Characteristics of Effluents from Small Municipal Wastewater Treatment Facilities in 1993

Since the early 1970s, 90% of the municipal waste water effluents discharged directly to the Southern California Bight (SCB) have come from the four largest treatment facilities: Hyperion Wastewater Treatment Plant (City of Los Angeles), Joint Water Pollution Control Plant (JWPCP) of the County Sanitation Districts of Los Angeles County, Wastewater Treatment Plants 1 and 2 of County Sanitation Districts of Orange County (CSDOC), and Point Loma Wastewater Treatment Plant (PLWTP) of the City of San Diego. SCCWRP has published annual effluent constituent concentrations and mass emission estimates for these four facilities for two decades. In addition, there are 15 smaller municipal wastewater facilities that discharge to the Southern California Bight (Figure 1, Appendix 1). SCCWRP summarized the mass emissions from these facilities in 1971, 1987, and 1989 (SCCWRP 1973, 1989, 1990).

In contrast to the large facilities, the small municipal wastewater facilities discharge effluent through relatively short, shallow-water outfalls and thus treat the sewage to a greater degree prior to discharge (SCCWRP 1990). As the mass emissions from the large facilities declines (see *Characteristics of Effluents from Large Municipal Wastewater Treatment Plants in 1993* in this report), the inputs to the bight from the small facilities may become more significant. Hence, we will summarize the mass emissions from these facilities more frequently.

In this report, we summarize concentrations of effluent constituents and estimate mass emissions for the small municipal wastewater facilities for 1993, and discuss trends in mass emissions from these facilities since 1971.

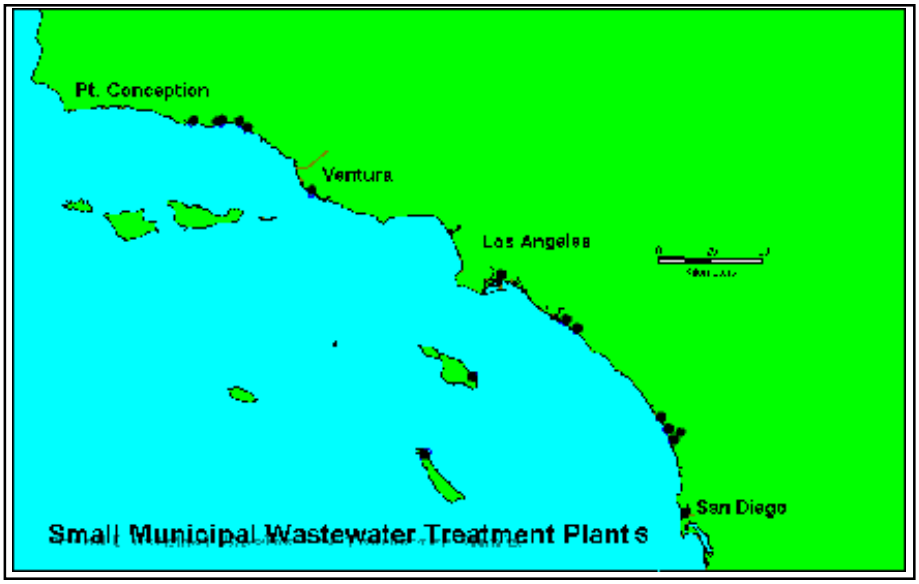
MATERIALS AND METHODS

We obtained data on effluent characteristics of the smaller facilities from the required effluent monitoring data reports that are sent to the Regional Water Quality Control Boards (Central Coast, Los Angeles, Santa Ana, and San Diego regions) under the National Pollutant Discharge Elimination System (NPDES) permits.

The frequency of effluent constituent measurements were determined by facility size and the type of sewage treated (residential or industrial). Flow was generally measured continuously; suspended solids, settleable solids, oil and grease, and biochemical oxygen demand (BOD) were generally measured daily or weekly; and trace organics and trace metals were measured from one to 12 times per year.

Monthly contaminant mass emissions were estimated from the product of mean daily flow and constituent concentration in month *i*. These were summed over all months to obtain the annual estimate (Appendix 1).

