Characteristics of Effluents from Small Municipal Wastewater Treatment Facilities in 1995

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ABSTRACT

The four largest municipal wastewater treatment facilities in southern California have historically contributed most of the anthropogenic contaminants to the Southern California Bight (SCB). During the past two decades, however, the quality of their effluents have improved dramatically due to increased source control, land disposal of sludge, improved sludge and primary treatment, and increased secondary treatment. As mass emissions from the large facilities have declined, inputs to the SCB from small municipal wastewater facilities may become more significant. This study summarizes effluent characteristics of the 15 small municipal wastewater facilities in southern California in 1995 and describes trends in constituent emissions from these facilities since 1971. Mass emissions were calculated from monthly measurements of flow and constituent concentrations for 1995. Comparison of the data among the facilities revealed the following trends: (1) Between 1987 and 1995, constituent contributions generally increased by a factor of two. (2) In 1995, the small wastewater facilities were significant contributors of lead to the SCB, accounting for 50% of the total muncipal wastewater lead emissions. (3) From 1994 to 1995, the volume of discharge to the SCB increased 9%. (4) From 1994 to 1995, approximately the same number of combined mass emissions of the constituents increased as decreased. (5) From 1994 to 1995, the small facilities continued to contribute 11% of the combined wastewater discharge generated by the small and large municipal wastewater facilities.

INTRODUCTION

The southern California coastal region is one of the most densely populated areas on the west coast of North America. The marine environment serves as a resource for a number of recreational, commercial, municipal, and industrial uses. These uses contribute a variety of contaminants to coastal waters. One common use for the ocean is to serve as a repository for man's wastes. The ocean has a limited capacity to assimilate these wastes without incurring environmental damage. To identify the most important sources of contamination, inputs of contaminants from different sources are measured. These measurements provide a basis for developing emission control strategies and, when measured over time, for assessing the effectiveness of these control strategies.

Since the early 1970s, municipal wastewater has been one of the major sources of contaminants to the marine environment of the SCB (SCCWRP 1973). Historically, 90% of the municipal wastewater effluents discharged directly into the SCB have been processed by the four largest treatment facilities: Hyperion Treatment Plant (HTP); operated by the City of Los Angeles; Joint Water Pollution Control Plant (JWPCP), operated by the County Sanitation Districts of Los Angeles County (CSDLAC); Wastewater Treatment Plants 1 and 2, operated by the County Sanitation Districts of Orange County (CSDOC); and Point Loma Wastewater Treatment Plant (PLWTP), operated by the City of San Diego. However, mass emissions from these large facilities have decreased substantially over the past two decades (see *Characteristics of Effluents from Large Municipal Wastewater Treatment Facilities in 1995* in this report). As mass emissions from the large facilities decline, inputs to the SCB from small municipal wastewater facilities in the southern California region may become more significant. In addition to the four large facilities (defined as facilities with discharge >25 mgd), 15 small municipal wastewater facilities discharge into the SCB through 14 ocean outfalls (Figure 1, Appendix 1). These small facilities are defined as facilities with discharge ≤25 mgd.

Although constituent characteristics are summarized in the monitoring reports produced by the small municipal wastewater facilities, the small facilities do not compare their effluent characteristics amongst each other or against the large municipal wastewater facilities. The Southern California Coastal Water Research Project (SCCWRP) summarized the mass emissions from the small facilities in 1971, 1987, 1989, 1993, and 1994 (SCCWRP 1973, 1989, 1990, 1995; Raco-Rands 1996). In this report, concentrations and mass emission estimates of effluent constituents are compared among the small municipal wastewater facilities; mass emission estimates are compared between small and large municipal wastewater facilities for 1995; and trends in mass emissions from the small facilities since 1971 are discussed.

MATERIALS AND METHODS

Data on effluent characteristics of the small facilities were obtained from the effluent monitoring data reports required by 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 small municipal wastewater facilities measured constituents at the following frequencies: (1) general constituents — (e.g., suspended solids, BOD, oil and grease, ammonia-N, etc.) — annually to once per day; (2) toxicity and trace metals — annually to monthly; and (3) organics — biennially to quarterly (Table 1). Reporting limits varied by as much as 200 times among the agencies (Table 2).

Two types of assessments were performed. First, annual mean concentrations were calculated using zeroes for months when constituent concentrations were below reporting limits. The annual mean was reported even if it was below the reporting limit. Second, annual contaminant mass emissions were estimated from the product of the mean daily flow, constituent concentration, and the number of days in the month *i*. These emissions were summed over all months to obtain the annual estimate:

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

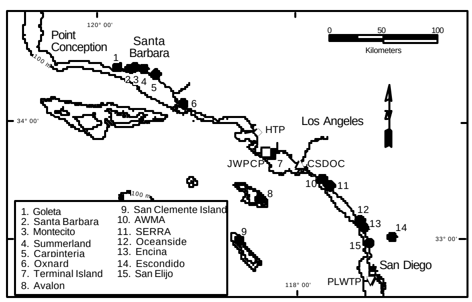
Where

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*.

Months with constituent concentrations below reporting limits were considered to have zero mass emissions. However, if the constituent was above the reporting limit in one or more months, the mass emissions for the month(s) were calculated, summed across all months, and included in the table of mass emissions. If a constituent concentration was not analyzed for a certain month or had unacceptable results, the annual mean concentration was used to calculate mass emissions for that month.

In past reports, effluent mass emissions were calculated 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 reporting limit, the mass emissions were not calculated, even though measurable concentrations were present in some months. Beginning with SCCWRP (1995), mass emissions were estimated for all months with measurable concentrations even when annual mean constituent concentrations were below reporting limits.

FIGURE 1. Locations of the municipal wastewater facilities that discharge to the Southern California Bight. POTWs = publicly owned treatment works. Large POTWs: HTP = Hyperion Treatment Plant; JWPCP = Joint Water Pollution Control Plant; CSDOC = County Sanitation Districts of Orange County; PLWTP = Point Loma Wastewater Treatment Plant.



RESULTS

1995 Effluents

In 1995, the 15 small municipal wastewater facilities discharged 143.1 million gallons per day (mgd) (541.6×10^6 L/day) of treated effluent into the SCB (Table 3). Daily flow rates varied over two orders of magnitude among the small facilities, ranging from 0.028 mgd (0.1×10^6 L/day) at the U.S. Navy's San Clemente Island Sewage Treatment Plant to 21.8 mgd (82.5×10^6 L/day) at the Encina Ocean Outfall. Most of the agencies provided secondary treatment, although the types of treatment ranged from a combination of primary/secondary to tertiary.

