Technical Memo

Date: July 18, 2006
To: Jeremy Lowe, PWA
From: David Pohl, PhD., P.E.
Cathy Hartman
Subject: Summary of Results from Sediment Sampling in Area B – Ballona Marsh

Purpose of Sediment Investigation

The Draft Ballona Wetland Existing and Historical Conditions Report presented a summary of the available water and sediment quality data for the Project Area and also identified several data needs/gaps in Section 5. One of the unknown factors in the assessment was the sediment quality in the existing tidal marsh within Area B (Ballona Marsh). Although sediment quality results were available from the Ballona Creek estuary, a direct correlation to the current sediment characteristics in the marsh could not made due to the significant difference in long-term loading history of these sediments. The sediments in the tidal marsh have experienced muted tidal flows and subsequent reduced constituent loadings while sediments in the Ballona Creek estuary have been subject to the full storm flows and constituent loadings from the entire Ballona Creek watershed. Sediment quality data from Ballona Marsh is needed to characterize the current baseline condition and evaluate the long-term quality of sediments in the restoration areas and potential impacts to the wetland species.

Sample Location and Study Methods

Eight stations located within the Ballona Marsh were sampled by the City of Los Angeles Department of Sanitation for sediment quality on May 5, 2006 (Figure 1).

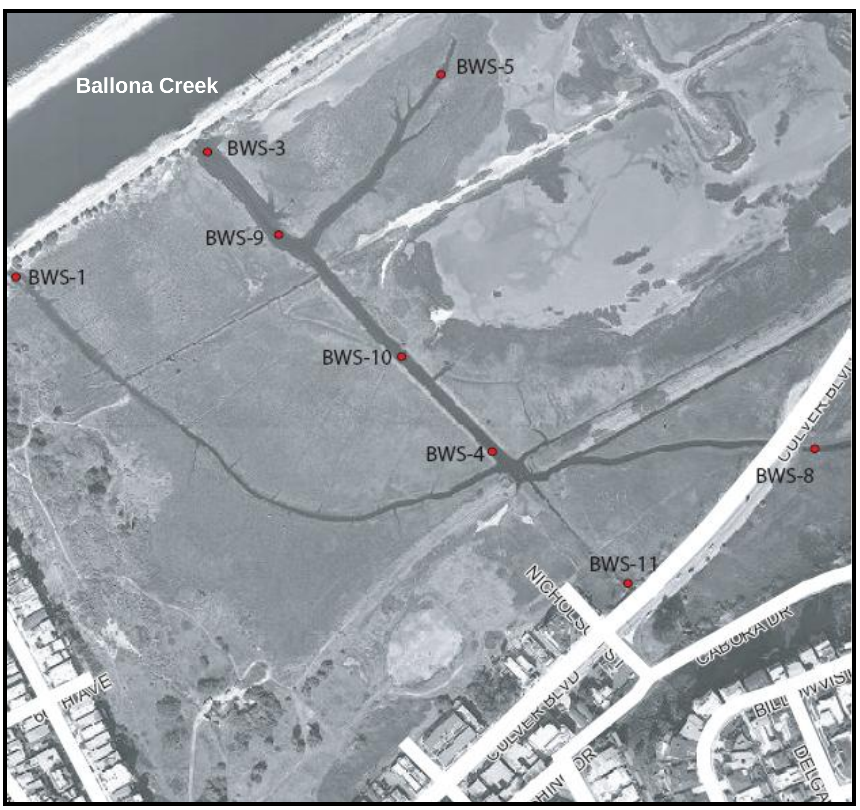

Figure 1. Sediment Quality Sampling Stations within Area B.

Sediments from the Ballona Marsh were analyzed for metals, PAHs, pesticides, PCBs, grain size, and toxicity. Most of the stations (BWS-3, 4, 5, 9, and 10) are within Area B's east channel between Ballona Creek and Culver Blvd. The east channel is connected to Ballona Creek by self-regulating tide gates which allow for muted tidal flow. One station, BWS-1, is located within the west channel, which is connected to Ballona Creek by a 36' pipe with a flap gate on the creek side which prevents tidal flows in while allowing drainage to occur. BWS-8 is located on the southeastern side of Culver Blvd., where it may be influenced by freshwater seeps. BWS-11 is located on the northwestern side of Culver Blvd. where it is likely influenced by storm water and urban runoff.

