Chapter 4. Sediment Characteristics

INTRODUCTION

Ocean sediment samples are collected and analyzed as part of the Point Loma Ocean Outfall (PLOO) monitoring program to characterize the surrounding physical environment and assess general sediment conditions. These conditions define the primary habitat for benthic invertebrates that live within or on the surface of sediments and can influence their presence and distribution. In addition, many species of demersal fish are associated with specific sediment types that reflect the habitats of their preferred prey (Cross and Allen 1993). Both natural and anthropogenic factors affect the composition, distribution and stability of seafloor sediments.

Natural factors that affect sediment conditions on the continental shelf include the strength and direction of bottom currents, exposure to wave action, seafloor topography, and proximity to geographic features such as submarine basins, canyons and hills, inputs associated with outflows from rivers and bays, beach erosion and runoff from other terrestrial sources, and decomposition of calcareous organisms (e.g., Emery 1960). The analyses of parameters such as sediment grain size and relative percentages of different sediment fractions (e.g., sand, silt and clay) can provide useful information concerning current velocity, amount of wave action and overall habitat stability in an area. Further, understanding sediment grain size distributions allows for better interpretations of the interactions between benthic organisms and the environment. For example, differences in sediment composition (e.g., fine vs. coarse particles) and associated levels of organic loading at specific sites can affect burrowing, tube building and feeding abilities of infaunal invertebrates, thus leading to changes in benthic community structure (Gray 1981, Snelgrove and Butman 1994). Geological history can also affect the chemical composition of local sediments. For example, erosion from cliffs and shores, and the flushing of sediments and other debris of terrestrial origin from bays, rivers and streams can contribute to the deposition and accumulation of metals in an area and also affect the overall organic content of sediments. Additionally, primary productivity by marine plankton is an important source of organics to the marine benthos (Mann 1982, Parsons et al. 1990). Finally, particle size composition can affect concentrations of chemical constituents within sediments. For example, levels of organic compounds and trace metals within seafloor sediments generally rise with increasing amounts of fine particles (Emery 1960, Eganhouse and Vanketesan 1993).

Municipal wastewater outfalls are one of many anthropogenic factors that can directly influence the composition and distribution of sediments through the discharge of treated effluent and the subsequent deposition of a wide variety of organic and inorganic compounds. Some of the most commonly detected compounds discharged via ocean outfalls are trace metals, pesticides and various organic compounds such as total organic carbon, nitrogen and sulfides (see Anderson et al. 1993). Moreover, the presence of large outfall pipes and their associated ballast materials (e.g., rock, sand) may alter the hydrodynamic regime of surrounding areas.

This chapter presents summaries and analyses of sediment grain size and chemistry data collected during 2007 at monitoring sites surrounding the PLOO. The primary goals are to: (1) assess possible effects of wastewater discharge on benthic habitats by analyzing spatial and temporal variability of various sediment parameters, (2) determine the presence or absence of sedimentary and chemical footprints near the discharge site, and (3) evaluate overall sediment quality in the region.

MATERIALS AND METHODS

Field Sampling

Sediment samples were collected at 22 benthic stations in the PLOO region during January and

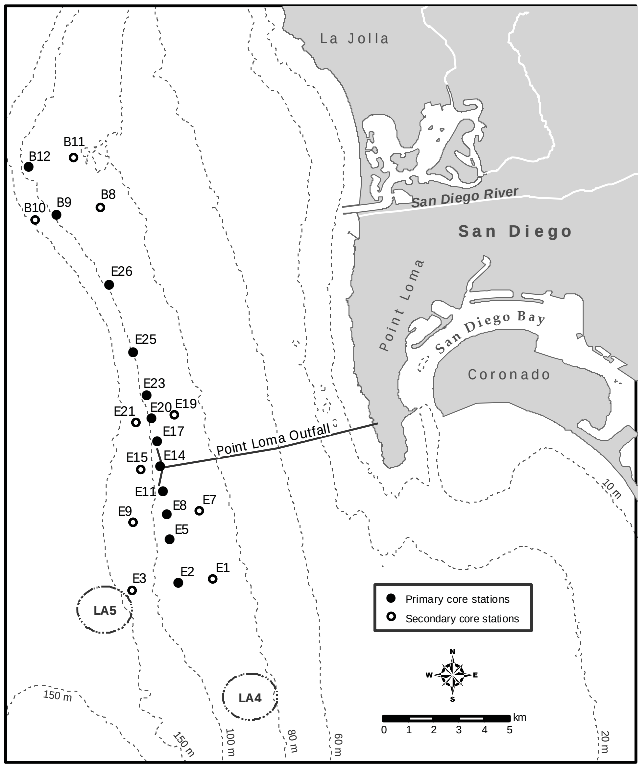

Figure 4.1

Benthic station locations sampled for the Point Loma Ocean Outfall Monitoring Program.