FIGURE 1. Locations of the small municipal wastewater facilities that discharged to the Southern California Bight in 1993.



Municipal Wastewater Facility	Flow (mgd[a])	Level of Treatment
Goleta	4.7	Primary/Secondary
Santa Barbara	7.2	Secondary
Montecito	1.0	Secondary
Summerland	0.14	Tertiary
Carpinteria	1.3	Secondary
Oxnard	17.4	Secondary
Terminal Island	17.2	Secondary
Avalon	0.57	Secondary
San Clemente Island	0.015	Secondary
AWMA[b]	17.8	Secondary
SERRA[c]	17.0	Secondary
Oceanside	11.4	Secondary
Encina	21.4	Secondary
San Elijo + Escondido	17.9	Primary/Secondary
Total	135.0	

[a]mgd=million gallons per day (1 mgd = 3,785,000 L/day).
[b]Aliso Water Management Agency.
[c]South East Regional Reclamation Authority.

TABLE 1. Volume and level of effluent treatment for the small municipal wastewater treatment facilities that discharged to the Southern California Bight in 1993. See Appendix 1 for complete facility names.

TABLE 2. Means and coefficients of variation (CV) of annual constituent concentrations in effluents from small municipal wastewater treatment plants that discharged to the Southern California Bight in 1993.

	Goleta		Santa Barbara		Montecito		Summerland		Carpinteria		Oxnard		Terminal Island	
Constituent	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
Flow (mgd)[a]	4.70	9	7.15	18	1.0	19	0.14	16	1.34	14	17.4	4	17.2	12
Flow (million L/day)	17.8	9	27.1	8	3.79	19	0.53	16	5.07	14	65.9	4	65.1	12
Suspended solids (mg/L)	37.4	19	12.5	48	6.8	23	4	69	14	46	14.5	44	11	60
Settleable solids(mL/L)	0.2	27	0.05	198	-	-	-	-	0.2	314	0.28	80	0.3	308
BOD[b] (mg/L)	50.0	22	5	-	6.0	9	5.34	29	13	37	17.0	20	5	49
Oil & Grease (mg/L)	6.4	27	7.53	-	2.8	97	-	-	2	0	2.36	19	2.9	23
Nitrate-N (mg/L)	-	-	-	-	-	-	-	-	-	-	5.26	82	-	-
Nitrite-N (mg/L))	-	-	-	-	-	-	-	-	-	-	1.11	124	-	-
Ammonia-N (mg/L)	38.2	13	-	-	-	-	4.25	188	20.0	72	9.50	48	0.3	72
Organic N (mg/L)	-	-	-	-	-	-	-	-	-	-	3.30	51	-	-
Total N (mg/L)	-	-	-	-	0.83	52	-	-	-	-	-	-	-	-
Cyanide (ug/L)	5	234	<5	-	<10	-	<40	-	5	141	25	124	1	332
Turbidity NTU[e]	41.9	26	3.7	57	1.1	38	-	-	8.1	77	4.67	42	3.0	29
Toxicity TU[f]	0.30	131	0.53	122	-	-	0	-	0.42	72	0.27	92	0.20	133
Silver (ug/L)	7	165	<10	-	<10	-	<50	-	5	141	<4	-	0.2	140
Arsenic (ug/L)	<5	-	1	-	<10	-	<10	-	<10	-	2.27	16	4	69
Cadmium (ug/L)	0.2	346	<10	-	<5	-	<30	-	<1	-	4.43	90	1	141
Chromium (ug/L)	1.5	249	<10	-	<10	-	<100	-	<2	-	<10	-	0.5[g]	200
Copper (ug/L)	39	14	<10	-	<50	-	<50	-	<50	-	17.7	23	8	61
Mercury (ug/L)	0.03	346	<0.2	-	<0.2	-	<2	-	<1	-	0.044	346	0.095	169
Nickel (ug/L)	4	346	<40	-	<50	-	<60	-	<10	-	21.3	16	23	186
Lead (ug/L)	1	234	<1	-	<10	-	<200	-	<6	-	6.06	264	1	200
Selenium (ug/L)	nd	-	2	-	<10	-	-	-	-	-	-	-	12.7	20
Zinc (ug/L)	40	55	60	-	<50	-	30	-	25	141	24.4	32	54	31
Phenols[h] (ug/L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorinated[i]	42	56	<10	-	<50	-	<50	-	5	141	<50[j]	-	<7[k]	-
Non-chlorinated[i]	47	39	<10	-	<50[k]	-	<50[j]	-	5	141	4	266	-	-
Total DDT (ug/L)	<0.04[j]	-	<10	-	-	-	n.d[l]	-	0.07	61	<0.1[j]	-	<0.013[j]	-
Total PCB (ug/L)	<1	-	<50	-	-	-	n.d.	-	0.05	141	<0.3[j]	-	<0.065[j]	-