Currently, there are no universally accepted criteria for assessing contaminated sediments. However, the Effect Range Low (ERL) and Effect Range Median (ERM) values originally developed by Long and Morgan (1990) and subsequently revised and expanded upon by Long and MacDonald (1992) and Long et al. (1995) can be used to evaluate the potential for sediment to cause adverse biological effects (Table 1). These parameters were developed from a large data set where results of both sediment toxicity bioassays (e.g., amphipod tests) and chemical analyses were available for individual samples. 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:

ERL – Effects Range Low: concentrations below which adverse biological effects are rarely observed; and

ERM – Effects Range Medium: concentrations above which adverse biological effects are more frequently, though not always observed.

Sediment chemistry data from samples collected in Area B were compared to the ER-L and or the ER-M data. In addition, for each sediment sample, ERM values were used to calculate a mean ERM quotient (ERM-Q). The concentration of constituents tested was divided by its ERM to produce a quotient, or proportion of the ERM equivalent to the magnitude by which the ERM value is exceeded or not exceeded. The mean ERM-Q for each sample was then calculated by summing the ERM-Qs for each COC 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 sample 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 channels within the existing marsh to the creek. 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. ERL and ERM 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 ERL or ERM value might indicate. Additionally, some regions of the country are naturally enriched in certain metals and local organisms have become adapted.

Table 1. Sediment Effects Guideline Values.

Parameter	Effects Range-Low (ER-L)	Effects Range-Median (ER-M)
Metals (mg/Kg)		
Antimony	2.0	2.5
Arsenic	8.2	70
Cadmium	1.2	9.6
Chromium	81	370
Copper	34	270
Lead	46.7	218
Nickel	20.9	51.6
Zinc	150	410
Organics (µg/Kg)		
Acenaphthene	16	500
Acenaphthylene	44	640
Anthracene	85.3	1,100
Fluorene	19	540
Naphthalene	160	2,100
Phenanthrene	240	1,500
Low-molecular weight PAH	552	3,160
Benz(a)anthracene	261	1,600
Benzo(a)pyrene	430	1,600
Chrysene	384	2,800
Dibenzo(a,h)anthracene	63.4	260
Fluoranthene	600	5,100
Pyrene	665	2,600
High molecular weight PAH	1,700	9,600
Total PAH	4,022	44,792
Total PCBs	22.7	180

Source: Long et al. 1995
ER-L = Concentration at lower tenth percentile at which adverse biological effects were observed or predicted.
ER-M = Concentration at which adverse biological effects were observed or predicted in 50% of test organisms.
mg/Kg = milligrams per kilogram.
µg /Kg = micrograms per kilogram.

Summary of Analytical Results

Sediments from Ballona Marsh were analyzed for four groups of constituents: metals, PAHs, pesticides, and PCBs. Concentrations of chemical constituents were expected to be greater in the estuary samples compared to Area B, due to greater overall loading from the Ballona Creek watershed. Flow into the existing tidal marsh of Area B has been restricted by tidal gates. Furthermore, waters from Ballona Creek that flow into the tidal marsh are from the tidally influenced portion of the creek where mixing of the fresh water creek flows with the salt water of Santa Monica Bay occurs. However, wetlands are known to act as a sink for lower mobility constituents such as heavy metals and semi-volatile compounds that include PAHs. Furthermore, Area B has been historically used for agricultural purposes (bean cultivation) and is subject to urban runoff for adjacent residential communities and transportation corridors (Culver Blvd. and Lincoln Ave.). Chemistry and toxicity results are presented in Table 2.