General constituents, at the individual plants, were above reporting limits in zero to 100% of the samples (Table 4). Most of the arsenic, copper, lead, selenium, and zinc measurements (53 to 93%) were above reporting limits. The majority of cadmium, chromium, mercury, nickel, and silver measurements (60 to 87%) were nondetectable. Trace organic measurements were nondetectable except for chlorinated and nonchlorinated phenolics at Goleta, and nonchlorinated phenolics and DDT measurements at Oxnard. All PCB measurements were nondetectable.

Also in 1995, 56% of the constituent concentrations varied among the facilities by one order of magnitude or more (Table 5). Forty percent of the annual mean constituent concentrations and toxicity values that were above reporting limits had coefficients of variation higher than 50%.

Mass emissions varied substantially among the facilities. The Encina Ocean Outfall had the highest emissions of biochemical oxygen demand (BOD), ammonia-N,

TABLE 1. Sampling frequency of constituents in effluent from the small municipal wastewater treatment facilities in southern California in 1995.

Constituent	Goleta	Santa Barbara	Montecito	Summerland	Carpinteria	Oxnard	Terminal Island
Suspended solids	5 Days/Week	1/Day	NR	Every 6 days	Every 6 days	NR	1/Week
Settleable solids	?/Day	1/Day	NR	1/Day	1/Day	NR	1/Week
BOD	1/Day	Every 6 days	NR	Every 6 days	Every 6 days	NR	1/Week
Oil and grease	1/Day	Every 6 days	NR	Monthly	Monthly	NR	1/Week
Nitrate-N	NA	NA	NA	NA	NA	NR	NR
Nitrite-N	NA	NA	NA	NA	NA	NR	NA
Ammonia-N	1/Day	Monthly	NR	Monthly	Monthly	NR	Monthly
Organic N	NA	NA	NA	NA	NA	NR	NA
Cyanide	Monthly	Semiannually	Annually	Annually	Semiannually	NR	Monthly
Turbidity	1/Day	1/Day	NR	Every 6 days	Every 6 days	NR	Continuous
Acute toxicity	Monthly	Quarterly	-	NA	Quarterly	NR	Monthly
Chronic toxicity	-	-	-	-	-	-	-
Macrocystis pyrifera	-	-	-	-	-	-	NA
Germ tube length	-	-	-	Annually	-	-	NA
Germination	-	-	-	Annually	-	-	NA
Strongylocentrotus purpuratus	-	Semiannually	-	Annually	-	-	NA
Menidia beryllina	-	-	-	Annually	-	-	Monthly
Arsenic	Monthly	Semiannually	Annually	Annually	Semiannually	NR	Monthly
Cadmium	Monthly	Semiannually	Annually	Annually	Semiannually	NR	Quarterly
Chromium	Monthly	Semiannually	Annually	Annually	Annually	NR	Quarterly [c]
Copper	Monthly	Semiannually	Annually	Annually	Semiannually	NR	Monthly
Lead	Monthly	Semiannually	Annually	Annually	Semiannually	NR	Quarterly
Mercury	Monthly	Semiannually	Annually	Annually	Semiannually	NR	Monthly
Nickel	Monthly	Semiannually	Annually	NA	Semiannually	NR	Quarterly
Selenium	Semiannually	Semiannually	NA	NA	Semiannually	NR	Quarterly
Silver	Monthly	Semiannually	Annually	Annually	Semiannually	NR	Monthly
Zinc	Monthly	Semiannually	Annually	Annually	Semiannually	NR	Monthly
Phenols	NA	Quarterly [d]	NA	NA	Annually [e]	NA	NA
Chlorinated phenols [f]	-	Quarterly	Annually	Annually	3/Year	NR	Quarterly [g]
Nonchlorinated phenols [f]	Semiannually	Quarterly	Annually	Annually	3/Year	NR	Quarterly
Total DDT	Semiannually	Biennially	Annually	NA	Semiannually	NR	Quarterly
Total PCB	Semiannually	-	-	NA	Semiannually	NR	Quarterly

[a]Carbonaceous BOD only.
[b]Ammonium.
[c]Only includes chromium VI.
[d]EPA method 420.2 (Colorimetric method).
[e]EPA method 420.3 (MBTH method).
[f]EPA method 604 or 625 (GC/MS method).
[g]Only includes 2,4,6-trichlorophenol and pentachlorophenol.
Dash = Data was not found.
BOD = Biochemical oxygen demand.
NA = Not analyzed.
NR = Not reported in annual report.

arsenic, cadmium, chromium, copper, lead, nickel, silver, and zinc (Table 6). South East Regional Reclamation Authority (SERRA) had the highest emission of suspended solids. The Aliso Ocean Outfall (Aliso Water Management Agency (AWMA)) had the highest emission of oil and grease. Perkins Wastewater Treatment Plant (City of Oxnard) had the highest emissions of cyanide and mercury, and the only measurable emission of DDT. Terminal Island Wastewater Treatment Plant had the highest emission of selenium. Goleta Wastewater Treatment Plant had the highest emission of nonchlorinated phenols.

The combined mass emissions of all trace metals for all of the small facilities was 31 mt. The combined mass emissions of individual trace metals was below 7 mt for all metals except for zinc, which was 16 mt (Table 6). The combined mass emissions of DDT was 0.3 kg, and there were no detectable emissions of PCB.

The small facilities contributed 11% of the total volume of municipal wastewater discharged into the SCB in 1995, but only 2 to 3% of the suspended solids, oil and grease, and BOD (Table 7). Relative to flow, the small facilities contributed a disproportionately small share of ammonia-N, arsenic, nickel, silver, and DDT. These facilities also contributed a disproportionately large share of cyanide, cadmium, chromium, lead, mercury, and zinc. The small facilities now contribute 50% of the lead mass emissions

Avalon	San Clemente Island	AWMA	SERRA	Oceanside	Encina	San Elijo	Escondido
5/Week	NR	5/Week	NR	NR	1/Day	1/Day	NR
Monthly	NR	5/Week	NR	NR	NR	1/Day	NR
5/Week	NR	5/Week[a]	1/Day[a]	NR[a]	1/Day	1/Day	NR[a]
Quarterly	NR	Monthly	Weekly	NR	1/Day	Monthly	NR
Quarterly	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA
Quarterly	Annually	Monthly	NR	NR	1/Day[b]	Quarterly	NR
NA	NA	NA	NA	NA	NA	NA	NA
Annually	Annually	Quarterly	Quarterly	Quarterly	Quarterly	3/Year	Quarterly
Weekly	NR	Weekly	NR	NR	1/Day	Weekly	NR
Quarterly	-	Monthly	NR	Monthly	Monthly	Quarterly	NR
Quarterly	-	Monthly	-	Monthly	Monthly	Quarterly	NR
NR	-	NR	Monthly	NR	NR	NR	NR
NR		NR	-	NR	NR	NR	NR
NR	-	NR	-	NR	NR	NR	NR
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
Annually	Annually	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly
Annually	Annually	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly
Annually	Annually	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly
Annually	Annually	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly
Annually	Annually	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly
Annually	Annually	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly
Annually	Annually	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly
Annually	NA	Quarterly	Quarterly	Quarterly	Quarterly	Semiannually	Quarterly
Annually	Annually	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly
Annually	Annually	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly
NA	Annually[e]	NA	NA	NA	NA	NA	NA
Annually	NA	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly
Annually	NA	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly
Annually	Annually	Semiannually	Semiannually	Quarterly	Quarterly	Quarterly	Quarterly
Annually	Annually	Semiannually	Semiannually	Quarterly	Quarterly	Quarterly	Quarterly

generated by the large and small municipal wastewater facilities, 31% of the cadmium, and 33% of the mercury mass emissions.