July 2007 (**Figure 4.1**). These stations are located along the 88, 98, and 116-m depth contours, and include 17 "E" stations located within 8 km of the outfall, and five "B" stations located greater than 11 km north of the outfall. Each sediment sample was collected from one side of a chain-rigged double Van Veen grab with a 0.1-m^2 surface area; the other grab sample from the cast was used for macrofaunal community analysis (see Chapter 5). Sub-samples for various analyses were taken from the top 2 cm of the sediment surface and handled according to EPA guidelines (USEPA 1987).

Laboratory Analyses

All sediment chemistry and grain size analyses were performed at the City of San Diego's Wastewater Chemistry Services Laboratory. Particle size analysis was performed using a Horiba LA-920 laser scattering particle analyzer, which measures particles ranging in size from 0.00049 to 2.0 mm (i.e., 11 to -1 phi). Coarser materials (e.g., very coarse sand, gravel, shell hash) were removed prior to analysis by screening the samples through a 2.0-mm mesh sieve. These data were expressed as "% coarse" of the total sample sieved.

Output from the Horiba particle size analyzer was categorized as follows: sand was defined as particles ranging from >0.0625 to 2.0 mm in size, silt as particles from 0.0625 to 0.0039 mm, and clay as particles <0.0039 mm (see **Table 4.1**). These data were standardized and combined with any sieved coarse fraction (i.e., particles >2.0 mm) to obtain a distribution of the coarse, sand, silt and clay fractions totaling 100%. The coarse fraction was included with the ≤2.0 mm fraction in the calculation of various particle size parameters, which were determined using a normal probability scale (see Folk 1968). These parameters were summarized and expressed as overall mean particle size (mm), phi size (mean, median, skewness, and kurtosis), and the proportion of coarse, sand, silt, and clay. The proportion of fine particles (% fines) was calculated as the sum of all silt and clay fractions.

Sediment samples were analyzed for total organic carbon (TOC), total nitrogen (TN), total sulfides, biochemical oxygen demand (BOD), total volatile solids (TVS), trace metals, chlorinated pesticides (e.g., DDT), polychlorinated biphenyl compounds (PCBs), and polycyclic aromatic hydrocarbons (PAHs; see **Appendix B.1**). TOC, TN, and TVS were measured as percent weight (%wt) of the sediment sample; BOD, sulfides and metals were measured in units of mg/kg and expressed as parts per million (ppm); pesticides and PCBs were measured in units of ng/kg and expressed as parts per trillion (ppt); PAHs were measured in units of µg/kg and expressed as parts per billion (ppb). The data reported herein were generally limited to values above the method detection limit (MDL). However, concentrations below MDLs were included as estimated values if the presence of the specific constituent could be verified by mass-spectrometry (i.e., spectral peaks confirmed). A detailed description of the analytical protocols may be obtained from the City of San Diego Wastewater Chemistry Services Laboratory (see City of San Diego 2008).

Table 4.1
A subset of the Wentworth scale representative of the sediments encountered in the PLOO region. Particle size is presented in phi, microns, and millimeters along with the conversion algorithms. The sorting coefficients (standard deviation in phi units) are based on categories described by Folk (1968).

Wentworth scale				Sorting coefficient	
Phi size	Microns	Millimeters	Description	Standard deviation	Sorting
-2	4000	4	Pebble	Under 0.35 phi	very well sorted
-1	2000	2	Granule	0.35–0.50 phi	well sorted
0	1000	1	Very coarse sand	0.50–0.71 phi	moderately well sorted
1	500	0.5	Coarse sand	0.71–1.00 phi	moderately sorted
2	250	0.25	Medium sand	1.00–2.00 phi	poorly sorted
3	125	0.125	Fine sand	2.00–4.00 phi	very poorly sorted
4	62.5	0.0625	Very fine sand	Over 4.00 phi	extremely poorly sorted
5	31	0.0310	Coarse silt		
6	15.6	0.0156	Medium silt		
7	7.8	0.0078	Fine Silt		
8	3.9	0.0039	Very fine silt		
9	2.0	0.0020	Clay		
10	0.98	0.00098	Clay		
11	0.49	0.00049	Clay		

Conversions for diameter in phi to millimeters: $D(mm) = 2^{-phi}$

Conversions for diameter in millimeters to phi: $D(phi) = -3.3219 \log_{10} D(mm)$

