Effluent discharges to the Southern California Bight from small municipal wastewater treatment facilities in 2005

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ABSTRACT

Twenty-three municipal wastewater treatment facilities (publicly owned treatment works; POTWs) discharge treated effluent directly to the Southern California Bight (SCB). Nineteen of these are small POTWs, each discharging less than 25 million gallons per day (mgd). Small POTW effluent characteristics have been analyzed periodically since 1971 to estimate total contaminant loading, to evaluate discharge trends, and to facilitate comparisons between pollutant sources within the SCB. This study continues the assessment of small POTW effluent by analyzing discharges from 2005. Total effluent volume, contaminant mass emissions, and annual average concentrations were calculated and compared to the previous assessments of discharges. Small POTW emissions were also compared to the largest point source of contaminants to the SCB, large POTWs. Total effluent volume from small POTWs was 245 L x 10^9 in 2005. Discharge volume has more than doubled since 1971, while mass emissions of most constituents have decreased during the same period. Although the long term trend in mass emissions has decreased, loads of many constituents were higher in 2005 than in 2000. The increased contaminant loading observed in 2005 was influenced by three factors: flow from four additional facilities that were not discharging into the SCB in 2000, increased flow due to record rainfall and associated infiltration in sewage systems in 2005, and higher constituent concentrations at individual facilities. In particular, the International WWTP (which was not included in the 2000 assessment) discharged relatively high concentrations of a range of constituents including suspended solids, BOD, oil/grease, ammonia-N, turbidity, toxicity, and phenols. Although mass emissions from small POTWs increased in 2005, they remain a relatively minor source of contaminants to the SCB relative to large POTWs; effluent volume and contaminant mass from all small POTWs combined is generally less than from any individual large POTW.

INTRODUCTION

The SCB is an important ecological, recreational, and economic resource adjacent to one of the most densely populated coastal regions in the United States (Culliton *et al*. 1990). The five coastal counties bordering the SCB are home to over 16 million people and 60 major point sources of contaminant discharge to the coastal ocean (US Census Bureau 2000, Lyon and Stein 2008). Since 1971, the Southern California Coastal Water Research Project (SCCWRP) has been compiling and analyzing effluent data from all major point-source dischargers to the coastal waters of the SCB. These discharge data are used to calculate total mass emission estimates for selected contaminants. Mass emission estimates can be used by environmental resource managers to assess total pollutant loading to the SCB, to compare the relative impact of a particular source, and to evaluate the long-term effects of management actions.

The largest point source of contaminants to the SCB is effluent discharge from POTWs (Lyon and Stein 2008). Twenty-three POTWs discharge treated effluent directly to the coastal ocean of the SCB. Four of these facilities discharge greater than 100 mgd and are analyzed separately as large POTWs. The distinction between large and small POTWs is not a regulatory classification; rather it is a practical distinction by SCCWRP to focus more frequent analyses on the facilities with the greatest discharge volumes. Effluent from the large POTWs is analyzed separately, most recently for discharges in 2003 and 2004 (Lyon *et al*. 2006). The remaining 19 POTWs each discharge less than 25 mgd via 15 ocean outfalls located throughout the SCB (Figure 1; Table 1). Since 1971, SCCWRP has periodically assessed inputs from these small POTWs. The most recent assessment of discharges from 2000 included 15 of the 19 facilities included in this study (Steinberger and Schiff 2003). The four additional

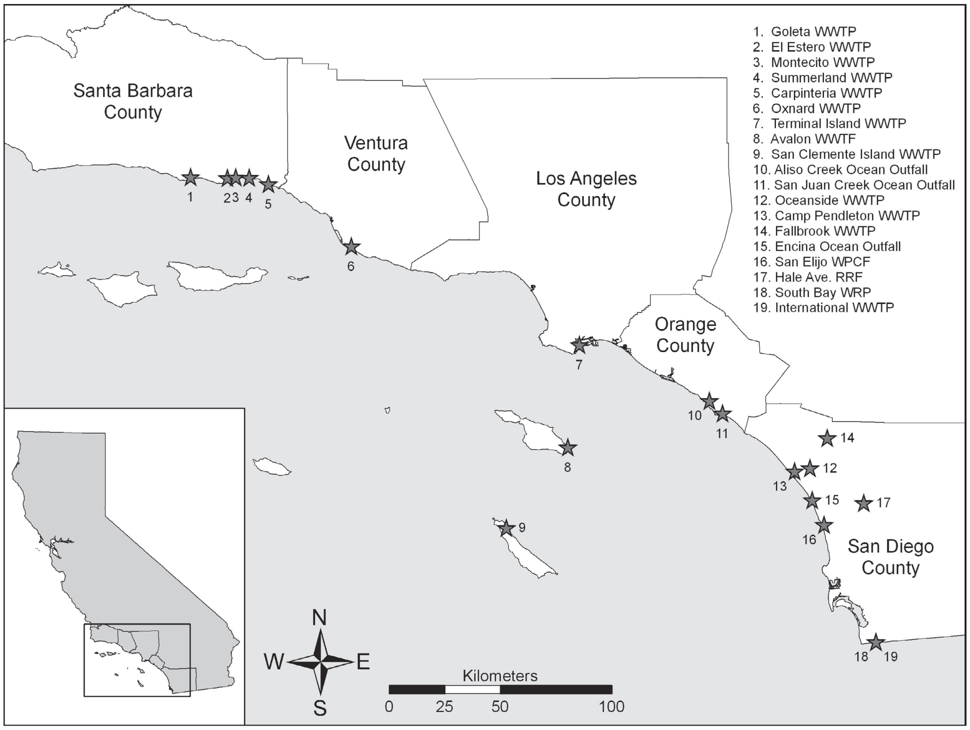

Figure 1. Locations of the small municipal wastewater facilities that discharge to the SCB.

facilities were not previously discharging directly to the ocean and therefore excluded from prior assessments of small POTW discharges to the SCB. The new ocean discharging facilities are the Fallbrook Waste Water Treatment Plant (WWTP) and Camp Pendleton WWTP, which both discharge through the Oceanside Ocean Outfall; and the South Bay Water Reclamation Plant and International WWTP, which discharge through the South Bay Ocean Outfall.

Table 1. Flow rates and treatment levels from small POTW facilities in 2005.

Facility	Effluent Flow (mgd)	Treatment Level
Goleta WWTP	4.50	Primary / Secondary
El Estero WWTP	8.22	Secondary
Montecito WWTP	1.14	Secondary
Summerland WWTP	0.19	Tertiary
Carpinteria WWTP	1.58	Secondary
Oxnard WWTP	24.48	Secondary
Terminal Island WWTP	15.96	Tertiary
Avalon WWTF	0.51	Secondary
San Clemente Island WWTP	0.02	Secondary
Aliso Creek Ocean Outfall	15.32	Secondary
San Juan Creek Ocean Outfall	21.27	Secondary
Oceanside WWTP	13.54	Secondary
Camp Pendleton WWTP	0.48	Secondary
Fallbrook Public Utility District WWTP	1.47	Tertiary
Encina Ocean Outfall	24.67	Secondary
San Elijo Water Pollution Control Facility	2.88	Secondary
Hale Ave. Resource Recovery Facility	13.86	Secondary
South Bay Water Reclamation Plant	3.96	Secondary
International WWTP	23.62	Advanced Primary
TOTAL	**177.66**	

Each small POTW facility varies in size and treatment. Effluent discharges and associated compliance monitoring requirements for each facility are stipulated by their National Pollutant Discharge Elimination System (NPDES) permit (Appendix I). Although each facility is required to monitor its effluent flow and chemistry, the specific constituents and minimum analysis frequencies vary by facility (Appendix II). NPDES permits also do not require integration of data from multiple dischargers or classes of dischargers to assess the cumulative impact to a water body. This poses a challenge to environmental resource managers who need to evaluate pollutant loads and trends from all sources on a regional or larger scale.

The goal of this study was to characterize effluent from small POTWs in 2005. To achieve this objective, flow, and chemistry data from all small POTWs discharging directly to the SCB were compiled and standardized to allow calculation of cumulative mass emission estimates for the entire bight and average constituent concentrations for each facility. To assess historical trends, these effluent data were then compared to results from previous assessments of small POTW discharges from 1971, 1989, 1995, and 2000. Small POTW effluent characteristics were also compared to large POTW discharges to assess their relative significance. Finally, to assess the effects of differences in treatment level, average constituent concentrations were compared to the level of treatment provided by the small POTW facilities.