Table 2. Analytical Results for Ballona Marsh Sediments

Parameter	Units	MDL	ER-L*	ER-M*	BWS-1	BWS-3	BWS-4	BWS-5	BWS-8	BWS-9	BWS-10	BWS-11
Toxicity												
Mean *Eohaustorius estuarius* survival (relative to control)	%				94.79	98.96	91.67	**64.58**	96.88	**34.38**	**60.42**	**9.38**
Sediment Size and TOC												
Gravel	%				0	0	0	0	0	0	0	0
Sand	%				51.2	70.2	79.7	22.8	47.4	37	30.5	47.4
Silt	%				41.8	24	16.6	51.5	46.6	51.5	57.9	45.1
Clay	%				7.11	5.98	3.73	25.8	6	11.5	11.6	7.47
Median size	microns				66	250	360	13	56	40	28	56
Mean size	microns				110	470	470	5.9	140	60	55	55
Total Organic Carbon	%	0.001			0.919	0.777	0.372	0.597	1.15	1.04	0.41	4.64
Metals												
Arsenic	mg/kg	0.22	8.2	70	6.13	3.7	4.26	**12.4**	**10.3**	**8.45**	5.56	**14.6**
Cadmium	mg/kg	0.02	1.2	9.6	**2.39**	**2.12**	**1.83**	**4.5**	**4.66**	**3.67**	**3.32**	**6.16**
Chromium	mg/kg	0.1	81	370	29.2	21.9	18	70.2	52.1	35.4	33.4	64.3
Copper	mg/kg	0.18	34	270	**35.3**	30.6	17	**60.8**	**82.9**	**48.8**	**39.3**	**440**
Lead	mg/kg	0.15	46.7	218	46.6	26.9	20.8	**103**	**92.5**	**62.6**	24	**248**
Mercury	mg/kg	4E-04	0.15	0.71	0.122	0.065	0.041	**0.229**	**0.272**	0.143	0.0976	**0.29**
Nickel	mg/kg	0.2	20.9	51.6	16	13.4	9.2	**30.7**	**27.9**	20.5	**21.7**	**38.5**
Silver	mg/kg	0.02	1	3.7	**1**	0.43	0.27	**3.77**	**1.54**	**1.85**	0.43	0.46
Zinc	mg/kg	0.21	150	410	**155**	109	54.9	**190**	**330**	**192**	124	**1770**
Selenium	mg/kg	0.35			0.48	0.56	0.55	<0.35	1.61	<0.35	0.42	0.55
PAHs												
Total detectable PAHs	mg/kg		4.022	44.79	0	0	0	0	0	0	0	1.5
Pesticides & PCBs												
Total detectable DDT	ug/kg		1.58	46.1	**3.6**	**17.1**	0	1.2	**7.3**	**5.6**	1	**9.6**
Total detectable chlordane	ug/kg		0.5	6	**4.5**	**51.4**	0	**1.2**	**2.4**	**2.7**	**1.2**	**6.7**
OP Pesticides												
Azinphosmethyl (Guthion)	ug/kg	13.8			<13.8	<13.8	<13.8	<13.8	<13.8	<13.8	<13.8	<13.8
Bolstar	ug/kg	1.5			<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Chlorpyrifos (Dursban)	ug/kg	1.6			<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6	<1.6
Coumaphos	ug/kg	13.5			<13.5	<13.5	<13.5	<13.5	<13.5	<13.5	<13.5	<13.5
Def	ug/kg	3.5			<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5	<3.5
Demeton (Total)	ug/kg	2.5			<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
Diazinon	ug/kg	2			<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Dichlorvos	ug/kg	3.3			<3.3	<3.3	<3.3	<3.3	<3.3	<3.3	<3.3	<3.3
Dimethoate	ug/kg	4.91			<4.91	<4.91	<4.91	<4.91	<4.91	<4.91	<4.91	<4.91
Disulfoton	ug/kg	1.8			<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8
EPN	ug/kg	1.8			<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8
Ethion	ug/kg	1.8			<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8
Ethoprop	ug/kg	1.4			<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4
Fensulfothion	ug/kg	18.7			<18.7	<18.7	<18.7	<18.7	<18.7	<18.7	<18.7	<18.7
Fenthion	ug/kg	2.7			<2.7	<2.7	<2.7	<2.7	<2.7	<2.7	<2.7	<2.7
Malathion	ug/kg	0.6			<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
Merphos	ug/kg	4.5			<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5	<4.5
Mevinphos	ug/kg	5.2			<5.2	<5.2	<5.2	<5.2	<5.2	<5.2	<5.2	<5.2
Naled	ug/kg	17			<17	<17	<17	<17	<17	<17	<17	<17
Parathion, ethyl	ug/kg	2.75			<2.75	<2.75	<2.75	<2.75	<2.75	<2.75	<2.75	<2.75
Parathion, methyl	ug/kg	3.4			<3.4	<3.4	<3.4	<3.4	<3.4	<3.4	<3.4	<3.4
Phorate	ug/kg	1.8			<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8
Prowl (Pendimethalin)	ug/kg	1.8			<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	300