Comparison of 1994 and 1995 Effluents

From 1994 to 1995, the combined volume of effluent discharged by the small facilities increased 9% (Table 8). Approximately the same number of combined constituent mass emissions increased as decreased during this period. DDT and copper had the largest percent increase (329% and 113%, respectively); and silver, cadmium, and nickel had the largest percent decrease (55, 48, and 45%, respectively).

From 1994 to 1995, the contribution of effluent discharge from the small facilities to the combined municipal wastewater discharge generated by the large and small facilities remained at 11% (Table 9). During this period, approximately the same number of constituent contributions increased as decreased. The largest increase was 12% for mercury (from 21 to 33%), the largest decrease was 25% for cadmium (from 56 to 31%). The contribution of suspended solids by the small facilities increased from 2 to 3%, whereas BOD, and oil and grease remained at 2% during this period.

TABLE 2. Reporting limits of constituents in effluent from the small municipal wastewater treatment facilities in southern California in 1995.

Constituent	Goleta	Santa Barbara	Montecito	Summerland	Carpinteria	Oxnard	Terminal Island
Suspended solids (mg/L)	NR	NR	NR	NR	NR	NR	NR
Settleable solids (ml/L)	NR	0.1	-	NR	NR	0.1	0.03
BOD (mg/L)	NR	NR	NR	5	NR	NR	NR
Oil and grease (mg/L)	NR	NR	NR	2	NR	NR	NR
Nitrate-N (mg/L)	NA	NA	NA	NA	NA	NR	NR
Nitrite-N (mg/L)	NA	NA	NA	NA	NA	NR	NA
Ammonia-N (mg/L)	NR	NR	NR	0.5-5	NR	NR	0.2- 0.3
Organic N (mg/L)	NA	NA	NA	NA	NA	NR	NA
Cyanide (µg/L)	5-20	10-20	10	40	100	5	10
Turbidity (NTU)	NR	NR	NR	NR	NR	NR	NR
Acute toxicity (TUa)	-	-	-	NA	-	-	-
Chronic toxicity (TUc)	-	-	-	-	-	-	-
Macrocystis pyrifera	-	-	-	-	-	-	NA
Germ tube length	-	-	-	17.86	-	-	NA
Germination	-	-	-	17.86	-	-	NA
Strongylocentrotus purpuratus	-	17.86	-	17.86	-	-	NA
Menidia beryllina	-	-	-	17.86	-	-	1
Arsenic (µg/L)	2-5	1	5	50	2	NR	1
Cadmium (µg/L)	0.5-5	10	2	10	1	4	2
Chromium (µg/L)	5	10	10	50	10	10	10
Copper (µg/L)	5	10	10	50	50	10	10
Lead (µg/L)	2-5	1	2	50	5	10	3
Mercury (µg/L)	0.2-0.5	0.2	0.2	2	1	0.5	0.3
Nickel (µg/L)	40-50	40	10	NA	10	NR	5
Selenium (µg/L)	-	1	NA	NA	5	-	1
Silver (µg/L)	0.5-10	10	10	50	10	4	0.4
Zinc (µg/L)	20	10	20	NR	50	10	10
Phenols	NA	100	NA	NA	NR	-	-
Chlorinated phenols (µg/L)	Unk.	-	-	-	-	10	-
2-Chlorophenol	Unk.	5-10	10	10	1-4	-	NA
2,4-Dichlorophenol	Unk.	5-10	10	10	1-3	-	NA
4-Chloro-3-methylphenol	Unk.	5-20	20	DU	1-3	-	NA
2,4,6-Trichlorophenol	Unk.	5-10	10	DU	1-10	-	1
Pentachlorophenol	Unk.	10-50	50	DU	1-4	-	7
Nonchlorinated phenols (µg/L)	Unk.	-	-	-	-	10	-
Phenol	Unk.	5-10	10	DU	1-2	-	NA
2-Nitrophenol	Unk.	5-10	10	DU	1-4	-	NA
2,4-Dimethylphenol	Unk.	5-10	10	DU	1-3	-	NA
2,4-Dinitrophenol	Unk.	10-50	50	DU	1-50	-	NA
4-Nitrophenol	Unk.	5-50	50	DU	1-3	-	NA
4,6-Dinitro-2-methylphenol	Unk.	5-50	50	DU	1-50	-	NA
Total DDT (µg/L)	-	NA	-	NA	-	0.005-0.01	-
o,p'-DDD	NA	NA	0.2	NA	-	-	0.006
p,p'-DDD	0.02	NA	0.2	NA	0.04	-	0.003
o,p'-DDE	NA	NA	0.2	NA	-	-	0.004
p,p'-DDE	0.02	NA	0.2	NA	0.02	-	0.003
o,p'-DDT	NA	NA	0.2	NA	-	-	0.004
p,p'-DDT	0.02	NA	0.2	NA	0.04	-	0.013
Total PCB (µg/L)	-	NA	-	NA	-	0.1-0.2	-
PCB-1016	0.1	NA	2	NA	0.1	-	0.046
PCB-1221	0.1	NA	2	NA	0.1	-	0.034
PCB-1232	0.1	NA	2	NA	0.1	-	0.033
PCB-1242	0.1	NA	2	NA	0.1	-	0.040
PCB-1248	0.1	NA	2	NA	0.1	-	0.057
PCB-1254	0.1	NA	2	NA	0.1	-	0.025
PCB-1260	0.1	NA	2	NA	0.1	-	0.065
PCB-1262	NA	NA	NA	NA	NA	-	0.060

NR = Not reported in annual report.
NA = Not analyzed.
Unk. = Unknown - not all data was obtained.
DU = Data unavailable.

NTU = Nephelometric turbidity units.
TUa (toxic units acute) = 100/96 hr LC 50 (percent waste giving 50% survival). If greater than 50% survival: TUa= Log (100-percentage survival in 100% waste)/1.7.
TUc (toxic units chronic) = 100/No Observed Effect Level (the maximum percent effluent that causes no observable effect on a test organism).

