

## 7.0 BALLONA CREEK WATERSHED MANAGEMENT AREA

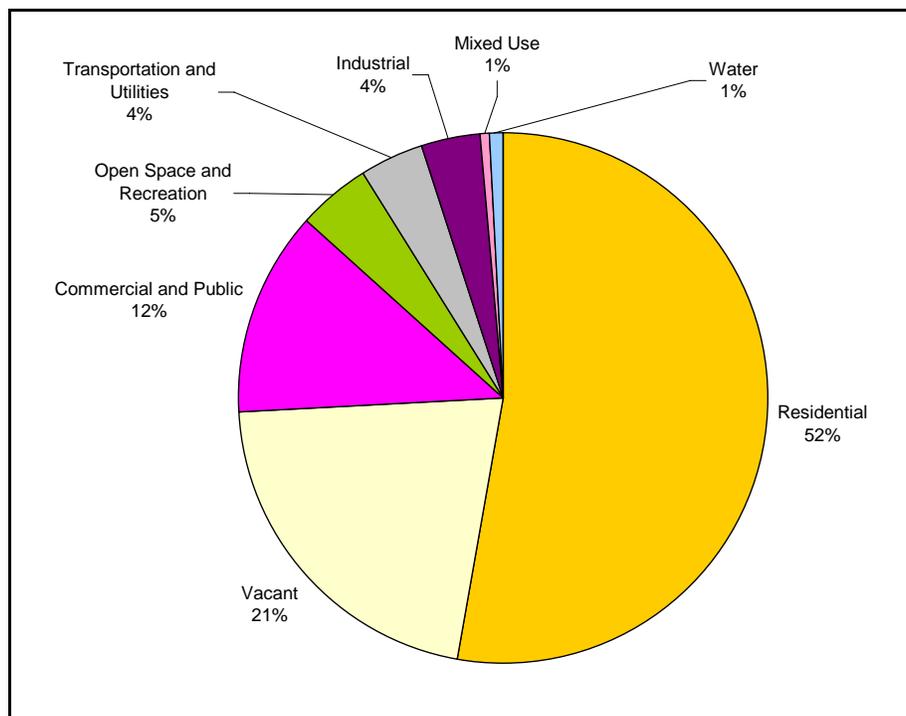
### 7.1 Watershed Description

#### 7.1.1 Watershed Land Use, Percent Impervious, and Population

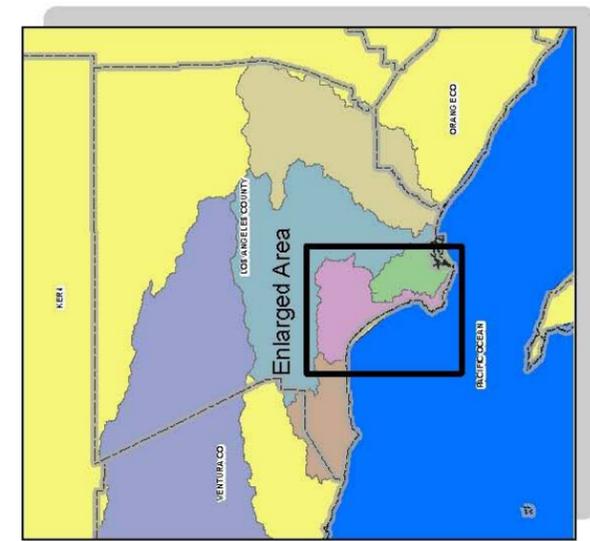
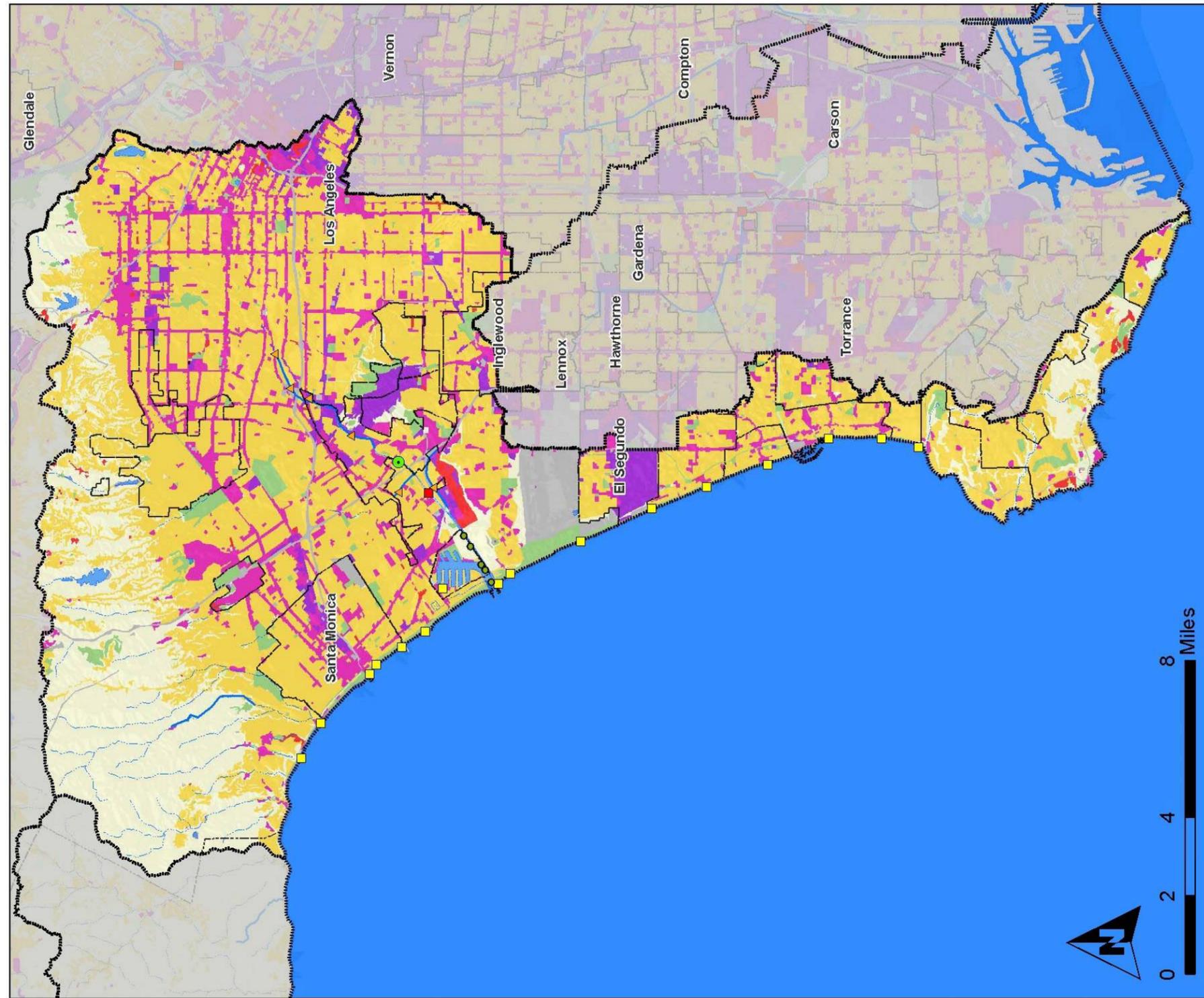
More than half of the Ballona Creek Watershed Management Area is composed of residential land uses (Figure 7-1). Vacant and commercial land uses also account for a large percentage of the area, comprising 21% and 12% of the area, respectively. The vacant areas are concentrated in the northern, higher elevations (Figure 7-2). This watershed also contains the Los Angeles International Airport along the coast north of El Segundo.

The average impervious area of the Ballona Creek Watershed is estimated to be 40% based on assumptions of imperviousness in each land use type. This is the second highest ratio of impervious land in the six Watershed Management Areas.

The population in the Ballona Creek WMA is heavily concentrated in the northeastern portion, above the mass emission station (Figure 7-3).



**Figure 7-1. Land Use Percentages in the Ballona Creek WMA.**



### Land Use Ballona Creek Watershed Management Area

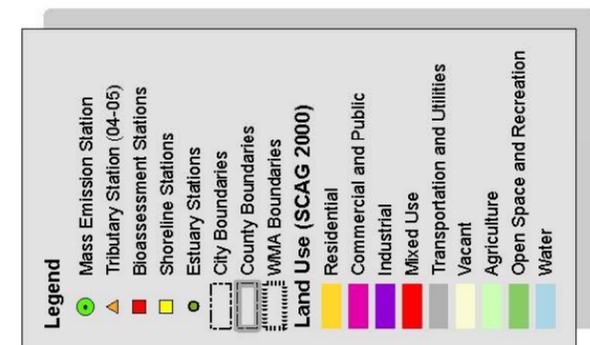
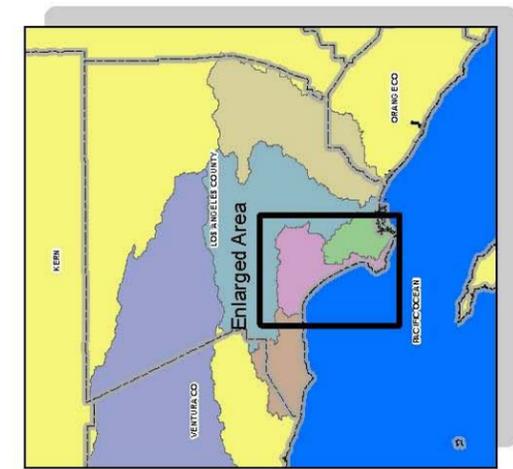
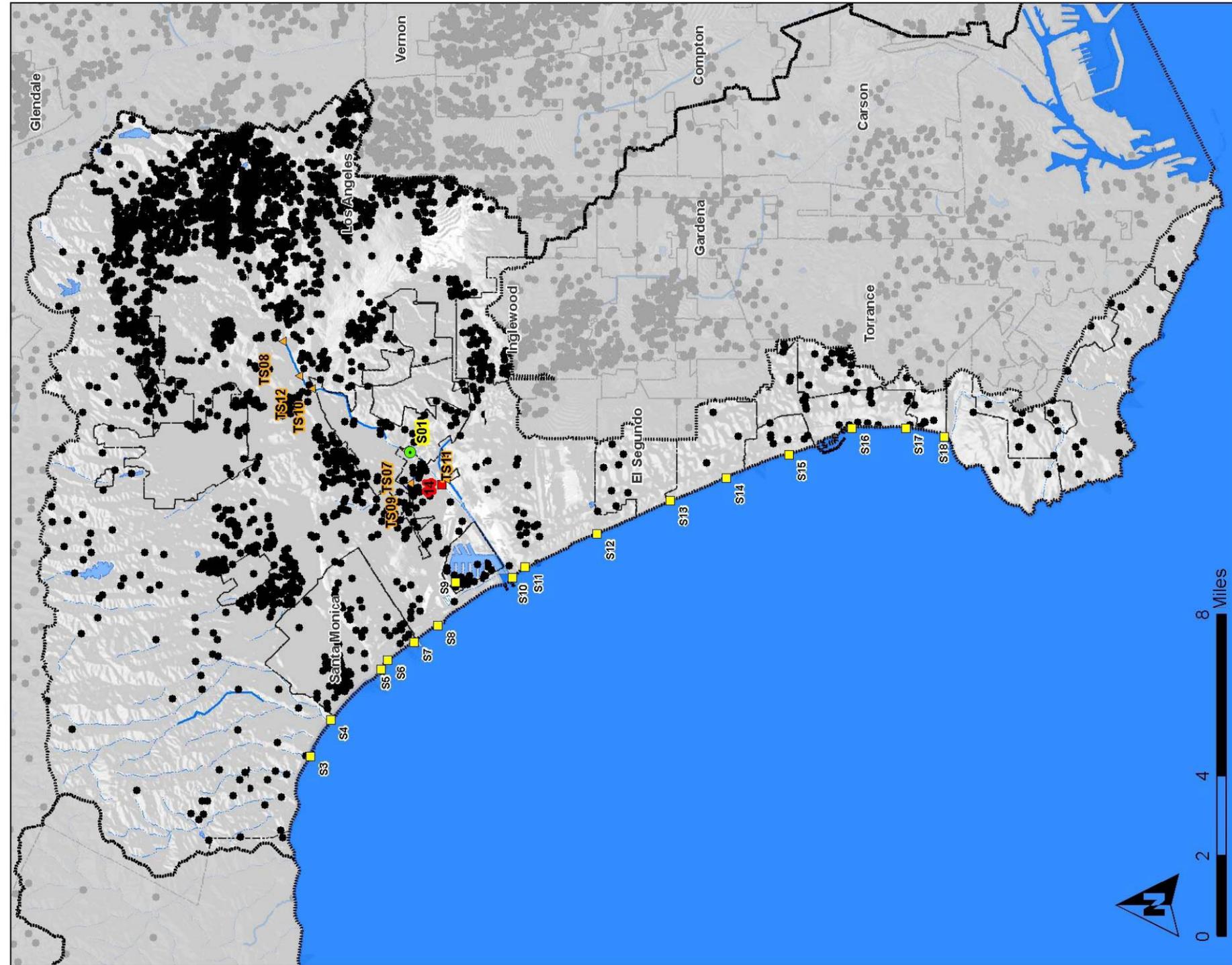


Figure 7-2. Land Use Distribution in the Ballona Creek WMA.



Population Density  
Ballona Creek Watershed Management Area

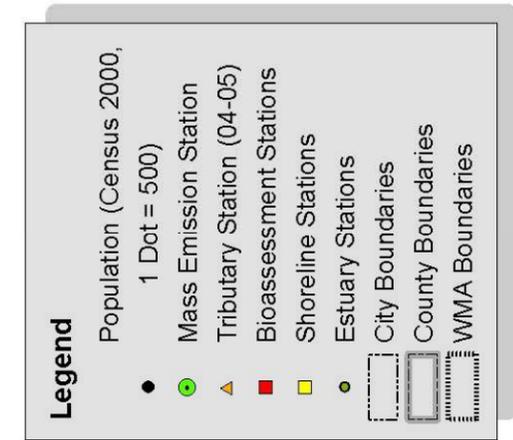


Figure 7-3. Population Density in the Ballona Creek WMA.

### **7.1.2 Hydrology and Monitoring Stations**

Ballona Creek is a watershed within the Los Angeles-Santa Monica Hydrologic Unit. The Ballona Creek Watershed covers approximately 130 square miles located in the western portion of the Los Angeles Basin and is made up by the Culver City, Wilshire, and Hollywood sub watersheds. Other sub watersheds drain directly to the coast. The headwaters of the watershed are located in the Santa Monica Mountains to the north and the Baldwin Hills to the south. Most of the Ballona Creek drainage network has been modified into storm drains, underground culverts, and open concrete channels. Ballona Creek is an open channel between Venice Boulevard and Pickford Street and its confluence with Santa Monica Bay (a length of approximately 9 miles). A few natural channels remain in the Santa Monica Mountains and Baldwin Hills.

The “S01” mass emission station monitors a large portion of the Ballona Creek Watershed. A bioassessment station is also adjacent to “S01” (Figure 7-4). Six Tributary Monitoring Stations were established in 2004-2005. Four of these stations were located upstream from “S01” and two stations were located on tributaries that have confluences with the main stem of Ballona Creek downstream of “S01”.

Figure 7-5 displays how sampling events in 2004-2005 coincided with daily rainfall or extended dry periods. The figure shows that all daily rainfall totals were below 2.5 inches. All wet weather monitoring events occurred during storms having less than 1.5 inches of rain. The wettest period was in late December and early January.