Data Analyses

Values for total PAH, total DDT and total PCB were calculated for each sample as the sum of all constituents with reported values. Values for each individual constituent are listed in **Appendix B.2**. Zeroes were substituted for all non-detects (i.e., null values) when calculating means. Summaries of parameters included detection rates (i.e., total number of reported values/total number of samples), annual means by station, annual means for all stations combined (areal mean), and the maximum value of each parameter during the year. Levels of contamination were further evaluated by comparing the results of this study to the Effects Range Low (ERL) sediment quality guidelines of Long et al. (1995) when available. The National Status and Trends Program of the National Oceanic and Atmospheric Administration (NOAA) originally calculated the ERLs to provide a means for interpreting monitoring data. The ERLs are considered to represent chemical concentrations below which adverse biological effects are rarely observed.

Results and Discussion

Particle Size Distribution

During 2007, ocean sediments collected off Point Loma were predominantly composed of very fine sands and coarse silt with mean particle sizes ranging from about 0.04 to 0.12 mm (**Table 4.2**). Differences in intra-station particle size composition between the winter and summer surveys ranged between 0–0.109 mm and 0.1–18.2% fines; the greatest differences occurred at three stations (E2, E3 and E9) located south of the outfall (**Appendix B.3**). Overall, fine sediments averaged about 40% region-wide during the year, ranging narrowly from a low of 29.6% to a high of 60.3% fines at the different stations. Several stations along the 98-m and 116-m depth contours from E21 south to E5 were composed of sediments that were slightly coarser than the

Table 4.2

Summary of particle size parameters and organic loading indicators at PLOO benthic stations during 2007. Data are annual means per station (n=2); SD=standard deviation; BOD=biological oxygen demand; TN=total nitrogen; TOC=total organic carbon; TVS=total volatile solids.

		Particle size						Organic indicators				
	Depth (m)	Mean (mm)	Mean (phi)	SD (phi)	Coarse (%)	Sand (%)	Fines (%)	BOD* (ppm)	Sulfides (ppm)	TN (%wt)	TOC (%wt)	TVS (%wt)
North reference stations												
B11	88	0.052	4.3	1.8	1.6	53.0	45.4	332	0.3	0.071	2.895	3.80
B8	88	0.042	4.6	1.6	0.0	43.2	56.9	300	8.1	0.075	0.901	2.94
B12	98	0.065	4.0	1.8	1.2	63.9	35.0	351	0.2	0.060	3.835	3.33
B9	98	0.051	4.3	1.7	0.0	56.9	43.2	334	1.8	0.063	0.953	2.90
B10	116	0.068	3.9	1.5	0.0	70.5	29.6	351	3.5	0.058	1.415	2.73
Stations north of the outfall												
E19	88	0.049	4.4	1.5	0.0	52.8	47.2	438	9.3	0.068	0.749	2.42
E20	98	0.060	4.1	1.5	0.5	62.2	37.4	325	7.5	0.055	0.643	2.06
E23	98	0.055	4.2	1.5	0.0	59.0	41.0	364	3.2	0.057	0.681	2.27
E25	98	0.058	4.1	1.5	0.0	61.1	39.0	285	6.1	0.050	0.668	2.40
E26	98	0.052	4.3	1.5	0.0	56.3	43.8	349	8.2	0.067	0.770	2.51
E21	116	0.061	4.0	1.5	0.0	66.4	33.6	373	5.9	0.050	0.630	2.01
Near outfall stations												
E11	98	0.074	3.8	1.3	0.0	70.0	30.0	216	10.5	0.045	0.671	1.56
E14	98	0.073	3.8	1.4	0.0	70.5	29.6	492	22.8	0.036	0.439	1.80
E17	98	0.066	3.9	1.4	0.0	67.3	32.8	407	14.8	0.047	0.548	1.87
E15	116	0.064	4.0	1.5	0.0	67.7	32.4	352	10.0	0.052	0.777	2.21
Stations south of the outfall												
E1	88	0.061	4.1	2.0	2.9	57.2	40.0	200	2.6	0.050	0.635	1.98
E7	88	0.055	4.2	1.5	0.0	57.6	42.4	309	8.7	0.034	0.695	2.25
E2	98	0.114	3.2	1.6	7.9	31.9	60.3	347	15.2	0.066	0.878	2.85
E5	98	0.065	4.0	1.5	0.0	65.5	34.5	285	4.2	0.042	0.643	2.06
E8	98	0.067	3.9	1.4	0.0	66.3	33.7	289	46.4	0.047	0.700	2.11
E3	116	0.121	3.2	1.7	5.1	59.3	35.7	221	13.1	0.036	0.507	1.89
E9	116	0.103	3.5	1.8	9.0	43.1	48.0	258	5.6	0.054	1.545	2.44
Detection rate (%)								100	98	98	100	100
Area mean		0.067	4.0	1.5	1.3	59.1	39.6	326	9.5	0.054	1.008	2.38
Area max		0.121	4.6	2.0	9.0	70.5	60.3	626	89.5	0.083	3.900	4.05

