stations

During dry weather in the urbanized watersheds, dissolved and total metals had significant positive correlations with TSS across most MES. In Ballona Creek, biochemical oxygen demand (BOD) and dissolved chromium were positively correlated with TSS, whereas in the Los Angeles River, dissolved nickel and VSS were positively correlated with TSS. Total zinc was the only constituent that had a positive correlation with TSS in Dominguez Channel during dry weather. Nutrients (i.e., dissolved phosphorus and nitrate as NO_3) had a significant negative correlation with TSS in Ballona Creek, whereas in the Los Angeles River, DO was negatively correlated with TSS.

In the less urbanized watersheds, total and dissolved metals were positively correlated with TSS at three of the four stations during dry weather. The metals arsenic, dissolved arsenic, and zinc were correlated with TSS at Malibu Creek; aluminum, copper, dissolved antimony, and lead were correlated with TSS at Coyote Creek; and copper was correlated with TSS at the San Gabriel River. Turbidity TKN and VSS were also positively correlated with TSS at Coyote Creek during dry weather. TKN was negatively correlated with TSS at Malibu Creek, whereas nitrate was negatively correlated with TSS at Coyote Creek.

Correlations between Constituents and Total Suspended Solids at Mass Emission Stations

Mass Emission/Watershed	Wet		Dry	
	Positively correlated with TSS	Negatively correlated with TSS	Positively correlated with TSS	Negatively correlated with TSS
Ballona Creek (S01)	Specific conductance, TDS, and VSS	Fecal coliforms	BOD and dissolved chromium	Dissolved phosphorus and nitrate as NO_3
Malibu Creek (S02)	Aluminum, barium, and dissolved chromium	None	Arsenic, dissolved arsenic, and zinc	TKN
Los Angeles River (S10)	Ammonia, dissolved barium, NH_3 as N, TOC, and VSS	None	Dissolved nickel, and VSS	DO
Coyote Creek (S13)	pH and TKN	None	Aluminum, copper, dissolved antimony, TKN, lead, turbidity, and VSS	Nitrate as NO_3 and nitrate as N
San Gabriel River (S14)	None	None	Copper	Dissolved nickel
Dominguez Channel (S28)	Chloride, dissolved barium, dissolved chromium, enterococci, streptococci, TKN, specific conductance, sulfate, TDS, and VSS	DO	Zinc	None
Santa Clara River (S29)	None	COD, fluoride, hardness as $CaCO_3$ specific conductance, and TDS	None	None

Wet Weather – Tributary Stations

During wet weather, ammonia, NH_3 as N, and VSS had a significant positive correlation with TSS at most of the tributary stations, as summarized in the table below. Of these constituents, only VSS was positively correlated with TSS at the Dominguez Channel MES. No other constituents had significant negative correlations with TSS at tributary stations during wet weather.

Dry Weather – Tributary Stations

Two stations had constituents that were positively correlated with TSS during dry weather. Dissolved nickel and VSS were positively correlated with TSS at Project Nos. 5246 & 74, and fecal coliforms and VSS were positively correlated with TSS at Dominguez Channel at 116th Street. None of these constituents were found to have a positive correlation with TSS during dry weather at the Dominguez Channel MES.

No consistent pattern emerged among constituents that were negatively correlated with TSS during dry weather at the tributary stations, as no constituent had a negative correlation with TSS at more than one site. At Project No. 1232, pH and chromium were negatively correlated to TSS, whereas at PD 669, aluminum and TKN were negatively correlated to TSS. Hardness as $CaCO_3$ had a significant negative correlation with TSS at PD-21 Hollypark Drain, whereas at Dominguez Channel at 116th Street, DO and TOC were negatively correlated with TSS.