METHODS

Annual mass emissions data for the small POTWs were compiled from effluent flow and chemistry data provided in each facility's monthly, quarterly, and annual discharge monitoring reports, which were obtained from the California Regional Water Quality Control Boards. Constituents included in this assessment were selected based on the availability of data and on the known influence of these constituents in the marine environment. General constituents included solids, biochemical oxygen demand (BOD), oil and grease, ammonia, nitrate, nitrite, and cyanide. Selected metals, phenols, dichlorodiphenyltrichloroethane (DDT), polychlorinated biphenyl (PCB), and polycyclic aromatic hydrocarbons (PAH) were also analyzed.

Constituent concentration data were standardized to monthly time steps. For constituents analyzed more than once per month, the arithmetic mean of all results in a given month was calculated. Where the frequency of constituent analysis was less than monthly or data for a given month were not available, the arithmetic mean of available data within the given year was calculated and used to populate months for which no data existed. The monthly flow and concentration data were then used to calculate annual discharge volumes and constituent mass emissions for each facility. Constituent concentrations below the reporting level were assigned a value of zero for calculating mass emission estimates.

The annual discharge volume (V) for each facility was calculated from the sum of the monthly effluent volumes:

$$V = \sum_{i=1}^{12} u F_i D_i$$

where Fi was the mean daily flow for the month i, Di was the number of days that discharge occurred during the month i, and u was the unit conversion factor for calculating the volume in liters (L).

Mass emission estimates (ME) were calculated from the product of the mean daily flow, the monthly constituent concentration, the number of days in the given month, and a unit conversion factor. *ME*s were calculated for each constituent for each month, and then summed over all months in the year to obtain an annual estimate:

$$ME = \sum_{i=1}^{12} u F_i C_i D_i$$

where Ci was the reported constituent concentration for the month i, and u was the appropriate unit conversion factor for calculating the ME in metric tons (mt), kilograms (kg), or liters (L).

Annual average flow-weighted concentrations (FWC) were calculated by dividing the annual ME for a given constituent by the total annual effluent volume (V).

$$FWC = u\,\frac{ME}{V}$$

where u was the unit conversion factor for reporting the FWC in the appropriate concentration units.

This approach for calculating FWC occasionally resulted in estimates below the reporting limit (RL) for constituents that had one or more non-detected results. In these cases, the FWC was reported as calculated. Constituents that were consistently not detected resulted in FWC of zero, and were reported as less than the RL. When more than one RL was used for a given constituent during the year, the greatest RL was reported.

Historical trends in mass emissions from small POTWs were analyzed by comparing results from 2005 to results of previous assessments from 1971, 1989, 1995, and 2000 reported by Steinberger and Schiff (2003). Small POTW discharges were also compared to large POTW effluent characteristics to determine the relative contribution of small POTWs to the cumulative impact from all POTWs. The most recent quality assured large POTW effluent data from 2004 were obtained from Lyon *et al*. (2006) for the comparison.

RESULTS

Small POTW Discharges in 2005

Combined daily effluent flow from the 19 small POTWs in 2005 was 178 mgd (Table 1). Flows from individual facilities ranged from 0.02 mgd (San Clemente Island WWTP) to over 24 mgd (Encina and Oxnard WWTPs), with a mean daily flow per facility of 9.4 mgd. These daily flow rates resulted in an annual effluent volume of 245 L x 10^9, which represents a 27% increase from the total annual volume in 2000 (Steinberger and Schiff 2003). Seventeen percent of the total effluent volume in 2005 (41 L x 10^9) was discharged by facilities that were not included in the assessment of small POTWs in 2000 by Steinberger and Schiff (2003). Excluding discharges by the four new facilities, effluent volume still increased by 5.6% from 2000 to 2005.

The level of treatment provided by each facility in 2005 varied from advanced primary treatment to full tertiary treatment. The International WWTP discharged 24 mgd of advanced primary treated effluent. Goleta WWTP discharged a blend of advanced primary and secondary treated effluent. Three facilities (Summerland, Terminal Island, and Fallbrook WWTPs) discharged effluent that received full tertiary treatment. The remaining 14 facilities discharged secondary treated effluent (Table 1).

Total mass emissions from small POTWs in 2005 included 4772 mt of suspended solids, 7605 mt of biochemical oxygen demand (BOD), and 26 L x 10^6 of settleable solids (Table 2). Small POTWs discharged over 5 thousand mt of ammonia-N, plus at least 586 mt of other nitrogen compounds (nitrate-N, nitrite-N, and organic-N), though this latter value is likely underestimated because fewer than half the facilities analyzed these constituents. Combined metals emissions from small POTWs totaled 18 mt, with zinc, copper, and nickel providing 58, 21, and 10% of the total metals load, respectively. Combined emissions of phenols were 954 kg. Only Oxnard WWTP detected PAHs in its effluent, resulting in a total estimated load of 0.52 kg. DDT and PCB were not detected in effluent from any small POTW facility in 2005.

The International WWTP discharged the highest average concentrations of many constituents, including suspended solids, BOD, oil/grease, ammonia-N, turbidity, chromium, nickel, and phenols (Table 3). The International WWTP effluent also showed the highest acute and chronic toxicity levels among small POTWs. The greatest concentrations of other constituents were widely distributed among the facilities. The highest concentration of settleable solids was detected in El Estero WWTP effluent. Fallbrook WWTP effluent contained the highest arsenic and selenium concentrations, while the greatest copper, lead, and zinc concentrations were found in Avalon, Encina, and Summerland effluent, respectively.

Trends in Small POTW Discharges

Since 1971, effluent flow from small POTWs has increased 158% to 178 mgd (Figure 2; Table 4). Although flow has increased, the general trend in mass emissions of most constituents has decreased. Mass emissions of suspended solids, BOD, oil/grease, and cyanide all decreased from 1971 to 2005. Ammonia-N was the only constituent analyzed in 1971 that has increased in small POTW effluent over the study period. Metals loads, which were not assessed in 1971, have been declining since 1989. Mass emissions of all metals except copper decreased from 14% (zinc) to nearly 100% (cadmium) between 1989 and 2005. Copper emissions increased 9% since 1989, however this is well below the 30% increase in flow during the same period. Further reductions in mass emissions of suspended solids and several metals continued in 1995 and 2000 (Table 4).

Despite the general trend of decreasing mass emissions since 1971, mass emissions of most constituents were greater in 2005 than in 2000 (Table 4). The greatest increases in contaminant loads were observed in suspended solids, BOD, nitrate-N, cyanide, and metals except cadmium and silver. Cadmium and silver were among the few constituent mass emissions that decreased from 2000 to 2005. Discharges from the new facilities included for the first time in this assessment contributed to the overall increase in mass emissions, but were not fully responsible for the observed increases. If the discharges from the facilities not included in previous assessments were excluded, constituent loads would have still increased from 2000 to 2005 (although by less), with the exception of oil/grease and zinc, which would have decreased without the new facility discharges. Average concentrations of many constituents also increased from 2000 levels. Flow-weighted concentrations that increased in 2005 included CBOD, nitrate-N, nitrite-N, cyanide, and 8 of the 10 metals included in this assessment. As with mass emissions, the metals that decreased in concentration were cadmium and silver.

Table 2. Estimated constituent mass emissions from small POTW dischargers in 2005.