*QC standard criteria failed for BOD samples collected in July. Data are reported despite this failure because results were found to be in the range of historical data and the batch failure applied only to seeded bottles (samples are not seeded).

surrounding area (**Figure 4.2**). Field observations of sediment samples from these stations indicated the presence of shell hash and/or coarse black sand (used as stabilizing material for the outfall pipe; Appendix B.3). No major changes to sediment size appeared to occur following the initiation of the wastewater discharge at the end of 1993 (**Figure 4.3**).

The particle size sorting coefficient reflects the range of grain sizes comprising sediments and is calculated as the standard deviation (SD) in phi size units (see Table 4.1). In general, areas composed of particles of similar size are considered to have well-sorted sediments (i.e., SD≤0.5 phi). In contrast, samples with particles of varied sizes are characteristic of poorly sorted sediments (i.e., SD≥1.0 phi). Sediments in the Point Loma region were poorly sorted in 2007 with sorting coefficients ranging from 1.3 to 2.0 phi (Table 4.2). These results are typical of the mid-shelf and reflect

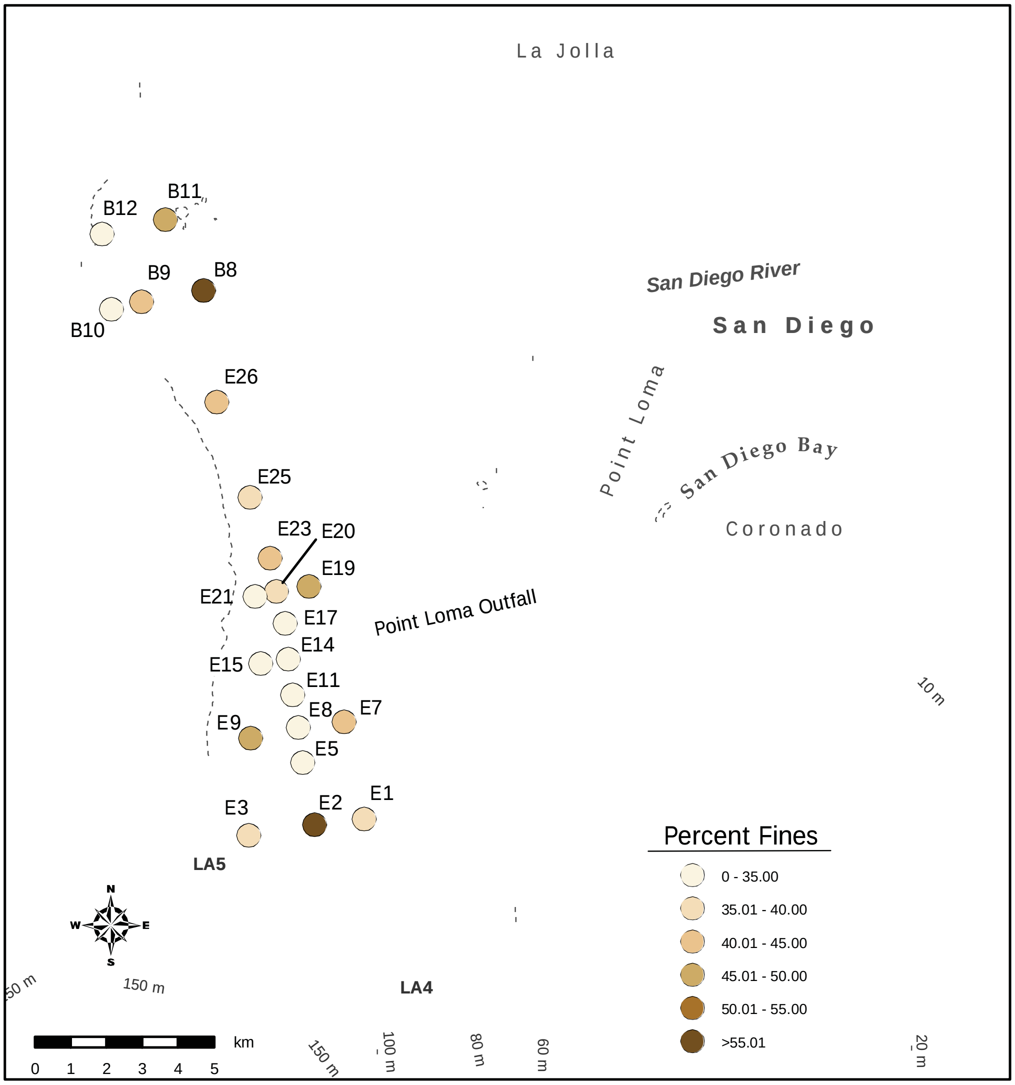

Figure 4.2
Particle size distribution for PLOO benthic stations sampled during 2007. Data are annual means (n=2).

the multiple origins of sediments in the region (see Emery 1960, City of San Diego 2007a). This also suggests that these sites are not subject to fast moving currents or large disturbances (e.g., storm surge, rapid suspension/deposition of materials).

Indicators of Organic Loading

Generally, the distribution of organic indicators in PLOO sediments during 2007 was similar to that seen prior to discharge (see City of San Diego 1995a). Detection rates were ≥98% for biochemical oxygen demand (BOD), total organic carbon (TOC), total nitrogen (TN), sulfides, and total volatile solids (TVS) (Table 4.2). With the exception of perhaps sulfides and BOD, concentrations of most indicators at stations nearest the discharge site (e.g., stations E11, E14, E15 and E17) were similar to values reported elsewhere in the region. For example, the highest concentrations of TOC, TN, and TVS occurred in sediments from three of the northern reference stations (i.e., B12, B8 and B11, respectively). Only sulfides, and to a lesser extent BOD, have demonstrated noticeable changes near the outfall that appear to be coincident the initiation of wastewater discharge (see Figure 4.3 and City of San Diego 2007b).

Trace Metals

Aluminum, arsenic, barium, chromium, copper, iron, lead, manganese, mercury, nickel, tin and zinc were