Avalon	San Clemente Island	AWMA	SERRA	Oceanside	Encina	San Elijo	Escondido
NR	NR	NR	NR	NR	NR	NR	NR
0.10	NR	0.10	NR	0.10	NR	NR	0.10
NR	NR	NR	NR	3	NR	NR	NR
6	NR	NR	5	2.5	NR	NR	1.0
NR	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA
0.1	NR	NR	NR	NR	NR	NR	NR
NA	NA	NA	NA	NA	NA	NA	NA
20	NR	20-50	20	8-20	1	NR	10
NR	NR	NR	NR	NR	NR	NR	NR
-	-	-	-	-	-	0.41-1	-
17.86	-	-	-	31.25-50	NR	-	NR
-	-	-	-	-	-	-	
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
NR	NR	2-3	3	40-70	NR	NR	1-1.2
5	NR	10-20	2-10	1-5	NR	NR	0.13-0.25
10	NR	10-50	10-200	4-10	NR	NR	1
20	NR	10-20	10-20	2-6	NR	NR	NR
50	NR	1-30	1-50	30-70	30	NR	0.6-1
0.2	NR	0.4-0.5	0.5	1	0.2	NR	0.5
40	NR	25-50	25	10-25	NR	NR	NR
4	NA	2-4	4	40	NR	NR	1.5-10
10	NR	10-30	10	5-10	NR	NR	1
50	NR	5	5	4	NR	NR	NR
-	NR	-	-	-	-	-	-
-	-	10-100	50-100	3-20	-	-	10-20
5	NA	-	-	NR	4	NR	NR
5	NA	-	-	NR	3	NR	NR
5	NA	-	-	NR	3	NR	NR
5	NA	10	-	3	3	NR	10
5	NA	-	-	NR	4	NR	NR
-	-	10-260	50-260	3-50		-	20-50
5	NA	-	-	NR	2	NR	NR
5	NA	-	-	NR	4	NR	NR
5	NA	-	-	NR	3	NR	NR
10	NA	50	-	3-50	42	NR	50
5	NA	-	-	NR	3	NR	NR
5	NA	50	-	10-50	24	NR	50
-	-	Unk.	0.040	0.1-0.27	-	-	0.1
NA	NR	-	-	NR	NA	NR	NR
0.02	NR	-	-	NR	0.11	NR	NR
NA	NR	-	-	NR	NA	NR	NR
0.02	NR	-	-	NR	0.04	NR	NR
NA	NR	-	-	NR	NA	NR	NR
0.02	NR	-	-	NR	0.12	NR	NR
-	-	Unk.	1.2	5.2	-	-	0.5
1	NR	-	-	NR	0.65	NR	NR
1	NR	-	-	NR	0.65	NR	NR
1	NR	-	-	NR	0.65	NR	NR
1	NR	-	-	NR	0.65	NR	NR
1	NR	-	-	NR	0.65	NR	NR
1	NR	-	-	NR	0.65	NR	NR
1	NR	-	-	NR	0.65	NR	NR
NA	-	-	-	NR	NA	NR	NR

DISCUSSION

The annual mean constituent concentrations varied considerably among the small wastewater treatment facilities due to the types of wastes treated (domestic and industrial), the 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 an artifact due to the high number of monthly concentrations that were below reporting limits.

TABLE 3. Volume and level of effluent treatment for the small municipal wastewater treatment facilities that discharged to the Southern California Bight in 1995.

Municipal Wastewater Facility	Flow (mgd[a])	Level of Treatment
Goleta	5.2	Primary/Secondary
Santa Barbara	8.1	Secondary
Montecito	1.1	Secondary
Summerland	0.17	Tertiary
Carpinteria	1.5	Secondary
Oxnard	19.5	Secondary
Terminal Island	16.9	Secondary
Avalon	0.67	Secondary
San Clemente Island	0.028	Secondary
AWMA	18.9	Secondary
SERRA	17.9	Secondary
Oceanside	12.9	Secondary
Encina	21.8	Secondary
San Elijo + Escondido	18.4	Secondary
Total	143.1	

See Appendix 1 for complete facility names.
[a]mgd = millions of gallons per day (1 mgd = 3,785,000 L/day).

Reporting limits for the small facilities were usually two times higher than those for the large facilities. The small facilities may now contribute the majority of trace metals besides lead to the SCB, but this determination cannot be made due to the large number of measurements that were nondetectable. For example, if all of the nondetectable concentrations for cadmium were equal in magnitude to the reporting limits, the cadmium contribution from the small facilities would increase from 31 to 62%. Although recommended or required reporting limits may be below discharge permit requirements (and thus in compliance with permit requirements), they complicate the assessment of total and long-term trends of mass emissions and the relative contributions of constituents to the SCB.

Effluent Trends, 1971-1995

The annual volume of effluent discharged from the small municipal wastewater treatment facilities to the SCB increased 107% from 1971 (SCCWRP 1973) to 1995 (Figure 2). During this period, mass emissions of ammonia increased 122% (Table 8). However, mass emissions of oil and grease decreased 89%, BOD decreased 79%, suspended solids decreased 77% (Figures 2 and 3), and cyanide decreased 81% (Table 8). These reductions can be attributed in large part to increased treatment of wastewater. In 1995, all trace metal emissions were less than in 1987; however, all the metals increased during this time span and then subsequently decreased (Figures 4 and 5).

Since 1971, the contribution of the small wastewater treatment facilities to the combined municipal wastewater discharge of the large and small facilities increased from 7 to 11% (Table 9). Between 1987 and 1995, constituent contributions usually increased by a factor of two. Although mass emissions of cyanide and most trace metals have decreased since 1971 and 1987, respectively, their contributions increased in 1995. This trend is due to the higher rate of decrease in mass emissions of trace metals and cyanide at the large facilities compared to the small facilities from 1971 to 1993 (SCCWRP 1995). The greatest increase from 1987 to 1995 was in lead (from 10 to 50%); however, the contribution of lead reached its peak of 72% in 1993.

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SCCWRP see Southern California Coastal Water Research Project.

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APPENDIX 1.

Names of the governing agencies and the small municipal wastewater treatment facilities that discharged to the Southern California Bight in 1995.

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
U.S. 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)

FIGURE 2. Combined effluent flow from the small municipal waste treatment facilities in southern California by year. MGD = millions of gallons per day.