Constituent	Goleta WWTP	El Estero WWTP	Montecito WWTP	Summerland WWTP	Carpinteria WWTP	Oxnard WWTP	Terminal Island WWTP	Avalon WWTF	San Clemente Island WWTP	Aliso Creek Ocean Outfall	San Juan Creek Ocean Outfall	Oceanside WWTP	Camp Pendleton WWTP	Fallbrook WWTP	Encina Ocean Outfall	San Elijo WPCF	Hale Ave RRF	South Bay WRP	Int'l WWTP	TOTAL
Volume (L x 10^9)	6.22	11.36	1.57	0.26	2.18	33.83	22.04	0.71	0.03	21.16	29.38	18.71	0.66	2.04	34.09	3.98	19.14	5.47	32.63	**245.45**
Suspended Solids (mt)	233.34	206.43	8.82	0.68	24.94	232.09	nd	18.07	0.20	201.34	322.28	93.80	6.60	6.99	294.69	63.83	164.58	10.15	2883.22	**4772.04**
Settleable Solids (L x 10^3)	1336.60	8467.18	132.71	nd	504.93	nd	nd	144.28	nd	nd	8317.99	1087.28	nd	nd	1957.56	964.46	nd	nd	3263.01	**26176.00**
BOD (mt)	366.43	--	8.12	0.81	11.25	--	nd	13.37	0.27	479.67	899.18	407.19	--	--	859.60	92.77	234.25	16.09	4215.72	**7604.73**
CBOD (mt)	--	145.59	--	--	--	586.98	--	--	--	--	--	--	7.91	--	--	--	--	--	--	**740.48**
Oil/grease (mt)	71.17	26.24	0.47	nd	6.55	155.57	nd	3.89	nd	nd	131.04	nd	--	1.26	38.80	3.23	9.85	9.76	407.83	**865.67**
Ammonia-N (mt)	227.87	196.16	0.05	0.01	0.47	645.17	7.34	7.32	0.06	393.01	571.02	371.85	2.26	21.58	911.53	83.62	182.74	0.47	1500.75	**5123.28**
Nitrate-N (mt)	--	--	--	--	--	37.55	155.40	18.78	0.48	--	--	--	--	29.10	--	--	--	156.41	--	**397.72**
Nitrite-N (mt)	--	--	--	--	--	32.12	--	--	--	--	--	--	--	7.89	--	--	--	--	--	**40.01**
Organic-N (mt)	--	--	--	--	--	115.75	32.14	--	--	--	--	--	--	--	--	--	--	--	--	**147.89**
Cyanide (kg)	--	--	nd	nd	nd	nd	18.53	nd	nd	nd	nd	546.39	nd	61.10	nd	180.65	nd	13.38	550.27	**1370.32**
Arsenic (kg)	1.04	--	nd	nd	nd	105.20	61.70	nd	0.03	32.95	nd	46.87	0.20	18.33	nd	nd	10.81	2.73	nd	**279.85**
Cadmium (kg)	nd	--	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	1.96	nd	**1.96**
Chromium (kg)	19.96	--	nd	nd	8.73	59.33	12.30	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	13.96	160.51	**274.79**
Copper (kg)	145.25	--	nd	nd	13.10	nd	149.26	54.61	0.64	297.98	337.18	51.46	26.38	24.44	549.15	nd	263.65	74.73	1720.48	**3708.31**
Lead (kg)	7.05	--	nd	nd	0.87	25.31	13.74	nd	0.02	nd	nd	nd	nd	nd	668.53	nd	10.17	nd	nd	**725.71**
Mercury (kg)	0.19	--	nd	nd	0.02	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	8.40	nd	0.26	**8.87**
Nickel (kg)	43.51	--	nd	nd	13.10	120.15	129.03	2.13	0.10	nd	237.89	46.40	3.78	nd	nd	nd	156.64	29.47	965.96	**1748.15**
Selenium (kg)	nd	--	--	--	nd	136.80	180.76	nd	nd	nd	nd	nd	2.65	95.72	nd	5.42	96.91	3.29	nd	**521.54**
Silver (kg)	nd	--	nd	nd	nd	nd	8.21	nd	nd	nd	nd	18.54	nd	nd	nd	nd	31.16	0.53	10.54	**68.97**
Zinc (kg)	369.02	--	62.86	31.36	109.14	202.66	479.68	38.30	1.44	713.77	910.98	280.36	62.85	34.62	2705.63	195.46	1557.87	177.91	2354.98	**10288.90**
Combined Metals (kg)	*586.02*	--	*62.86*	*31.36*	*144.96*	*649.45*	*1034.67*	*95.04*	*2.24*	*1044.71*	*1486.06*	*443.63*	*95.87*	*173.12*	*3923.31*	*200.88*	*2135.60*	*304.57*	*5212.71*	***17627.05***
Phenols (kg)	nd	nd	nd	nd	nd	8.95	nd	--	--	nd	nd	nd	nd	nd	nd	nd	710.03	nd	235.30	**954.28**
Total DDT (kg)	nd	--	nd	--	nd	nd	nd	--	nd	nd	nd	nd	--	nd	nd	nd	nd	nd	nd	**nd**
Total PAH (kg)	nd	--	nd	nd	nd	0.52	nd	--	--	nd	nd	nd	--	nd	nd	nd	nd	nd	nd	**0.52**
Total PCB (kg)	nd	--	nd	--	nd	nd	nd	--	nd	nd	nd	nd	--	nd	nd	nd	nd	nd	nd	**nd**

Dash = Constituent was not analyzed or data were not available.
nd = Not detected.

Table 3. Annual average flow-weighted constituent concentrations in effluent from small POTWs in 2005.

Constituent	Goleta WWTP	El Estero WWTP	Montecito WWTP	Summerland WWTP	Carpinteria WWTP	Oxnard WWTP	Terminal Island WWTP	Avalon WWTF	San Clemente Island WWTP	Aliso Creek Ocean Outfall	San Juan Creek Ocean Outfall	Oceanside WWTP	Camp Pendleton WWTP	Fallbrook WWTP	Encina Ocean Outfall	San Elijo WPCF	Hale Ave RRF	South Bay WRP	Int'l WWTP	Overall Average
Suspended Solids (mg/L)	38	18	5.6	2.6	11	6.9	<1	25	7.0	9.52	10.97	5.01	10.00	3.43	8.65	16.04	8.60	1.86	88.36	14.59
Settleable Solids (mL/L)	0.22	0.75	0.08	<0.1	0.23	<0.1	<0.04	0.20	<2	<0.1	0.28	0.06	<0.1	<0.1	0.06	0.24	<0.2	<0.1	0.10	0.12
BOD (mg/L)	58.90	--	5.17	3.09	5.15	17.35	<2	18.85	9.67	22.67	30.60	21.77	--	--	25.22	23.32	12.24	2.95	129.20	24.13
CBOD (mg/L)	--	12.82	--	--	--	--	--	--	--	--	--	--	12.00	--	--	--	--	--	--	12.41
Oil/grease (mg/L)	11.44	2.31	0.30	<3	3.00	4.60	<5	5.48	<10	<5	4.46	<3	--	0.62	1.14	0.81	0.52	1.79	12.50	2.72
Ammonia-N (mg/L)	36.60	17.27	0.03	0.05	0.21	19.07	0.33	10.31	2.15	18.57	19.43	19.88	3.43	10.60	26.74	21.02	9.55	0.09	45.99	13.75
Nitrate-N (mg/L)	--	--	--	--	--	1.11	7.05	26.47	17.20	--	--	--	--	14.29	--	--	--	28.62	--	15.79
Nitrite-N (mg/L)	--	--	--	--	--	0.95	--	--	--	--	--	--	--	3.87	--	--	--	--	--	2.41
Organic-N (mg/L)	--	--	--	--	--	3.42	1.46	--	--	--	--	--	--	--	--	--	--	--	--	2.44
Cyanide (ug/L)	--	--	<5	<5	<5	<5	0.84	<20	<5000	<25	<25	29.20	<10	30.00	<2	45.40	<0.06	2.45	16.86	7.34
Turbidity (NTU)	44.47	11.56	1.28	0.57	2.34	5.26	0.60	17.55	2.20	5.79	5.50	2.77	4.31	1.29	4.62	5.04	4.19	1.54	61.47	9.60
Acute Toxicity (TUa)	1.58	0.52	0.69	--	0.10	--	0.20	--	0.77	<0.41	<0.41	1.06	0.77	<0.588	0.77	0.62	0.15	<1.6	7.40	0.91
Chronic Toxicity (TUc)	15.90	17.86	31.25	17.86	17.86	17.86	<1.67	17.86	1.00	<50	<50	<33.3	<20	<25	17.90	<31.2	<50	25.00	352.00	28.02
Arsenic (ug/L)	0.17	--	<10	<10	<2	3.11	2.80	<30	1.20	1.56	<5	2.51	0.30	9.00	<10	<5	0.57	0.50	nd	1.21
Cadmium (ug/L)	<0.2	--	<5	<5	<0.2	<0.2	<10	<1	<0.5	<5	<5	<0.9	<2.23	<5	<25	<10	<2	0.36	nd	0.02
Chromium (ug/L)	3.21	--	<10	<10	4.00	1.75	0.56	<4	<0.5	<5	<5	<4	<0.2	<10	<50	<50	<5	2.56	4.92	0.94
Copper (ug/L)	23.35	--	<10	<10	6.00	<20	6.77	77.00	22.73	14.08	11.47	2.75	40.00	12.00	16.11	<100	13.77	13.67	52.73	17.36
Lead (ug/L)	1.13	--	<10	<10	0.40	0.75	0.60	<2	0.80	<5	<5	<5	<2.23	<5	19.61	<100	0.53	<1.4	nd	1.32
Mercury (ug/L)	0.03	--	<0.01	<0.01	0.01	<0.2	<0.2	<1	<0.1	<0.2	<0.2	<0.3	<0.2	<0.4	<0.2	<0.4	0.44	<0.09	0.01	0.03
Nickel (ug/L)	7.00	--	<10	<10	6.00	3.55	5.85	3.00	3.50	<10	8.10	2.48	5.73	<15	<25	<50	8.18	5.39	29.60	4.91
Selenium (ug/L)	<2	--	--	--	<2	4.04	8.20	<10	<0.5	<10	<10	<10	4.02	47.00	<10	1.36	5.06	0.60	nd	4.39
Silver (ug/L)	<1	--	<10	<10	<1	<1	0.37	<2	<0.5	<10	<10	0.99	<2.23	<5	<25	<10	1.63	0.10	0.32	0.19
Zinc (ug/L)	59.30	--	40.00	120.00	50.00	5.99	21.76	54.00	51.20	33.73	31.00	14.99	95.30	17.00	79.37	49.10	81.38	32.55	72.17	50.49
Phenols (ug/L)	<10	<20	<100	<50	<100	0.26	<10	--	--	<20	<20	<0.4	<27	<50	<33	<50	37.09	<6.07	7.21	2.62
Total DDT (ug/L)	<0.05	--	<0.05	--	<0.05	<0.001	<0.05	--	<0.05	<0.1	<0.1	<0.012	--	<0.06	<0.025	<0.06	<0.1	<0.1	nd	nd
Total PAH (ug/L)	<0.5	--	<10	<10	<10	0.02	<10	--	--	<20	<20	<0.1	--	<10	<0.04	<10	<10	<7.68	nd	0.00
Total PCB (ug/L)	<0.5	--	<0.5	--	<0.5	<0.01	<0.5	--	<0.5	<0.5	<0.5	<0.121	--	<0.5	<0.4	<0.5	<2	<4	nd	nd