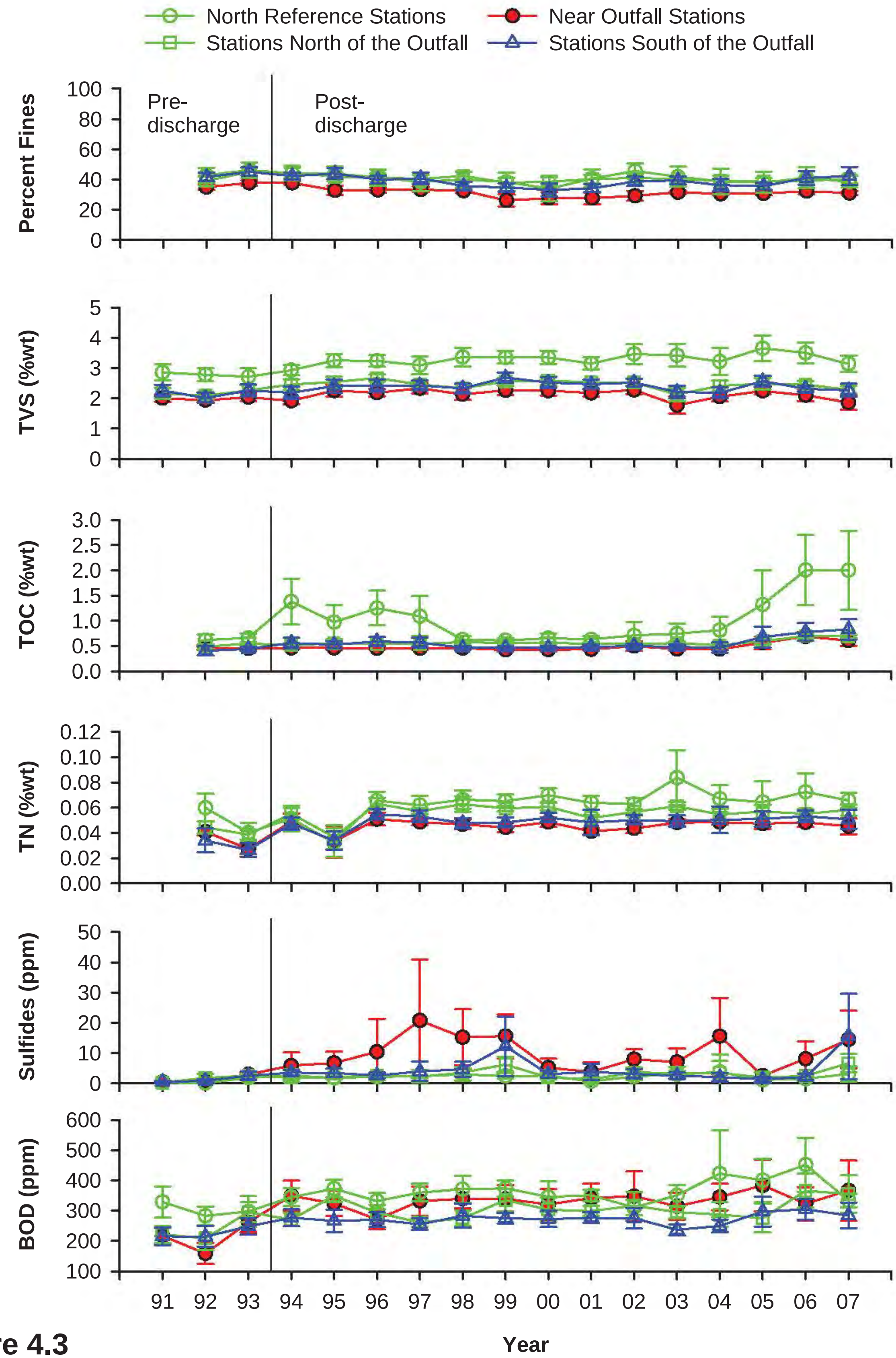

Figure 4.3
Summary of particle size and organic indicator data surrounding the PLOO from 1991–2007: BOD=biological oxygen demand, TN=total nitrogen, TOC=total organic carbon, TVS=total volatile solids, %wt=percent weight. Data are expressed as means pooled over all stations in each station group (see Table 4.2; n=≤14); error bars represent 95% confidence limits.

detected in 100% of the sediment samples collected in the Point Loma region during 2007 (**Table 4.3**). Other metals that were detected in at least 50% of the samples included antimony, cadmium, silver and thallium; selenium was detected in 34% of the samples; beryllium was not detected at all. Concentrations of each metal were variable. The highest average concentrations of almost all of the metals occurred in sediments from the north references stations and/or the stations south of the outfall. For example, station E3, located closest to the LA-5 dumpsite, had sediments with the highest concentrations of copper, lead, mercury, and zinc. In contrast, none of the highest concentrations occurred in the sediments closest to the PLOO. Of all the metals, only silver exceeded environmental threshold values during the year; i.e., the ERL for silver was exceeded at several stations throughout the region, but not at stations closest to the outfall.

Pesticides

Chlorinated pesticides were detected in up to 70% of the samples collected from PLOO stations in 2007 (**Table 4.4**, Appendix B.2). Total DDT (primarily p,p-DDE) was the most prevalent pesticide, occurring in sediments from all stations at concentrations averaging between 60–440 ppt (Table 4.4). Concentrations of total DDT were lower than the ERL of 1580 ppt for this pesticide. Another pesticide