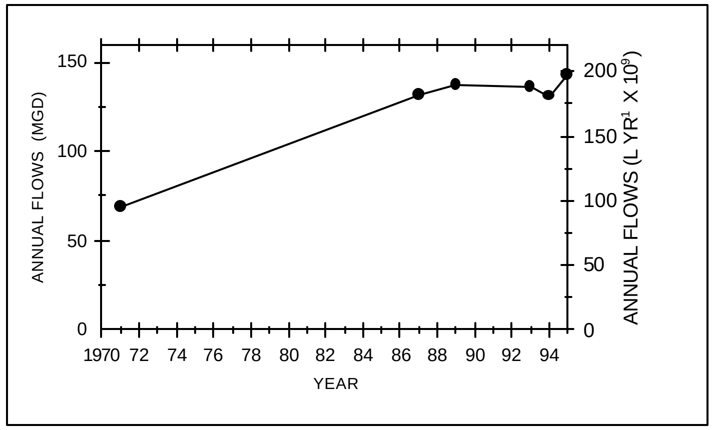


FIGURE 3. Combined mass emissions of biochemical oxygen demand, suspended solids, and oil and grease from the small municipal wastewater treatment facilities in southern California by year.

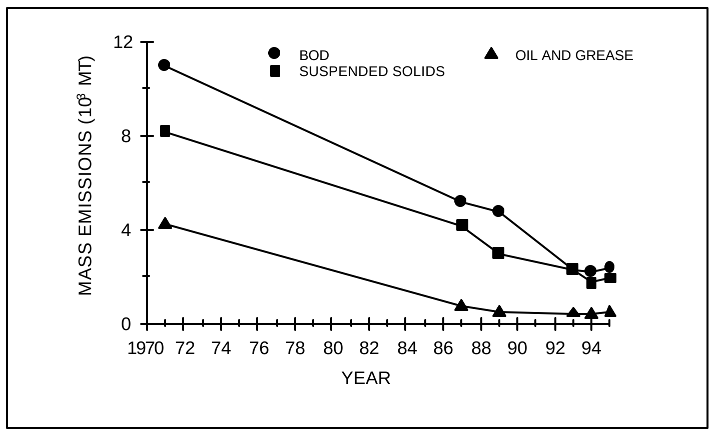


FIGURE 4. Combined mass emissions of zinc, copper, lead, and nickel from the small municipal wastewater treatment facilities in southern California by year.

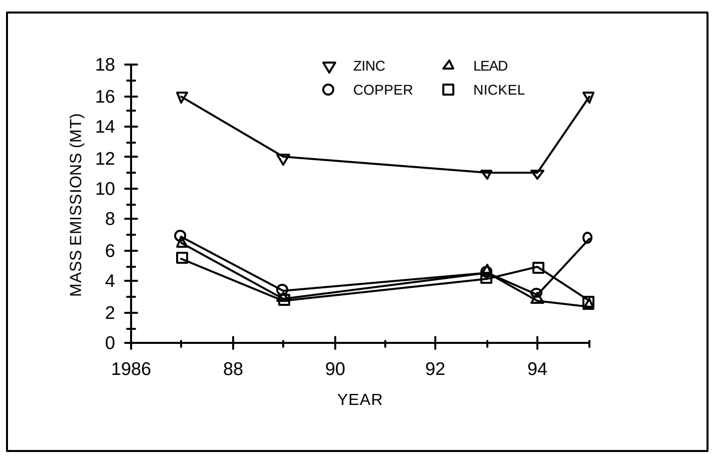


TABLE 4. Percent of detectable monthly constituent measurements in effluent from the small municipal wastewater treatment facilities in southern California in 1995.

Constituent	Goleta	Santa Barbara	Montecito	Summerland	Carpinteria	Oxnard	Terminal Island
Suspended solids	100	100	100	100	100	100	100
Settleable solids	100	58	-	0	100	33	0
BOD	100	100	100	100	100	100	100
Oil and grease	100	100	100	8	100	100	100
Nitrate-N	NA	NA	NA	NA	NA	100	NR
Nitrite-N	NA	NA	NA	NA	NA	100	NA
Ammonia-N	100	100	100	25	100	100	75
Organic N	NA	NA	NA	NA	NA	100	NA
Cyanide	33	0	0	0	0	92	0
Turbidity	100	100	100	100	100	100	100
Acute toxicity	50	75	-	NA	0	58	17
Chronic toxicity	-	-	-	-	-	-	-
Macrocystis pyrifera	-	-	-	-	-	-	NA
Germ tube length	-	-	-	0	-	-	NA
Germination	-	-	-	0	-	-	NA
Strongylocentrotus purpuratus	-	50	-	0	-	-	NA
Menidia beryllina	-	-	-	0	-	-	25
Arsenic	0	100	0	0	50	100	100
Cadmium	0	0	0	0	0	0	0
Chromium	8	0	0	0	0	0	10
Copper	92	100	0	0	0	92	8
Lead	8	100	0	0	0	17	100
Mercury	0	0	0	0	0	33	0
Nickel	8	0	0	NA	0	100	25
Selenium	0	50	NA	NA	0	-	100
Silver	58	0	100	0	0	0	25
Zinc	92	100	100	100	50	10	0
Phenols	-	0	NA	NA	100	-	-
Chlorinated phenols	100	0	0	DU	0	0	0
2-Chlorophenol	NR	0	0	0	0	NR	NA
2,4-Dichlorophenol	NR	0	0	0	0	NR	NA
4-Chloro-3-methylphenol	NR	0	0	DU	0	NR	NA
2,4,6-Trichlorophenol	NR	0	0	DU	0	NR	0
Pentachlorophenol	NR	0	0	DU	0	NR	0
Nonchlorinated phenols	100	0	0	DU	0	8	NA
Phenol	NR	0	0	DU	0	NR	NA
2-Nitrophenol	NR	0	0	DU	0	NR	NA
2,4-Dimethylphenol	NR	0	0	DU	0	NR	NA
2,4-Dinitrophenol	NR	0	0	DU	0	NR	NA
4-Nitrophenol	NR	0	0	DU	0	NR	NA
4,6-Dinitro-2-methylphenol	NR	0	0	DU	0	NR	NA
Total DDT	0	NA	0	NA	0	17	0
o,p'-DDD	NA	NA	0	NA	NA	NR	0
p,p'-DDD	0	NA	0	NA	0	NR	0
o,p'-DDE	NA	NA	0	NA	NA	NR	0
p,p'-DDE	0	NA	0	NA	0	NR	0
o,p'-DDT	NA	NA	0	NA	NA	NR	0
p,p'-DDT	0	NA	0	NA	0	NR	0
Total PCB	0	NA	0	NA	0	0	0
PCB-1016	0	NA	0	NA	0	0	0
PCB-1221	0	NA	0	NA	0	0	0
PCB-1232	0	NA	0	NA	0	0	0
PCB-1242	0	NA	0	NA	0	0	0
PCB1248	0	NA	0	NA	0	0	0
PCB-1254	0	NA	0	NA	0	0	0
PCB-1260	0	NA	0	NA	0	0	0
PCB-1262	NA	NA	NA	NA	NA	-	0

NA = Not analyzed.
NR = Not reported in annual report.
DU = Data unavailable.
Unk. = Unknown - not all data was obtained.