Dash = Constituent was not analyzed or data were not available.
nd = Measurement was below detection level, however RL/MDL was not provided or not found.
< = Less than the reporting level; if more than one RL was used during the year, the highest was reported here.

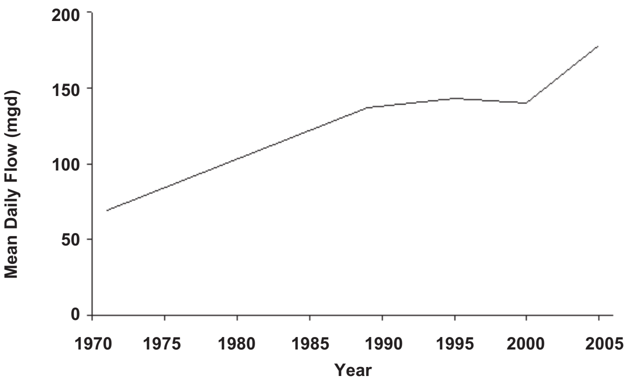

Figure 2. Combined effluent flow from small POTWs between 1971 and 2005.

The most significant changes in mass emissions from individual facilities were observed at El Estero WWTP, Summerland WWTP, Terminal Island WWTP, and Hale Ave. RRF. Both El Estero and Summerland flows increased by approximately 40%, but mass emissions of several general constituents increased by 89% or greater. Terminal Island effluent volume remained the same as in 2000, but with an upgrade to tertiary treatment mass emissions of solids, BOD, and oil/grease all decreased to non-detectable levels, while ammonia-N decreased 79% and several metals decreased between 21 and 83%. Flow from Hale Ave decreased 3%, while mass emissions of suspended solids, BOD, oil/grease, and ammonia-N all decreased between 30 and 60%.

Small POTW vs. Large POTW Discharges

Combined effluent volume from the small POTWs was similar to the effluent volume of the smallest large POTW facility, Point Loma Wastewater Treatment Plant (PLWTP). Although the volume was nearly equal, cumulative mass emissions of many constituents were significantly lower from small POTWs than from PLWTP (Table 5). These included loads of solids, BOD, oil/grease, cadmium, copper, phenols, and PAH. The relative contribution of small POTW loads to total Bight-wide mass emissions from all POTWs has increased as large POTW effluent quality has improved (Lyon and Stein 2008). However, small POTW loads of most constituents remain relatively minor compared to large POTW discharges. Small POTW effluent volume contributed approximately 14% of the total discharge from small and large POTWs combined. Small POTWs produced disproportionately large loads of nitrate-N, nitrite-N, cyanide, lead, mercury, and zinc,

Table 4. Historical mass emissions of selected constituents from small POTWs combined, and the percent changes for selected years.

Constituent	Mass Emissions					Percent Change		
	1971	1989	1995	2000	2005	1971-2005	1989-2005	2000-2005
Number of Facilities	21	14	15	15	19			
Flow (mgd)	69	137	143	140	178	158%	30%	27%
Suspended Solids (mt)	8,200	2,984	1,924	1,819	4,772	-42%	60%	162%
BOD (mt)	11,000	4,751	2,364	2,882	7,605	-31%	60%	164%
Oil/Grease (mt)	4,200	460	463	676	866	-79%	88%	28%
Ammonia-N (mt)	1,600	2,716	3,559	3,401	5,123	220%	89%	51%
Cyanide (mt)	8	0.67	1.5	0.35	1.4	-83%	104%	295%
Arsenic (mt)	--	0.84	0.38	0.17	0.28	--	-67%	69%
Cadmium (mt)	--	0.53	0.45	0.42	0.002	--	-100%	-100%
Chromium (mt)	--	0.84	1.4	0.09	0.28	--	-67%	199%
Copper (mt)	--	3.4	6.8	0.82	3.7	--	9%	351%
Lead (mt)	--	2.9	2.4	0.09	0.73	--	-75%	725%
Mercury (mt)	--	0.23	0.01	0.002	0.01	--	-96%	493%
Nickel (mt)	--	2.8	2.7	0.52	1.7	--	-38%	236%
Selenium (mt)	--	--	0.63	0.26	0.52	--	--	101%
Silver (mt)	--	0.58	0.63	0.09	0.07	--	-88%	-22%
Zinc (mt)	--	12	16	8.2	10	--	-14%	25%
Combined Metals (mt)	--	24	31	11	18	--	-27%	65%
Total DDT (kg)	--	nd	0.3	0.0005	nd	--	nc	-100%
Total PCB (kg)	--	nd	nd	nd	nd	--	nc	nc

Dash = Constituent was not analyzed or data were not available.
nc = No change.
nd = Not detected.

Table 5. Estimated constituent mass emissions from small POTWs in 2005 and large POTWs in 2004.

Constituent	Combined Small POTWs 2005	PLWTP 2004	OCSD 2004	JWPCP 2004	HTP 2004	Combined Large POTWs 2004	Relative Contribution from Small POTWs
Volume (L x 10^9)	245	241	326	443	442	1,453	14.5%
Suspended Solids (mt)	4,772	10,301	11,394	6,865	8,890	37,451	11.3%
Settleable Solids (L x 10^3)	26,176	103,518	102,451	44,281	nd	250,250	9.5%
BOD (mt)	7,605	24,383	18,841	2,772	8,266	54,262	12.3%
CBOD (mt)	740	--	--	--	--	--	100.0%
Oil/grease (mt)	866	3,426	3,655		186	7,267	10.6%
Ammonia-N (mt)	5,123	6,585	8,873	14,476	15,622	45,556	10.1%
Nitrate-N (mt)	398	18	--	2.9	9.6	30	92.9%
Nitrite-N (mt)	40	--	--	24	--	24	62.8%
Organic-N (mt)	148	--	--	2,541	1,686	4,226	3.4%
Cyanide (kg)	1,370	452	652	1,758	699	3,560	27.8%
Arsenic (kg)	280	264	725	605	1,221	2,815	9.0%
Cadmium (kg)	2.0	20	170	nd	77	267	0.7%
Chromium (kg)	275	489	1,021	nd	648	2,158	11.3%
Copper (kg)	3,708	10,268	12,737	2,695	9,177	34,878	9.6%
Lead (kg)	726	nd	375	nd	1,755	2,130	25.4%
Mercury (kg)	8.9	nd	6.7	nd	3.0	10	47.8%
Nickel (kg)	1,748	1,251	11,873	8,457	3,747	25,328	6.5%
Selenium (kg)	522	266	1,946	3,118	456	5,787	8.3%
Silver (kg)	69	55	490	nd	624	1,169	5.6%
Zinc (kg)	10,289	5,660	14,157	2,127	9,742	31,686	24.5%
Combined Metals (kg)	17,627	18,273	43,501	17,004	27,450	106,228	14.2%
Phenols (kg)	954	2,720	1,955	2,607	26	7,309	11.5%
Total DDT (kg)	nd	nd	nd	nd	0.13	0.13	0.0%
Total PAH (kg)	0.52	39	nd	8.9	23	71	0.7%
Total PCB (kg)	nd	nd	nd	nd	nd	nd	0.0%