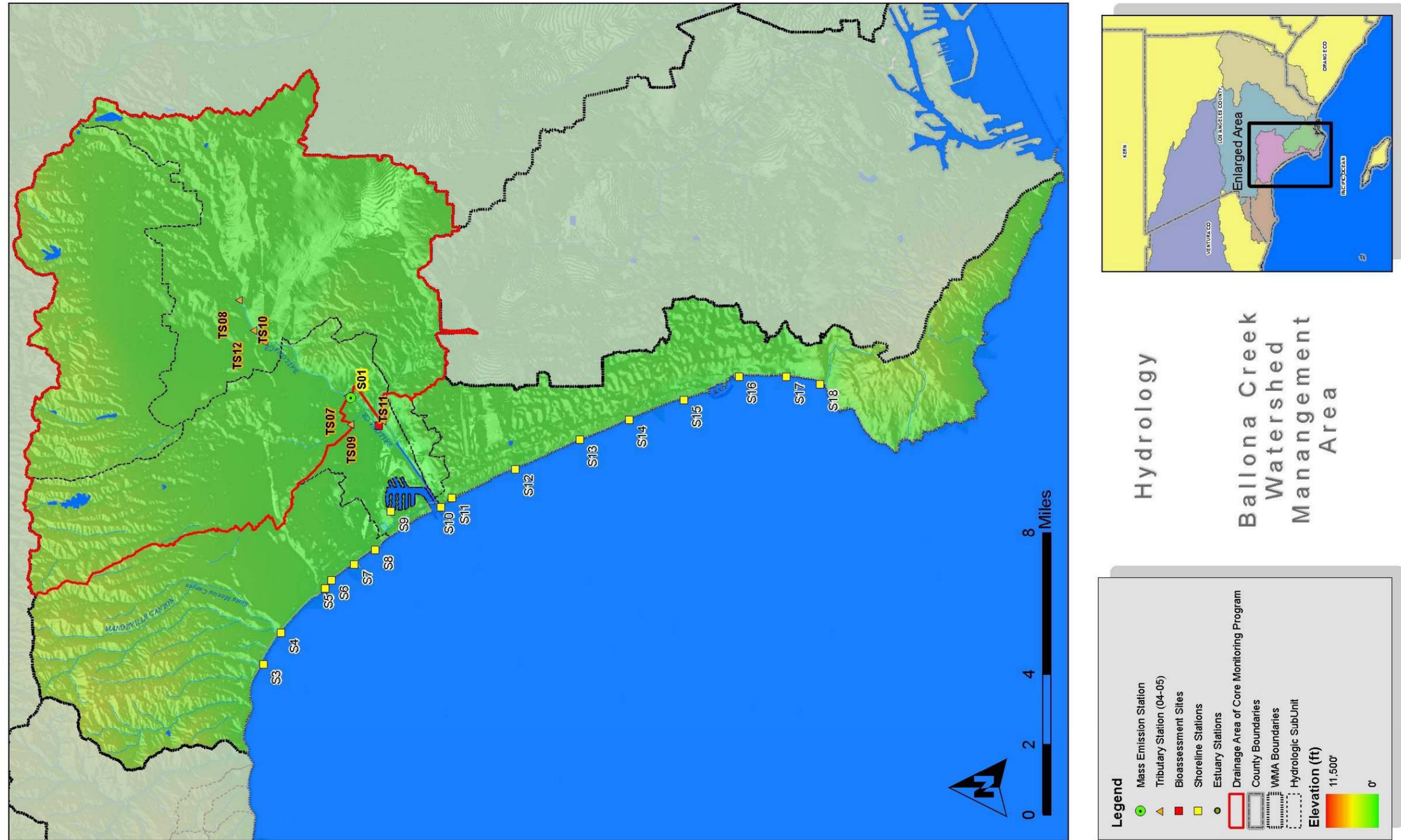
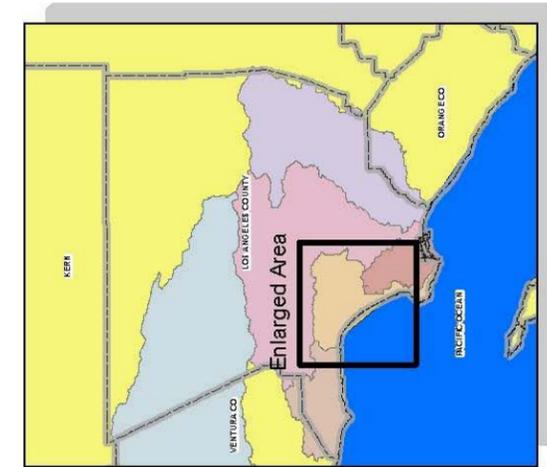
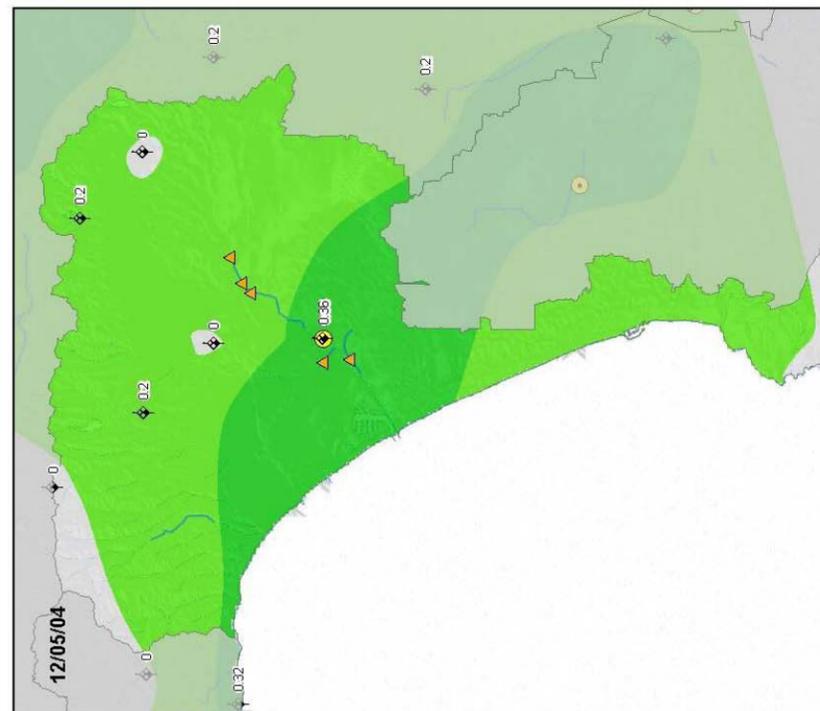
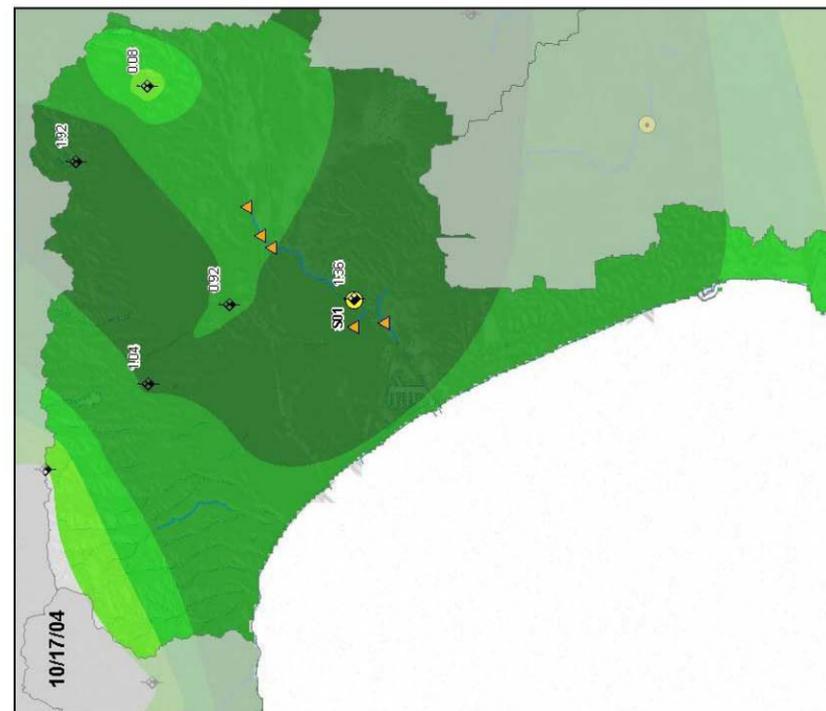
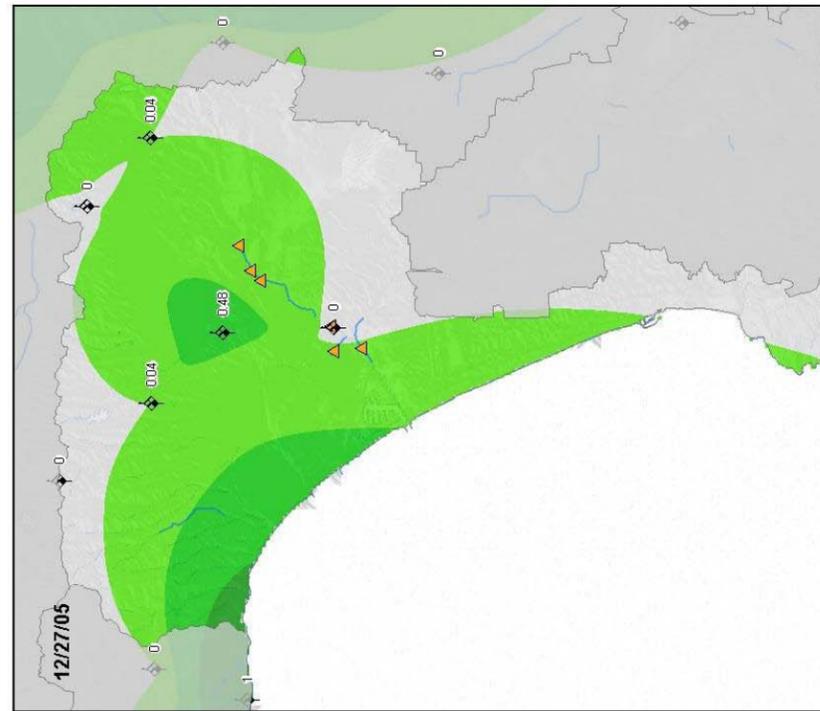
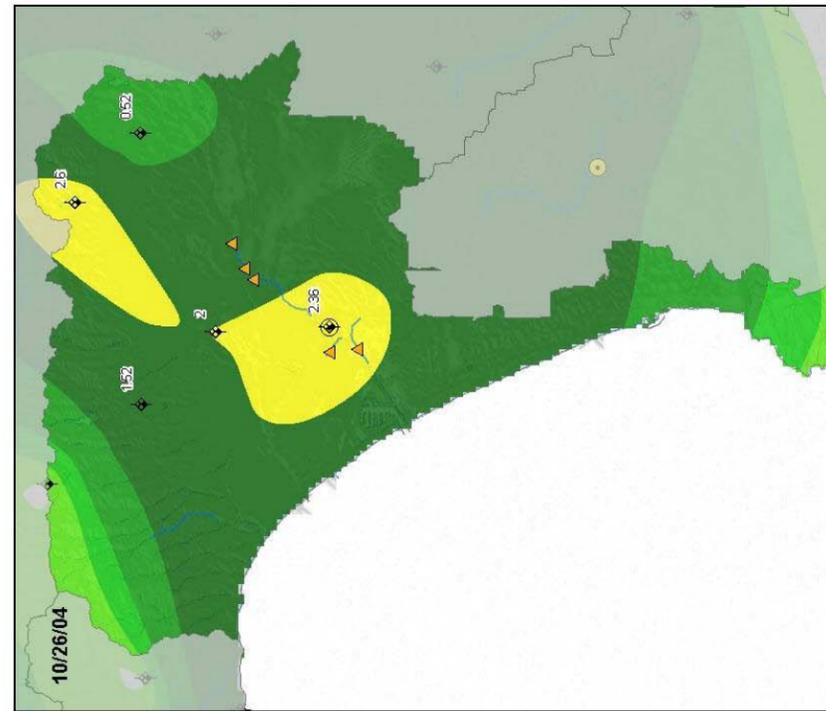


Figure 7-4. Hydrology and Monitoring Stations in the Ballona Creek WMA.





Monitored Storm Event Precipitation  
Ballona Creek Watershed Management Area

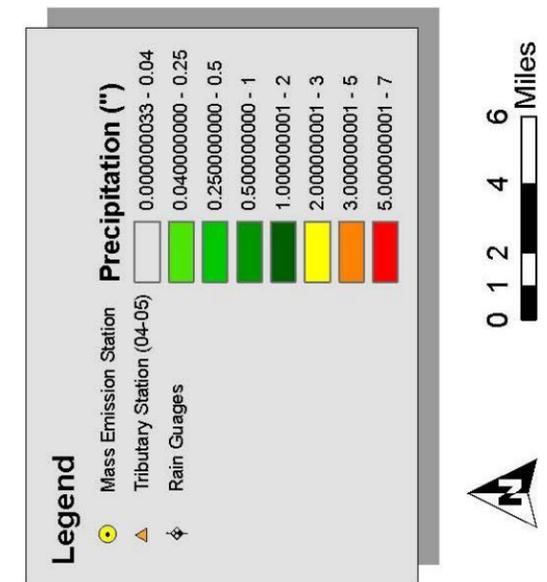
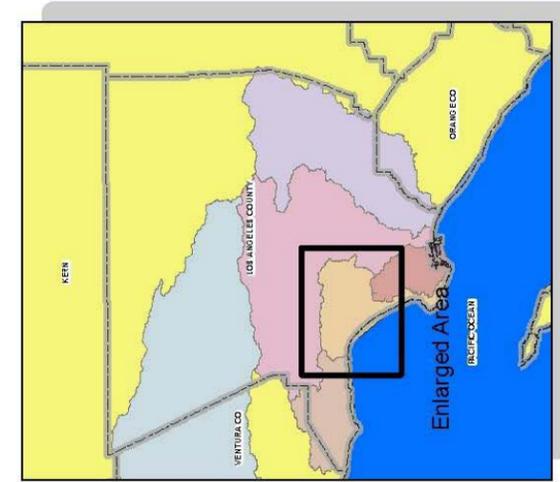
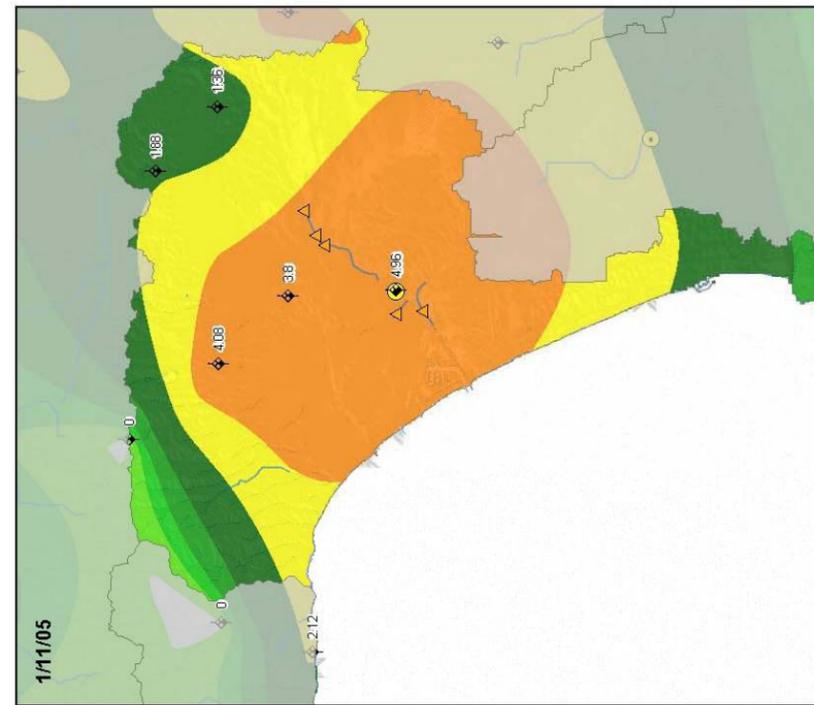
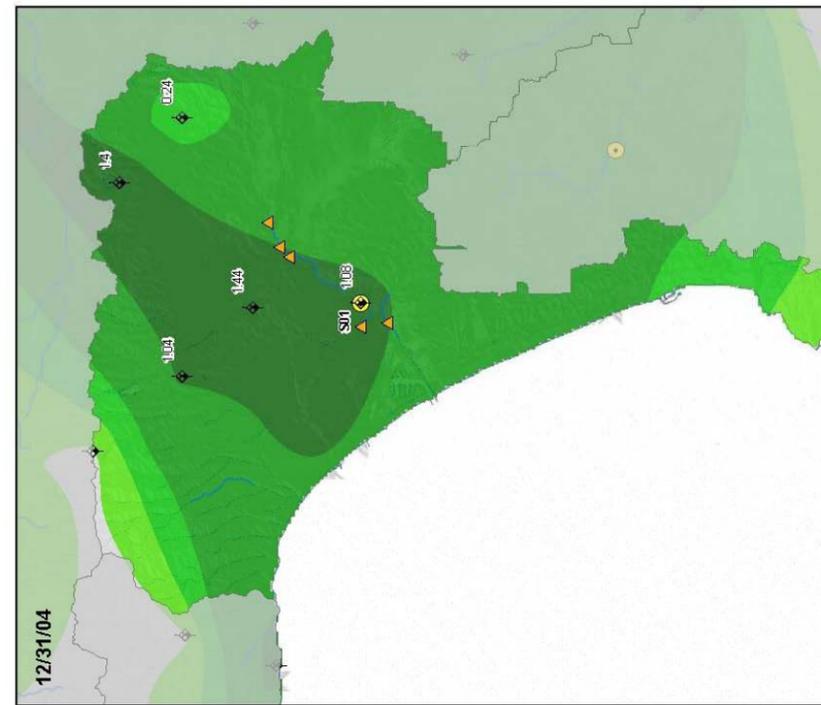
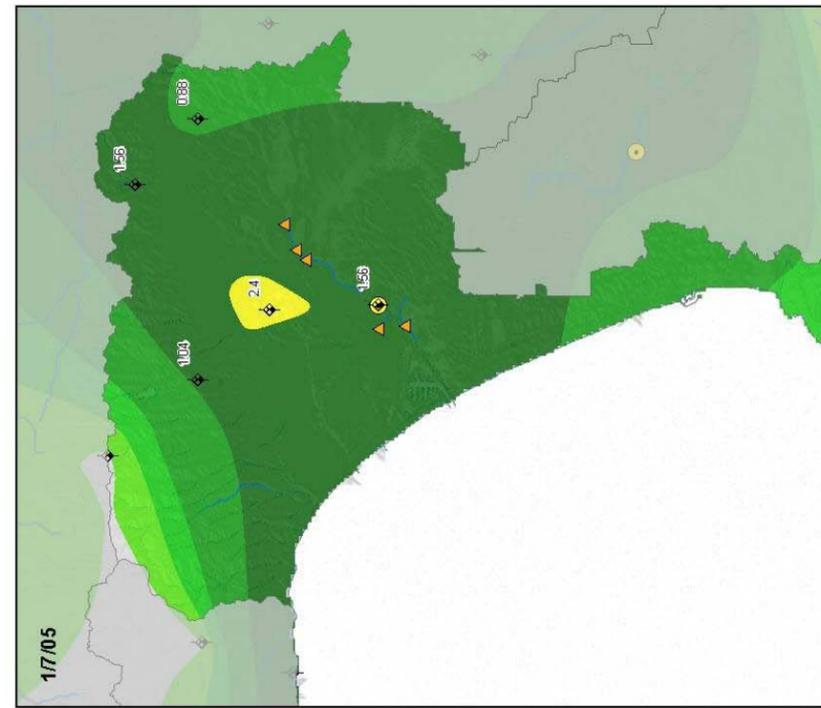


Figure 7-6. Distribution of Rainfall in the Ballona Creek WMA during the first four monitored events.



Monitored Storm Event Precipitation  
Ballona Creek Watershed Management Area

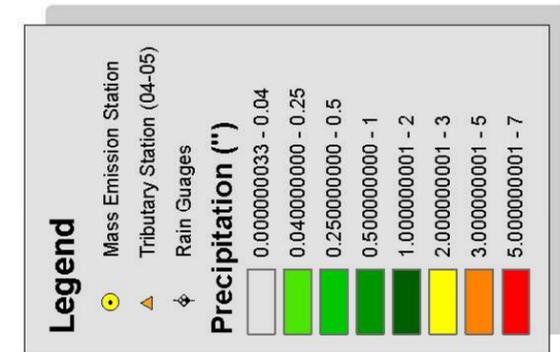


Figure 7-7. Distribution of Rainfall in the Ballona Creek WMA during the last three monitored events.

## 7.2 Flow Monitoring

A historical summary of recently monitored and total storm volumes is presented in Figure 7-8. Monitored flow (green bars) represents the amount of storm flow that is represented in the mass emission station composite sampling. Total flow (blue bars) represents the total amount of storm flow over the entire storm event.