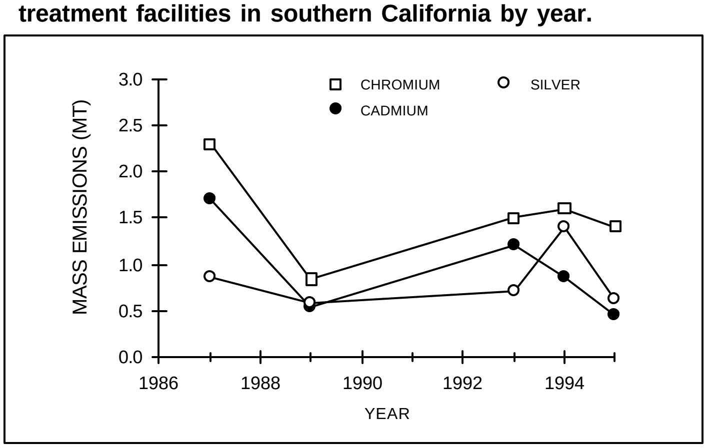
Avalon	San Clemente Island	AWMA	SERRA	Oceanside	Encina	San Elijo	Escondido
100	92	100	100	100	100	100	100
50	0	17	100	25	100	100	0
100	42	100	100	92	100	100	100
50	50	100	50	67	100	75	10
NR	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA
100	100	100	100	100	100	100	100
NA	NA	NA	NA	NA	NA	NA	NA
0	0	0	0	0	50	0	50
100	100	100	100	100	100	100	100
25	-	Unk.	-	100	92	50	50
0	-	Unk.	-	33	100	-	100
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
50	0	0	50	0	100	25	25
0	100	0	0	0	100	25	50
0	0	0	0	25	100	0	75
0	0	33	100	0	100	0	100
0	0	33	50	0	75	100	25
0	0	0	0	0	50	0	0
0	0	0	0	0	100	0	100
0	NA	33	50	0	100	100	50
0	0	0	0	0	100	50	25
100	100	100	100	75	100	100	100
-	0	-	-	-	-	-	-
0	NA	0	0	0	0	0	0
0	NA	-	-	NR	0	NR	NR
0	NA	-	-	NR	0	NR	NR
0	NA	-	-	NR	0	NR	NR
0	NA	0	-	0	0	NR	0
0	NA	-	-	NR	0	NR	NR
0	NA	0	0	0	0	0	0
0	NA	-	-	NR	0	NR	NR
0	NA	-	-	NR	0	NR	NR
0	NA	-	-	NR	0	NR	NR
0	NA	0	-	0	0	NR	0
0	NA	-	-	NR	0	NR	NR
0	NA	0	-	0	0	NR	0
0	0	Unk	0	0	0	0	0
NA	NR	Unk	-	NR	NA	NR	NR
0	NR	Unk	-	NR	0	NR	NR
NA	NR	Unk	-	NR	NA	NR	NR
0	NR	Unk	-	NR	0	NR	NR
NA	NR	Unk	-	NR	NA	NR	NR
0	NR	Unk	-	NR	0	NR	NR
0	0	Unk	0	0	0	0	0
0	NR	Unk	-	NR	0	NR	NR
0	NR	Unk	-	NR	0	NR	NR
0	NR	Unk	-	NR	0	NR	NR
0	NR	Unk	-	NR	0	NR	NR
0	NR	Unk	-	NR	0	NR	NR
0	NR	Unk	-	NR	0	NR	NR
0	NR	Unk	-	NR	0	NR	NR
NA	-	Unk	-	NR	NA	NR	NR

TABLE 5. Means and coefficients of variation of annual constituent concentrations in effluents from small municipal wastewater treatment facilities that discharged to the Southern California Bight in 1995.

Constituent	Goleta[a] Mean	Goleta[a] CV	Santa Barbara[a] Mean	Santa Barbara[a] CV	Montecito[a] Mean	Montecito[a] CV	Summerland[a] Mean	Summerland[a] CV	Carpinteria[a] Mean	Carpinteria[a] CV	Oxnard[a] Mean	Oxnard[a] CV	Terminal Island[a] Mean	Terminal Island[a] CV
Flow (mgd)	5.16	15	8.09	23	1.10	20	0.17	20	1.51	17	19.5	8	16.9	8
Flow (millions of L/day)	19.5	15	30.6	23	4.18	20	0.66	20	5.70	17	73.9	8	64.1	8
Suspended solids (mg/L)	33.6	19	11.8	30	7.6	22	6	27	17	32	6.6	20	6	30
Settleable solids (mL/L)	0.15	27	0.3	129	-	-	nd	-	0.3	71	0.04	148	<0.04[b]	-
BOD (mg/L)	47.1	16	7.8	22	5.2	28	4	74	14	23	15.9	16	3	27
Oil & Grease (mg/L)	7.2	10	2.2	23	3.5	93	0.26	346	2.1	14	2	27	3	23
Nitrate-N (mg/L)	NA	-	NA	-	NA	-	NA	-	NA	-	3.9	87	NR	-
Nitrite-N (mg/L)	NA	-	NA	-	NA	-	NA	-	NA	-	0.9	65	NA	-
Ammonia-N (mg/L)	33.7	12	19.6	35	0.5	27	0.2	186	3	295	15	28	0.3	70
Organic N (mg/L)	NA	-	NA	-	NA	-	NA	-	NA	-	2.2	44	NA	-
Cyanide (µg/L)	9	157	<20[b]	-	<10	-	<40	-	<100	-	36	66	<10	-
Turbidity (NTU)	31	8	5.1	56	1.1	9	1.7	51	4.6	78	2.5	15	2.5	34
Acute toxicity (TUa)	0.4	107	0.82	67	-	-	NA	-	0	-	0.47	99	0.07	234
Chronic toxicity (TUc)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Macrocystis pyrifera	-	-	-	-	-	-	-	-	-	-	-	-	NA	-
Germ tube length	-	-	-	-	-	-	<17.86	-	-	-	-	-	NA	-
Germination	-	-	-	-	-	-	<17.86	-	-	-	-	-	NA	-
Strongylocentrotus purpuratus	-	-	<17.86	-	-	-	<17.86	-	-	-	-	-	NA	-
Menidia beryllina	-	-	-	-	-	-	<17.86	-	-	-	-	-	0.25	181
Arsenic (µg/L)	<5[b]	-	4	101	<5	-	<50	-	1	141	2.7	36	4	38
Cadmium (µg/L)	<5[b]	-	<10	-	<2	-	<10	-	<1	-	<4	-	<2	-
Chromium (µg/L)	0.7	346	<10	-	<10	-	<50	-	<10	-	<10	-	0.4	316
Copper (µg/L)	31	67	15	47	<10	-	<50	-	<50	-	13.1	36	0.8	346
Lead (µg/L)	0.5	346	3	47	<2	-	<50	-	<5	-	3.22	245	<3	-
Mercury (µg/L)	<0.5	-	<0.2	-	<0.2	-	<2	-	<1	-	0.22	153	<0.3[b]	-
Nickel (µg/L)	4	346	<40	-	<10	-	NA	-	<10	-	26.8	31	2	200
Selenium (µg/L)	nd	-	0.5	141	NA	-	NA	-	<5	-	-	-	14	64
Silver (µg/L)	0.4	97	<10	-	20	-	<50	-	<10	-	<4	-	0.04[e]	190
Zinc (µg/L)	41	49	60	-	30	-	30	-	<50	-	53.1	210	47	23
Phenols (µg/L)	-	-	<100	-	-	-	-	-	16	-	-	-	-	-
Chlorinated	14	40	<50[b]	-	<50[b]	-	-	-	<50[b]	-	<10	-	<7	-
Nonchlorinated	20	-	<50[b]	-	<50[b]	-	-	-	<50[b]	-	0.8	346	-	-
DDT (µg/L)	<0.02	-	-	-	<0.2	-	NA	-	<0.1	-	0.01	253	<13	-
PCB (µg/L)	<0.1	-	-	-	<2	-	NA	-	<0.5	-	<0.2[b]	-	<0.06	-