Dash = Constituent was not analyzed or data were not available.
nd = Not detected.

ranging from 25% (zinc) to 93% (nitrate-N) of the total POTW load. All other contaminant loads were discharged by small POTWs at levels less than or equal to 14% of the total load, proportional to the effluent volume contribution.

DISCUSSION

Small POTWs continue to be a relatively minor source of contaminants to the SCB compared to large POTW discharges and non-point source runoff (Lyon and Stein 2008). Although mass emissions of many constituents increased in 2005, the combined contaminant loads were generally less than those from a large POTW discharging the same effluent volume. The relatively minor impact of small POTW discharges can be evaluated not only directly by assessment of effluent quality, but also by examination of sediment chemistry surrounding the outfalls. A bight-wide assessment of receiving water quality and sediment chemistry 2003 found that sediments in proximity to small POTW outfalls were among the least contaminated sediments sampled (Schiff *et al*. 2006).

Since 1971 and the implementation of the Clean Water Act, contaminant emissions from point source dischargers have decreased dramatically as a result of source control measures and improved treatment practices. The pattern of continually improving effluent quality even as effluent volume has increased is well documented in large POTWs (Steinberger and Stein 2004, Lyon *et al*. 2006, Lyon and Stein 2008). A similar pattern existed with small POTWs from 1971 to 2000 (Steinberger and Schiff 2003). In 2005 however, the trend reversed and mass emissions of many contaminants were discharged in amounts not observed since 1995 (metals) and 1971 (general constituents).

The increases in small POTW mass emissions observed in 2005 were likely caused by a combination of three factors: discharges from additional facilities not included in previous assessments, increased flow due to record rainfall, and increased contaminant concentrations. Four additional facilities discharged effluent directly to the SCB in 2005 that were not included in the previous assessment. These facilities discharged 41 L x 10^9 or 17% of the total effluent volume in 2005. Prior to this assessment, effluent from these facilities was entering the coastal ocean indirectly via river discharge and was unaccounted for in analyses of small POTW discharges to the SCB. If the additional facilities were excluded from this assessment, mass emissions of constituents such as suspended solids, BOD, oil/grease, and ammonia-N would have remained similar to their 1995 and 2000 levels (Figure 3). The additional effluent from these facilities was a significant contributor to the overall increases in small POTW mass emissions in 2005.

Another contributor to increased mass emissions was greater effluent flow due to record rainfall that southern California experienced in 2005 (National Weather Service 2005). Several POTWs reported above normal flows in January and February 2005 due to increased infiltration of surface runoff into their sewage collection systems. Heavy rainfall likely also reduced demand for reclaimed water, resulting in discharge of additional volume that would have been diverted for further treatment and reuse under normal circumstances. The influence of rainfall on mass emissions was examined by normalizing constituent loads based on calendar year rain totals for downtown Los Angeles (National Weather Service 2007). Although most mass emissions increased in 2005, the rainfall normalized values for metals actually decreased, continuing the trend of decreasing emissions since 1989 (Figure 4).

The final factor contributing to increased contaminant loads from small POTWs was the higher level of constituent concentrations. The International WWTP, which was not included in previous assessments, discharges advanced primary treated effluent with concentrations of several general constituents and phenols well above levels found in effluent from other facilities (Figure 5). To evaluate the effect of treatment level on constituent concentrations, facilities were grouped by level of treatment and mean flow-weighted concentrations were determined for each level: advanced primary, blended primary and secondary, secondary, and tertiary. General constituents and several metals demonstrated a consistent pattern of decreasing concentration with each level of increased treatment (Table 6; Figure 6). A similar pattern was observed temporally in large POTWs as the relative volume of secondary treated effluent increased incrementally over the past two decades (Lyon *et al*. 2006).

Discharge from the additional facilities included

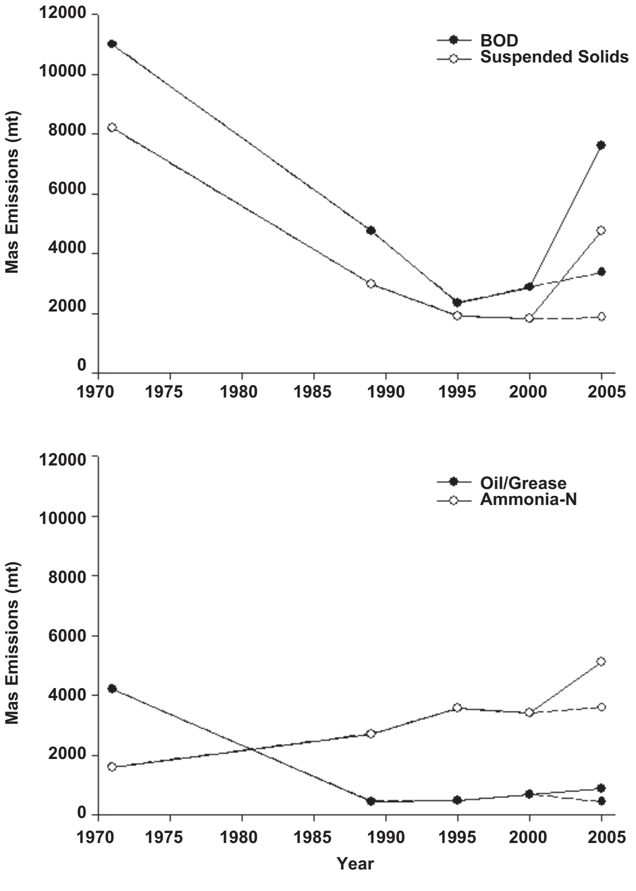

Figure 3. Trends in cumulative mass emissions of selected general constituents from small POTWs between 1971 and 2005. The solid lines indicate emissions from all facilities; the dashed lines indicate emissions from only facilities included in the 2000 assessment.

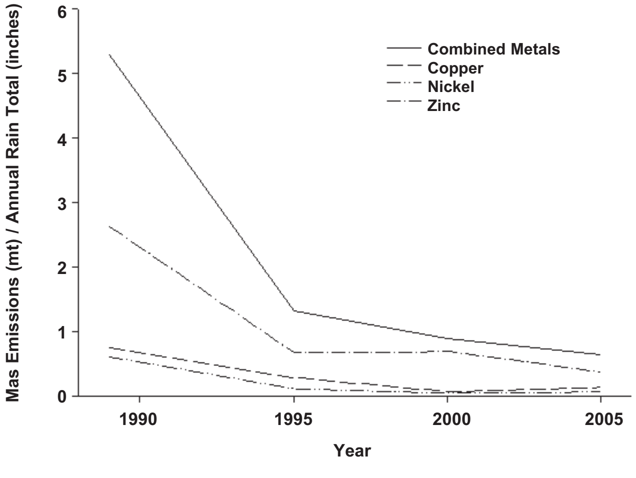

Figure 4. Rainfall normalized cumulative mass emissions of combined metals and selected individual metals from small POTWs between 1989 and 2005. Metals data prior to 1989 were not available.