Parameter	Units	MDL	ER-L*	ER-M*	BWS-1	BWS-3	BWS-4	BWS-5	BWS-8	BWS-9	BWS-10	BWS-11
Ronnel	ug/kg	1.4			<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4
Stirophos	ug/kg	6.2			<6.2	<6.2	<6.2	<6.2	<6.2	<6.2	<6.2	<6.2
Sulfotep	ug/kg	1.14			<1.14	<1.14	<1.14	<1.14	<1.14	<1.14	<1.14	<1.14
Tokuthion	ug/kg	1.8			<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8
Trichloronate	ug/kg	1.3			<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3	<1.3
Trifluralin	ug/kg	4.4			<4.4	<4.4	<4.4	<4.4	<4.4	<4.4	<4.4	<4.4
Pyrethroids												
Bifenthrin	ug/kg				ND	ND	ND	ND	ND	ND	ND	34J
Cyfluthrin	ug/kg				ND	ND	ND	ND	ND	ND	ND	ND
Cypermethrin	ug/kg				ND	ND	ND	ND	ND	ND	ND	ND
Esfenvalerate/Fenvalerate	ug/kg				ND	ND	ND	ND	ND	ND	ND	ND
Lambda cyhalothrin	ug/kg				ND	ND	ND	ND	ND	ND	ND	ND
Permethrin	ug/kg				ND	ND	ND	ND	ND	ND	ND	ND
PCBs												
Total detectable PCBs	ug/kg		22.7	180	16	**25**	0	0	0	**36**	0	**24**
Mean ER-M quotient					0.22	0.80	0.07	0.32	0.32	0.26	0.15	0.84

MDL = Method Detection Limit is the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero, as defined in 40 CFR Part 136 Appendix B.

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

Toxicity results in **bold** = moderately toxic (per Bight criteria)

Toxicity results in **<u>bold</u>** = highly toxic (per Bight criteria)

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

Chemistry results in **<u>bold</u>** = exceeds ER-M

J - Estimated value

Metals

Eight metals, including arsenic, cadmium, copper, lead, mercury, nickel, silver, and zinc exceeded the ER-L at some of the stations within the Ballona Marsh. Four metals, including copper, lead, silver, and zinc, exceeded the ER-M at some of the stations. There were detections of all other metals at all stations, including chromium and selenium, at concentrations below the ER-L and ER-M values.

- *Arsenic* exceeded the ER-L of 8.2 mg/kg at four stations; BWS-5, BWS-8, BWS-9, and BWS-11. Values ranged from 8.45 to 14.6 mg/kg at BWS-11. None approached the 70 mg/kg ER-M.

- *Cadmium* exceeded the ER-L of 1.2 mg/kg at all stations sampled. Values ranged from a low of 1.83 mg/kg at BWS-4 to 6.16 mg/kg at BWS-11. None exceeded the ER-M value of 9.6 mg/kg.

- *Copper* exceeded the ER-L of 34 mg/kg at six out of eight stations and the ER-M of 270 mg/kg at one station. ER-L exceedances ranged from just above the ER-L at BWS-1 up to nearly 83 mg/kg at BWS-8. The ER-M was exceeded at BWS-11 with a detected value of 440 mg/kg.

- *Lead* exceeded the ER-L of 46.7 mg/kg at four stations, including one exceedance of the ER-M of 218 mg/kg. Stations BWS-5, -8, and -9 each exceeded with values between 62.6 and 103 mg/kg. The exceedance of the ER-M was a value of 248 mg/kg detected at BWS-11. At BWS-1, the level of lead approached the ER-L but was detected just below it at 46.6 mg/kg.

- *Mercury* exceeded the ER-L of 0.15 mg/kg at three stations but had no exceedances of the ER-M of 0.71 mg/kg. Exceedances at stations BWS-5, -8, and -11 ranged from 0.229 to 0.29 mg/kg.

- *Nickel* exceeded the ER-L of 20.9 mg/kg at four stations and approached the ER-L at one. Exceedances at stations BWS-5, -8, -10, and -11 ranged from a low of 21.7 mg/kg at BWS-10 to a high of 38.5 mg/kg at BWS-11. The 20.5 mg/kg detected at BWS-9 fell just below the ER-L. Nickel was not detected at any stations at levels above the ER-M.