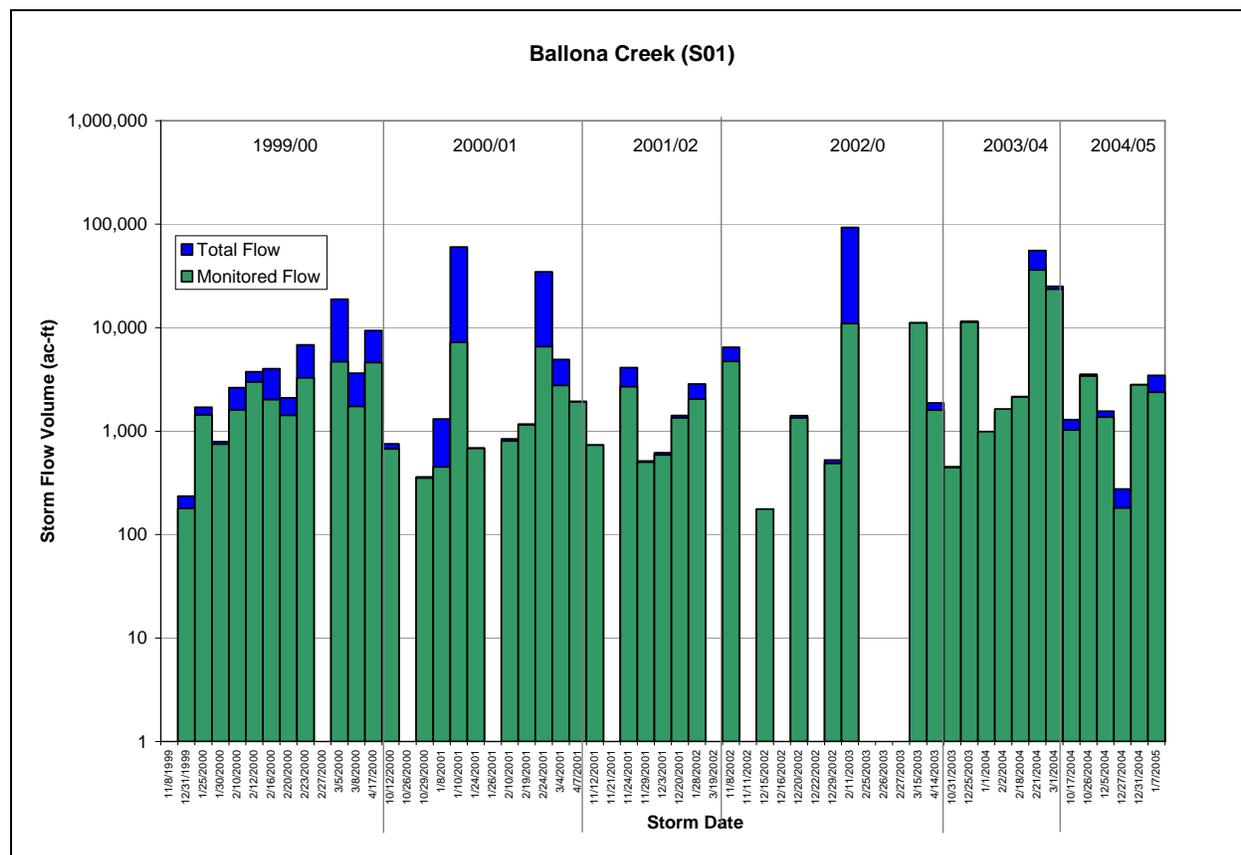


Figure 7-8. Summary of Historical Storm Flow Volumes.

## 7.3 Core Stormwater Monitoring Summary

### 7.3.1 Mass Emissions

Four wet weather events and two dry weather events were monitored at the Ballona Creek mass emission site during the 2004-2005 monitoring season. Sampling occurred during storms on October 17 and 26, 2004, December 5, 2004 and January 11, 2004. The dry weather sampling events were conducted on November 16, 2004 and March 9, 2005. The results from these sampling events are discussed in the following section (7.3.1.1) and presented in Appendix C, Table 5. Highlighted cells in Table 5 represent concentrations exceeding respective water quality objectives. This discussion presents the results based on groups of constituents (general chemistry, nutrients, bacterial indicators, metals, semi-volatiles and PCBs, and pesticides and

herbicides). A summary of the historical data and an assessment of trend analyses performed on the water quality data are presented in Section 7.3.1.2. Constituents of concern (COC) for the Ballona Creek Watershed are listed in Section 7.3.1.3.

### **7.3.1.1 2004-2005 Results**

General constituents include cyanide, pH, total petroleum hydrocarbons (TPH), oil & grease, total phenols and dissolved oxygen. Of these, only pH and cyanide exceeded water quality objectives (Appendix C, Table 5). The pH was measured at 6.07 units during the second storm, which was below (more acidic) the lower limit permissible by the Basin Plan. Cyanide exceeded objectives during two storm events. Other general water chemistry indicators are hardness, turbidity, TSS, VSS, MBAS, TOC, COD, BOD, and the major minerals that comprise TDS. Only chloride, fluoride, sulfate, TDS and turbidity have WQOs. None of these WQOs were exceeded during any sampling event. The major ions that comprise TDS were measured at greater concentrations in samples collected during the dry weather events than those collected in wet weather, which is likely because rainfall tends to dilute the levels of these ions in storm flow. Turbidity, TSS, VSS, and BOD were greater in stormwater samples than in dry weather samples.

For the nutrients, only nitrate-N and nitrite-N have defined WQOs. Neither of these constituents was measured at concentrations above their WQO in any sample. Other nutrients were detected at low concentrations in both wet weather and dry weather samples.

Samples were analyzed for bacterial indicators during three of the four wet weather events and during both dry weather monitoring events. Bacterial densities were not monitored during the January 11, 2005 storm event. Total coliform, fecal coliform, and enterococcus exceeded WQOs in all storm samples collected. Although WQOs for fecal streptococcus have not been established, it should be noted that fecal streptococcus levels were equal or greater than enterococcus levels for the same events. Enterococcus exceeded criteria during the November 16, 2004 dry weather event while total and fecal coliform exceeded objectives during the March 9, 2005 dry weather event.

Concentrations of four metals, including aluminum, copper, lead, and zinc, exceeded water quality objectives during at least two storm events. Total copper and lead exceeded objectives during every storm event; total zinc exceeded during three storm events and total aluminum exceeded only during two storm events. Dissolved copper exceeded criteria during two storms. Total copper was the only metal that exceeded the WQO during both dry weather events.

Four metals including beryllium, hexavalent chromium, mercury, and thallium were not detected in any sample in either the total or dissolved states. Additionally, dissolved aluminum, cadmium, manganese, and silver were not detected in any sample. Concentrations of all remaining metals were below water quality objectives during all wet and dry sampling events.

None of the semi-volatile organics, PCBs or herbicides was detected in any of the wet or dry weather samples collected during the 2004-2005 monitoring season.

Diazinon and prometryn were the only pesticides detected in stormwater samples. Diazinon was detected at 0.04 µg/L on October 26, 2004 and it exceeded the WQO on December 5, 2004 with

a concentration of 0.13 µg/L. Prometryn was detected at a concentration of 4.56 µg/L on October 17, 2004 and 5.39 µg/L on December 5, 2004. Concentrations of all pesticides, including diazinon and prometryn, were not detected during the dry weather events.

### **7.3.1.2 Historical Review**

Table 7-1 presents annual means for the constituents that were monitored from 1995 to 2005 with the appropriate water quality objectives. Each observation was compared to the lowest applicable WQO from the Basin Plan, Ocean Plan, or the California Toxic Rule (CTR) and those above the WQO were highlighted. Water quality objectives for metals are hardness dependent. Metal concentrations were determined using a mean hardness value; however, individual events show specific hardness for that particular event. Therefore, results for individual events may show different results that may be less than water quality objectives. Individual events for each year are presented in the annual reports.

The yellow-highlighted cells in Table 7-1 indicate that a constituent's detection limit is greater than the WQO. For statistical analyses, one-half the detection limit is used in place of a non-detect result. Therefore, annual means generated from values highlighted in yellow may be misrepresentative of actual concentrations. Table 7-1 suggests that total mercury and total thallium have consistently exceeded WQOs; however, since the detection limits are greater than the WQO, actual concentrations could not be determined. In addition, the Ocean Plan was developed for the protection of marine resources. It applies specifically to discharges to the ocean and not to discharges to enclosed bays, estuaries or inland waters. The Ocean Plan criteria were intended for ocean water samples representative of the discharge area after initial dilution has been completed (SWRCB 2001). Therefore, applying the Ocean Plan criteria to stormwater samples collected upstream of the Ballona Creek mouth and interpreting these results should be done with caution. Concentrations for these constituents were not considered as exceedances.

Table 7-1 also presents frequency and mean magnitude of exceedance ratios for each constituent. The frequency ratio was determined by dividing the total number of years a constituent was analyzed into the number of times the mean value of a constituent exceeded the WQO. The mean magnitude of exceedance was determined by dividing the WQO for a constituent into the constituents mean value for each year, then calculating the average magnitude of exceedance. A frequency ratio greater than 0.5 (50%) and a mean exceedance ratio greater than 1.0 were used as the criteria for determining whether a given parameter should be considered as a COC.

Blue highlighted cells in Table 7-1 represent exceedances of water quality objectives; yellow cells represent constituents in which the detection limits were above water quality objectives and were not considered exceedances; orange cells represent a frequency ratio greater than 0.5 (50% exceedance) and a mean exceedance ratio greater than 1.0.

Table 7-1. Annual Mean Concentration for Constituents Measured at the Ballona Creek Mass Emission Site, 1994 to 2005.

Constituent	Units	Lowest WQO <sup>1</sup>	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	Frequency Ratio	Mean Exceedance Ratio <sup>2</sup>
General															
Alkalinity	mg/l				27.0	68.6	69.0	66.7	68.1	60.9	189.2	166.6	114.7	0.0	
Bicarbonate	mg/l				27.0	68.6	69.0	80.1	82.9	74.3			166.3	0.0	
BOD	mg/l				29.4	19.7	45.9	12.9	9.4	19.2	10.7	16.7	21.3	0.0	
Calcium	mg/l				10.3	30.6	31.5	26.0	27.1	25.3			43.1	0.0	
Carbonate	mg/l								1.0	1.0			1.0	0.0	
Chloride	mg/l	500			5.9	29.1	24.2	27.9	25.1	22.8	73.7	75.1	40.9	0.0	0.1
COD	mg/l				118.2	103.2	63.7	41.6	53.1	148.1	64.7	43.3	55.5	0.0	
Cyanide	mg/l	0.004							0.01	0.01	0.01	0.01	0.01	1.0	1.7
Dissolved Oxygen	mg/l	<5									8.6	9.9	10.3	0.0	0.5
Fluoride	mg/l	1.6				0.1	0.2	0.2	0.2	0.2	0.4	0.3	0.3	0.0	0.2
Hardness	mg/l				34.0	124.4	117.8	97.2	126.1	108.2	276.2	273.0	171.4	0.0	
Magnesium	mg/l				2.0	11.7	9.5	7.9	11.8	11.8			15.5	0.0	
MBAS	mg/l						0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	
Oil and Grease	mg/l		2.2	3.0	2.5		7.1	3.5	4.0	5.7	3.8	2.5	2.1	0.0	
pH		6.5/8.5			7.1	7.1	7.4	7.2	7.3	7.2	8.2	7.6	7.0	0.0	
Potassium	mg/l				1.8	3.5	3.5	3.4	3.8	4.5			4.7	0.0	
Sodium	mg/l				5.4	19.3	22.9	20.7	24.5	25.2			34.1	0.0	
Specific Conductance	umhos/cm				113.3	357.0	346.2	342.4	322.0	306.5	786.0	798.6	468.2	0.0	
Sulfate	mg/l	500			8.8	53.4	42.8	38.8	41.2	40.5	106.2	124.1	62.6	0.0	0.1
Total Dissolved Solids	mg/l	2000			69.5	221.6	217.8	206.5	194.5	206.3	511.0	503.2	282.8	0.0	0.1
Total Organic Carbon	mg/l				5.1	8.7	11.8	9.2	9.5	14.6	7.3	6.5	10.7	0.0	
Total Phenols	mg/l								0.1	0.1	0.1	0.1	2.5	0.0	
Total Suspended Solids	mg/l				108.5	264.8	200.7	170.2	164.9	291.7	199.0	63.6	385.4	0.0	
TPH	Mg/l			2.57	2.99	2.69		2.73	2.34	3.19	2.35	1.70	0.37	0.0	
Turbidity	ntu	225			30.0	81.3	91.0	65.7	47.0	62.5	17.9	15.6	23.3	0.0	0.2
Volatile Suspended Solids	mg/l				42.0	76.0	61.5	48.3	46.6	82.8	14.2	26.8	98.8	0.0	
Nutrients															
Ammonia	mg/l				0.23	0.76	0.45	0.63	0.56	0.45			0.84	0.0	
Dissolved Phosphorus	mg/l				0.17	0.31	0.24	0.27	0.20	0.32	0.20	0.19	0.26	0.0	
Kjeldahl-N	mg/l				1.67	2.38	4.48	2.82	2.20	3.94	3.16	1.16	3.84	0.0	
NH3-N	mg/l				0.18	0.63	0.37	0.52	0.47	0.37	0.54	0.26	0.70	0.0	
Nitrate	mg/l				2.14	4.04	3.64	5.23	3.04	2.18	3.66	4.28	1.80	0.0	
Nitrate-N	mg/l	10			0.48	0.91	0.82	1.28	0.70	0.49	0.83	1.01	0.50	0.0	0.1
Nitrite-N	mg/l	1			0.06	0.10	0.18	0.14	0.21	0.16	1.01	0.42	0.24	0.1	0.3
Total Phosphorus	mg/l				0.42	0.34	0.35	0.36	0.24	56.00	0.31	0.21	0.43	0.0	
Indicator Bacteria															
Fecal Coliform	mpn/100ml	400	209,500	3,301,667	73,000	3,103,333	65,293	137,556	2,538,375	277,625	88,753	62,320	20,325	1.0	2245
Enterococcus	mpn/100ml	104	355,283	1,203,333			196,667	168,911	615,000	276,000	118,670	74,216	115,125	1.0	3337
Fecal Streptococcus	mpn/100ml		401,667	1,853,333	291,667	430,000	266,693	348,222	1,000,000	431,000	128,670	108,416	152,625	0.0	
Total Coliform	mpn/100ml	10,000	528,333	4,633,333	2,891,667	3,486,667	441,539	378,889	3,506,375	482,000	187,503	166,220	143,100	1.0	153
Metals															
Dissolved Aluminum	ug/l					1284.3	77.2	119.2	71.2	50.0	50.0	50.0	50.0	0.0	

Table 7-1. Annual Mean Concentration for Constituents Measured at the Ballona Creek Mass Emission Site, 1994 to 2005.

Constituent	Units	Lowest WQO <sup>1</sup>	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	Frequency Ratio	Mean Exceedance Ratio <sup>2</sup>
Dissolved Antimony	ug/l								2.5	1.8	1.3	1.6	1.4	0.0	
Dissolved Arsenic	ug/l								2.5	2.0	2.2	2.4	1.8	0.0	
Dissolved Barium	ug/l				8.0	46.9	35.4	38.1	29.5	33.3			34.6	0.0	
Dissolved Beryllium	ug/l								0.5	0.5	0.5	0.5	0.5	0.0	
Dissolved Boron	ug/l					164.0	194.3	132.8	133.1	125.6			297.6	0.0	
Dissolved Cadmium	ug/l	1-4.7							0.5	0.5	0.5	0.5	0.5	0.0	0.2
Dissolved Chromium	ug/l	27-150.3			2.8				3.0	1.6	2.7	2.8	2.0	0.0	0.0
Dissolved Chromium +6	ug/l								5.0	5.0	5.0	5.0	5.0	0.0	
Dissolved Copper	ug/l	3.6-21.3			2.3	30.4	9.3	8.8	6.9	9.9	7.1	9.8	7.4	0.3	0.9
Dissolved Iron	ug/l				117.5	1679.9	103.1	246.7	129.0	210.7	113.3	76.0	95.2	0.0	
Dissolved Lead	ug/l	0.8-7.5				19.4			2.5	1.7	2.1	2.2	2.0	0.2	1.4
Dissolved Manganese	ug/l					85.4			50.0	61.3			50.0	0.0	
Dissolved Mercury	ug/l								0.5	0.5	0.5	0.5	0.5	0.0	
Dissolved Nickel	ug/l	20.9-122.9			2.9	11.3			3.6	4.7	5.3	4.3	4.4	0.0	0.1
Dissolved Selenium	ug/l								2.5	2.5	3.3	3.4	2.5	0.0	
Dissolved Silver	ug/l								0.5	0.5	0.5	0.5	0.5	0.0	
Dissolved Thallium	ug/l								2.5	2.5	2.5	2.5	2.5	0.0	
Dissolved Zinc	ug/l	47-277.1			46.3	154.9	50.1		57.0	49.2	30.0	43.8	34.5	0.1	0.5
Total Aluminum	ug/l	1000				2320.0	446.1	341.3	400.8	76.0	73.7	128.0	2984.6	0.3	0.8
Total Antimony	ug/l	6							2.5	1.7	1.4	1.7	2.4	0.0	0.3
Total Arsenic	ug/l	32			1.4				2.5	1.5	2.3	2.5	2.8	0.0	0.1
Total Barium	ug/l				20.5	72.4	47.7	50.8	36.8	36.7			101.3	0.0	
Total Beryllium	ug/l	4							0.5	0.5	0.5	0.5	0.5	0.0	0.1
Total Boron	ug/l					236.6	245.3	176.1	157.0	168.2			781.4	0.0	
Total Cadmium	ug/l	1.1-5.5				0.8			0.5	0.5	0.5	0.5	0.9	0.0	0.2
Total Chromium	ug/l	50			5.8	6.4			3.0	2.4	7.0	5.5	8.0	0.0	0.1
Total Chromium +6	ug/l										5.0	5.0	5.0	0.0	
Total Copper	ug/l	3.7-22.2			12.0	39.3	18.3	16.1	14.8	20.0	12.2	16.4	49.5	0.8	2.0
Total Iron	ug/l				404.0	7564.6	597.2	832.5	797.0	370.0	238.0	188.0	4128.6	0.0	
Total Lead	ug/l	0.8-11.6			8.8	35.1	6.5	4.9	6.1	2.4	2.7	1.9	36.6	0.7	3.4
Total Manganese	ug/l					126.0			57.4	164.4			169.6	0.0	
Total Mercury	ug/l	0.16			19.9				0.5	0.5	0.5	0.5	0.5	1.0	23.3
Total Nickel	ug/l	20.9-123.2			4.0	6.9	6.8	5.7	4.4	5.5	11.2	5.4	10.6	0.0	0.1
Total Selenium	ug/l	60			2.6				2.5	2.5	3.3	3.6	2.5	0.0	0.1
Total Silver	ug/l	2.8							0.5	0.5	0.5	0.5	0.61	0.0	0.2
Total Thallium	ug/l	2							2.5	2.5	2.5	2.5	2.5	1.0	1.3
Total Zinc	ug/l	48-283			80.3	382.1	95.9	73.1	87.0	52.1	49.7	60.1	180.4	0.2	0.9
Pesticides															
Diazinon	ug/l	0.08							0.005	0.074	0.051	0.030	0.037	0.0	0.4
Prometryn	ug/l										1	1	2.59	0.0	