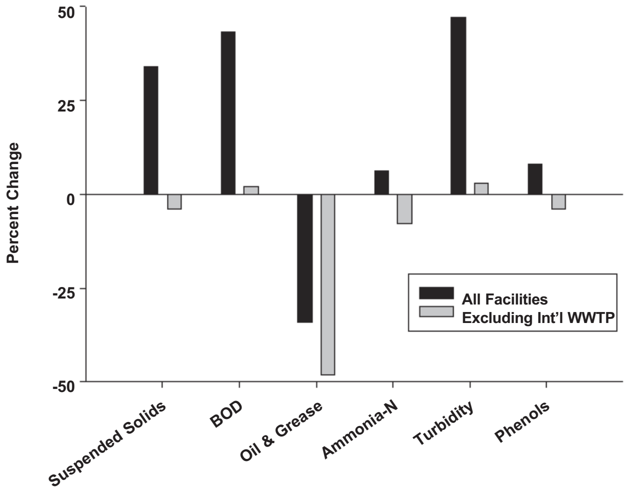

Figure 5. Percent change in mean flow weighted concentrations from small POTWs with and without International WWTP between 2000 and 2005.

in this assessment, particularly the advanced primary effluent from the International WWTP, appears to be the most significant factor in the observed increases of general contaminant emissions, such as suspended solids and BOD, from small POTWs in 2005. However, the International WWTP effluent had little effect on metals emissions, with most concentrations increasing significantly even when effluent from the International WWTP was excluded from the analysis. Metals emissions seem to have been influenced more by increased flow than by high concentrations from any particular facility. The heavy rainfall in 2005 could have contributed to both increased influent metals concentrations and increased mass emissions due to higher flow.

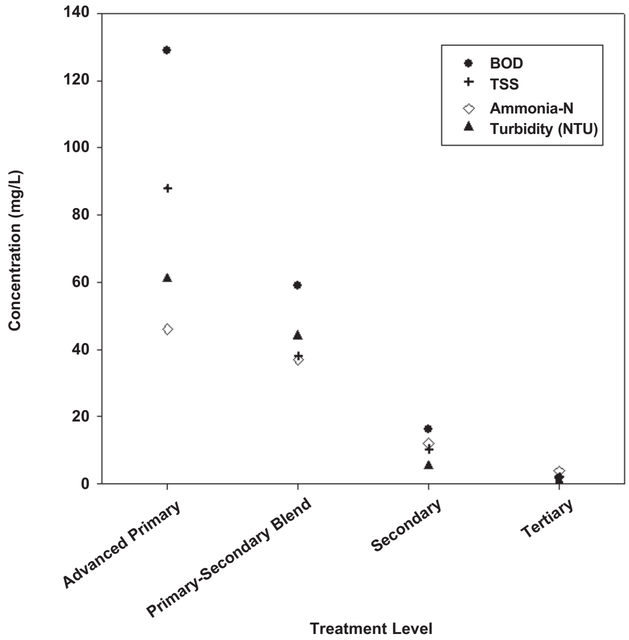

Figure 6. Mean concentrations of selected constituents by level of treatment.

Table 6. Annual average flow-weighted constituent concentrations by level of treatment.

Constituent	Advanced Primary n=1	Primary / Secondary n=1	Secondary n=14	Tertiary n=3
Suspended Solids (mg/L)	88.36	37.50	10.37	2.01
Settleable Solids (mg/L)	0.10	0.22	0.14	nd
BOD (mg/L)	129.20	58.90	16.25	1.54
CBOD (mg/L)	--	--	12.41	--
Oil/grease (mg/L)	12.50	11.44	1.88	0.21
Ammonia-N (mg/L)	45.99	36.60	11.98	3.66
Nitrate-N (mg/L)	--	--	18.35	10.67
Nitrite-N (mg/L)	--	--	0.95	3.87
Organic-N (mg/L)	--	--	3.42	1.46
Cyanide (ug/L)	16.86	--	5.93	10.28
Turbidity (NTU)	61.47	44.47	5.28	0.82
Arsenic (ug/L)	nd	0.17	0.75	3.93
Cadmium (ug/L)	nd	nd	0.03	nd
Chromium (ug/L)	4.92	3.21	0.64	0.19
Copper (ug/L)	52.73	23.35	16.74	6.26
Lead (ug/L)	nd	1.13	1.70	0.20
Mercury (ug/L)	0.01	0.03	0.03	nd
Nickel (ug/L)	29.60	7.00	3.53	1.95
Selenium (ug/L)	nd	nd	1.26	27.60
Silver (ug/L)	0.32	nd	0.21	0.12
Zinc (ug/L)	72.17	59.30	47.59	52.92
Phenols (ug/L)	7.21	nd	3.11	nd
Total DDT (ug/L)	nd	nd	nd	nd
Total PAH (ug/L)	nd	nd	0.002	nd
Total PCB (ug/L)	nd	nd	nd	nd

Dash = Constituent was not analyzed or data were not available.
nd = Not detected.

It is important to note that many POTW facilities continue to discharge effluent to inland water bodies such as rivers that ultimately flow to the coastal ocean. These inputs are not included in our assessments of direct ocean discharges. Stein and Ackerman (2007) found that POTW discharge could contribute a significant proportion of the total dry-weather flow from rivers that receive POTW effluent (34 and 98% in the Los Angeles and San Gabriel River watersheds, respectively). Effluent from the inland POTWs is not addressed in this assessment because the discharges are mixed with other watershed-based flows prior to reaching the ocean, confounding the ultimate impact of the discharges on the coastal ocean. Further, assessing the effluent from inland POTWs along with the ocean discharging POTWs would introduce the potential for double counting of the contaminants discharged from the inland POTWs as their contributions are already included in analyses of runoff from the rivers they discharge into. Future efforts to assess the combined contributions of inland POTW discharges could be included in a broader program to compile and analyze regional stormwater mass emissions data, which is being initiated by SCCWRP.

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Appendix I. Small POTW facility information.

Outfalls / Facilities	NPDES Permit	County	SWQCB Region	Average Flow (mgd)	Treatment Level
Goleta WWTP	CA0048160	Santa Barbara	Central Coast	4.50	Primary / Secondary
El Estero WWTP	CA0048143	Santa Barbara	Central Coast	8.22	Secondary
Montecito WWTP	CA0047899	Santa Barbara	Central Coast	1.14	Secondary
Summerland WWTP	CA0048054	Santa Barbara	Central Coast	0.19	Tertiary
Carpinteria WWTP	CA0047364	Santa Barbara	Central Coast	1.58	Secondary
Oxnard WWTP	CA0054097	Ventura	Los Angeles	24.48	Secondary
Terminal Island WWTP	CA0053856	Los Angeles	Los Angeles	15.96	Tertiary
Avalon WWTF	CA0054372	Los Angeles	Los Angeles	0.51	Secondary
San Clemente Island WWTP	CA0110175		Los Angeles	0.02	Secondary
Aliso Creek Ocean Outfall	CA0107611	Orange	San Diego	15.32	Secondary
San Juan Creek Ocean Outfall	CA0107417	Orange	San Diego	21.27	Secondary
Oceanside Ocean Outfall				***15.49***	
Oceanside WWTP	CA0107433	San Diego	San Diego	13.54	Secondary
Camp Pendleton WWTP	CA0109347	San Diego	San Diego	0.48	Secondary
Fallbrook Public Utility District WWTP	CA0108031	San Diego	San Diego	1.47	Tertiary
Encina Ocean Outfall	CA0107395	San Diego	San Diego	24.67	Secondary
San Elijo Ocean Outfall				***16.74***	
San Elijo Water Pollution Control Facility	CA0107999	San Diego	San Diego	2.88	Secondary
Hale Ave. Resource Recovery Facility	CA0107981	San Diego	San Diego	13.86	Secondary
South Bay Ocean Outfall				***27.58***	
South Bay Water Reclamation Plant	CA0109045	San Diego	San Diego	3.96	Secondary
International WWTP	CA0108928	San Diego	San Diego	23.62	Advanced Primary

Appendix II. Frequency of constituent analyses by small POTWs in 2005.