See Appendix 1 for complete facility names.
[a]mgd=million gallons per day.
[b]BOD=biochemical oxygen demand.
[c]Carbonaceous BOD only.
[d]Ammonium.
[e]NTU=nephelometric turbidity units.

Constituent concentrations below method detection limits were treated as zeros. If data were missing for a month, the mass emission for that month was estimated from the product of the annual mean constituent concentration and the number of days in the month.

In past reports, effluent mass emission were estimated from the product of the total annual flow and the mean annual constituent concentrations (SCCWRP 1973, 1989, 1990). If the annual mean constituent concentration was below the detection limit, the mass emissions was not estimated, even though there may have been measurable concentrations during some months. Beginning with this report, mass emissions were estimated for all months with measurable concentrations even though annual mean constituent concentrations may have been below detection limits.

RESULTS

In 1993, the 15 small municipal wastewater facilities discharged 135 million gallons per day (mgd) (511 x 10^6 L/day) of treated effluent into the SCB (Table 1). Daily flow rates varied over three orders of magnitude among the small facilities. Most of the agencies provided secondary treatment, although the type of treatment ranged from a combination of primary/secondary to tertiary.

The concentrations of effluent constituents varied by up to three orders of magnitude among the small facilities (Table 2). Three-quarters of the constituents varied by more than an order of magnitude. At individual treatment plants, 59% of the mean monthly constituent concentrations and toxicity values had coefficients of variation higher than 50%.

Mass emissions also varied greatly among facilities. Encina had the highest emissions of BOD, cyanide, silver, arsenic, cadmium, chromium, copper, nickel, lead, and zinc (Table 3). SERRA had the highest emissions of ammonia and mercury, and Goleta had the highest emissions of chlorinated and nonchlorinated phenols. Emissions of total suspended solids were highest at Escondido, oil and grease at Santa Barbara, selenium at Terminal Island, DDT at Oceanside, and PCBs at Carpinteria.

Avalon		San Clemente Island		AWMA		SERRA		Oceanside		Encina		San Elijo		Escondido	
Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
0.57	19	0.015	7	17.8	12	17.0	8	11.4	4	21.4	9	2.89	4	15.0	5
2.16	19	0.057	7	67.4	12	64.3	8	43.1	4	81.0	9	10.9	4	56.8	5
17.2	32	6.6	68	7.7	21	11.5	13	6.9	31	6.9	21	17.2	35	20.5	93
0.002	234	nd	-	-	-	0.2	33	0.02	234	0.07	24	0.5	170	2.3	198
3.92	25	10.23	108	5.3[c]	13	5.1[c]	10	3.65[c]	49	25	17	28.5	20	8.2[c]	22
<3	-	1.56	218	1.9	60	0.8	346	3.5	42	0.7	48	1.8	32	1.4	83
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.24	50	0.22	-	16.7	42	37.1	36	20.7	20	28.3[d]	14	26	11	28.6	13
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
36	156	nd	-	nd	-	<45	-	<20	-	62	29	<1	-	53	75
4	32	1.8	75	-	-	4.4	10	2.76	24	5.7	15	10	38	6.3	65
-	-	-	-	0.15	200	-	-	1.04	27	0.91	62	0.97	49	1.18	41
<10	-	nd	-	<30	-	<50	-	<10	-	21	69	10	82	0.3	200
<100	-	1	-	1	141	<26	-	<10	-	3.9	113	<30	-	0.95	77
<5	-	nd	-	<30	-	3	200	<2	-	32	62	2.5	200	0.07	117
<10	-	nd	-	<30	-	<125[g]	-	<20	-	42	158	38	59	1	77
30	37	29	-	25	85	<60	-	1	200	89	121	28	81	10	36
<0.2	-	1	-	<2[j]	-	0.23	173	<9	-	0.1	77	<2	-	<0.05	-
<40	-	22	-	15	141	<135	-	<10	-	80	74	23	200	15	85
<100	-	nd	-	<30	-	50	116	<5	-	88	55	140	59	3.3	139
-	-	-	-	<4	-	-	-	-	-	-	-	-	-	-	-
103	58	52	-	50	28	19	200	35	68	139	39	58	43	65	23
8	200	nd	-	-	-	-	-	-	-	-	-	-	-	<0.04[j]	-
-	-	-	-	<10	-	<160	-	<5	-	<84	-	<10	-	-	-
-	-	-	-	<10	-	<220	-	<5	-	<8	-	<10	-	-	-
<0.02	-	-	-	<0.04	-	-	-	0.05	115	-	-	<0.05[j]	-	nd	-
<0.5	-	nd	-	<0.4	-	-	-	<0.6	-	nd	-	<1[j]	-	nd	-