Correlations between Constituents and Total Suspended Solids at Tributary Stations

Tributary Station/Watershed	Wet		Dry	
	Positively correlated with TSS	Negatively correlated with TSS	Positively correlated with TSS	Negatively correlated with TSS
Project No. 1232 (TS19)	Ammonia, NH_3 as N, and VSS	None	None	pH and chromium
PD 669 (TS20)	VSS	None	None	Aluminum and TKN
Project Nos. 5246 & 74 (TS21)	None	None	Dissolved nickel and VSS	None
PD 21-Hollypark Drain (TS22)	Ammonia, NH_3 as N, and VSS	None	None	Hardness as $CaCO_3$
D.D.I. 8 (TS23)	Ammonia and NH_3 as N	None	None	None
Dominguez Channel at 116th Street (TS24)	VSS	None	Fecal coliforms and VSS	DO and TOC

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. All storms were manually sampled for TSS at the Santa Clara MES, although not required. The TSS concentration for each storm is shown in Table 4-6 and depicted on figures 4-11 through 4-14. 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 on October 1 (all stations except Santa Clara). Volumes used in the calculation are included in Table 4-9. Concentration units were either µg/L, mg/L, or MPN/100mL. 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 2009–2010 Wet Weather Monitoring Season. Constituent loads were calculated to determine if there was a correlation between storm event size and the total load for a given constituent. The first 24 hours of flow data from October 1, 2009, at each MES was used to calculate dry weather low flow estimations for each of the watersheds other than San Gabriel River and Dominguez Channel. At San Gabriel River, flow data from 2009–10Event02 were used, whereas flow data from September 7, 2009, were used for Dominguez Channel.

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

Ballona Creek (S01)

The constituents TKN, TDS, TSS, and total phosphorus displayed a typical first-flush loading signature during the first storm event of the season. Thus, although the total rainfall at Ballona Creek during the first monitored storm event (i.e., 2009–10Event13) was only 40% of the precipitation of the fourth monitored storm event (i.e., 2009–10Event19); loads of TKN, TDS, TSS, and total phosphorus were two or more times higher during the first storm event. Higher loads of the metals copper, and zinc generally were correlated with higher flow volumes during 2009–10Event13 and 2009–10Event19, whereas dissolved chromium loads were correlated with TSS. Nitrate and TPH had fairly consistent loads during 2009–10Event13, 2009–10Event16, and 2009–10Event19, but had no measurable load during the smallest storm event (i.e., 2009–10Event15).

Dry weather loads at Ballona Creek were highest during 2009–10Event02 for TSS, TKN, copper, and total phosphorus. TSS and TKN concentrations were greater by approximately one order of magnitude during 2009–10Event02 than during any of the other three dry weather monitoring events. Loads of TDS were fairly consistent over the four monitored dry weather events, ranging from approximately 1.3 million pounds to 1.4 million pounds. Metal loads of zinc and dissolved chromium varied moderately over the four events, peaking during either 2009–10Event02 or 2009–10Event14.

Malibu Creek (S02)

Rainfall totals during 2009–10Event19 (6.56 inches) were substantially higher than rainfall totals during the other three monitored storm events (3.80 inches or less) at Malibu Creek. As a result, constituent loads were approximately ten or more times higher during 2009–10Event19 than they were during 2009–10Event13, 2009–10Event15, or 2009–10Event16. 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 TSS loads at Malibu Creek ranged from 1511 pounds during 2009–10Event28 to 12,847 pounds during 2009–10Event14. TDS loads were highest during 2009–10Event02, and ranged from approximately 700,000 pounds during 2009–10Event28 to approximately 1.500,000 pounds during 2009–10Event02. TKN loads were substantially higher during 2009–10Event28 than any of the other three monitoring events, whereas nitrate as N was highest during 2009–10Event14. No distinct pattern was observed for metals loads. Copper loads were highest during 2009–10Event12, whereas zinc loads were highest during 2009–10Event14.

Los Angeles River (S10)

Rainfall totals during 2009–10Event19 (4.80 inches) were substantially higher than rainfall totals during 2009–10Event13 (0.44 inch), 2009–10Event15 (0.11 inch), or 2009–10Event16 (0.52 inch) at Los Angeles River. As a result, nearly all constituent loads were highest during 2009–10Event19. Loads of TKN, TDS, TSS, and dissolved chromium displayed a typical first-flush loading curve during 2009–10Event13, the first storm event of the season. Copper, zinc, nitrate, and total phosphorus appeared to be more closely associated with storm flow volume.

Dry weather loads for TSS, TDS, TKN, total phosphorus, and dissolved chromium were greatest during 2009–10Event02 and 2009–10Event14. TSS loads ranged from approximately 530,000 pounds during 2009–10Event12 to 5,100,000 pounds during 2009–10Event02, whereas TDS ranged between 25,000,000–26,000,000 pounds across all four dry weather monitoring events. Copper, and zinc loads had no distinct pattern over the four events. Copper loading was highest during 2009–10Event28, whereas zinc loading was highest during 2009–10Event12. Nitrate as N loads were substantially higher during 2009–10Event14 than during any of the other dry weather monitoring events.