- *Silver* was detected at levels exceeding the ER-L of 1 mg/kg at four stations, including one exceedance of the ER-M of 3.7 mg/kg. Stations BWS-1, -8, and -9 were each detected at concentrations between 1 and 1.85 mg/kg. The single exceedance of the ER-M was at BWS-5, at which a concentration of 3.77 mg/kg was detected.

- *Zinc* exceeded the ER-L of 155 mg/kg at five stations, including one exceedance of the ER-M of 410 mg/kg. Samples collected from stations BWS-1, -5, -8, and -9 were each found to have concentrations between 155 mg/kg at BWS-1 and 330 mg/kg at BWS-8. The single exceedance of the ER-M was at BWS-11, where a concentration of 1,770 mg/kg was detected.

PAHs

Total detectable PAHs were below the ER-L values at seven of the eight stations monitored in the Ballona Marsh. Total detectable PCBs were only detected at BWS-11 with a value of 1.5 mg/kg, below the ER-L of 4.02 mg/kg.

Pesticides

Three organochlorine pesticides, including total detectable DDT, total detectable chlordane, and dieldrin exceeded the ER-L at stations within Area B. Total detectable chlordane exceeded the ER-M at two stations. Other organochlorine pesticides detected, for which there are no current ER-L/ER-M guidelines, include nonachlors, enfosulfans, and oxychlordane. Cis-nonachlor was detected at station BWS-3, at a concentration of 5.4 µg/kg and at BWS-11 at a concentration of 2.9 µg/kg. Trans-nonachlor was detected at six of the eight stations at values ranging from a low of 0.4 µg/kg at BWS-5 to a high of 16.6 µg/kg at BWS-3. No nonachlors were detected at BWS-4 or BWS-8. Endosulfan I was detected at BWS-1 at a concentration of 0.6 µg/kg. Oxychlordane was detected at BWS-11 at a concentration of 1.3 µg/kg. OP pesticides and pyrethroids were also detected at BWS-11.

Total detectable DDT exceeded the ER-L at five stations, BWS-1, -3, -8, -9, and -11, with values ranging from 3.6 µg/kg at BWS-1 to 17.1 µg/kg at BWS-3. Total detectable DDT was below the ER-L value at BWS-5 and BWS-10 and was not detected at BWS-4. No levels were detected above the ER-M of 46.1 µg/kg.

Total detectable chlordane exceeded the ER-L of 0.5 µg/kg at seven out of eight sampled stations and the ER-M of 6 µg/kg at two stations. No chlordanes were detected at BWS-4. The ER-M was exceeded at BWS-3 and BWS-11, with respective values of 51.4 µg/kg and 6.7 µg/kg.

Dieldrin was detected in three of the eight stations sampled. Values above the ER-L of 0.02 µg/kg ranged from 1 µg/kg at BWS-9 to 1.3 µg/kg at BWS-1 to 2.4 µg/kg at BWS-3. The remaining five stations were non-detect, however, the method detection limit for this constituent was 0.8 µg/kg, a higher value then the ER-L. These five stations may in fact have exceeded the ER-L if they were between 0.02 and 0.8 µg/kg. No samples exceeded the ER-M of 8 µg/kg.

One OP pesticide and one pyrethroid were detected at levels above their method detection limits at BWS-11. Prowl (pendimethalin) was detected at concentrations of 300 µg/kg and bifenthrin at an estimated value of 34 µg/kg. These analytes are emerging contaminants of concern and do not have established ER-Ls or ER-Ms.

PCBs

Total detectable PCBs exceeded the ER-L of 22.7 µg/kg at three stations, BWS-3, BWS-9, and BWS-11. None exceeded the 180 µg/kg ER-M. The exceedances ranged from 24 and 25 µg/kg at BWS-11 and BWS-3 to 36 µg/kg at BWS-9.

ERM –Q Results

ERM-Q values were above the threshold of 0.10 at seven of the eight stations monitored in the Ballona Marsh. Only BWS-4 had a mean ERM-Q value below 0.10, with a value of 0.07.