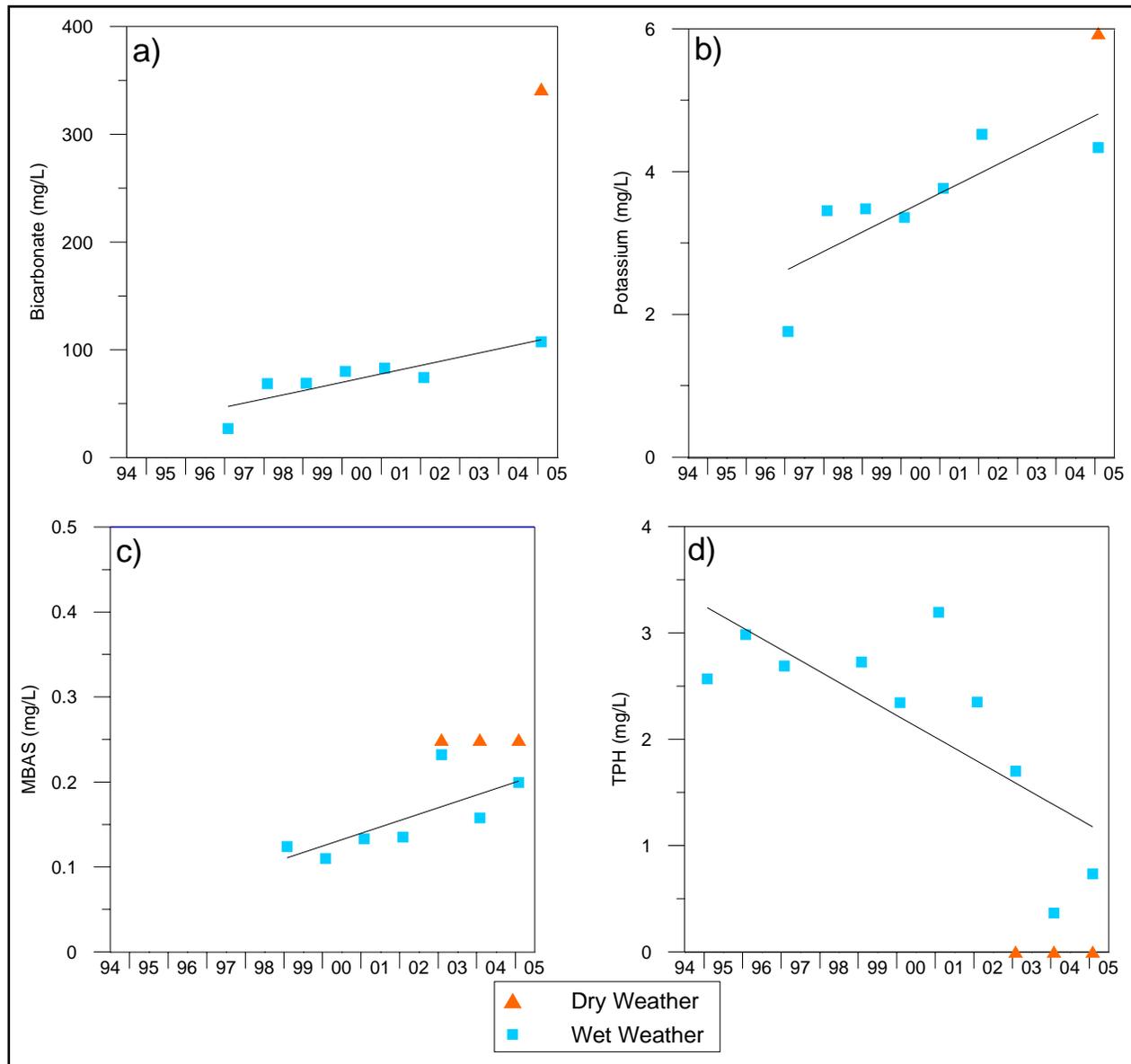
<sup>1</sup>WQO for metals are hardness dependent and were based on minimum hardness by year.

<sup>2</sup>Mean Exceedance Ratio calculated using annual mean concentrations reported up to four significant figures. Ratio shown may not exactly equal ratio of mean values shown in table due to rounding of presented means.

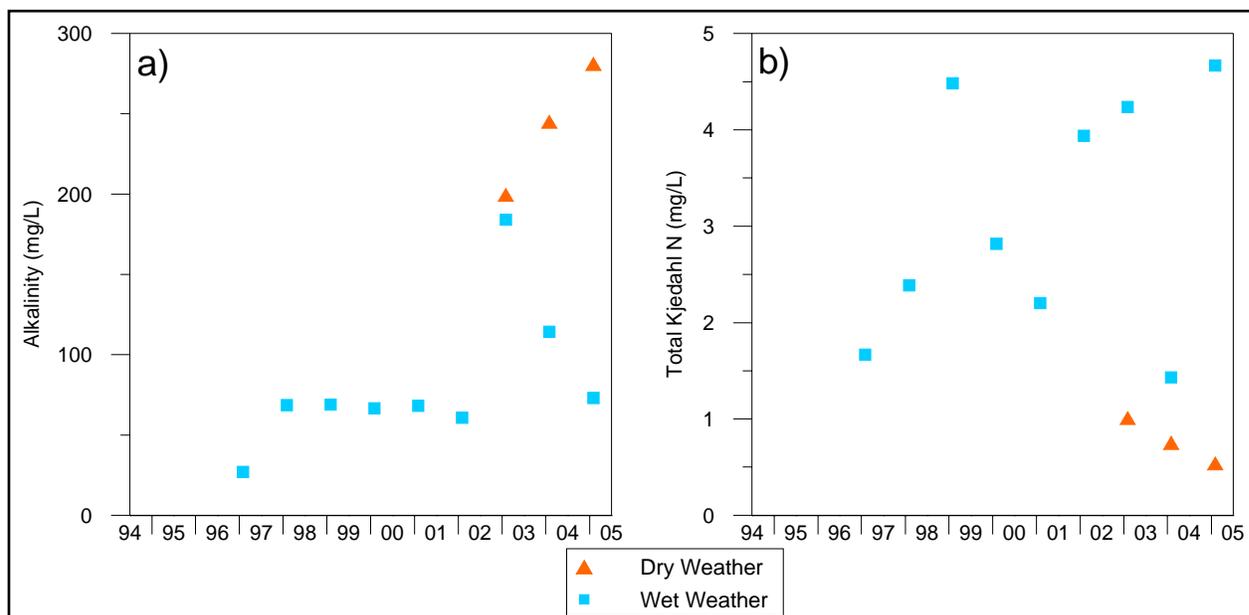
Blue = WQO Exceedances; Yellow = DL above WQO; Orange = Frequency ratio > 0.5, Mean exceedance > 1.0.

Cyanide, bacterial indicators and total copper and total lead were the only constituents that consistently exceeded WQOs. The mean annual total coliform, fecal coliform, and enterococcus densities exceeded WQO in all ten years; enterococcus was not sampled during the 1996-1997 and 1997-1998 seasons. Cyanide exceeded objectives every year since 2000. Total copper exceeded objectives 80% of the time while total lead had a 70% exceedance rate. Other metals, including total aluminum, mercury, and zinc and dissolved copper, lead, and zinc exceeded water quality objectives in at least one year. The annual mean value of total aluminum and zinc exceeded WQO in two years, while total mercury exceeded objectives by two orders of magnitude in 1996-1997. The annual mean value of dissolved copper exceeded water quality criteria during three years, while dissolved lead and zinc only exceeded WQOs in 1997-1998.

Regression analyses were performed on the water quality data collected since 1995-1996 to determine if any of the constituents had a significantly increasing or decreasing trend. In Ballona Creek wet weather data, very few constituents were identified as having significant trends, either increasing or decreasing. Bicarbonate, potassium and MBAS had significantly increasing trends (Figure 7-9a-c). Total petroleum hydrocarbon (TPH) was the only constituent that had a significantly decreasing trend (Figure 7-9d). The remaining constituents had concentrations that were either very consistent throughout the monitoring program, or were highly variable. During dry weather, alkalinity has been significantly increasing during the last three years, likely a result of increasing levels of minerals, and Total Kjeldahl Nitrogen (TKN) has been significantly decreasing during the same time period (Figure 7-10a-b).



**Figure 7-9. Scatterplot and Trends for Bicarbonate (a), potassium (b), MBAS (c) and Total Petroleum Hydrocarbons (d) at Ballona Creek Mass Emission Site, 1996 to 2005.**



**Figure 7-10. Scatterplot and Dry Weather Trends for Alkalinity (a) and Total Kjeldahl Nitrogen (b) at Ballona Creek Mass Emission Site, 1996 to 2005.**

### 7.3.1.3 Constituents of Concern

The constituents of concern for Ballona Creek are shown in Figure 7-11 and Table 7-2. A constituent is considered a COC if its frequency ratio exceeds 0.5 and/or mean exceedance ratio exceeds 1.0 (see Section 7.3.1.2 for an explanation of how frequency ratios and mean exceedance ratios are derived). Therefore, COC's as they are designated in this report serve as flags for water quality managers and should not be used for other purposes such as regulatory compliance.

At the mass emission site in Ballona Creek, the COCs included cyanide, bacterial indicators, total copper and total and dissolved lead. The yearly mean value for enterococcus typically exceeded the WQO by over 3,000 times (Figure 7-11). Fecal coliform values exceeded the WQO by over 2,000 times and total coliform values were greater than two orders of magnitude above the WQO. Total copper and total and dissolved lead also had mean magnitude of exceedance ratios greater than 1.0, indicating they frequently exceeded their respective WQOs. Total copper had a mean exceedance ratio of 2.0, while total and dissolved lead had mean exceedance ratios of 3.4 and 1.4, respectively. Total metals had greater exceedance ratios than the corresponding ratio for the metal in its dissolved state. None of these constituents have significantly increasing or decreasing trends. Based on the 2004-2005 monitoring data, only enterococcus concentrations of all the COCs indicated a "first flush" phenomena in that the highest concentrations were observed in the first storm event.

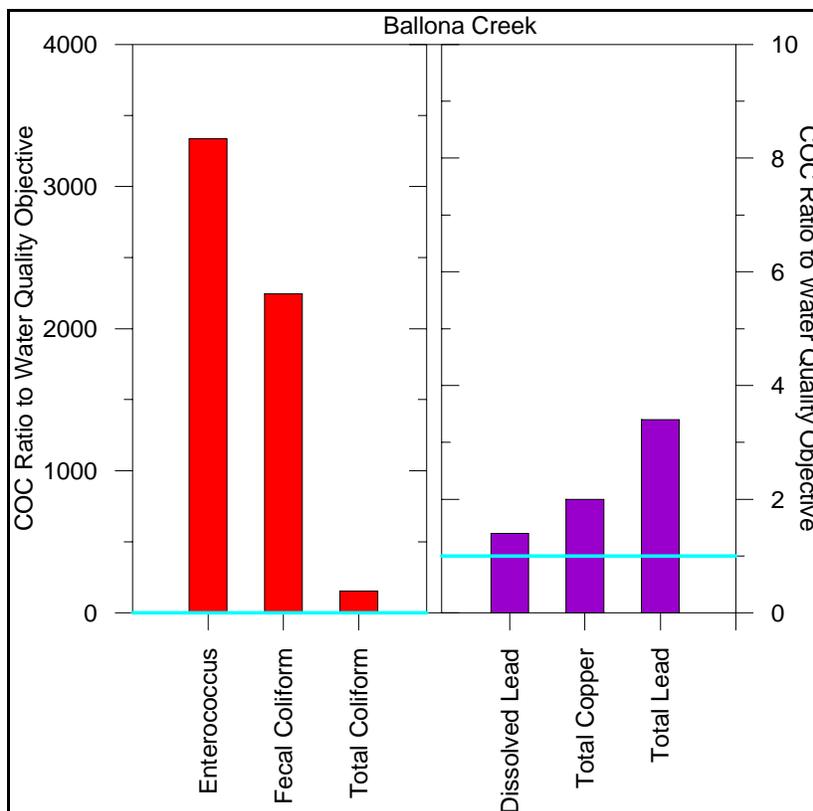


Figure 7-11. Mean Exceedance Ratio for Constituents Frequently Exceeding WQOs at Ballona Creek Mass Emission Site.

Table 7-2. Constituents of Concern, Increasing Trends and Comparison to 303(d) List in Ballona Creek.

Constituent	Constituents of Concern Based on Mass Emission Data Frequency/Magnitude	Constituents Indicating Increasing Trend	Comparison to 303(d) List
Cyanide	X		
Enterococcus	X		
Fecal Coliform	X		X
Total Coliform	X		X
Total Copper	X		
Total Lead	X		
Total Selenium			X
Dissolved Copper			X
Dissolved Lead	X		X
Dissolved Zinc			X
MBAS		X	
Potassium		X	
Bicarbonate		X	

Cyanide had a mean exceedance ratio of 1.7 and was identified as a COC; however, it is not included in Figure 7-11 as the graph focuses on indicator bacteria and metals. The origin of cyanide detected in the stormwater samples can be from a number of potential anthropogenic and natural non-point sources. It is assumed that potential industrial point sources are regulated under their own individual NPDES permit. Stormwater runoff from metal plating and finishing operations can be source of cyanide. Non-point sources of cyanide may include pesticide use. The largest likely source of cyanide in the WMA is air-borne deposition from motor vehicle emissions. The amount of cyanide that could be released to the environment from natural sources is comparatively low. Potential natural sources of cyanide include incomplete combustion from forest fires, decomposition of plant material and fungi. Water concentrations of cyanide tend to breakdown within days, but may bind to organic matter in sediments carried by stormwater and remain more persistent ([www.eco-usa.net](http://www.eco-usa.net), [www.dsf.health.state.pa](http://www.dsf.health.state.pa), [www.cynaidecode.org](http://www.cynaidecode.org), [www.npi.gov](http://www.npi.gov)).

Total mercury and total thallium have exceeded objectives since 2000-2001 (Table 7-1). However, it should be noted that the detection limits for these constituents are greater than the water quality objectives. Therefore, these constituents were not identified as COC's because actual values could not be determined.

MBAS, potassium and bicarbonate were the only constituents identified to have increasing trends. Although the Los Angeles Region Basin Plan does not have an established WQO for MBAS, the measured MBAS concentrations were compared to the San Diego Region Basin Plan WQO for MBAS (0.5 mg/L). The highest mean concentration of MBAS occurred during the 2002-2003 monitoring season and was less than half the San Diego Region WQO for MBAS. All three of the constituents with increasing trends were below the WQO.

Table 7-2 summarizes the constituents of concern based on the mass emission data and compares them to pollutants on the 303(d) list for Ballona Creek. Constituents indicating increasing trends are also shown in Table 7-2. The first column of Table 7-2 lists constituents of concern as determined from the integrated data set of annual mean values; the second column lists constituents that show an increasing trend even though concentrations may be below water quality objectives; and the third column is presented for comparison purposes and provides constituents that are 303(d) listed.

For the most part, the development of the COC list based on historical water quality data is consistent with those constituents 303(d) listed for the Ballona Creek Watershed (Table 7-2). Ballona Creek is 303(d) listed for metals, organics and bacterial indicators. The list includes the following metals: dissolved copper, dissolved lead and dissolved zinc. Dissolved lead has been identified as a COC in the Ballona Creek Watershed. Even though dissolved copper and zinc were not identified as COC's, concentrations of both metals have exceeded water quality objectives in at least one sampling event throughout the monitoring period. Total selenium is 303(d) listed; however, concentrations have never exceeded WQO during the past ten years. Alternatively, cyanide, total copper, and total lead have been identified as constituents of concern in the Ballona Creek Watershed; however, they are not included on the 303(d) list. Tissue samples have shown high levels of organics, including chlordane, DDT, dieldrin and PCBs. Water and sediment samples have caused toxicity to test species. Several TMDLs have already been developed for Ballona Creek and the Ballona Creek Estuary. A TMDL for copper, lead, selenium and zinc, establishes waste load allocations for these metals to the water column in

Ballona Creek. A separate TMDL was adopted for concentrations of chlordane, DDT, PCBs, PAHs, cadmium, copper, lead, silver, and zinc in Ballona Creek Estuary sediments. Other factors, such as tidal mixing, sediment transport and point sources may be influencing the sediment quality in Ballona Creek Estuary. Therefore a direct link between sediment degradation and urban runoff quality cannot be assessed within the context of this report.

### 7.3.2 Water Column Toxicity Monitoring

Samples collected from the Ballona Creek mass emission site were analyzed for toxicity to *Ceriodaphnia dubia* survival and reproduction and sea urchin fertilization. Composited wet and dry event samples from each season were tested from 2002-2005.

Water column toxicity monitoring determined that stormwater collected from the Ballona Creek mass emission station on October 17, 2004 only inhibited sea urchin fertilization. Stormwater collected on October 26, 2004 affected *Ceriodaphnia dubia* and sea urchin reproduction. Dry weather samples collected during 2004-2005 affected *C. dubia* and sea urchin fertilization. Stormwater and dry weather samples were not toxic to the survival of *C. dubia*.

Toxicity monitoring performed prior to the 2004-2005 season determined that some stormwater samples collected from Ballona Creek inhibited sea urchin fertilization. Wet weather samples collected during 2002-2003 and 2003-2004 only affected sea urchin fertilization. The dry weather samples were not toxic to the organisms. The Study of the Impact of Stormwater Discharge on the Beneficial Uses of Santa Monica Bay found that sea urchin fertilization was significantly reduced by exposure to undiluted wet weather stormwater samples collected from Ballona Creek in 1995-1996, 1996-1997, and 1997-1998. Stormwater from the season's first storm was found to be most toxic.