Coyote Creek (S13)

At Coyote Creek, rainfall totals during 2009–10Event19 (5.68 inches) were substantially higher than rainfall totals during 2009–10Event13 (1.24 inches), 2009–10Event15 (0.83 inch), or 2009–10Event16 (1.16 inches). As a result, constituent loads were greater during 2009–10Event19. Total phosphorus loads of TKN, TDS, TSS, and nitrate all appeared to be associated with storm flow volume as the highest loads occurred during 2009–10Event19, followed by similar loads during 2009–10Event13 and 2009–10Event16, and the lowest loads during 2009–10Event15. Copper, zinc, TPH, and dissolved chromium loads were slightly lower during 2009–10Event13 than during either 2009–10Event15 or 2009–10Event16.

Dry weather loads for total phosphorus, TKN, and TSS were substantially higher during 2009–10Event02 than during any of the other three monitoring events. Loads of TSS ranged from approximately 54,000 pounds during 2009–10Event14 to more than 540,000 pounds during 2009–10Event02. Loads of TDS ranged from approximately 4.2 million pounds during 2009–10Event12 to 4.9 million pounds during 2009–10Event02. Nitrate as N and TPH loads were highest during 2009–10Event14 and 2009–10Event28, whereas zinc loads were highest during 2009–10Event12. Loads of copper and dissolved chromium remained varied little over the course of the sampling events.

San Gabriel River (S14)

Rainfall totals at San Gabriel River during 2009–10Event19 (7.04 inches) were substantially higher than rainfall totals during 2009–10Event13 (1.68 inches), 2009–10Event15 (0.83 inch), or 2009–10Event16 (3.52 inches). As a result, constituent loads were greater during 2009–10Event19. However, loads for nitrate, TPH, TDS, copper, zinc, dissolved chromium, and total phosphorus were higher during 2009–10Event15, which had the lowest total rainfall of the four monitored storms, than during 2009–10Event13 or 2009–10Event16. Possibly the long dry period (55 days) prior to the storm on December 7, 2009 (2009–10Event15), allowed constituent concentrations to build up in the watershed before being flushed by out by rain. Since the storm event on December 11, 2009 (2009–10Event16), occurred only three days after than 2009–10Event15 had ended, it is possible that the much larger storm produced slightly smaller constituent loads. TSS and TKN appeared to be associated with storm flow volume as the highest loads occurred during 2009–10Event19, followed by 2009–10Event13.

Dry weather loads at San Gabriel River were substantially higher during 2009–10Event02 and 2009–10Event14 for TKN, nitrate as N, total phosphorus, zinc, copper, TDS, TSS, TPH, and dissolved chromium. Loads for TDS, TKN, nitrate as N, total phosphorus, zinc, and copper were highest during 2009–10Event02, whereas loads for, dissolved chromium, TPH, and TSS were highest during 2009–10Event14. TSS loads ranged from approximately 910,000 pounds during 2009–10Event28 to approximately 5,570,000 pounds during 2009–10Event02.

Dominguez Channel (S28)

Rainfall totals during 2009–10Event19 (3.64 inches) were substantially higher than rainfall totals during 2009–10Event13 (1.32 inches), 2009–10Event15 (0.71 inch), or 2009–10Event16 (1.16 inches) at Dominguez Channel. As a result, most constituent loads were higher during 2009–10Event19. Loads of TDS, nitrate, TPH, copper, zinc, total phosphorus, and dissolved chromium all appeared to be associated with storm flow volume as the highest loads occurred during 2009–10Event19, which had the greatest volume of flow. A typical first-flush signature, however, was observed for several constituents (i.e., total phosphorus, TKN, TSS, and TDS) during the initial storm event, 2009–10Event13. Loads of total phosphorus, TKN, TSS, and TDS were higher during 2009–10Event13, despite its much lower amount of rainfall, than during 2009–10Event19. Copper, zinc, and nitrate loads were highest during 2009–10Event19, followed by 2009–10Event15.