[g]Only includes chromium VI.
[h]EPA method 420.2 (Colorimetric method).
[i]EPA method 604 or 625 (GC/MS method).
[j]Maximum of the range of detection limits reported.
[k]Only includes 2,4,6-trichlorophenol and pentachlorophenol.
[l]nd=not detectable.

TABLE 3. Estimates of constituent mass emissions from small municipal wastewater treatment facilities that discharged to the Southern California Bight in 1993.

Constituent	Goleta	Santa Barbara	Montecito	Summerland	Carpinteria	Oxnard	Terminal Island	Avalon	San Clemente Island
Flow[a] (L x 10^9/ yr)	6.5	9.9	1.4	0.20	1.8	24	24	0.79	0.02
Suspended solids (mt)[b]	245	129	9.7	0.84	26	348	249	14	0.13
BOD[c] (mt)	328	49	8.2	1.1	24	408	129	3.1	0.21
Oil & Grease (mt)	42	74	3.7	-	3.7	57	69	-	0.03
Nitrate-N (mt)	-	-	-	-	-	127	-	-	-
Nitrite-N (mt)	-	-	-	-	-	26	-	-	-
Ammonia-N (mt)	249	-	-	0.74	37	226	7.9	0.19	0.005
Organic N (mt)	-	-	-	-	-	79	-	-	-
Total N (mt)	-	-	1.2	-	-	-	-	-	-
Cyanide (kg)	30	-	-	-	9.5	584	13	31	-
Silver (kg)	43	-	-	-	9.0	-	3.8	-	-
Arsenic (kg)	-	10	-	-	-	54	95	-	0.02
Cadmium (kg)	1.1	-	-	-	-	108	24	-	-
Chromium (kg)	10	-	-	-	-	-	12[f]	-	-
Copper (kg)	253	-	-	-	-	425	192	24	0.60
Mercury (kg)	0.14	-	-	-	-	1.0	2.2	-	0.02
Nickel (kg)	24	-	-	-	-	512	563	-	0.46
Lead (kg)	7.0	-	-	-	-	145	25	-	-
Selenium	-	20	-	-	-	-	300	-	-
Zinc (kg)	258	592	-	6.0	45	588	1,281	80	1.1
Phenols[g] (kg)	-	-	-	-	-	-	-[i]	5.8	-
Chlorinated[h]	270	-	-	-	9.5	-	-	-	-
Non-chlorinated[h]	305	-	-	-	9.5	99	-	-	-
Total DDT (kg)	-	-	-	-	0.13	-	-	-	-
Total PCB (kg)	-	-	-	-	0.09	-	-	-	-

See Appendix 1 for complete facility names.
[a]Annual flow volumes are the sum of the mean daily flow per month times the number of days in each month.
[b]mt=metric tons.
[c]BOD=biochemical oxygen demand.
[d]Only includes carbonaceous BOD.