TIEs determined the toxicity in 2002-2003 stormwater was due to particulate-bound toxicants, one or more non-polar organic compounds and cationic metals. In 2003-2004 the stormwater toxic pollutant was believed to be a volatile compound.

### 7.3.3 Tributary Monitoring

During the 2004-2005 wet weather season, six mass emission sites located on tributaries to the main stem of Ballona Creek were monitored. These stations were placed to identify segments of the Ballona Creek Watershed that may be contributing higher concentrations of a contaminant(s) than other segments. From the furthest downstream to the furthest upstream, these stations were identified as Centinela Creek, Sepulveda Channel, Benedict Canyon, Adams Drain, Fairfax Drain and Cochran. Two of these monitoring sites (Centinela Creek and Sepulveda Channel) were located on tributaries downstream of the long-term Ballona Creek mass emission station. Five storm events and two dry weather events were monitored at each tributary mass emission station. Of these monitoring events, only three storms and a single dry season event coincided with sampling at the mass emission station. Results from all monitoring events are discussed by tributary in the following sections and presented in Appendix F, Tables 1-6.

### 7.3.3.1 Centinela Creek (TS07)

The Centinela Creek tributary monitoring site is located on Centinela Creek near the intersection of Centinela Blvd. and Highway 90. The confluence with Ballona Creek is downstream of the mass emission station. The tributary was monitored during storm events on October 17 and 26, 2004, and December 5, 27 and 31, 2004. Dry weather events were monitored on November 2, 2004 and March 9, 2005.

The 2004-2005 results are presented in Appendix F, Table 1. Only three conventional constituents exceeded water quality objectives during any of the five storm events monitored in 2004-2005 and only one constituent exceeded objectives during the dry weather event. Cyanide exceeded the WQO during three storm events and turbidity exceeded the WQO during one storm event with a measurement of 392 NTU. The pH value exceeded the WQO during the dry weather event on November 2, 2004 with a measurement of 8.8. The high pH value may have been the result of high photosynthesis by attached algae, as dissolved oxygen levels in Centinela Creek also peaked on this date. The high pH most likely resulted in the measurable carbonate concentration, which was not detected during all monitoring events with the exception of November 2, 2004. High pH levels tend to shift the equilibrium of the carbonate system to favor carbonate over bicarbonate.

Total coliform, fecal coliform and enterococcus densities all exceeded WQOs during all five storm events monitored. Total coliform values ranged from 160,000 to 500,000 MPN/100mL; fecal coliform values ranged from 17,000 to 500,000 MPN/100mL and enterococcus values ranged from 160,000 to 240,000 MPN/100mL. Total coliform, fecal coliform, and enterococcus bacteria also exceeded the WQO during the dry weather events, but values were lower. During dry weather events, total coliform values ranged from 5,000 to 17,000 MPN/100mL; fecal coliform values ranged from 700 to 5,000 MPN/100mL and enterococcus values ranged from 220 to 500 MPN/100mL.

Nitrate-N and Nitrite-N are the only nutrients with water quality objectives. They did not exceed the WQO during any of the storm or dry weather events.

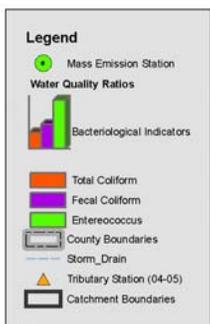
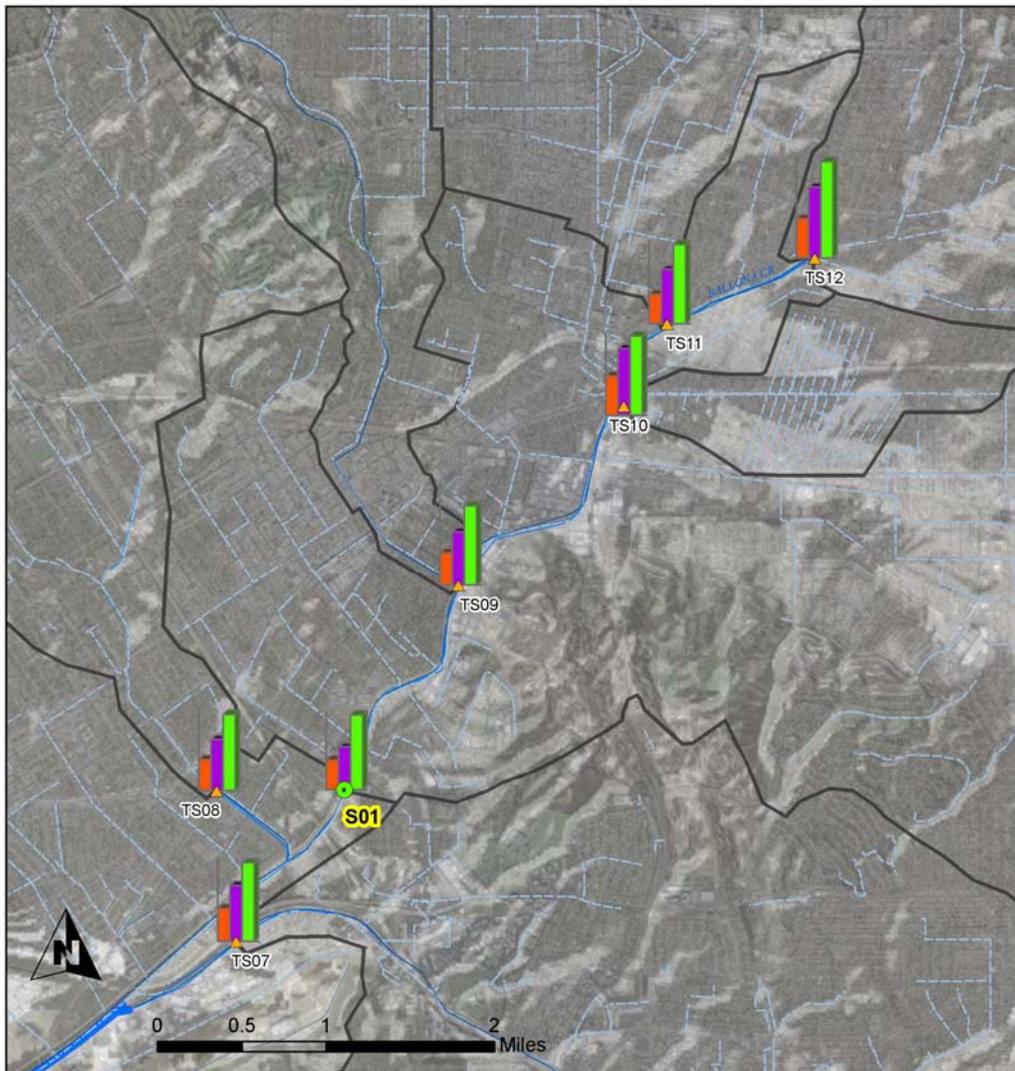
Four total metals, including aluminum, copper, lead and zinc exceeded WQOs during the storm events monitored in 2004-2005. Total copper exceeded the WQO during all five storm events ranging from 19.5 to 82.9 µg/L. Total aluminum exceeded the WQO four out of five storms ranging from 4420 to 7000 µg/L. Total lead exceeded WQO during four storm events ranging from 11.2 to 59 µg/L and total zinc exceeded WQO during three storms ranging from 212 to 296µg/L. Three dissolved metals exceeded WQOs during the storm events, including copper, lead and zinc. Copper exceeded WQO during three storm events ranging from 10.8 to 13.7 µg/L. Lead exceeded the WQO during one storm event with a value of 5.91 µg/L and zinc exceeded WQO during two storm events and with measurements of 57.5 and 66.4 µg/L. Total copper was the only metal that exceeded the WQO during dry weather with values ranging from 23.9 to 29.5 µg/L.

All of the semi-volatiles and PCB's were not detected during all five storms and the two dry weather events. Diazinon exceeded the WQO during two storm events with values of 0.11 and 0.12 µg/L. Diazinon was detected below the WQO during the dry weather event on March 9, 2005. All other pesticides and herbicides were not detected during the monitoring events.

The confluence of Centinela Creek with Ballona Creek is downstream of the Ballona Creek mass emission site. Therefore, the potential loading of constituents from Centinela Creek is not captured by the water quality monitoring conducted at the Ballona Creek mass emission site. However, stormwater from Centinela Creek contains some of the same COCs measured at the Ballona Creek mass emission station. For instance, oil and grease levels exceeded WQOs at Centinela Creek and the mass emission station on December 5, 2004. In addition, when bacteria levels exceeded WQO criteria at Centinela Creek, fecal and total coliforms and enterococcus levels also were exceeded at the mass emission station. Likewise, nearly every event in which total copper, lead, zinc, aluminum or dissolved copper exceeded WQOs at Centinela Creek, concentrations of the same metals at the mass emission station also exceeded applicable criteria.

The magnitude of exceedance (Water Quality Ratios) for bacteriological indicators for this tributary station is compared to the mass emission station and the other tributary stations on Figure 7-12. The magnitude of exceedance is presented at each of the tributary stations based on the ratio of the mean concentrations for all the sampling events to date, to the applicable water quality objective. For bacteriological indicators, the magnitude of exceedance of the WQO is similar for all the tributaries and the mass emission station. No one or set of tributaries appear to be a primary source of bacterial indicator exceedances based on concentration. Comparisons of the loadings from each tributary are presented in Conclusions Section (Section 12) of this report.

Figure 7-13 presents the magnitude of exceedance (Water Quality Ratios) for the selected metals at this tributary station, the mass emission station and the other tributary stations. The metals shown include dissolved and total copper and dissolved and total lead. These metals were selected because they were consistently detected at concentrations above the WQO in many of the tributaries and the mass emission station. The magnitude of exceedance is presented at each of the tributary stations based on the ratio of the mean concentrations for all the sampling events to date, to the applicable water quality objective. For these metals, the magnitude of exceedance of the WQO is higher for total copper and lead at the Centinela station compared to further upstream tributary and channel locations that include Sepulveda, Benedict, and the MES. The farthest upstream tributary locations are characterized by greater exceedances than Centinela and the other downstream locations. Based on concentration, Centinela and the farthest upstream tributaries appear to exhibit greater exceedances of the WQO for the selected metals. Comparisons of the loadings from each tributary are presented in Conclusions Section (Section 12) of this report.

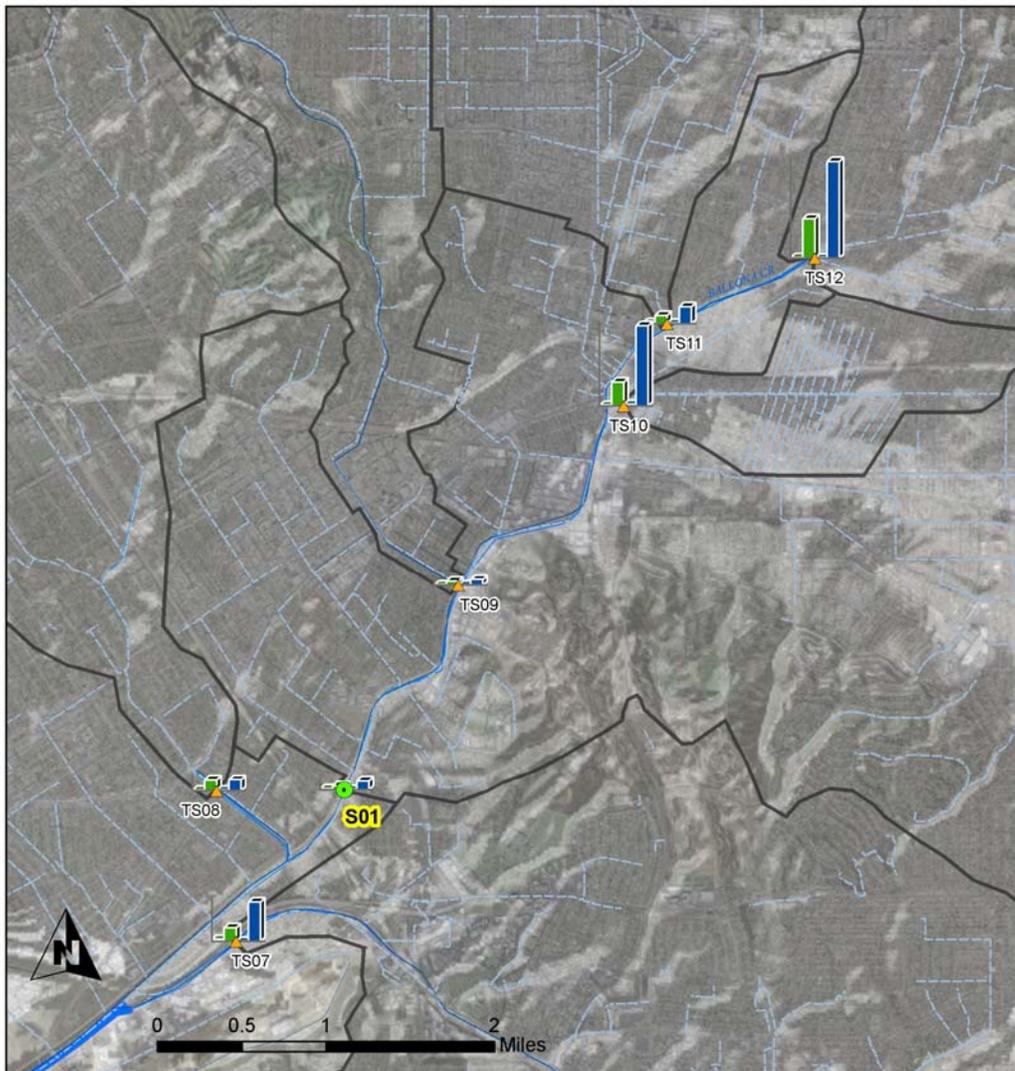


Summary of Magnitude of Exceedance of Water Quality Objective at the Ballona Creek Tributary Stations



\* Water Quality Ratio = Mean Concentration divided by the Water Quality Objective

**Figure 7-12. Summary of Magnitude of Exceedance of Water Quality Objectives for Bacteriological Indicators at the Ballona Creek Tributary Stations.**



Summary of Magnitude of Exceedance of Water Quality Objective at the Ballona Creek Tributary Stations



\* Water Quality Ratio = Mean Concentration divided by the Water Quality Objective

Figure 7-13. Summary of Magnitude of Exceedance of Water Quality Objectives for Selected Metals at the Ballona Creek Tributary Stations.

### 7.3.3.2 Sepulveda Channel (TS08)

The Sepulveda Channel tributary monitoring site is located on the Sepulveda Channel at Culver Blvd. The confluence of Sepulveda Channel with Ballona Creek is downstream of the mass emission station. The tributary was monitored during storm events on October 17 and 26, December 5, 27 and 31, 2004. Dry weather events were sampled on November 2, 2004 and March 9, 2005.

The 2004-2005 results are presented in Appendix F, Table 2. Only one conventional constituent exceeded WQO during the monitoring events. Cyanide exceeded objectives during one storm and one dry season event with values of 0.007 and 0.05 mg/L, respectively. TPH, oil and grease, and carbonate were not detected during any of the events monitored in 2004-2005.

Total and fecal coliform and enterococcus all exceeded WQOs during all five storm events. Sepulveda Canyon is on the current 303(d) list for coliform bacteria levels. Total coliform values ranged from 130,000 to 300,000 MPN/100mL; fecal coliform values ranged from 2,400 to 170,000 MPN/100mL and enterococcus values ranged from 90,000 to 240,000 MPN/100mL. Although the values were lower, all three constituents exceeded the WQO during the dry weather events. During dry weather, total coliform values ranged from 30,000 to 35,000 MPN/100mL; fecal coliform values ranged from 3,000 to 9,000 MPN/100mL and enterococcus values ranged from 800 to 9,000 MPN/100mL.

Nitrate-N and Nitrite-N are the only nutrients with WQOs. They did not exceed the WQO during any of the storm or dry weather events. Ammonia levels peaked at 5.77 mg/L on October 17, 2004, but ranged from 0 to 0.5 mg/L on the other sampling dates. Sepulveda Canyon is on the current 303(d) list for ammonia.

Seven total metals, including aluminum, antimony, cadmium, copper, lead, nickel, and zinc exceeded WQOs during the storm events. Copper exceeded the objectives during all five storm events ranging from 22.9 to 324 µg/L. Aluminum and lead exceeded the WQO during four of the five events. Sepulveda Canyon is on the current 303(d) list for lead. Aluminum values ranged from 3,163 to 1,710 µg/L and lead values ranged from 11.9 to 116 µg/L. Zinc exceeded WQO three out five storms, ranging from 116 to 1,340 µg/L. Antimony and nickel exceeded the WQOs during two storm events and cadmium exceeded objectives during one storm event with a value of 2.84 µg/L. Only one dissolved metal exceeded WQO during the storm events. Copper exceeded the WQO during two storms with values of 9.64 and 9.78 µg/L. Total copper was the only metal that exceeded the WQO during the dry weather event with a measurement of 22.9 µg/L.

All of the semi-volatiles and PCBs were not detected during all five storms and one dry weather event. Bis(2-Chloroethoxy) methane was measured on March 9, 2005. Diazinon exceeded the WQO during one storm event with a value of 0.19 µg/L. Chlorpyrifos was detected during one storm event; however, it was measured below the water quality objective. All other pesticides and herbicides were not detected during the monitoring events.

Sepulveda Channel transports constituents of concern to Ballona Creek downstream of the Ballona Creek mass emission site. Although COC loadings at Ballona Creek cannot be

attributed to flow from Sepulveda Channel, samples from the two sites had similar COCs. Bacteria exceedances coincided with excursions of total and fecal coliforms and enterococcus at the mass emission station. When total copper, lead, zinc, or aluminum exceeded applicable WQOs at the mass emission station, concentrations of the same metals at Sepulveda Creek also typically exceeded standards.

Figures 7-12 and 7-13 present a summary of the magnitude of exceedance (Water Quality Ratios) for bacteriological indicators and selected metals, respectively, at this and the other tributary stations and the mass emissions station. For bacteriological indicators, the magnitude of exceedance of the WQO is similar for all the tributaries and the mass emission station. No one or set of tributaries appear to be a primary source of bacterial indicator exceedances based on concentration. Based on concentration, the Sepulveda location is characterized by slightly greater exceedances for metals than the MES, and significantly lower exceedances of the WQO for selected metals compared to Centinela and the further upstream tributaries. Comparisons of the loadings for the constituents presented in these figures for each tributary are presented in Conclusions Section (Section 12) of this report.