[a]The number of significant figures are those reported by the agencies. See Appendix 1 for complete facility names.
[b]Maximum of the range of detection limits reported.
nd = Not detected.
NA = Not analyzed.
NR = Not reported in annual report.
Dash = Not applicable, or data not found.

FIGURE 5. Combined mass emissions of chromium, cadmium, and silver from the small municipal wastewater treatment facilities in southern California by year.



Avalon[a]		San Clemente Island[a]		AWMA[a]		SERRA[a]		Oceanside[a]		Encina[a]		San Elijo[a]		Escondido[a]	
Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
0.67	22	0.028	21	18.9	10	17.9	7	12.9	7	21.8	10	3.07	4	15.3	5
2.52	22	0.107	21	71.5	10	67.9	7	49.0	7	82.6	10	11.6	4	57.9	5
19	15	4	83	9.7	18	13.3	49	7.8	40	7.4	14	9.4	18	7.7	30
0.07	117	nd	-	0.08	245	0.2	21	0.2	240	0.06	30	0.2	43	<0.1	-
2	30	8	134	5.8	13	5.9	10	4.1	53	28	10	6.7	9	7.2	19
4.9	127	0.8	272	5.1	8	1.4	113	2.0	77	0.7	70	0.7	66	0.8	128
51	33	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.0	95	0.13	-	14.2	14	27	30	22.0	10	24.2	13	20	36	23.1	13
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<20	-	nd	-	<50[b]	-	<20	-	<20	-	1.3	120	nd	-	20	141
3.4	39	1.1	57	3.7	12	4.5	53	4.3	30	4.3	12	4	17	3.1	23
0.15	200	-	-	-	-	-	-	1.02	19	0.76	48	<1	-	0.42	113
-	-	-	-	-	-	-	-	33.3	245	20.63	56	-	-	20.23	88
<17.86	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	141	nd	-	<3[b]	-	2	118	<70[b]	-	4	20	0.8	200	0.33	200
<5[b]	-	10	-	<20[b]	-	<10[b]	-	<5[b]	-	14	19	3	200	0.4	122
<10	-	nd	-	<50[b]	-	<200[b]	-	2	200	42	52	nd	-	2	67
<20	-	nd	-	7	173	85	169	<6[b]	-	118	35	nd	-	11	63
<50[b]	-	nd	-	1	173	3	137	<70[b]	-	68	86	28	62	0.73	200
<1[b]	-	nd	-	<0.5[b]	-	<0.5	-	<1	-	<0.2	-	nd	-	<0.5	-
<40	-	nd	-	<50[b]	-	<25	-	<25	-	59	31	nd	-	8	52
<5[b]	-	-	-	2	173	9.5	141	<40	-	5	13	3	115	0.95	120
<10	-	nd	-	<30[b]	-	<10	-	<10[b]	-	18	39	5	20	2	200
84	-	40	-	25	54	93	49	11	75	234	51	48	20	75	35
-	-	nd	-	-	-	-	-	-	-	-	-	-	-	-	-
<20[b]	-	-	-	<100[b]	-	<100[b]	-	<20[b]	-	<4	-	nd	-	<20	-
<20[b]	-	-	-	<260[b]	-	<260[b]	-	<50	-	<42	-	nd	-	<20	-
<10[b]	-	nd	-	-	-	<0.04	-	<0.27	-	<5.6	-	nd	-	<0.1	-
<50[b]	-	nd	-	-	-	<1.2	-	<5.2	-	<0.65	-	nd	-	<0.5	-

TABLE 6. Estimates of constituent mass emissions from small municipal wastewater treatment facilities that discharged to the Southern California Bight in 1995.

Constituent	Goleta	Santa Barbara	Montecito	Summerland	Carpinteria	Oxnard	Terminal Island	Avalon	San Clemente Island
Flow [a] (L x 10^9/ yr)	7.1	11	1.5	0.24	2.1	27	23	0.92	0.04
Suspended solids (mt)	245	137	12	1.4	36	179	146	17	0.14
BOD (mt)	342	89	8.2	0.95	30	430	69	1.7	0.33
Oil and Grease (mt)	51	24	5.6	0.04	4.4	52	77	4.4	0.03
Nitrate-N (mt)	-	-	-	-	-	106	-	46	-
Nitrite-N (mt)	-	-	-	-	-	24	-	-	-
Ammonia-N (mt)	242	209	0.83	0.04	7.9	409	6.7	0.98	0.005
Organic N (mt)	-	-	-	-	-	59	-	-	-
Cyanide (kg)	64	-	-	-	-	975	-	-	-
Arsenic (kg)	-	40	-	-	2.1	74	88	3.8	-
Cadmium (kg)	-	-	-	-	-	-	-	-	0.39
Chromium (kg)	4.4	-	-	-	-	-	9.4	-	-
Copper (kg)	230	170	-	-	-	360	20	-	-
Lead (kg)	4.6	33	-	-	-	94	-	-	-
Mercury (kg)	-	-	-	-	-	6.1	-	-	-
Nickel (kg)	27	-	-	-	-	720	42	-	-
Selenum (kg)	-	5.8	-	-	-	-	319	-	-
Silver (kg)	2.9	-	30	-	-	-	1.1	-	-
Zinc (kg)	299	671	46	6.6	61	1,457	1,108	78	1.6
Phenols (kg)	-	-	-	-	33	-	-	-	-
Chlorinated	100	-	-	-	-	-	-	-	-
Nonchlorinated	143	-	-	-	-	23	-	-	-
DDT (kg)	-	-	-	-	-	0.3	-	-	-
PCB (kg)	-	-	-	-	-	-	-	-	-

Dash = Constituent was below detection limits, not analyzed, or data was not found.
[a]Annual flow volumes are the sum of the mean daily flow per month times the number of days in each month.