detected during the year was hexachlorobenzene (HCB), which occurred in concentrations averaging 33–400 ppt. This pesticide was detected in 30% of the samples at a total of 10 different sites located either to the north or the south of the PLOO. Two other pesticides were also detected, but in only single samples. These included BHC (beta isomer) in a sample from station E3 in January, and heptachlor detected in sediments at station E26 in July (Appendix B.2). As with the metals, pesticide values showed no patterns relative to wastewater discharge.

PCBs and PAHs

PCBs were detected in 32% of the sediment samples collected from eleven stations in 2007, most of which were located to the south of the PLOO (Table 4.4). Total PCB concentrations were highest in sediments from the three sites located immediately adjacent to (i.e., station E3) or further to the east of the LA-5 dredge disposal site (i.e., stations E2 and E1), and from one station (E9) located between LA-5 and the PLOO discharge site. Sediments from each of these stations also had the greatest number of PCB congeners that were detected (e.g., up to 28/sample; see Appendix B.2). PCBs have historically occurred at these and other stations located relatively near the LA-5 disposal site.

In contrast to PCBs, low levels of various PAH compounds were detected in all samples analyzed for 2007 (Table 4.4). All total PAH values were less than the ERL of 4022 ppt. The most prevalent PAHs were 1-methylnapthalene, 2,6-dimethylnapthalene, 2-methylnaphthalene, benzo(A)anthracene, biphenyl, naphthalene, and phenanthrene (Appendix B.2). Each of these PAHs was detected in at least 40% of the samples. There was no apparent relationship between PAH concentrations and proximity to the outfall discharge site.