#### **7.3.3.3 Benedict Canyon (TS09)**

The Benedict Canyon tributary monitoring site is located in Culver City where Duquesne Avenue crosses Ballona Creek. The tributary monitoring site is designed to monitor flow from the Benedict Canyon Channel. The tributary was monitored during storm events on October 17 and 26, December 5, 27 and 31, 2004. Dry weather events were sampled on November 2, 2004 and March 9, 2005. The one dry weather event was monitored on November 2, 2004. The three storms monitored on October 17, October 26, and December 5, 2004 and the dry season event on March 9, 2005 were the only events that coincided with monitoring at the mass emission station.

The 2004-2005 results are presented in Appendix F, Table 3. Three general water chemistry constituents exceeded WQOs during the monitoring events. Cyanide exceeded objectives during one storm event with a value of 0.007 mg/L. Turbidity exceeded the WQO during one storm event with a measurement of 233 NTU. Oil and grease was only detected during the dry season event on March 9, 2005 however the concentration was below water quality criteria. TPH and oil and grease were not detected during any of the events monitored in 2004-2005. Carbonate was not detected during any of the events monitored in 2004-2005.

Total and fecal coliform and enterococcus all exceeded WQOs during all five storm events. Total coliform values ranged from 220,000 to 300,000 MPN/100mL; fecal coliform values ranged from 22,000 to 240,000 MPN/100mL and enterococcus values ranged from 90,000 to 300,000 MPN/100mL. Bacteria levels during the dry season were lower than during storms, but total and fecal coliform and enterococcus still exceeded applicable standards. During dry weather, total coliform values ranged from 30,000 to 170,000 MPN/100mL; fecal coliform values ranged from 130 to 900 MPN/100mL and enterococcus values ranged from 700 to 1,700 MPN/100mL.

Nitrate-N and Nitrite-N are the only nutrients with WQOs. They did not exceed the WQO during any of the storm or dry weather events.

Six total metals, including aluminum, cadmium, copper, lead, nickel, and zinc exceeded WQOs during the storm events. Copper exceeded the objectives during all five storm events ranging from 26.4 to 98.8 µg/L. Aluminum and lead exceeded the WQOs during four of the five events. Aluminum values ranged from 2,440 to 8,100 µg/L and lead values ranged from 12.4 to 47.3 µg/L. Zinc exceeded WQO three out five storms, ranging from 198 to 267 µg/L. Cadmium and nickel exceeded objectives during one storm event with values of 2.81 and 20.9 µg/L, respectively. Only one dissolved metal exceeded WQO during the storm events. Copper exceeded the WQO during two storms with values of 9.81 and 10 µg/L. Total copper was the only metal that exceeded WQO during the dry weather event with a measurement of 15.3 µg/L.

All of the semi-volatiles and PCBs were not detected during all five storms and one dry weather event. Bis(2-Ethylhexyl) phthalate was measured on March 9, 2005. Diazinon exceeded the WQO during three storm events with values of 0.085, 0.129 and 0.61 µg/L. All other pesticides and herbicides were not detected during the monitoring events.

When bacteria levels at Benedict Canyon failed to comply with WQO criteria, exceedances of total and fecal coliforms and enterococcus also occurred at the Ballona Creek mass emission station. Exceedances of WQOs for total copper, lead, zinc, and aluminum at Benedict Canyon usually coincided with exceedances of the same metals at the mass emission station.

Figures 7-12 and 7-13 present a summary of the magnitude of exceedance (Water Quality Ratios) for bacteriological indicators and selected metals, respectively, at this and the other tributary stations and the mass emissions station. For bacteriological indicators, the magnitude of exceedance of the WQO is similar for all the tributaries and the mass emission station. No one or set of tributaries appear to be a primary source of bacterial indicator exceedances based on concentration. Based on concentration, Benedict Canyon station exhibits the lowest exceedances for the selected metals compared to the Centinela station and the farthest upstream tributaries. Comparisons of the loadings for the constituents presented in these figures for each tributary are presented in Conclusions Section (Section 12) of this report.

#### **7.3.3.4 Adams Drain (TS10)**

Adams Drain is located in the northern portions of Culver City near the intersection of La Cienega Blvd. and Ballona Creek. The tributary was monitored during storm events on October 17 and 26, December 5, 27 and 31, 2004. Dry weather events were sampled on November 2, 2004 and March 9, 2005. The three storms monitored on October 17, October 26, and December 5, 2004 and the dry season event on March 9, 2005 were the only events that coincided with monitoring at the mass emission station.

The 2004-2005 results are presented in Appendix F, Table 4. Three conventional constituents exceeded WQOs during the storm events. Cyanide exceeded the WQO during three storms with values ranging from 0.006 to 1.7 mg/L and pH did not meet the WQO during one storm event with a measurement of 6.4. All constituents were below water quality objectives during the dry weather event. Carbonate was not detected during any of the events monitored in 2004-2005.

Total and fecal coliform and enterococcus all exceeded WQOs during all five storm events. Total coliform values ranged from 240,000 to 900,000 MPN/100mL; fecal coliform values ranged from 240,000 to 500,000 MPN/100mL and enterococcus values ranged from 140,000 to

300,000 MPN/100mL. Total coliform and enterococcus exceeded WQOs during the dry weather events with values of 240,000 and 2,800 to 14,000 MPN/100mL, respectively.

Nitrate-N and Nitrite-N are the only nutrients with WQOs. They did not exceed the WQO during any of the storm or dry weather events.

Eight total metals, including aluminum, antimony, cadmium, copper, lead, nickel, silver and zinc exceeded WQOs during the storm events. Copper, lead and zinc exceeded the WQO during all five storm events. Copper values ranged from 19.9 to 283 µg/L; lead values ranged from 10.7 to 204 and zinc measurements ranged from 105 to 1,120 µg/L. Aluminum and nickel exceeded objectives during four out of five storms. Aluminum values ranged from 2,711 to 8,960 µg/L and nickel values ranged from 20.2 to 28.4 µg/L. Antimony, cadmium and silver exceeded the WQO during two storm events. Antimony values were 7.05 and 10.2 µg/L; cadmium values were 2.77 and 2.96 µg/L and silver measurements were 1.08 and 20.6 µg/L. Three dissolved metals exceeded WQOs during the storm events. Lead exceeded the WQO during all five storm events with values ranging from 1.2 to 5.27 µg/L. Copper exceeded objectives during four of the five storms with values ranging from 4.51 to 12.9 µg/L. Zinc exceeded the WQO during two storm events with measurements of 70.5 and 106 µg/L. Total copper was the only metal that exceeded WQO during the dry weather events with a measurements ranging from 17.4 µg/L to 28.0 µg/L.

All of the semi-volatiles and PCBs were not detected during all five storms and one dry weather event. Bis(2-Ethylhexyl) phthalate and 2,4,5-Trichlorophenol were measured on March 9, 2005. Diazinon exceeded the WQO during two storm events with values of 0.094 and 0.207 µg/L. Chlorpyrifos exceeded WQO during one storm event with a value of 0.094 µg/L. All other pesticides and herbicides were not detected during the monitoring events.

Adams Drain contributes to high levels of COCs at the Ballona Creek mass emission station. Cyanide and pH did not comply with applicable WQOs at the two stations on October 17 and October 26, 2004, respectively. Exceedances of total and fecal coliforms and enterococcus at Adams Drain and the mass emission station occurred regularly on the same sampling dates. Total copper, lead, zinc, and aluminum routinely did not comply with WQOs and these excursions coincided with exceedances at the mass emission station on October 17 and 26 and December 5, 2004.

Figures 7-12 and 7-13 present a summary of the magnitude of exceedance (Water Quality Ratios) for bacteriological indicators and selected metals, respectively, at this and the other tributary stations and the mass emissions station. For bacteriological indicators, the magnitude of exceedance of the WQO is similar for all the tributaries and the mass emission station. No one or set of tributaries appear to be a primary source of bacterial indicator exceedances based on concentration. Based on concentration, Adams station and the farthest upstream tributaries including Fairfax and Cochran, appear to exhibit greater exceedances of the WQO for the selected metals. Comparisons of the loadings for the constituents presented in these figures for each tributary are presented in Conclusions Section (Section 12) of this report.

### 7.3.3.5 Fairfax Drain (TS11)

The Fairfax Drain tributary monitoring site is located in Los Angeles where Fairfax Avenue crosses Ballona Creek. The tributary was monitored during storm events on October 17 and 26, December 5 and 27, 2004 and January 7, 2005. Dry weather events were sampled on November 2, 2004 and March 9, 2005. The three storms monitored on October 17, October 26, and December 5, 2004 and the dry weather event on March 9, 2005 were the only events that coincided with monitoring at the mass emission station.

The 2004-2005 results are presented in Appendix F, Table 5. Only one general water chemistry constituent exceeded WQOs during the storm events; dry weather water quality complied with WQOs. Cyanide exceeded the WQO during one storm with a value of 0.005 mg/L.

Total and fecal coliform and enterococcus all exceeded WQOs during all five storm events. Total coliform values ranged from 130,000 to 300,000 MPN/100mL; fecal coliform values ranged from 17,000 to 240,000 MPN/100mL and enterococcus values ranged from 130,000 to 300,000 MPN/100mL. Total coliform, fecal coliform, and enterococcus bacteria also exceeded the WQO during the dry weather events, but values were lower. During dry weather events, total coliform values ranged from 16,000 to 50,000 MPN/100mL; fecal coliform values ranged from 300 to 14,000 MPN/100mL and enterococcus values ranged from 1,300 to 1,700 MPN/100mL.

Nitrate-N and Nitrite-N are the only nutrients with WQOs. They did not exceed the WQO during any of the storm or dry weather events.

Six total metals, including aluminum, antimony, copper, lead, nickel, and zinc exceeded WQOs during the storm events. Copper and lead exceeded the objectives during all five storm events. Copper measurements ranged from 14.3 to 177 µg/L and lead measurements ranged from 4.37 to 73.6 µg/L. Aluminum exceeded the WQO during four of the five events, with concentrations ranging from 1,160 to 7,640 µg/L. Nickel and zinc exceeded WQOs three out five storms. Nickel values ranged from 24 to 28.8 µg/L and zinc values ranged from 231 to 422 µg/L. Antimony exceeded the WQO during one storm event with a measurement of 7.84 µg/L. Two dissolved metals exceeded WQOs during the storm events. Lead exceeded objectives during two storm events with values of 2.06 and 3.28 µg/L and copper exceeded the WQO during one storm with a value of 10.6 µg/L. Total copper was the only metal that exceeded objectives during the dry weather events with values ranging from 11.1 to 14.3 µg/L.

All of the semi-volatiles and PCB's were not detected during all five storms and one dry weather event. Acetophenone and Bis(2-Ethylhexyl) phthalate were measured on March 9, 2005. Diazinon was detected during one storm event; however, the measurement was below the WQO. All other pesticides and herbicides were not detected during the monitoring events.

Cyanide exceedances were also recorded at both stations on October 17, 2004. Like all tributary stations in the watershed, bacteria exceedances at Fairfax Drain coincided with exceedances of total and fecal coliforms and enterococcus at the mass emission station. Total metals criteria were routinely exceeded and excursions occurred at both stations on October 17 and 26 and December 5, 2004.

Figures 7-12 and 7-13 present a summary of the magnitude of exceedance (Water Quality Ratios) for bacteriological indicators and selected metals, respectively, at this and the other tributary stations and the mass emissions station. For bacteriological indicators, the magnitude of exceedance of the WQO is similar for all the tributaries and the mass emission station. No one or set of tributaries appear to be a primary source of bacterial indicator exceedances based on concentration. Based on concentration, Fairfax station and the other farther upstream tributaries (Adams and to a greater extent Cochran) appear to exhibit greater exceedances of the WQO for total copper and lead. Comparisons of the loadings for the constituents presented in these figures for each tributary are presented in Conclusions Section (Section 12) of this report.

#### **7.3.3.6 Cochran (TS12)**

The Cochran tributary monitoring site is located in the Mid-City community of Los Angeles near the upstream extent of Ballona Creek at Cochran Avenue. The tributary was monitored during storm events on October 17 and 26, December 5 and 27, 2004 and January 7, 2005. Dry weather events were sampled on November 2, 2004 and March 9, 2005. The three storms monitored on October 17, October 26, and December 5, 2004 and the dry season event on March 9, 2005 were the only events that coincided with monitoring at the mass emission station.

The 2004-2005 results are presented in Appendix F, Table 6. Cyanide exceeded the WQO during three storms with values ranging from 0.006 to 1.3 mg/L. Carbonate was not detected during most of the events monitored in 2004-2005, but was measured on March 9, 2005, which coincided with the peak (8.37) in pH values. Carbonate, in equilibrium with bicarbonate and hydroxide in natural waters, becomes more common as waters become more acid.

Total and fecal coliform and enterococcus all exceeded WQOs during all five storm events. Total coliform values ranged from 170,000 to 900,000 MPN/100mL; fecal coliform values ranged from 24,000 to 900,000 MPN/100mL and enterococcus values ranged from 240,000 to 1,600,000 MPN/100mL. Total coliform, fecal coliform, and enterococcus bacteria also exceeded the WQO during the dry weather events, but values were lower. During dry weather, total coliform values ranged from 9,000 to 160,000 MPN/100mL; fecal coliform values ranged from 500 to 17,000 MPN/100mL and enterococcus values ranged from 700 to 2,200 MPN/100mL.

Nitrate-N and Nitrite-N are the only nutrients with WQOs. They did not exceed the WQO during any of the storm or dry weather events.

Nine total metals, including aluminum, antimony, cadmium, chromium, copper, lead, nickel, silver and zinc exceeded WQOs during the storm events. Copper exceeded the WQO during four out of the five storms with values ranging from 16.1 to 699 µg/L. Aluminum and lead exceeded WQOs during three of the five storm events. Aluminum values ranged from 1115 to 23,200 µg/L and lead values ranged from 14.3 to 449 µg/L. Nickel and zinc exceeded objectives during two storms. Nickel values were 22.3 and 54.6 µg/L and zinc measurements were 922 and 3,500 µg/L. Antimony, cadmium, chromium and silver exceeded the WQOs during one storm event with values of 16.5, 7.27, 59.8 and 14.9 µg/L, respectively. Two dissolved metals exceeded the objectives during the storm events. Copper and lead exceeded objectives during one storm event with values of 9.16 and 6.88 µg/L, respectively. Total copper was the only metal that exceeded WQO during the dry weather event with a measurement of 14.1 µg/L.

All of the semi-volatiles and PCBs were not detected during all five storms and one dry weather event. Acetophenone and Bis(2-Ethylhexyl) phthalate were measured on March 9, 2005. Chlorpyrifos exceeded the WQO during one storm event with a value of 0.231 µg/L. All other pesticides and herbicides were not detected during the monitoring events.

Tributary monitoring determined that Cochran is a source of COCs at the Ballona Creek mass emission station. Similar to other tributaries, exceedances of total and fecal coliforms and enterococcus at Cochran and the mass emission station occurred on the same dates. Furthermore, total copper, lead, zinc, and/or aluminum exceedances did not comply with applicable criteria on October 17 and/or December 5, 2004 at both stations.

A summary of the magnitude of exceedance (Water Quality Ratios) for bacteriological indicators and selected metals at this and the other tributary stations and the mass emissions station is presented on Figures 7-12 and 7-13, respectively. For bacteriological indicators, the magnitude of exceedance of the WQO is similar for all the tributaries and the mass emission station. No one or set of tributaries appear to be a primary source of bacterial indicator exceedances based on concentration. Based on concentration, the Cochran station exhibits the greatest exceedance of the WQO for total copper and lead compared to the other tributaries. The magnitude of exceedance is similar to the upstream location at Adams and much lower than the mid-channel and lower tributary stations. Comparisons of the loadings for the constituents presented in these figures for each tributary are presented in Conclusions Section (Section 12) of this report.

#### **7.3.3.7 Summary of Other Tributary Studies – Dry Weather Characterization for Metals and Bacteria in Ballona Creek (Southern California Coastal Water Research Project)**

The Southern California Coastal Water Research Project completed a study in 2003-2004 to further characterize dry weather concentrations of metals and bacteria in Ballona Creek. The goal of the study was to characterize these concentrations during dry weather flows and to identify the relative contribution of various portions of the watershed to the total dry season loading of metals and bacteria. The study consisted of three sampling events conducted during the spring and summer of 2003 on 40 actively flowing storm drains and 12 in-channel sampling locations. The samples collected were analyzed for total and dissolved metals and bacteriological indicators. Flow measurements were also obtained at each sampling station to determine loads. In addition to load estimates, the data was used to determine mean concentration, temporal variability, spatial distribution and substantial inputs to the creek.

The results of the study indicated that metal concentrations in Ballona Creek were below the WQO in 96% to 100% of the samples collected in-channel. Bacteria densities were observed to exceed the WQO in the majority of the storm drains and in-channel samples. The exhibited exceedances for bacteria are consistent with the results of the Core Monitoring presented in this section. Greater frequency and magnitude of exceedance of the metal WQO for dissolved copper, total copper and total lead were observed for the Core Monitoring results.

The results of this study also indicated that the distribution of higher metals and elevated bacteria concentrations for the dry weather flows was “bimodal.” The highest concentrations were detected between km 3 and 6, immediately upstream of the tidal portion of Ballona Creek, and between km 9 and 12, below the portion of the watershed where Ballona Creek daylights from an

underground storm drain to an exposed channel. These results are consistent with the findings of the tributary sampling as part of the Core Monitoring program that are summarized in Figures 7-12 and 7-13. As presented in Figure 7-13, concentration of metals are higher (as indicated by the higher magnitude of exceedance of the WQO) below the mass emission station (Centinela and Sepulveda stations), and the highest in the farther upstream stations (Adams and Cochran).