Constituent	Goleta WWTP	El Estero WWTP	Montecito WWTP	Summerland WWTP	Carpinteria WWTP	Oxnard WWTP	Terminal Island WWTP	Avalon WWTF	San Clemente Island WWTP	Aliso Creek Ocean Outfall	San Juan Creek Ocean Outfall	Oceanside WWTP	Camp Pendleton WWTP	Fallbrook WWTP	Encina Ocean Outfall	San Elijo WPCF	Hale Ave RRF	South Bay WRP	International WWTP
Suspended Solids	5/week	Daily	1/ 6 days	1/ 6 days	1/ 6 days	Daily	Weekly	5/week	Monthly	5/week	5/week	Daily	5/week	Daily	5/week	Daily	Daily	Daily	Daily
Settleable Solids	5/week	Daily	Daily	Daily	Daily	Daily	Weekly	Monthly	Monthly	5/week	5/week	5/week	5/week	5/week	5/week	5/week	5/week	Monthly	Daily
BOD	5/week	na	1/ 6 days	1/ 6 days	1/ 6 days	Daily	Weekly	5/week	Monthly	Monthly	Monthly	Monthly	na	na	3/week	Monthly	Weekly	Daily	Daily
CBOD	na	Daily	na	na	na	na	na	na	na	na	na	na	Monthly	na	na	na	na	na	na
Oil/Grease	Weekly	1/ 6 days	Monthly	Monthly	1/ 6 days	Daily	Weekly	Monthly	Monthly	Monthly	Monthly	Monthly	Monthly	Monthly	Weekly	Monthly	Monthly	Monthly	Daily
Turbidity	5/week	Daily	1/ 6 days	1/ 6 days	1/ 6 days	Daily	Daily	Weekly	Monthly	Weekly	Weekly	5/week	Weekly	Daily	5/week	Weekly	Daily	Monthly	Daily
Cyanide	Annually	na	Annually	Annually	Annually	Quarterly	Monthly	Annually	Annually	Quarterly	Quarterly	Quarterly	Quarterly	Annually	Quarterly	Semiannually	Quarterly	Monthly	Weekly
Ammonia-N	Monthly	Daily	Monthly	Monthly	Monthly	Weekly	Monthly	Quarterly	Quarterly	Monthly	Monthly	Monthly	Monthly	Monthly	Weekly	Monthly	Monthly	Monthly	Weekly
Nitrate-N	na	na	na	na	na	Monthly	na	Quarterly	na	na	na	na	na	Quarterly	na	na	na	Monthly	na
Nitrite-N	na	na	na	na	na	Monthly	na	na	na	na	na	na	na	Quarterly	na	na	na	na	na
Organic-N	na	na	na	na	na	Monthly	na	na	na	na	na	na	na	na	na	na	na	na	na
Acute Toxicity	-	-	-	na	-	na	-	na	-	-	-	-	-	Quarterly	-	-	-	-	Monthly
Atherinops affinis (survival)	-	-	-	-	-	-	-	-	-	-	-	-	Quarterly	-	-	-	-	Monthly	-
Menidia beryllina (survival)	-	Quarterly	Annually	-	-	-	-	-	-	-	-	Monthly	-	-	-	-	-	-	-
Mysidopsis bahia (survival)	-	-	-	-	-	-	Monthly	-	-	-	-	-	-	-	-	-	-	-	-
Pimephales promelas (survival)	Quarterly	-	-	-	Quarterly	-	-	-	Annually	Monthly	Monthly	-	-	-	Monthly	Quarterly	Monthly	-	-
Chronic Toxicity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Atherinops affinis (survival)	-	-	-	-	-	Monthly	-	-	Semiannually	-	-	-	-	-	-	-	-	-	-
Haliotis rufescens (development)	Quarterly	-	Annually	-	-	-	Monthly	-	-	-	-	-	-	-	-	-	-	Monthly	Weekly
Macrocystis pyrifera (germination)	-	-	-	-	-	-	-	-	-	Monthly	Monthly	Monthly	-	-	-	-	Monthly	-	-
Menidia beryllina (growth)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Menidia beryllina (survival)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Monthly	-	-	-	-
Mytilis edulis (development)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Quarterly	-	-	-
Strongylocentrotus purpuratus (fertilization)	-	Semiannually	-	Annually	Semiannually	-	-	Quarterly	-	-	-	-	Quarterly	Quarterly	-	-	-	-	-
Arsenic	Monthly	na	Annually	Annually	Annually	Quarterly	Quarterly	Annually	Annually	Quarterly	Quarterly	Quarterly	Quarterly	Annually	Quarterly	Semiannually	Quarterly	Monthly	Weekly
Cadmium	Monthly	na	Annually	Annually	Annually	Quarterly	Quarterly	Annually	Annually	Quarterly	Quarterly	Quarterly	Quarterly	Annually	Quarterly	Semiannually	Quarterly	Monthly	Weekly
Chromium	Monthly	na	Annually	Annually	Annually	Quarterly	Quarterly	Annually	Annually	Quarterly	Quarterly	Quarterly	Quarterly	Annually	Quarterly	Semiannually	Quarterly	Monthly	Weekly
Copper	Monthly	na	Annually	Annually	Annually	Quarterly	Monthly	Annually	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Annually	Quarterly	Semiannually	Quarterly	Monthly	Weekly
Lead	Monthly	na	Annually	Annually	Annually	Quarterly	Monthly	Annually	Annually	Quarterly	Quarterly	Quarterly	Quarterly	Annually	Quarterly	Semiannually	Quarterly	Monthly	Weekly
Mercury	Monthly	na	Annually	Annually	Annually	Quarterly	Monthly	Annually	Annually	Quarterly	Quarterly	Quarterly	Quarterly	Annually	Quarterly	Semiannually	Quarterly	Monthly	Weekly
Nickel	Monthly	na	Annually	Annually	Annually	Quarterly	Monthly	Annually	Annually	Quarterly	Quarterly	Quarterly	Quarterly	Annually	Quarterly	Semiannually	Quarterly	Monthly	Weekly
Selenium	Annually	na	na	na	Annually	Monthly	Quarterly	Annually	Annually	Quarterly	Quarterly	Quarterly	Quarterly	Annually	Quarterly	Semiannually	Quarterly	Monthly	Weekly
Silver	Monthly	na	Annually	Annually	Annually	Quarterly	Monthly	Annually	Annually	Quarterly	Quarterly	Quarterly	Quarterly	Annually	Quarterly	Semiannually	Quarterly	Monthly	Weekly
Zinc	Monthly	na	Annually	Annually	Annually	Quarterly	Quarterly	Annually	Annually	Quarterly	Quarterly	Quarterly	Quarterly	Annually	Quarterly	Semiannually	Quarterly	Monthly	Weekly
Phenols	na	Quarterly	Annually	Annually	Quarterly	Quarterly	na	na	na	Quarterly	Quarterly	Quarterly	Quarterly	Annually	Quarterly	Semiannually	Quarterly	Monthly	Weekly
Total DDT	Annually	na	Annually	na	Semiannually	Monthly	Quarterly	Annually	Annually	Semiannually	Semiannually	Semiannually	Semiannually	Annually	Semiannually	Annually	Semiannually	Monthly	Weekly
Total PAH	Annually	na	Annually	Annually	Quarterly	Quarterly	Quarterly	Annually	na	Semiannually	Semiannually	Semiannually	Semiannually	Annually	Semiannually	Annually	Semiannually	Quarterly	Monthly
Total PCB	Annually	na	Annually	na	Semiannually	Monthly	Quarterly	Annually	Annually	Semiannually	Semiannually	Semiannually	Semiannually	Annually	Semiannually	Annually	Semiannually	Monthly	Weekly

na = Not analyzed.
Dash = Not applicable.

Appendix III. Analytical methods used for constituent analyses by small POTWs and/or contract laboratories in 2005.