The combined emission of all trace metals for all of the small facilities was 28 mt. The combined mass emission of individual trace metals was below 5 mt for all metals except for zinc, which was 11 mt (Table 3). The combined emission of DDT were less than 1 kg and the combined emission of PCBs were less than 0.1 kg.

The small facilities accounted for 11% of the total volume of municipal wastewater discharged to the SCB in 1993, but only 2-3% of the suspended solids, oil and grease, and BOD (Table 4). The small facilities contributed a disproportionately low share of ammonia, arsenic, copper, silver, and DDT. They contributed most of the mass emissions of lead and cadmium, and a disproportionately high share of cyanide, chromium, mercury, nickel, and zinc.

DISCUSSION

The annual mean constituent concentrations varied considerably among the wastewater treatment facilities due to the type of wastes treated (domestic and industrial), source control, the volume of water removed for reclamation and inland discharge, and the efficiency and degree of treatment (primary, secondary, or tertiary). The monthly concentrations of some constituents also varied substantially at individual treatment plants. Coefficients of variation higher than 100% generally were due to a high proportion of monthly concentrations below detection limits.

The annual combined volume of effluent discharged from the small municipal wastewater treatment facilities nearly doubled from 1971 to 1993 and ammonia increased 129% (Table 5) (SCCWRP 1973). However, oil and grease decreased 90%, BOD decreased 79%, suspended solids decreased 72%, and cyanide decreased 55%.

The combined volume of effluent discharged from the small facilities decreased slightly (1%) from 1989 to 1993 (Table 5) (SCCWRP 1990). The combined mass emissions of slightly more than half of the constituents increased during this period (Table 5). The largest increases were in cyanide and cadmium; the largest decreases were in mercury and arsenic.

The estimated mass emissions of DDT and PCB were small in 1993, but comparisons with previous years were not possible because of how emissions were estimated. Before 1993, the mass emissions of constituents with annual mean concentrations below detection limits were

AWMA	SERRA	Oceanside	Encina	San Elijo	Escondido	Total
25	23	16	30	4.0	21	188
192	272	111	205	69	426	2,297
132[d]	120[d]	58[d]	740	114	170[d]	2,285
47	19	56	19	6.9	28	425
-	-	-	-	-	-	127
-	-	-	-	-	-	26
411	876	327	837[e]	104	592	3,668
-	-	-	-	-	-	79
-	-	-	-	-	-	1.2
-	-	-	1,837	-	1,078	3,583
-	-	-	613	40	5.1	714
24	-	-	116	-	20	319
-	73	-	950	10	1.5	1,168
-	-	-	1,252	150	26	1,450
619	-	12	2,628	109	201	4,464
-	5.6	-	3.7	-	-	13
366	-	-	2,334	89	308	4,196
-	1,180	-	2,590	559	69	4,575
-	-	-	-	-	-	320
1,228	438	547	4,100	229	1,342	10,735
-	-	-	-	-	-	5.8
-	-	-	-	-	-	280
-	-	-	-	-	-	414
-	-	0.78	-	-	-	0.91
-	-	-	-	-	-	0.09

[e]Ammonium.
[f]Only includes Chromium V I.
[g]EPA method 420.2 (Colorimetric method).
[h]EPA method 604 or 625 (GC/MS method).
[i]Only includes 2,4,6-trichlorophenol and pentachlorophenol.

	Mass Emissions			Percent of Total	
Constituent	Large[a]	Small[b]	Total	Large	Small
Flow (mgd[c])	1,075	135	1,210	89	11
Suspended solids (mt[d])	75,211	2,297	77,508	97	3
BOD[e](mt)	136,009	2,285	138,294	98	2
Oil and Grease (mt)	18,143	425	18,568	98	2
Ammonia-N (mt)	41,019	3,668	44,687	92	8
Cyanide (mt)	14	3.6	18	80	20
Silver (mt)	6.0	0.7	6.7	90	10
Arsenic (mt)	5.2	0.3	5.5	95	5
Cadmium (mt)	0.6	1.2	1.8	33	67
Chromium (mt)	6.8	1.5	8.3	82	18
Copper (mt)	45	4.5	50	91	9
Mercury (mt)	0.02	0.01	0.03	67	33
Nickel (mt)	31	4.2	35	88	12
Lead (mt)	1.8	4.6	6.4	28	72
Zinc (mt)	82	11	93	88	12
DDT (kg)	9.2	0.9	10	91	9
PCB (kg)	nd[f]	0.09	-	-	-