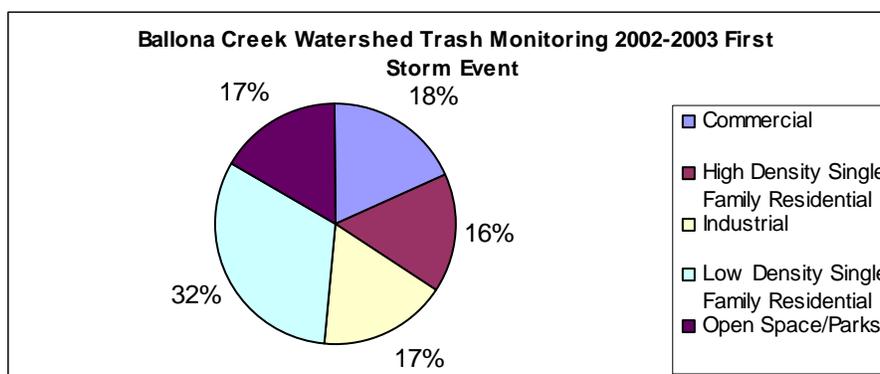
These portions of the Creek correspond to where the storm drains that exhibit the highest concentrations and loads discharge to the channel. The greatest volume of discharge was observed in 4 of the 40 drains sampled, consisting of approximately 85% of the total flow to the channel. It was further determined that eight of the 40 drains contribute between 91% and 93% of the total daily load for metals. The highest concentrations of both metals and bacteria were attributed to 9 drains. The conclusions of the study indicated that although there is a large variability in the concentrations observed in the drains and in the channel, management of a relatively small number of storm drains during dry weather flows has the potential to significantly reduce metal and bacterial loads during dry weather periods, and improve water quality in Ballona Creek (Southern California Coastal Water Research Project, 2004).

### 7.3.4 Trash Monitoring

Trash monitoring surveys were conducted during the 2002-2003 and 2003-2004 storm seasons. Nine storm events were monitored during 2002-2003 and six events were monitored during 2003-2004. The sampling results for anthropogenic trash for each year are summarized below. Photos for four storm events, including the first storm, are provided in Appendix D, Figures 17-20.

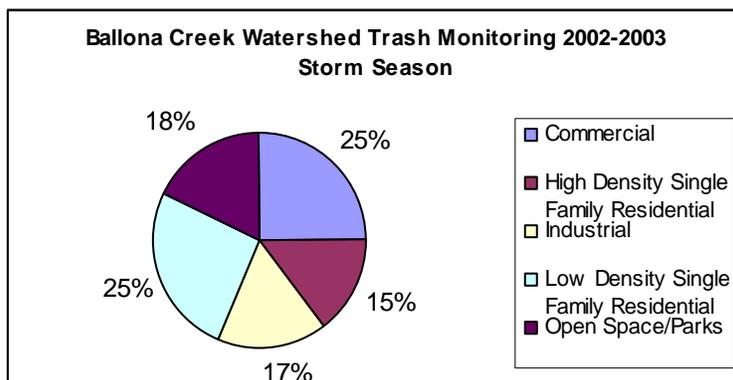
#### 2002-2003 Sampling Results

The first storm event of the season, November 7, 2002, produced the most amount of trash contributing 36.3% of the total trash collected during the entire season. Low density single family residential was the largest contributor of trash during the first storm of the season producing 32% of the total trash, followed by commercial land use which contributed 18% of the total trash (Figure 7-14). Industrial and open space/parks each contributed 17% and high density single family residential contributed 16%.



**Figure 7-14. Percent totals for anthropogenic trash per land use collected in the Ballona Creek Watershed for the 2002-2003 first storm event.**

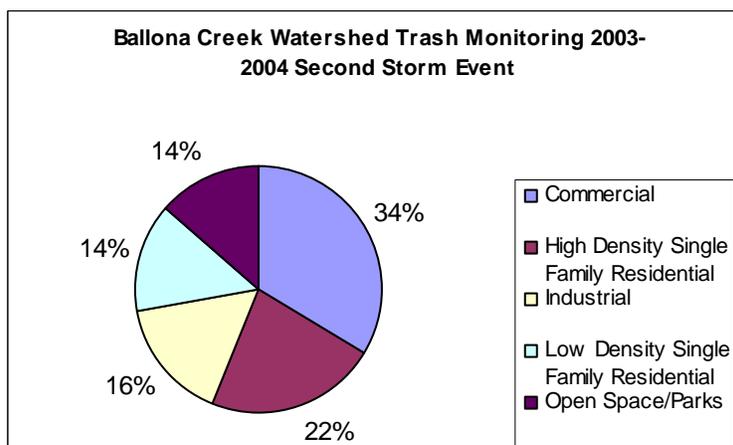
Based on the total amount of trash collected during the 2002-2003 storm season, the largest contributors by land use were low density single family residential and commercial, which each contributed 25% of the total trash collected. Open space/parks and industrial produced 18% and 17%, respectively. High density single family residential produced the least amount of trash contributing 15% of the total trash collected (Figure 7-15).



**Figure 7-15. Percent totals for anthropogenic trash per land use collected in the Ballona Creek Watershed for the 2002-2003 storm season.**

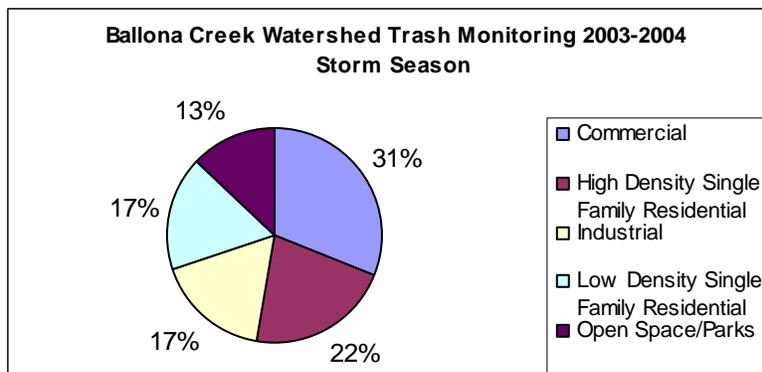
**2003-2004 Sampling Results**

The largest amount of trash was collected during the second storm event of the season which occurred on January 2, 2004. The second storm event contributed 28.1% of the total trash collected during the entire storm season. Commercial land use was the largest contributor of trash during the second storm of the season, producing 34% of the total trash collected, followed by high density single family residential which contributed 22% (Figure 7-16). Industrial land use contributed 16%, and low density single family residential and open space/parks each produced 14%.



**Figure 7-16. Percent totals for anthropogenic trash per land use collected in the Ballona Creek Watershed for the 2003-2004 second storm event.**

Commercial land use was the largest contributor of trash during the entire 2003-2004 storm season producing 31% of the total trash collected, followed by high density single family residential which contributed 22% of the total trash (Figure 7-17). Industrial and low density single family residential each produced 17% and open space/parks contributed 13%.



**Figure 7-17. Percent totals for anthropogenic trash per land use collected in the Ballona Creek Watershed for the 2003-2004 storm season.**

### Trash Monitoring Data Analysis

LACDPW is currently in the third year of the five-year trash monitoring program. Upon completion of the program, a detailed analysis of the trash monitoring data will be performed.

### 7.3.5 Shoreline Monitoring

Shoreline monitoring began in 2001 and continued through 2004. Water samples were collected daily from 16 stations along the Ballona Creek Watershed shoreline from July 1 through June 30 of each year and analyzed for indicator bacteria, including total coliforms, fecal coliforms, and enterococcus. Sampling locations are presented in Figure 7-4. The monitoring results for each sampling year are summarized below.

#### 2001-2002 Sampling Results

S10 is the only station within the Ballona Creek drainage area and downstream of the mass emission station, S01, and the tributary stations. The results from this station indicate that bacterial densities were higher during wet weather than dry weather, which was the pattern for all stations monitored along the shoreline. Mean bacterial densities for S10 were highest for total coliforms and enterococcus during wet weather. The mean total coliform density was the highest of all stations and the mean enterococcus density was the second highest of all stations during wet weather. There were exceedances of bacteria standards for all three indicators at S10 during dry and wet weather, which correspond with bacteria exceedances that occurred at the mass emission station and the tributary stations within the Ballona Creek Watershed. Approximately 8% of samples collected during 2001-2002 exceeded bacteria standards.

Stations located outside of the Ballona Creek drainage area but within the watershed management area have shown similar results. Mean bacterial densities were higher during wet weather than dry weather at all stations. Stations S4, S5, S9 and S16 had the highest bacterial

densities during dry and wet weather. Stations located in the northern portion of the watershed (S4, S5 and S9) generally had higher mean densities than those in the southern portion (S16). All of these stations are located adjacent to large storm drains or piers. There were exceedances of at least one indicator bacteria at all stations during dry or wet weather in the 2001-2002 sampling season, with more exceedances occurring during wet weather. Station S5 had the highest percentage of exceedances (18%) followed by S16 (15%) and S4 (12%).

### **2002-2003 Sampling Results**

Similar to the 2001-2002 results, S10 mean bacterial densities were higher during wet weather than dry weather, with higher densities of total coliforms and enterococcus. There were exceedances of all three indicator bacteria at S10 during dry and wet weather, with more exceedances occurring during wet weather. These results also correspond with bacteria exceedances that occurred at the mass emission station and the tributary stations within the Ballona Creek Watershed. Approximately 17% of samples collected during 2002-2003 exceeded bacteria standards.

The additional shoreline stations located within the management area have shown similar results to the 2001-2002 sampling season. Mean bacterial densities were higher during wet weather than dry weather at all stations. The highest bacterial densities during dry weather were found at stations S4, S5 and S16. There were exceedances of at least one indicator bacteria at all stations during dry or wet weather in the 2002-2003 sampling season, with more exceedances occurring during wet weather. Station S16 had the highest percentage of exceedances, with 28%, followed by S4 and S9 (22%) and S5 (21%).

### **2003-2004 Sampling Results**

Similar to the previous sampling results, S10 mean bacterial densities were higher during wet weather than dry weather. This station had the highest mean total coliform density and one of the highest mean enterococcus densities during dry weather. There were exceedances of all three indicator bacteria at S10 during dry and wet weather, with more exceedances occurring during wet weather. These results also correspond with bacteria exceedances that occurred at the mass emission station and the tributary stations within the Ballona Creek Watershed. Approximately 12% of samples collected during 2003-2004 exceeded bacteria standards.

The additional shoreline stations located within the management area have shown similar results to the previous sampling seasons. Mean bacterial densities were higher during wet weather than dry weather at all stations. The highest bacterial densities during dry weather were found at stations S5, S6, S9 and S16, which were located near flowing storm drains or piers. There were exceedances of at least one indicator bacteria at all stations during dry or wet weather in the 2003-2004 sampling season, with more exceedances occurring during wet weather. Station S9 had the highest percentage of exceedances, with 25%, followed by S6 (18%), S5 (9%) and S16 (8%).

Further discussion of toxicity results and inter-relationships on a cross-watershed basis is presented in Section 10. Due to the limited data-set on a watershed basis, the inter-relationship discussion is presented on regional basis in Section 10. Correlations between toxicity results with COC are discussed in this section using the results from all the watersheds.

## 7.4 Regional Monitoring Summary

### 7.4.1 Bioassessment Results/Discussion

Information on the stream bioassessment surveys of October 2003 and October 2004 originally appeared in annual monitoring reports submitted to LACDPW (BonTerra 2004, Weston 2005). In the discussion below, ratings of the benthic macroinvertebrate communities is based on a CFG Southern California Index of Biotic Integrity (IBI) (Ode et al. In Press), a quantitative scoring system based on the cumulative value of seven biological metrics. The scoring range is 0-70, and the scores are categorized into qualitative ratings of Very Poor (0-13), Poor (14-26), Fair (27-40), Good (41-55), and Very Good (56-70). Additional individual metrics and aspects of species composition are discussed when notable. Section 10 of this report provides more overview and detail of the results from the regional monitoring.

#### 7.4.1.1 Introduction

Stream bioassessment monitoring was conducted at one site in the Ballona Creek Watershed. The location of the site is presented in Figure 7-4, and a description of the site and the justification for the monitoring location is presented in Table 7-3. The site was located in the main channel of Ballona Creek upstream of South Sepulveda Blvd. The creek is fully concrete lined in the monitoring reach.

**Table 7-3. Ballona Creek Watershed stream bioassessment monitoring sites. October 2003 and 2004.**

Station	Receiving Water Body	Location – Date	Coordinates	Justification
14	Ballona Creek Lined channel	Ballona Creek at I-405 and S. Sepulveda Blvd – Oct. 25	N 34° 00.444' W 118° 23.757'	Original location relocated due to tidal influence

#### 7.4.1.2 Benthic Macroinvertebrate Community

The benthic macroinvertebrate community in Ballona Creek had a CFG Southern California Index of Biotic Integrity score of 6 in 2003 and 10 in 2004, with a quality rating of Very Poor for both years (Table 7-4). The community was dominated by Chironomid midges in both years, although they were much more dominant in 2004. Baetid mayflies (*Baetis*, *Fallceon quilleri*) and the caddisfly *Hydroptila* were more abundant in 2003. There were no taxa collected that were highly intolerant to impairment (tolerance value of 0, 1, or 2.) Water quality was variable between the two surveys, likely due to the 2004 survey being conducted approximately one week after a significant rain event. The 2004 survey recorded substantially lower pH, water temperature, dissolved oxygen, and specific conductance, while turbidity was much higher.

**Table 7-4. Index of Biotic Integrity and Water Quality Measures of the Ballona Creek Watershed.**

Ballona Creek Watershed	Station 14 Ballona Creek (lined channel)	
	Oct-03	Oct-04
Survey		
Index of Biotic Integrity/ Qualitative Rating	6 Very Poor	10 Very Poor
Water Quality		
Temperature ©	22	17.8
pH	8.4	7.5
Specific Conductance (ms/cm)	1.170	0.683
Hardness (mg/L CaCO <sub>3</sub> )	NS	244
Dissolved Oxygen (mg/l)	15.96	6.98

#### **7.4.1.3 Relationship of Bioassessment to Constituents of Concern**

Data from the mass emissions stations, summarized in Section 7.3, were used to identify possible relationships between constituents of concern and impacts to the benthic macroinvertebrate communities. Additional impairments identified in the 303(d) listing were not considered here due to a lack of available recent data.

Bioassessment Station 14-Ballona Creek was located in close proximity to the Ballona Creek mass emissions station S01 (Figure 7-5). The benthic community was rated Very Poor in Ballona Creek, and the physical habitat in this stream reach was also poor. Constituents of concern that exceeded WQOs included copper and lead. Total copper and lead consistently exceeded water quality objectives and lead was the only dissolved metal to exceed WQOs. High concentrations of heavy metals have long been known to negatively impact macroinvertebrate communities (e.g., Winner et al. 1980). Bacteria levels were consistently very high, and while bacteria alone likely did not directly impact the benthic community, high densities generally indicate other water quality issues such as elevated fine organic matter or nutrients that could degrade the system. Two pesticides were detected in stormwater samples, diazinon and prometryn, and these would likely have a deleterious effect on the macroinvertebrate community.

The Ballona Creek Watershed was also monitored at six tributary sites upstream of the bioassessment monitoring site. In addition to the COC exceedances listed above, cyanide, oil and grease, pH, and various metals were detected in concentrations that exceeded WQOs.

#### **7.4.2 Estuary Sampling Program Results/Discussion**

Five stations within the Ballona Creek Estuary, identified as 4053, 4213, 5735, 5767, and 5787 were monitored under the supervision of SCCWRP in the summer of 2003. The locations of the stations are presented in Figure 7-18. Samples were analyzed for sediment chemistry, sediment toxicity and benthic macroinvertebrate diversity. The results from these sampling events are discussed in the following section and presented in Table 7-5. The complete list of laboratory analytical data results are presented in Appendix E, Table 4.

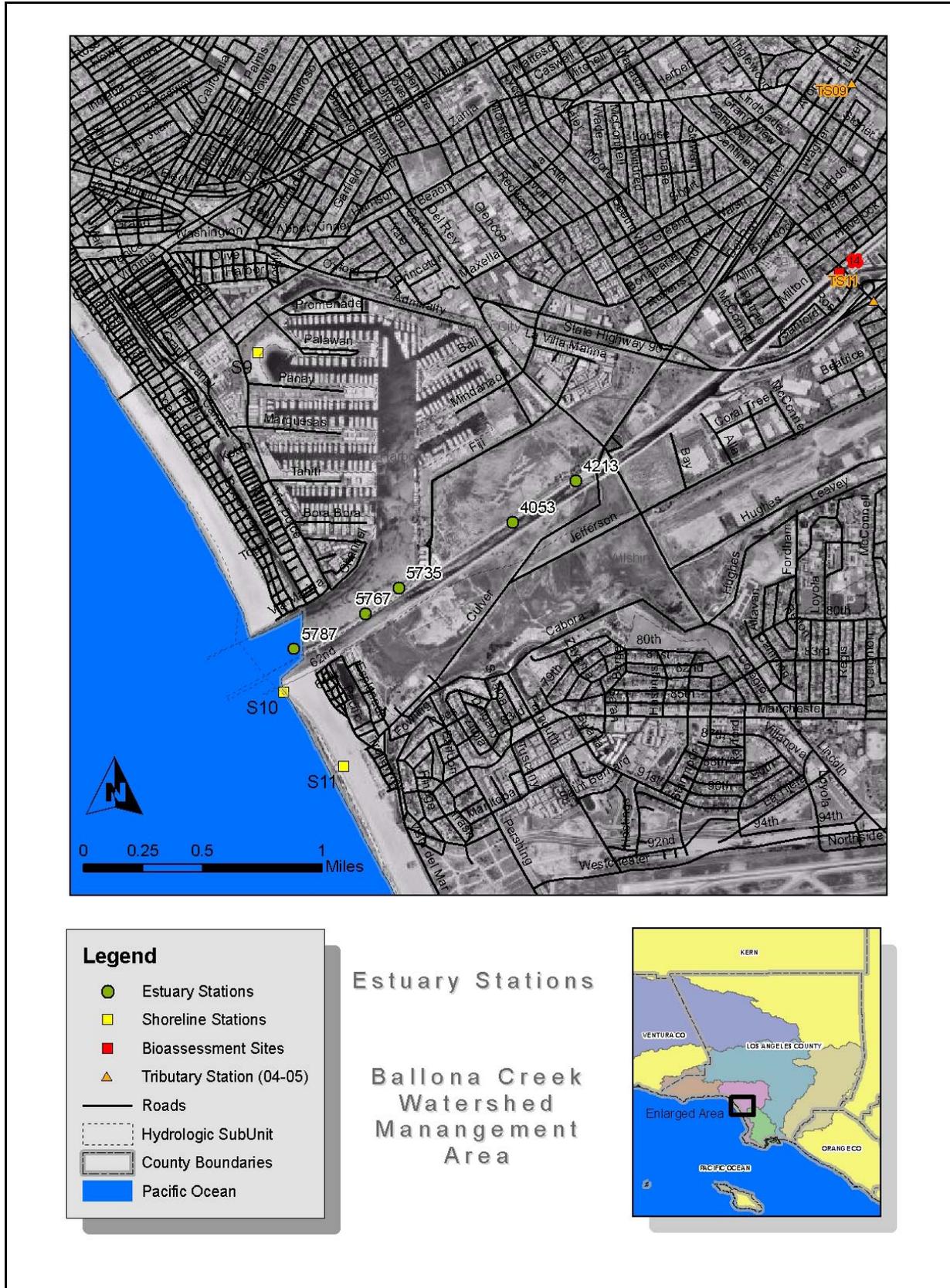


Figure 7-18. Ballona Creek Estuary Sampling Stations.