Dry weather monitoring loads for TSS, nitrate as N, copper and zinc were highest during 2009–10Event12, whereas the TKN was highest during 2009–10Event02. Loads of TDS and dissolved chromium varied little over the four monitored dry weather events. TPH loads were four times higher during 2009–10Event14 and 2009–10Event28 than during 2009–10Event02 and 2009–10Event12.

Santa Clara River (S29)

Rainfall totals during 2009–10Event19 (7.88 inches) were more than three times higher than rainfall totals during 2009–10Event13 (2.44 inches), 2009–10Event15 (0.92 inch), or 2009–10Event16 (2.44 inches) at Santa Clara River. As a result, TSS loads were substantially higher during 2009–10Event19. In general, however, constituent loads in this watershed were extremely low relative to other watersheds (i.e., one to two orders of magnitude lower). Loads of TKN, TDS, nitrate, TPH, copper, zinc, total phosphorus, and dissolved chromium all peaked during storm flow2009–10Event15, whereas TSS was highest during 2009–10Event19. The second highest constituent loads occurred during 2009–10Event13 for TKN, TSS, and total phosphorus, whereas loads of TDS, nitrate, TPH, copper, zinc, and dissolved chromium were highest during 2009–10Event19.

Dry weather loads at the Santa Clara River MES for TSS, TPH, and nitrate as N were highest during 2009–10Event28 and 2009–10Event14. TDS loads were highest during 2009–10Event14 and were lowest during 2009–10Event28. Loads for the metals, dissolved chromium, and zinc were highest during 2009–10Event14, whereas copper loads remained relatively steady over all four dry weather monitoring events. Total phosphorus loads also varied little over the four sampling events. Overall, constituent loads at Santa Clara River were substantially lower than all other MES, with the exception of Malibu Creek.

4.3.3 Total Suspended Solids Trend Analysis

TSS concentrations from 2001 to the 2010 were examined using non parametric Mann-Kendall trend analysis to determine if significant positive or negative trends were occurring in any of the seven monitored watersheds. The table below presents statistical trend information on TSS data collected at each of the MES over the past ten years. The data are shown graphically on figures 4-15.1 through 4-15.4.

Coyote Creek had the only significant trend (i.e., p-value less than 0.05) in TSS concentrations over the last ten 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 = 0.077), San Gabriel River (p-value = 0.053), and Santa Clara River (p-value = 0.054) also had negative trends that did not quite reach the 0.05 p-value that determined whether or not the trend was significant. The more urbanized watersheds of Ballona Creek (p-value = 0.378), Los Angeles River (p-value = 0.477), and Dominguez Channel (p-value = 0.481) had substantially higher p-values than the less urbanized watersheds and, hence, did not demonstrate either a positive or negative TSS trend.

Trend Analysis of Total Suspended Solids Concentrations at Mass Emission Stations from 2001–2010

Station	p-value	Trend
Ballona Creek at Sawtelle (S01)	0.378	Not significant
Malibu Creek at Piuma (S02)	0.077	Negative – not significant
Los Angeles River at Wardlow (S10)	0.477	Not significant
Coyote Creek at Spring (S13)	**0.007**	Negative – significant
San Gabriel River (S14)	0.053	Negative – not significant
Dominguez Channel at Artesia (S28)	0.481	Not significant
Santa Clara River (S29)	0.054	Negative – not significant

Shading indicates significant p-value.

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 site (i.e., two wet weather samples and two dry weather samples). Dry weather samples were collected on December 1, 2009 (2009–10Event14), and March 23, 2010 (2009–10Event28). Wet weather samples were collected during the first rain event of the season on October 13, 2009 (2009–10Event13), and on January 17, 2010 (2009–10Event19), 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. The NOEC was 100% test substance for each of the MES for both survival and reproduction, indicating that no observable adverse effects to the organism occurred in exposure to the undiluted test samples.

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 one toxicity unit (TU) for survival and one 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 IC_{50}). A TU value greater than or equal to 1.00 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. NOECs were 100% of the sample water for each emission station, whereas IC_{25} and IC_{50} values were greater than 100% test substance and TUs were equal to 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 no toxicity was observed for either the survival or reproduction endpoints. The NOEC was 100% test substance for each of the MES for both survival and reproduction, and 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 1.00.