Summary of Acute Testing Results

The mean percent survival of the test organism, *E. estuarius*, exposed to Ballona Marsh sediments ranged from 9 to 99%. Percent survival was the lowest at stations BWS-9 and BWS-11, with values of 34% and 9%, respectively. Station BWS-9 is the second sampling location from the tide gates to Ballona Creek. These results indicate a potential impact from Ballona Creek sediments and storm water to Area B based on the historical data showing toxicity of sediments from the Ballona Creek estuary (Bight 03 draft report, SCCWRP 2004). The results for BWS-11, which is located in a tributary channel adjacent to Culver Blvd. indicates a potential for impact from urban runoff that is resulting in toxic response to aquatic organisms. The mean percent survival of *E. estuarius* at BWS-5 and BWS-10 were 65% and 61%, suggesting that the sediments in these areas were moderately toxic to the test organisms. The remaining stations had a mean percent survival range between 92 and 99%, which suggests that the sediments in this area did not demonstrate an acute toxic response.

Summary of Geotechnical Testing Results

Sand, silt, and clay were the dominant sediment constituents at the stations monitored in the Ballona Marsh. Sand dominated the sediment composition at five stations, BWS-1, -3, -4, -8, and -11, followed by silt. Silt was the dominant constituent at BWS-5, followed by clay, and at BWS-9 and -10, followed by sand. Median grain size ranged from 13 to 360 microns. TOC content ranged from 0.37 to 4.64%. Station BWS-4 had the largest median grain size and the lowest TOC content.

Conclusions

Three of the stations displayed similar patterns of metals exceedances in Area B. BWS-5, -8, and -11 had the most number of metals exceedances (eight, eight, and seven exceedances, respectively) and all had mean ERM-Q values above the 0.10 threshold. These stations each exceeded criteria for arsenic, cadmium, copper, lead, mercury, nickel, and zinc; including ER-M exceedances at BWS-11 for copper, lead, and zinc and at BWS-5 for silver. BWS-8 also exceeded the ER-L for silver. These stations are each located in tributary channels off of the main channel, and therefore may be subject to less circulation than the main channel. The existing marsh is also not open to full tidal flow, but muted flow controlled by the tide gates. Sediment quality data collected from the Ballona Creek estuary during the 2003 Bight program also shows metals exceedances of copper, lead, and zinc, but at generally lower levels that those found within the marsh (Table 3). Cadmium exceeded the ER-L at each station sampled within Area B, but did not exceed criteria within Ballona Creek sediments sampled during the 2003 Bight program. It was reported to have exceeded the ER-L in Ballona Creek sediments in the draft Total Maximum Daily Load report for Toxic Pollutants in Ballona Creek Estuary (CRWQCB & US EPA, Region IX, 2005). Cadmium has not been found to exceed water quality criteria within Ballona Creek.

Table 3. Range of Values for Constituents Found to Exceed within Ballona Marsh and Ballona Creek Estuary Sediments

	Ballona Marsh		Ballona Creek Estuary Range
	Range	Max	
Metals (mg/kg)			
Arsenic	3.7 – 14.6	BWS-11	2.37 – 4.01
Cadmium	1.83 – 6.16	BWS-11	0.13 – 0.96
Chromium	18 – 70.2	BWS-5	10.6 – 21.9
Copper	17 – 440	BWS-11	10.6 – 36.4
Lead	20.8 – 248	BWS-11	12.7 – 111
Mercury	0.041 – 0.29	BWS-11	0.03 – 0.11
Nickel	9.2 – 38.5	BWS-11	7.6 – 13.3
Selenium	<0.35 – 1.61	BWS-8	NA
Silver	0.27 – 3.77	BWS-5	0.36 – 0.87
Zinc	54.9 – 1770	BWS-11	73.5 – 202
PAHs (mg/kg)			
Total detectable PAHs	0 – 1.5	BWS-11	0.069 – 1.93
Pesticides and PCBs (ug/kg)			
Total detectable DDT	0 – 17.1	BWS-3	0 – 17.3
Total detectable chlordane	0 – 51.4	BWS-3	0 – 21.6
Prowl (Pendimethalin)	<1.8 – 300	BWS-11	NA
Bifenthrin	ND – 34J	BWS-11	NA
Total detectable PCBs	0 – 36	BWS-9	0 – 8

These three samples are located in tributaries off of the main channel (BWS-5), adjacent to Culver Blvd. (BWS-11), and in a tributary that also receives freshwater inputs and runoff from adjacent residential communities (BWS- 8). The results from the metals analysis of these samples indicate the following:

- Area B may be acting as a sink for these metals that migrate to Area B in suspended sediment from Ballona Creek. Concentrations are in some locations greater in Area B possibly due to the control of tidal flows that limits the level of circulation and flushing that is observed in the Ballona Creek estuary, even through the creek estuary is subject to greater constituent loading.