[a]Hyperion Wastewater Treatment Plant (City of Los Angeles), Joint Water Pollution Control Plant of the County Sanitation Districts of Los Angeles County, Wastewater Treatment Plants 1 and 2 of County Sanitation Districts of Orange County, and Point Loma Wastewater Treatment Plant (City of San Diego).
[b]Facililites covered in this report.
[c]mgd=millions of gallons per day (1 mgd=3,785,000 L/day).
[d]mt=metrictons.
[e]BOD = bio chemical oxygen demand.
[f]nd = non detectable.

TABLE 4. Estimates of constituent mass emissions from large (>150 mgd, n=4) and small (<25 mgd, n=15) municipal wastewater treatment facilities that discharged to the Southern California Bight in 1993.

set to zero, even though there may have been measurable quantities discharged during the year. For 1993, mass emissions were calculated for each month and summed for the annual estimate, although the annual mean constituent concentration may have been below detection limits.

The contribution of the small facilities to the combined municipal wastewater discharge of the large and small facilities remained about the same from 1989 (10%) to 1993 (11%) (SCCWRP 1990). The contribution by the small facilities of suspended solids, BOD, and oil and grease remained about 2-3% during this period. However, the cyanide contribution from the small facilities increased from 6% of the total discharge in 1989 to 20% in 1993, and the total metals contribution increased from 7% in 1989 to 14% in 1993. Contributions from the small facilities for seven of the nine trace metals increased during this period; cadmium increased from 22% to 67%, chromium from 4% to 18%, and lead from 10% to 72%.

In recent years, the number of effluent monitoring analyses reporting concentrations below detection limits (BDL) has increased. Effluent constituent concentrations have decreased due to source control and increased and improved treatment. If detection limits of the recommended or required techniques are below discharge permit requirements, then BDL results are in compliance with permit requirements. However, BDL results complicate the assessment of total and long-term trends of mass emission into the SCB.

CONCLUSIONS

The volume of discharge and the estimated mass emissions of suspended solids, BOD, and oil and grease from the small municipal wastewater facilities declined since 1989. The relative contributions of these constituents from the small facilities to the combined emissions of the large and small municipal wastewater facilities have remained about the same (11%). However, the estimated emissions of cyanide and most of the trace metals from the small facilities increased, as has their relative contribution to the combined emissions of the large and small municipal wastewater facilities.

REFERENCES

SCCWRP. see *Southern California Coastal Water Research Project.*

Southern California Coastal Water Research Project. 1973. The ecology of the Southern California Bight: Implications for water quality management. Southern California Coastal Water Research Project, El Segundo. 531 pp.

Southern California Coastal Water Research Project. 1989. Marine outfalls: 1987 inputs from wastewater treatment plants, power plants, and industrial facilities. Pp.30-37, *In:* Southern California Coastal Water Research Project, Annual Report 1988-89. Southern California Coastal Water Research Project, Long Beach.

Southern California Coastal Water Research Project. 1990. Characteristics of effluents from small municipal wastewater treatment plants, electrical generating stations, and industrial facilities in 1989. Pp.16-24, *In:* Southern California Coastal Water Research Project, Annual Report 1989-90. Southern California Coastal Water Research Project, Long Beach.

ACKNOWLEDGEMENTS

Author Valerie Raco thanks the small municipal wastewater facilities, and the Central, Los Angeles, and San Diego Regional Water Quality Control Boards for providing monitoring data that are submitted to meet NPDES permit requirements. She also thanks J. Allen and J. Cross for reviewing the manuscript.

APPENDIX 1.

Names of the governing agencies and the small municipal wastewater treatment facilities that discharged to the Southern California Bight in 1993.