Constituent	Goleta WWTP	El Estero WWTP	Montecito WWTP	Summerland WWTP	Carpinteria WWTP	Oxnard WWTP	Terminal Island WWTP	Avalon WWTF	San Clemente Island WWTP	Aliso Creek Ocean Outfall	San Juan Creek Ocean Outfall	Oceanside WWTP	Camp Pendleton WWTP	Fallbrook WWTP	Encina Ocean Outfall	San Elijo WPCF	Hale Ave RRF	South Bay WRP	International WWTP
Suspended Solids	SM 2540 D	SM 2540 D	SM 2540 D	SM 2540 D	SM 2540 D	SM 2540 D	SM 2540 D	SM 2540 D	SM 2540 D	SM 2540 D	EPA 160.2	SM 2540 D	SM 2540 D	SM 2540 D	SM 2540 D	SM 2540 D	SM 2540 D	SM 2540 D	SM 2540 D
Settleable Solids	SM 2540 F	SM 2540 F	SM 2540 F	SM 2540 F	SM 2540 F	SM 2540 F	SM 2540 F	SM 2540 F	SM 2540 F	SM 2540 F	EPA 160.5	SM 2540 F	SM 2540 F	SM 2540 F	nf	SM 2540 F	SM 2540 F	SM 2540 F	SM 2540 F
BOD	SM 5210	na	SM 5210 B	SM 5210 B	SM 5210 B	SM 5210	SM 5210 B	SM 5210	EPA 405.1	SM 5210	SM 5210 B	SM 5210 B	na	na	SM 5210	SM 5210	SM 5210	SM 5210	SM 5210
CBOD	na	nf	na	na	na	na	na	na	na	na	na	na	nf	na	na	na	na	na	na
Oil/Grease	SM 5520	nf	EPA 1664	EPA 1664	EPA 1664	EPA 1664	EPA 1664	EPA 1664	EPA 1664	EPA 1664	EPA 413.1	EPA 1664	nf	EPA 1664	nf	nf	EPA 1664	EPA 1664	EPA 1664
Turbidity	SM 2130 B	SM 2130 B	SM 2130 B	SM 2130 B	SM 2130 B	SM 2130 B	SM 2130 B	SM 2130 B	SM 2130 B	SM 2130 B	EPA 180.1	SM 2130 B	SM 2130 B	SM 2130 B	SM 2130 B	SM 2130 B	SM 2130 B	SM 2130 B	SM 2130 B
Cyanide	SM 4500-CN	na	SM 4500-CN	SM 4500-CN	SM 4500-CN	SM 4500-CN	EPA 335.4	SM 4500-CN	SM 4500-CN	EPA 335.2	EPA 335.2	EPA 335.2	EPA 335.2	EPA 335.2	SM 4500-CN	nf	EPA 335.2	nf	nf
Ammonia-N	SM 4500-NH3	SM 4500-NH3	SM 4500-NH3	SM 4500-NH3	SM 4500-NH3	SM 4500-NH3	SM 4500-NH3	SM 4500-NH3	EPA 350.2	EPA 350.3	EPA 350.3	SM 4500-NH3	nf	EPA 350.2	nf	nf	nf	nf	nf
Nitrate-N	na	na	na	na	na	nf	na	nf	na	na	na	na	na	EPA 300.0	na	na	na	nf	na
Nitrite-N	na	na	na	na	na	nf	na	na	na	na	na	na	na	EPA 300.0	na	na	na	na	na
Organic-N	na	na	na	na	na	nf	na	na	na	na	na	na	na	na	na	na	na	na	na
Acute Toxicity	-	-	-	na	-	na	-	na	-	-	-	-	-	nf	-	-	-	-	nf
Atherinops affinis (survival)	-	-	-	-	-	-	-	-	-	-	-	-	nf	-	-	-	-	EPA/600/4-90/027F	-
Menidia beryllina (survival)	-	EPA 600/4-90/027F	EPA 600/4-90/027F	-	-	-	-	-	-	-	-	EPA 821/R-02/012	-	-	-	-	-	-	-
Mysidopsis bahia (survival)	-	-	-	-	-	-	EPA 600/4-85/013	-	-	-	-	-	-	-	-	-	-	-	-
Pimephales promelas (survival)	EPA 2000.0	-	-	-	EPA 600/4-85/013	-	-	-	EPA 600/4-85/013	EPA 600/4-85/013	EPA 600/4-85/013	-	-	-	EPA 600/4-85/013	EPA 600/4-85/013	nf	-	-
Chronic Toxicity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Atherinops affinis (survival)	-	-	-	-	-	EPA 600/R-95/136	-	-	EPA 600/R-95/136	-	-	-	-	-	-	-	-	-	-
Haliotis rufescens (development)	EPA 600/R-95/136	-	EPA 600/R-95/136	-	-	-	EPA 600/R-95/136	-	-	-	-	-	-	-	-	-	-	EPA 600/R-95/136	EPA 600/R-95/136
Macrocystis pyrifera (germination)	-	-	-	-	-	-	-	-	-	EPA 600/R-95/136	EPA 600/R-95/136	EPA 600/R-95/136	-	-	-	-	EPA 600/R-95/136	-	-
Menidia beryllina (growth)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Menidia beryllina (survival)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	nf	-	-	-	-
Mytilis edulis (development)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	nf	-	-	-
Strongylocentrotus purpuratus (fertilization)	-	EPA 600/R-95/136	-	EPA 600/R-95/136	EPA 600/R-95/136	-	-	EPA 600/R-95/136	-	-	-	-	EPA 600/R-95/136	EPA 600/R-95/136	-	-	-	-	-
Arsenic	EPA 200.8	na	EPA 200.7	EPA 200.7	EPA 200.8	EPA 200.8	SM 3114	EPA 200.8	EPA 200.8	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.8	EPA 200.7	SM 3113 B	nf	EPA 200.7	nf	nf
Cadmium	EPA 200.8	na	EPA 200.7	EPA 200.7	EPA 200.8	EPA 200.8	EPA 200.7	EPA 200.8	EPA 200.8	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.8	EPA 200.7	SM 3111 B	nf	EPA 200.7	nf	nf
Chromium	EPA 200.8	na	EPA 200.7	EPA 200.7	EPA 200.8	EPA 200.8	EPA 200.7	EPA 200.8	EPA 200.8	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.7	SM 3111 B	nf	EPA 200.7	nf	nf
Copper	EPA 200.8	na	EPA 200.7	EPA 200.7	EPA 200.8	EPA 200.8	EPA 200.7	EPA 200.8	EPA 200.8	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.8	EPA 200.7	SM 3111 B	nf	EPA 200.7	nf	nf
Lead	EPA 200.8	na	EPA 200.7	EPA 200.7	EPA 200.8	EPA 200.8	EPA 200.7	EPA 200.8	EPA 200.8	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.8	EPA 200.7	SM 3112 B	nf	EPA 200.7	nf	nf
Mercury	EPA 245.1	na	EPA 245.1	EPA 245.1	EPA 245.1	EPA 200.8	SM 3112	EPA 200.8	EPA 245.1	EPA 245.1	EPA 245.1	EPA 245.1	EPA 7470 A	EPA 7470 A	EPA 7470 A	nf	EPA 245.1	nf	nf
Nickel	EPA 200.8	na	EPA 200.7	EPA 200.7	EPA 200.8	EPA 200.8	EPA 200.7	EPA 200.8	EPA 200.8	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.8	EPA 200.7	SM 3111 B	nf	EPA 200.7	nf	nf
Selenium	EPA 200.8	na	na	na	EPA 200.8	EPA 200.8	SM 3114	EPA 200.8	EPA 200.8	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.8	EPA 200.7	SM 3113 B	nf	EPA 200.7	nf	nf
Silver	EPA 200.8	na	EPA 200.7	EPA 200.7	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.8	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.8	EPA 200.7	SM 3111 B	nf	EPA 200.7	nf	nf
Zinc	EPA 200.8	na	EPA 200.7	EPA 200.7	EPA 200.8	EPA 200.8	EPA 200.7	EPA 200.8	EPA 200.8	EPA 200.7	EPA 200.7	EPA 200.7	EPA 200.8	EPA 200.7	SM 3111 B	nf	EPA 200.7	nf	nf
Phenols	na	EPA 420.1	EPA 420.1	EPA 625	EPA 420.1	EPA 625	na	na	na	EPA 625	EPA 625	EPA 625	EPA 625	EPA 625	EPA 625	EPA 625	EPA 625	EPA 625	EPA 625
Total DDT	EPA 608	na	EPA 608	na	EPA 608	EPA 608	EPA 608	EPA 608	EPA 608	EPA 608	EPA 608	EPA 608	nf	EPA 608	EPA 608	EPA 608	EPA 608	EPA 608	EPA 608
Total PAH	SM 8270C SIM	na	EPA 625	EPA 625	EPA 625	EPA 625	EPA 625	EPA 625	EPA 625	EPA 625	EPA 625	EPA 610	nf	EPA 625	EPA 610	EPA 625	EPA 625	EPA 625	EPA 625
Total PCB	EPA 608	na	EPA 608	na	EPA 608	EPA 608	EPA 608	EPA 608	EPA 608	EPA 608	EPA 608	EPA 608	nf	EPA 608	EPA 608	EPA 608	EPA 608	EPA 608	EPA 608

nf = Not found.
dash = Not applicable.
na = Not analyzed.