Summary and Conclusions

Ocean sediments at stations surrounding the PLOO in 2007 were comprised primarily of very fine sands and coarse silt. Overall, these sediments were poorly sorted and consisted of particles of varied sizes. This suggests that the region was subject to low wave and current activity and/or physical disturbance. Several stations along the 98-m and 116-m depth contours were composed of sediments that were slightly coarser than the surrounding area. Field observations of sediment samples from these stations indicated the presence of shell hash and/or coarse black sand. Overall, differences in the particle size composition of sediments off Point Loma are likely affected by both anthropogenic and natural influences, including outfall construction materials, the offshore disposal of dredged materials, the multiple geological origins of specific sediment types, and recent deposits of detrital materials (e.g., see Emery 1960).

Table 4.3

Concentrations of trace metals (ppm) detected at each PLOO benthic station during 2007. Data are annual means (n=2); ERL=effects range low threshold value; na=not available; nd=not detected. See Appendix B for MDLs and names for each metal represented by periodic table symbol.

Station	Al	Sb	As	Ba	Be	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Se	Ag	Tl	Sn	Zn
North reference stations																		
B11	12150	0.39	3.5	48.0	nd	0.074	25.0	5.3	20500	3.5	141.0	0.028	9.1	0.360	0.91	0.128	1.51	40.0
B8	14550	0.37	2.8	53.1	nd	0.060	23.1	6.9	16900	2.6	140.5	0.041	10.3	0.207	2.97	0.682	1.83	37.9
B12	8320	0.42	4.2	26.0	nd	0.083	27.6	1.3	22950	2.5	84.0	0.021	6.9	0.329	nd	nd	1.17	36.8
B9	11900	0.44	2.8	67.5	nd	0.060	25.0	4.3	19000	2.9	121.5	0.028	8.6	0.127	1.85	0.263	1.80	38.3
B10	9115	0.31	2.5	30.4	nd	0.066	19.3	3.7	14200	2.2	91.6	0.018	6.4	0.133	0.95	0.199	1.37	29.8
Stations north of the outfall																		
E19	12650	0.25	3.3	47.9	nd	0.044	19.1	6.6	13950	2.8	118.0	0.035	8.3	0.265	2.00	0.483	1.56	32.4
E20	9910	0.15	2.4	33.8	nd	0.083	15.8	5.2	11600	1.5	95.4	0.020	7.2	nd	1.32	0.628	1.13	28.2
E23	10955	0.12	2.1	40.5	nd	0.070	17.6	5.9	12650	2.6	104.3	0.028	7.7	nd	1.44	0.565	1.45	29.1
E25	11450	0.40	2.5	41.9	nd	0.062	19.0	5.7	13950	2.5	124.5	0.030	8.2	nd	2.95	0.747	1.77	29.5
E26	11700	0.36	3.0	42.0	nd	0.051	19.3	5.6	14050	2.7	123.0	0.031	8.5	0.221	2.58	0.825	1.60	31.0
E21	8560	0.13	2.6	27.2	nd	0.050	14.0	4.5	9960	2.1	80.2	0.021	6.0	nd	1.06	0.363	1.00	23.6
Near outfall stations																		
E11	8130	0.13	2.4	27.9	nd	0.050	14.1	4.2	10315	1.8	81.0	0.018	6.0	nd	0.56	0.121	1.21	22.4
E14	7120	0.10	2.3	26.6	nd	0.066	13.3	4.1	9485	1.6	73.5	0.015	5.8	0.127	0.41	0.408	1.08	21.5
E17	7845	0.15	3.0	28.5	nd	0.067	14.1	4.6	10250	1.9	78.9	0.022	6.1	nd	0.53	0.294	1.07	22.1
E15	8470	0.20	2.1	28.9	nd	0.073	15.7	5.5	10850	2.5	80.8	0.020	6.4	0.145	0.55	0.213	1.31	25.5
Stations south of the outfall																		
E1	12650	0.11	2.6	45.3	nd	nd	18.9	7.6	14200	3.9	116.5	0.060	7.3	nd	1.06	0.943	1.37	32.4
E7	11405	0.14	2.5	42.3	nd	0.074	17.8	5.9	13050	2.7	106.8	0.034	7.7	nd	1.73	0.361	1.36	32.5
E2	17500	0.24	2.9	77.1	nd	nd	23.9	11.7	21350	3.1	152.0	0.053	9.2	nd	1.30	0.909	1.32	36.7
E5	9345	0.28	2.0	32.3	nd	0.059	15.1	4.7	11050	1.8	90.1	0.026	6.4	0.137	0.97	0.621	1.24	26.6
E8	10280	0.18	2.1	38.5	nd	0.066	16.7	5.5	11950	2.7	96.0	0.026	7.3	0.121	0.77	0.393	1.69	26.8
E3	11650	0.22	2.8	54.0	nd	0.037	16.6	13.3	14200	6.8	108	0.071	6.6	0.195	1.12	0.602	1.38	40.6
E9	8410	0.30	3.6	30.1	nd	0.055	17.8	6.9	12550	2.8	76.6	0.025	6.7	nd	0.35	0.136	1.16	34.6
Detection rate (%)	100	55	100	100	0	91	100	100	100	100	100	100	100	34	77	75	100	100
Area mean	10639	0.25	2.7	40.5	nd	0.058	18.6	5.9	14044	2.7	103.8	0.031	7.4	0.108	1.25	0.450	1.38	30.8
Area max	18300	0.88	4.5	78.8	nd	0.107	28.7	14.2	24200	8.4	154.0	0.095	10.9	0.443	5.84	1.390	2.11	44.9
ERL	na	na	8.2	na	na	1.200	81.0	34.0	na	46.7	na	0.200	20.9	na	1.00	na	na	150.0