Toxicity tests measuring *S. purpuratus* fertilization in exposures to dry weather effluent samples from each of the seven MES indicated that toxicity to *S. purpuratus* fertilization was observed in dry weather samples collected from Ballona Creek MES, Malibu Creek MES, Los Angeles River MES, San Gabriel River MES, Dominguez Channel MES, and Santa Clara River MES. NOECs were calculated to be equal to or less than 6% of the sample water for each of these sites, whereas the NOEC at Coyote Creek was greater than 100% sample water. Although IC_{25} and

IC_{50} values at these stations were all greater than 100% test substance, the TUs for Ballona Creek, Malibu Creek, Los Angeles River, San Gabriel River, Dominguez Channel, and Santa Clara River were calculated to be 16.67.

Because the initial results from the chronic *S. purpuratus* test exceeded 1.00 TU, and control fertilization met acceptance criteria, a TIE study was initiated as required in the NPDES Municipal Permit. The initial component of the TIE process is to conduct a baseline test to determine appropriate TIE test dilutions. However, when baseline tests were conducted on dry weather samples collected from Ballona Creek, Malibu Creek, Los Angeles River, San Gabriel River, Dominguez Channel, and Santa Clara River MES, no toxicity was observed. NOEC values were 100% for each of the sites. Due to the lack of toxicity observed in "baseline" testing, there was no reason to continue with further TIE manipulations. The initial toxicity that was observed in the dry weather samples at Ballona Creek MES, Malibu Creek MES, Los Angeles River MES, San Gabriel River MES, Dominguez Channel MES, and Santa Clara River MES may have been caused by volatile compound(s) that dissipated to non toxic levels during the baseline TIE tests.

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 Category 1 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*, published on November 8, 2001, by the Los Angeles RWQCB, 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 among other things. 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 Measure to Address Pathogen Pollution in Surface Waters: A Total Maximum Daily Load Implementation Guidance Manual for Massachusetts 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 off bacteria, and therefore cover 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. 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* by G. Fred Lee, Ph.D. and Anne Jones-Lee, Ph.D., 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* by A.P. Davis, M. Shokouhian, and S. Ni. 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*.

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 can be largely attributable to the presence of eroded sulfur-rich sediment. 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 site. 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 Chloride and Total Dissolved Solids

An article titled Residential Sources of Contamination on EPA's website states that elevated levels of chloride may be a result of fertilizers, animal waste, industrial wastes, minerals, or seawater. Another common source of chloride is household water softening units, which use sodium chloride to regenerate ion exchange units used to remove magnesium from water. Chloride increases TDS concentrations.

4.3.6.5 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. Sudden influx of rainwater is the most likely explanation for the low pH observed during wet weather in some of the tributary stations. The fact that more than half of the variability in pH is explained by alkalinity supports this explanation.

Conversely, pH above 8.5 could indicate highly mineralized waters, for example groundwater seepages that are not as diluted, especially during dry weather. A common human factor 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.

4.3.6.6 Ammonia and Nitrite

Ammonia exists naturally in the environment and is also an important commercial and industrial chemical, according to the New York Department of Health (NYDP, 2008. It is used in agriculture (fertilizers), as a refrigerant, in water treatment processes, in cleaning products and in the manufacture of many products including other chemicals, plastics, textiles, explosives and pesticides. Ammonia is produced by the decomposition of organic matter. One particular ammonia source of interest is wastewater treatment plants. According to Water Supply and Pollution Control, by Warren Viessman, Jr. and Mark J. Hammer, there is an average of 24 mg/L of ammonia–nitrogen (NH_3-N) in biologically treated domestic wastewater that has not undergone denitrification.

Nitrite is a naturally occurring inorganic ion that is part of the nitrogen cycle. Microbial action in soil or water decomposes wastes containing organic nitrogen into ammonia, which is then oxidized to nitrite and nitrate. Because nitrite is easily oxidized to nitrate, nitrate is the compound predominantly found in groundwater and surface waters. Contamination with nitrogen-containing fertilizers (e.g., potassium nitrate and ammonium nitrate), or animal or human organic wastes, can raise the concentration of nitrate in water.

4.4 Recommendations

The following recommendation for improving monitoring techniques is presented below. As it is a recommended monitoring change, it could be initiated by LACFCD, after appropriate consultation with the Los Angeles RWQCB and Copermittees:

- Tributary monitoring is 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.