- Urban Runoff and aerial deposition from Culvert Blvd. is impacting the sediments in the existing channels adjacent to the primary transportation corridor for Playa del Rey. As presented in Table 3, the majority of the highest concentrations of metals were detected in the sediment at BSW-11 located adjacent to Culver Blvd.

- Urban Runoff from adjacent communities and from portions of Area B that have been filled and subject to agricultural and oil/gas extraction may be contributing to metals concentrations in the channel sediments subject to these flows.

- It appears that metals from Ballona Creek could be accumulating in marsh sediments due to lack of tidal flushing, or there may be a source of metals other than Ballona Creek, such as urban runoff and stormwater flows from Culver Blvd. For constituents such as copper and zinc, where the highest values found in the marsh exceed those found in the creek by up to 10 times, a secondary source seems likely.

Total detectable PAHs were below method detection limits (MDLs) at each Area B station except for BWS-11, where, although detected, the concentrations were still below the ER-L. The MDLs for many of the PAHs were higher than the ER-Ls but lower than the ER-Ms. These constituents may have approached the ER-Ls if a method of analysis with a lower detection limit was used. The range of total detectable PAHs found during 2003 Bight sampling was similar.

Total detectable PCBs were detected at four stations within Area B, with exceedances of the ER-L at three of those (BWS-3, -9, and -11). Total detectable PCBs were detected at one station during 2003 Bight sampling at a concentration below the ER-L. The higher values found within marsh sediments may indicate a secondary source or accumulation due to lack of tidal flushing.

Three organochlorine pesticides, including total detectable DDT, total detectable chlordane, and dieldrin, exceeded the ER-L at stations within Area B. Total detectable chlordane exceeded the ER-M at two stations. The highest concentrations of each pesticide detected were at BWS-3, the station closest to the tide gates connecting the marsh to Ballona Creek. DDT and total detectable chlordane were also found to exceed sediment quality criteria within the Ballona Creek estuary during the 2003 Bight program, and had a similar range of values compared to marsh sediments. This may indicate that Ballona Creek is a potential source of the pesticides found within Ballona Marsh. The second highest concentrations of each pesticide were at BWS-11, the station farthest from Ballona Creek's influence. This may indicate a secondary source of pesticides, such as stormwater flows and urban runoff. It is possible that Area B may be its own source of pesticide contamination. Portions of Area B southeast of Ballona Marsh were used as agricultural fields prior to the nationwide ban on DDT in 1972.

Two other pesticides were found only at BWS-11. Pendimethalin is an OP pesticide known as Prowl that is used as an herbicide and is considered of low acute toxicity (http://www.epa.gov/epaoswer/hazwaste/minimize/factshts/pendmeth.pdf). Bifenthrin is a pyrethroid insecticide and miticide classified as "Restricted Use" due to toxicity to fish and aquatic organisms; its use is prohibited in areas where it may result in exposure of endangered species (http://www.fs.fed.us/foresthealth/pesticide/bifenthr.html). That these two pesticides were found only at BWS-11, where the primary influence is stormwater runoff and urban flows, may indicate that those flows are a transport mechanism. These constituents were not analyzed in sediments collected from the Ballona Creek estuary in 2003.

The sediments at two stations in Area B were found to be highly toxic to test organisms. BWS-11 had a survival rate of less than 10% and also had the highest number of ER-M exceedances of any other station. BWS-11 is located adjacent to Culver Blvd. and is subject to urban runoff and aerial deposition from this transportation corridor. BWS-9, located near the tide gates had a survival rate of just over 34% and a significant number of ER-L exceedances. Two sites in Ballona Creek were also found to be highly toxic.

Higher concentrations of metals and pesticides were detected in the sediments collected in Area B compared to the sediments sampled in Ballona Creek estuary. Most of the exceedances of the sediment guidelines within Area B were found in tributaries of the main channel both near the tidal inflow from the creek and at locations that are subject to urban runoff and fresh water flows from groundwater seeps. Ballona Creek is a known source of metals and toxic pollutants, as is evident by the toxicity test results and the current and proposed TMDLs for this watershed. Stormwater and urban runoff flows from the highly urbanized areas surrounding Area B, as well as from former agricultural fields, may also be a contributing factor. Current muted tidal flows may be inadequate to provide sufficient flushing and circulations that would reduce long-term accumulation of these constituents in Area B sediments.

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