CENTRAL REGIONAL WATER QUALITY CONTROL BOARD

- Goleta Sanitary District - Goleta Wastewater Treatment Plant
- City of Santa Barbara - El Estero Wastewater Treatment Plant
- Montecito Sanitary District - Montecito Wastewater Treatment Plant
- Summerland Sanitary District - Summerland Wastewater Treatment Plant
- Carpinteria Sanitary District - Carpinteria Wastewater Treatment Plant

LOS ANGELES REGIONAL WATER QUALITY CONTROL BOARD

- City of Oxnard - Perkins Wastewater Treatment Plant
- City of Los Angeles - Terminal Island Wastewater Treatment Plant
- City of Avalon - Santa Catalina Island Sewage Treatment Plant
- US Navy - Navy Auxiliary Landing Field - San Clemente Island Sewage Treatment Plant

SAN DIEGO REGIONAL WATER QUALITY CONTROL BOARD

- AWMA (Aliso Water Management Agency) - Aliso Ocean Outfall
  - El Toro Wastewater Reclamation Plant
  - Los Alisos Wastewater Treatment Plant
  - AWMA Joint Regional Treatment Plant
  - AWMA Coastal Water Treatment Plant
- SERRA (South East Regional Reclamation Authority) - SERRA Ocean Outfall
  - Capistrano Beach Wastewater Treatment Plant
  - Moulton Niguel Water District 3A Treatment Plant
  - City of San Clemente Wastewater Treatment Plant
  - Santa Margarita Water District
    - Oso Creek Water Reclamation Plant
    - Chiquita Water Reclamation Plant
  - Jay B. Latham Regional Wastewater Treatment Plant
- City of Oceanside Water Utilities Department - Oceanside Ocean Outfall
  - La Salina Wastewater Treatment Plant
  - San Luis Rey Wastewater Treatment Plant
  - Fallbrook Sanitary District, Plant 1 and Plant 2
- Encina Wastewater Authority - Encina Ocean Outfall
  - Meadow Lark Water Reclamation Plant
  - Shadow Ridge Water Reclamation Plant
  - Gafner Water Reclamation Plant
- San Elijo Joint Powers Authority - San Elijo Water Pollution Control Facility
  - City of Escondido, Hale Avenue Resource Recovery Facility (treated separately from San Elijo).

Constituent	Mass Emissions 1971[a]	1987[b]	1989[c]	1993	Percent Change 1971-1993	1989-1993
Flow (mgd[d])	69	132	137	135	96	-1
Suspended solids (mt[e])	8,200	4,193	2,984	2,297	-72	-23
BOD[f] (mt)	11,000	5,178	4,751	2,285	-79	-52
Oil and Grease (mt)	4,200	708	460	425	-90	-8
Ammonia-N (mt)	1,600	1,757	2,716	3,668	129	35
Cyanide (mt)	8	1.7	0.67	3.6	-55	437
Silver (mt)	-	0.87	0.58	0.71	-	22
Arsenic (mt)	-	0.43	0.84	0.32	-	-62
Cadmium (mt)	-	1.7	0.53	1.2	-	126
Chromium (mt)	-	2.3	0.84	1.5	-	79
Copper (mt)	-	6.9	3.4	4.5	-	32
Mercury (mt)	-	0.18	0.23	0.01	-	-96
Nickel (mt)	-	5.5	2.8	4.2	-	50
Lead (mt)	-	6.5	2.9	4.6	-	59
Zinc (mt)	-	16	12	11	-	-8
DDT (kg)	-	nd[g]	nd	0.91	-	-
PCB (kg)	-	nd	nd	0.09	-	-

[a]data from SCCWRP (1973).
[b]data from SCCWRP (1988).
[c]data from SCCWRP (1990).
[d]mgd=millions of gallons per day.
[e]mt=metric tons.
[f]BOD= biochemical oxygen demand.
[g]nd=not detectable.

TABLE 5. Combined estimate of mass emissions of constituents from the 15 small (<25 mgd) municipal wastewater treatment facilities that discharged to the Southern California Bight for 1971, 1987, 1989, and 1993.

APPENDIX 2.
Mass Emission Equation

Annual mass emissions (ME) of constituents were estimated from:

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

where

F_i = mean daily flow in month *i*:
C_i = constituent concentration in month *i*, or annual mean concentration (for months not measured); and
D_i = number of days in month *i*.