TABLE 7. 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 1995.

	Mass Emissions			Percent of Total	
Constituent	Large[a]	Small[b]	Total	Large	Small
Flow (mgd)	1,106	143	1,249	89	11
Suspended solids (mt)	73,463	1,924	75,387	97	3
BOD (mt)	137,999	2,364	140,363	98	2
Oil and grease (mt)	19,198	463	19,661	98	2
Ammonia-N (mt)	41,337	3,559	44,896	92	8
Cyanide (mt)	6.5	1.5	8.0	81	19
Arsenic (mt)	5.0	0.38	5.38	93	7
Cadmium (mt)	0.98	0.45	1.43	69	31
Chromium (mt)	7.0	1.4	8.4	83	17
Copper (mt)	53	6.8	59.8	89	11
Lead (mt)	2.4	2.4	4.8	50	50
Mercury (mt)	0.02	0.01	0.03	67	33
Nickel (mt)	30	2.7	32.7	92	8
Silver (mt)	5.4	0.63	6.03	90	10
Zinc (mt)	86	16	102	84	16
DDT (kg)	3.1	0.3	3.4	91	9
PCB (kg)	nd	nd	0	-	-

[a]Hyperion Treatment Plant (City of Los Angeles), Joint Water Pollution Control Plant (County Sanitation Districts of Los Angeles County), Wastewater Treatment Plants 1 and 2 (County Sanitation Districts of Orange County), and Point Loma Wastewater Treatment Plant (City of San Diego).
[b]Facililites covered in this report.
nd = Not detected.

	AWMA	SERRA	Oceanside	Encina	San Elijo	Escondido	Total
	26	25	18	30	4.2	21	197
	255	332	136	223	40	164	1,924
	151	147	72	842	28	153	2,364
	134	34	36	19	3.1	18	463
	-	-	-	-	-	-	152
	-	-	-	-	-	-	24
	369	659	393	727	86	489	3,599
	-	-	-	-	-	-	59
	-	-	-	37	-	426	1,502
	-	44	-	120	3.1	6.8	382
	-	-	-	432	11	8.3	452
	-	61	36	1,257	-	32	1,400
	175	2,076	-	3,513	-	233	6,777
	35	67	-	2,016	116	16	2,382
	-	-	-	5.1	-	-	11
	-	-	-	1,765	-	158	2,712
	52	236	-	135	13	20	781
	-	-	-	533	21	38	626
	653	2,285	197	7,190	202	1,589	15,844
	-	-	-	-	-	-	33
	-	-	-	-	-	-	100
	-	-	-	-	-	-	166
	-	-	-	-	-	-	0.3
	-	-	-	-	-	-	0

TABLE 8. Combined estimate of mass emissions of constituents from the 15 small (<25 mgd) municipal wastewater treatment facilities that discharged to the Southern California Bight from 1971 to 1995.

	Mass Emissions						Percent Change		
Constituent	1971[a]	1987[b]	1989[c]	1993[d]	1994[e]	1995	1971-1995	1987-1995	1994-1995
Flow (mgd)	69	132	137	135	131	143	107	8	9
Suspended solids (mt)	8,200	4,193	2,984	2,297	1,737	1,924	-77	-54	11
BOD (mt)	11,000	5,178	4,751	2,285	2,207	2,364	-79	-54	7
Oil and grease (mt)	4,200	708	460	425	377	463	-89	-35	23
Ammonia-N (mt)	1,600	1,757	2,716	3,668	3,118	3,559	122	103	14
Cyanide (mt)	8	1.7	0.67	3.6	2.2	1.5	-81	-12	-32
Arsenic (mt)	-	0.43	0.84	0.32	0.44	0.38	-	-12	-14
Cadmium (mt)	-	1.7	0.53	1.2	0.87	0.45	-	-74	-48
Chromium (mt)	-	2.3	0.84	1.5	1.6	1.4	-	-39	-13
Copper (mt)	-	6.9	3.4	4.5	3.2	6.8	-	-1	113
Lead (mt)	-	6.5	2.9	4.6	2.8	2.4	-	-63	-14
Mercury (mt)	-	0.18	0.23	0.01	0.008	0.01	-	-94	25
Nickel (mt)	-	5.5	2.8	4.2	4.9	2.7	-	-51	-45
Silver (mt)	-	0.87	0.58	0.71	1.4	0.63	-	-28	-55
Zinc (mt)	-	16	12	11	11	16	-	0	45
DDT (kg)	-	nd	nd	0.91	0.07	0.3	-	-	329
PCB (kg)	-	nd	nd	0.09	0.09	nd	-	-	-

[a]SCCWRP (1973).
[b]SCCWRP (1989).
[c]SCCWRP (1990).
[d]SCCWRP (1995).
[e] Raco-Rands (1996).
nd = Not detected.

TABLE 9. Contributions of constituent mass emissions from small municipal wastewater treatment facilities to the combined municipal wastewater discharged to the Southern California Bight for 1971 to 1995.

	Contribution of Small Facilities (% of Total[a])					Difference in Percent Contribution		
Constituent	1971	1987	1993	1994	1995	1971-1995	1987-1995	1994-1995
Flow	7	10	11	11	11	4	1	0
Suspended solids	3	3	3	2	3	0	0	1
BOD	4	3	2	2	2	-2	-1	0
Oil and grease	6	3	2	2	2	-4	-1	0
Ammonia-N	3	4	8	7	8	5	4	1
Cyanide	4	6	20	15	19	15	13	4
Arsenic	-	3	5	9	7	-	4	-2
Cadmium	-	16	67	56	31	-	15	-25
Chromium	-	4	18	19	17	-	13	-2
Copper	-	5	9	6	11	-	6	5
Lead	-	10	72	68	50	-	40	-18
Mercury	-	31	33	21	33	-	2	12
Nickel	-	7	12	15	8	-	1	-7
Silver	-	5	10	20	10	-	5	-10
Zinc	-	6	12	13	16	-	10	3
DDT	-	-	9	1	9	-	-	8
PCB	-	-	-	-	-	-	-	

[a]Total = Combined municipal wastewater from the small and large municipal wastewater treatment facilities.
BOD = Biochemical oxygen demand.