Table 7-5. Analytical Results for Constituents Analyzed in the Ballona Creek Estuary.

Constituent	Units	ER-L*	ER-M*	Ballona Creek Estuary				
				4053	4213	5735	5767	5787
<b>Toxicity</b>								
Mean <i>Eohaustorius</i> Survival	%			<b>0</b>	<b>59</b>	<b>27</b>	<b>19</b>	90
<b>Infauna Community Indices</b>								
Number of species	#/0.1 m <sup>2</sup>			37	12	45	53	85
Total abundance	#/0.1 m <sup>2</sup>			16,836	5767	1628	1800	3809
Shannon-Wiener diversity				1.31	1.09	2.57	2.52	2.23
Evenness				0.36	0.44	0.67	0.63	0.50
Dominance				2	2	6	5	4
<b>Sediment Size and TOC</b>								
Gravel	%			55.00	55.70	0.21	0.29	0.68
Sand	%			35.62	42.34	48.53	57.80	79.65
Silt	%			8.62	1.80	48.76	39.84	18.97
Clay	%			0.84	0.16	2.50	2.07	0.70
Median size	microns			2222.89	2187.01	58.30	125.47	710.87
Mean size	microns			1759.90	2093.95	115.75	133.83	221.73
TOC	%			4.946	0.497	0.669	1.196	0.352
<b>Metals</b>								
Arsenic	mg/kg	8.2	70	4.01	2.37	3.54	7.52	2.97
Cadmium	mg/kg	1.2	9.6	0.84	0.13	0.83	0.96	0.31
Chromium	mg/kg	81	370	21.9	19.5	21.1	19.3	10.6
Copper	mg/kg	34	270	<b>36.4</b>	11.5	32.9	33.4	10.6
Lead	mg/kg	46.7	220	41.0	12.7	<b>111.0</b>	<b>59.3</b>	35.5
Mercury	mg/kg	0.15	0.71	0.11	0.03	0.05	0.08	0.03
Nickel	mg/kg	20.9	51.6	13.1	9.7	13.3	12.5	7.6
Silver	mg/kg	1	3.7	0.86	0.44	0.66	0.87	0.36
Zinc	mg/kg	150	410	<b>202.0</b>	73.5	<b>186.0</b>	<b>165.0</b>	107.0
<b>Pesticides</b>								
Total detectable DDT	µg/kg	1.58	46.1	<b>17.3</b>	1.4	<b>5.4</b>	<b>9.7</b>	0.0
Total detectable chlordane	µg/kg	0.6	6	<b>21.6</b>	<b>1.3</b>	0	0	0
<b>PAHs</b>								
Total detectable PAHs	µg/kg	4022	44,800	1929	69	182	488	408
<b>PCBs</b>								
Total detectable PCBs	µg/kg	22.7	180	0.0	0.0	8.0	0.0	0.0
<b>Mean ER-M quotient</b>				<b>0.44</b>	0.08	<b>0.15</b>	<b>0.14</b>	0.07

\* Effects Range-Low and Effects Range-Median (Long et al. 1995)

Chemistry results in **bold** = exceeds ER-L

Chemistry results in **bold** = exceeds ER-M

Toxicity in **bold** = identified as moderately toxic (Bight 03 draft report, SCCWRP 2004)

Toxicity in **bold** = identified as highly toxic (Bight 03 draft report, SCCWRP 2004)

Mean ERM-Q in **bold** = above 0.10 threshold (Long et al. 1998)

NR = not reported

J = Estimated value above MDL and below RL

Currently, there are no universally accepted criteria for assessing contaminated sediments. However, SCCWRP decided to utilize Effect Range-Low (ER-L) and Effect Range-Median (ER-M) values to evaluate the potential for sediment to cause adverse biological effects (Long et al. 1995). The guidelines were intended to provide informal (non-regulatory) effects-based benchmarks of sediment chemistry data (Long et al. 1998). Two effects categories have been identified:

**ER-L – Effects Range-Low:** concentrations below which adverse biological effects are rarely observed; and

**ER-M – Effects Range-Median:** concentrations above which adverse biological effects are more frequently, though not always observed.

Sediment chemistry data from samples collected from each of the estuaries were compared to the ER-L and or the ER-M data (Table 7-5).

In addition, for each estuary ER-M values were used to calculate a mean ER-M quotient (ERM-Q). The concentration of each constituent was divided by its ER-M to produce a quotient, or proportion of the ER-M equivalent to the magnitude by which the ER-M value is exceeded or not exceeded. The mean ERM-Q for each embayment was then calculated by summing the ERM-Qs for each constituent and then dividing by the total number of ERM-Qs assessed. ERM-Qs were not calculated for constituents below the detection limit and thus were not used in the generation of the mean ERM-Q. The mean ERM-Q thus represents an assessment for each embayment of the cumulative sediment chemistry relative to the threshold values. In this way, the cumulative risks of effect to the benthic community can provide a mechanism to compare embayments. This method has been used and evaluated by several researchers (Hyland et al. 1999, Carr et al. 1996, Chapman 1996, and Long et al. 1995) throughout the country.

The aggregate approach using an ERM-Q is a more reliable predictor of potential toxicity but should not be used to infer causality of specific contaminants. ER-L and ER-M values were originally derived to be broadly applicable and they cannot account for site-specific features that may affect their applicability on a more local or regional level. Local differences in geomorphology can result in chemicals being more or less available and therefore more or less toxic than an ER-L or ER-M value might indicate. Additionally, some regions of the country are naturally enriched in certain metals and local organisms have become adapted.

**Sediment Chemistry.** Sediments were analyzed for four groups of constituents: metals, pesticides, PAHs and PCBs. Three metals, including copper, lead, and zinc exceeded the ER-L at some of the stations within the Ballona Creek Estuary. Copper exceeded the ER-L at one station, 4053, with a value of 36.4 mg/kg. Lead exceeded the ER-L at two stations, 5735 and 5767, with values of 111 and 59.3 mg/kg, respectively. Zinc exceeded the ER-L at three of the five stations with values ranging from 165 to 202 mg/kg. There were detections of all other metals at all stations; however, concentrations were below the ER-L and ER-M values.

The only pesticides with concentrations above ER-L and ER-M values were total detectable DDT and total detectable chlordane. Total detectable DDT exceeded the ER-L at three stations, with values ranging from 5.4 to 17.3 µg/kg. Total detectable DDT was below the ER-L value at station 4213 and was not detected at station 5787. Total detectable chlordane exceeded the ER-L at one station, 4213, with a value of 1.3 µg/kg and exceeded the ER-M at station 4053 with a value of 21.6 µg/kg. Total detectable chlordane was not detected at the other three stations.

Total detectable PAHs were below the ER-L values at all five stations monitored in the Ballona Creek Estuary. Total detectable PCBs were only detected at station 5735 but were below the ER-L.

ERM-Q values were above the threshold of 0.10 at three out of the five stations monitored in the Ballona Creek Estuary. Stations 4053, 5735 and 5767 had mean ERM-Q values above the 0.10 threshold, with values of 0.44, 0.15 and 0.14, respectively. The other two stations had mean ERM-Q values below 0.10, with values of 0.07 and 0.08.

Three of the stations displayed similar patterns of exceedances in the Ballona Creek Estuary. Stations 4053, 5735, and 5767, the stations in the middle of the estuary, had the most number of exceedances and all had mean ERM-Q values above the 0.10 threshold. The sediments at these stations were also identified as highly toxic to the test organisms (see below). The station

located at the bottom of the estuary, 5787, did not have any exceedances, and had the lowest ERM-Q value and the highest percent survival rate of *E. estuarius* (see below).

**Sediment Toxicity.** The mean percent survival of the test organism, *E. estuarius*, exposed to Ballona Creek Estuary sediments ranged from 0 to 90%. Percent survival was the lowest at stations 4053, 5735, and 5767, with values of 0%, 27% and 19%, respectively. These values suggest that the Ballona Creek Estuary sediments in these areas are highly toxic to the test organisms (Bight 03 draft report, SCCWRP 2004). The mean percent survival of *E. estuarius* at station 4213 was 59%, suggesting that the sediments in this area were moderately toxic to the test organisms. Station 5787 had a mean percent survival of 90%, which suggests that the sediments in this area were not toxic.

**Benthic Community Structure.** Total abundance ranged from 1,628 organisms/0.1m<sup>2</sup> at station 5735 to 16,836 organisms/0.1m<sup>2</sup> at station 4053. The total number of species ranged from 12 at station 4213 to 85 organisms/0.1m<sup>2</sup> at station 5787. Species diversity was highest at station 5735 with a value of 2.57 and lowest at station 4213 with a value of 1.09. Evenness values ranged from 0.36 at station 4053 to 0.67 at station 5735. Dominance values ranged from 2 to 6.

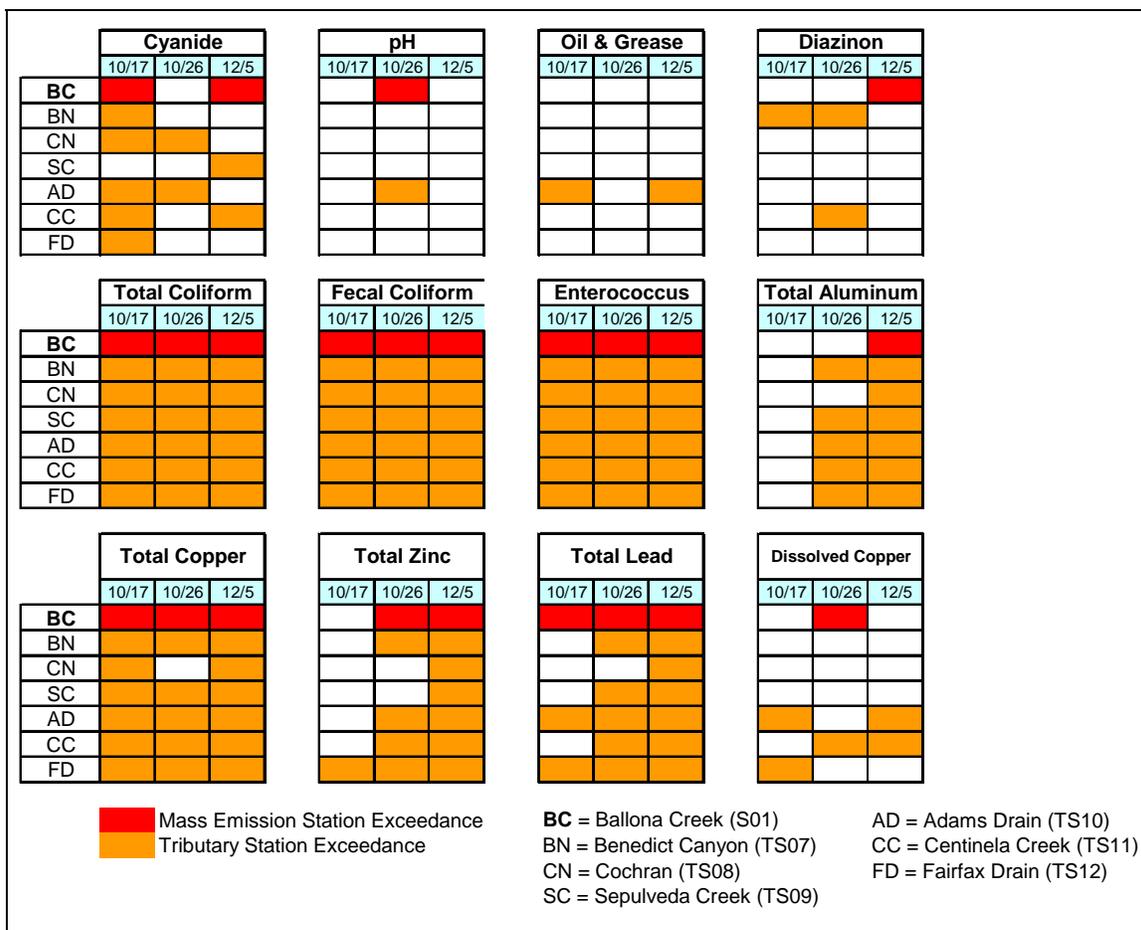
**Sediment Size.** Sand, gravel and silt were the dominant sediment constituents at the stations monitored in the Ballona Creek Estuary. Sand dominated the sediment composition at two stations, 5767 and 5787, followed by silt. Gravel was the dominant sediment constituent at stations 4053 and 4213 followed by sand, and silt was the dominant constituent at station 5735, followed by sand. Median grain size ranged from 58.3 to 2222.9 microns. TOC content ranged from 0.35 to 4.95%. Station 4053 had the largest median grain size and the highest TOC content.

## 7.5 Conclusions

The water quality monitoring conducted during the past ten years at the Ballona Creek mass emission site has identified several COCs that persistently exceed WQOs. These COCs include cyanide, indicator bacteria (total coliform, fecal coliform and enterococcus) and metals (total copper and total and dissolved lead). None of the COCs had concentrations that were shown to have significantly increasing or decreasing trends. However, several other constituents that were not identified as COCs did exhibit trends in their concentration levels through the history of the monitoring program. Bicarbonate, potassium and MBAS were shown to have significantly increasing concentrations. The concentrations of total petroleum hydrocarbons, however, significantly decreased during the same time period.

Figure 7-19 displays the events that were monitored congruently at the Ballona Creek mass emission station and its tributaries and lists some COCs that exceeded applicable standards at the mass emission station. If COCs measured at a tributary station exceeded the standard on a common sampling date, the tributaries are listed in the table as well. The table shows that bacteria, total copper, and total lead exceeded WQOs at the mass emission station on nearly every monitoring date and that exceedances coincided at many, if not all tributaries. Total zinc had exceedances at the mass emission station during the October 26<sup>th</sup> and the December 5<sup>th</sup> storms with many associated tributary exceedances. Cyanide had exceedances at the mass emissions station on two events and corresponding exceedances in many of the tributaries. Other

constituents had less of a connection between water quality exceedances at the mass emission station and exceedances at the tributary stations.



**Figure 7-19. Comparative Summary of Constituents Frequently Exceeding WQOs at Ballona Creek and its Tributaries.**

The magnitude of exceedance (Water Quality Ratios) for bacteriological indicators and selected metals at Centinela Creek and the other tributary stations and the mass emission station was presented on Figures 7-12 and 7-13, respectively. For bacteriological indicators, the magnitude of exceedance of the WQO is similar for all the tributaries and the mass emission station. No one or set of tributaries appear to be a primary source of bacterial indicator exceedances based on concentration. Based on concentration, Sepulveda and the further upstream tributaries appear to exhibit greater exceedances of the WQO for the selected metals. These results are consistent with the findings of the dry weather characterization study of Ballona Creek conducted by the Southern California Coastal Water Research Project. The results of this study also indicated that the distribution of higher metals and elevated bacteria concentrations for the dry weather flows was “bimodal.” The highest concentrations were detected between km 3 and 6, immediately upstream of the tidal portion of Ballona Creek, and between km 9 and 12, below the portion of the watershed where Ballona Creek daylights from an underground storm drain to an exposed channel.

The results of this study further concluded that these portions of the Creek correspond to where the storm drains that exhibit the highest concentrations and loads discharge to the channel. The greatest volume of discharge was observed in 4 of the 40 drains sampled, consisting of approximately 85% of the total flow to the channel. It was further determined that eight of the 40 drains contribute between 91% and 93% of the total daily load for metals. The highest concentrations of both metals and bacteria were attributed to 9 drains. The conclusions of the study indicated that although there is a large variability in the concentrations observed in the drains and in the channel, management of a relatively small number of storm drains during dry weather flows has the potential to significantly reduce metal and bacterial loads during dry weather periods, and improve water quality in Ballona Creek (Southern California Coastal Water Research Project, 2004).

Trash monitoring in the 2002-2003 and 2003-2004 storm seasons has identified the amounts flowing into the storm drain system per land use from the Ballona Creek Watershed. In 2002-2003, the first storm event of the season produced the most amount of trash, while the second storm event contributed the most amount of trash during the 2003-2004 storm season. Low Density Single Family Residential was the largest contributor of trash during the first storm of the 2002-2003 season and commercial land use was the largest contributor of trash during the second storm event of the 2003-2004 season. Based on the results for the entire storm seasons, low density single family residential and commercial produced the most amount of trash during 2002-2003 and commercial land use was the largest contributor during the 2003-2004 storm season.

Shoreline monitoring from 2001-2004 within Ballona Creek Watershed indicated that bacterial densities were higher during wet weather than dry weather. Stations located in the northern portion of the watershed generally had higher mean densities than those in the southern portion, as well as those stations that were located adjacent to large storm drains or piers. There were exceedances of bacteria standards of at least one indicator bacteria at all stations during dry or wet weather in all three sampling seasons, with more exceedances occurring during wet weather. These exceedances correspond with the bacteria exceedances that occurred at the mass emission station and the tributary stations within the Ballona Creek Watershed.

Stream bioassessment monitoring was conducted in October 2003 and October 2004. Bioassessment monitoring sites were established at one location in the Ballona Creek Watershed to assess biological integrity and to detect biological trends and responses to pollution in receiving waters throughout the region. The Ballona Creek site was located in an urbanized portion of the watershed and received urban runoff. The benthic macroinvertebrate community had CFG Southern California Index of Biotic Integrity scores of 6 and 10, and quality ratings of Very Poor for both years.

The Ballona Creek Estuary was monitored to estimate the extent and magnitude of ecological change in the SCB and to determine the mass balance of pollutants that currently reside within the SCB. Sediments from five stations within the estuary were analyzed for chemistry, toxicity and benthic macroinvertebrate diversity. The results of the chemistry assessment indicated that three metals, copper, lead and zinc, were detected above the ER-L or ER-M values. Total detectable DDT and total detectable chlordane were found in high concentrations. Three stations had ERM-Q values above the 0.10 threshold. Sediment toxicity was identified as moderately toxic to the test organisms at one station and highly toxic at three stations.