Table 4.4

Concentrations of total DDT, hexachlorobenzene (HCB), total PCB, and total PAH at PLOO benthic stations in 2007. DDT, HCB and PCB data are expresed in parts per trillion (ppt), while PAH data are expressed in parts per billion (ppb).

Station	tDDT	HCB	tPCB	tPAH
North reference stations				
B11	145	135	—	243.4
B8	158	150	15	116.2
B12	60	385	—	77.0
B9	75	—	—	111.1
B10	70	—	—	107.2
Stations north of the outfall				
E19	358	—	10	98.4
E20	275	—	—	79.8
E23	380	—	151	148.9
E25	108	—	—	88.5
E26	165	385	—	91.7
E21	250	—	—	84.6
Near outfall stations				
E11	80	—	41	79.1
E14	65	—	—	103.3
E17	280	—	34	81.7
E15	70	—	—	106.0
Stations south of the outfall				
E1	440	50	4113	104.0
E7	395	—	42	98.5
E2	360	235	517	101.6
E5	110	150	50	94.9
E8	95	80	—	66.4
E3	140	400	6136	80.8
E9	200	33	491	66.7
Detection rate (%)	70	30	32	100

Concentrations of various contaminants, including most indicators of organic loading (e.g., TN, TOC, TVS), trace metals, pesticides (e.g., DDT), PCBs and PAHs in sediments off Point Loma remained within the natural range of variability for San Diego and other areas of the southern California continental shelf (see Schiff and Gossett 1998, Noblet et al. 2003, Schiff et al. 2006). The only metal that exceeded ERL values for southern California was silver, which was present in relatively high concentrations throughout the region. Most of these contaminants were detected rarely or in low concentrations during 2007. For example, PCBs and various chlorinated pesticides (HCB, BHC and heptachlor) had detection rates ≤32% during the year. Although DDT and PAHs were detected in sediments at most stations, these compounds were present at concentrations below their respective ERLs.

There were few clear patterns in sediment contaminant concentrations relative to the PLOO discharge site in 2007 other than the typical slightly higher sulfide and BOD levels. Instead, the highest concentrations of several organic indicators, metals and PCBs were found in sediments from the southern and/or northern-most stations. These included the highest concentrations of copper, lead, mercury, zinc and total PCBs in sediments near the LA-5 disposal site. In general, concentrations of contaminants have been higher at these southern stations than elsewhere off San Diego, and are most likely the result of misplaced deposits of dredged material that were originally destined for LA-5. Previous studies have attributed elevated levels of various contaminants such as PAHs, PCBs, trace metals, and DDT in this area to the deposits from LA-5 (see Anderson et al. 1993; City of San Diego 2003; Steinberger et al. 2003), while many were also present in high concentrations in sediments collected from San Diego Bay (see City of San Diego 2003).

Wastewater discharge does not appear to be significantly impacting sediment quality in the vicinity of the PLOO after 14 years of outfall operation. Overall, there is little or no evidence of organic and contaminant loading in the region, with measured parameters existing at levels within the range of natural variability for reference areas throughout the Southern California Bight (e.g., see City of San Diego 2007b). The only sustained effects have been restricted to mostly a few sites located nearest the PLOO discharge site, including station E14 near the center of the outfall wye, and stations E11 and E17 located near the ends of the southern and northern diffuser legs, respectively. These effects include an in increase in sediment particle size through time, measurable increases in sulfide concentrations, and smaller increases in BOD. However, there is no evidence that the outfall discharge is affecting the quality of benthic sediments to the point that it will degrade the resident marine biota (e.g., also see Chapter 5).

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