Marine Outfalls: 1987 Inputs from Wastewater Treatment Plants, Power Plants, and Industrial Facilities

In southern California, open coastal outfalls are used to discharge effluent from 16 municipal wastewater facilities, seven open coastal power plants (seven additional power plants discharge into harbors or tidal prisms), and four industrial facilities (Figure 1; Appendix 1). The Southern California Coastal Water Research Project reviewed and estimated the emissions for all these sources (SCCWRP 1973) and determined that emissions from the four largest municipal wastewater facilities discharged over 90% of the outfall contaminant inputs to the Southern California Bight. SCCWRP has continued to summarize annual effluent values for these four facilities and the City of Oxnard Perkins Wastewater Treatment Plant since 1971. Discharge data for 1988 from the four "big" dischargers, the Oxnard plant, and the South East Regional Reclamation Association Water Treatment Plant (SERRA) are listed in the preceding 1988 SCCWRP Annual Report article. This is the first time since 1973 that the 11 "smaller" wastewater dischargers have been re-evaluated by SCCWRP.

In addition to wastewater, outfall discharge data were collected for the 14 electricity-generating power plants and three petroleum processing refineries (industrial dischargers) that discharged into southern California coastal waters in 1987.

Methods

In 1988, Henry Schafer and Karen Englehart collected updated information about marine discharges from the 11 smaller municipal wastewater treatment plants and three petroleum refineries from the 1987 National Pollution Discharge Eliminations System (NPDES) monitoring data that were submitted to regulatory

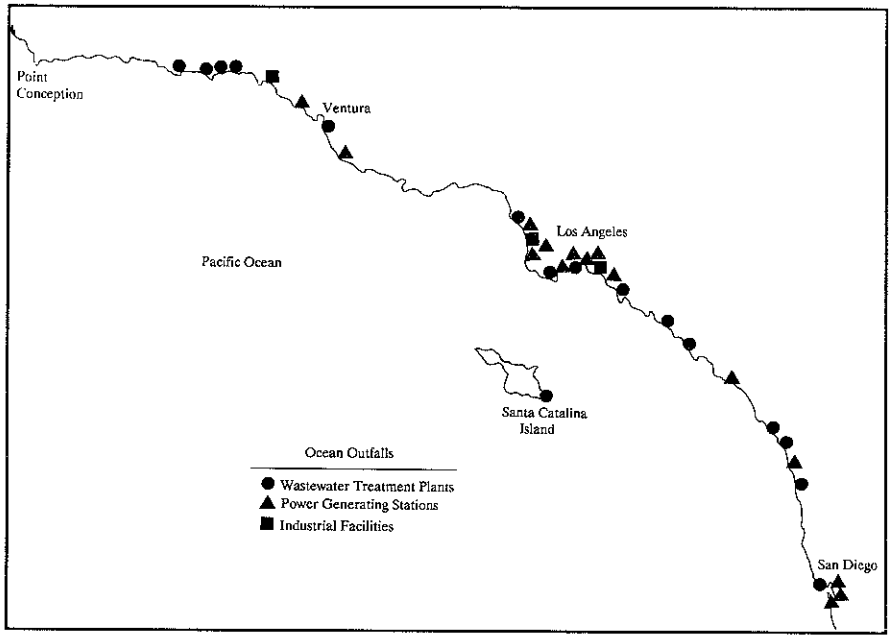


Figure 1. Location of marine outfalls located along the southern California coast.

agencies. Information about 1987 power plant discharges was collected from the records of the power plant operators: Southern California Edison, the Los Angeles City Department to Water and Power, and San Diego Gas and Electric. These data were used to estimate the total 1987 effluent concentrations and mass emissions discharged from municipal wastewater treatment facilities and flows from electric generating plants and petroleum refineries.

Results

A list of southern California marine outfalls and their 1987 flow volumes is presented in Table 1. Municipal wastewater treatment facilities discharged 1,330 million gallons per day (mgd) of treated effluent, power generating plants discharged 7,425 mgd of cooling water, and petroleum refineries discharged 9 mgd of treated process water and refinery wastewater.

Effluent discharge flows and the types of treatment and discharge for each of the 11 smaller wastewater treatment plants in 1987 are presented in Table 2. The combined flow from these facilities was 10% of the total flow from all municipal wastewater treatment plants. Approximately 80% of the effluent discharged by the smaller dischargers received secondary treatment, while only 40% of the flow from the larger plants received secondary treatment. The combined emissions of suspended solids, biological oxygen demand (BOD), and oil and grease comprised only 2% to 3% of the total emissions of the five largest dischargers. Additionally, emis-

Table 1. Southern California marine outfalls, their 1987 flow volumes, and the type of treatment or use.

Facility[a]	Flow (mgd[b])	Treatment (mgd)
Municipal Outfalls		
Goleta	7	Primary
Santa Barbara	9	Secondary
Montecito	1.1	Secondary
Summerland	0.1	Tertiary
Oxnard	18	Secondary
Hyperion	378	Primary/Secondary 100/278
JWPCP	366	Primary/Secondary 200/166
Terminal Island[c]	20	Secondary
Avalon	0.6	Secondary
CSDOC	252	Primary/Secondary 140/112
Aliso	13	Secondary
SERRA	15	Secondary
Encina	20	Primary/Secondary 50/50
Oceanside	9	Secondary
San Elijo	17.	Primary/Secondary 3/14
San Diego	183	Primary
Total	1310	
Power Plants		Use
Mandalay	200	Cooling water
Ormond Beach	583	Cooling water
Scattergood	273	Cooling water
El Segundo	316	Cooling water
Redondo	618	Cooling water
Long Beach[c]	102	Cooling water
Harbor[c]	182	Cooling water
Haynes[c]	910	Cooling water
Los Alamitos[c]	930	Cooling water
Huntington Beach	201	Cooling water
San Onofre	2310	Cooling water
Encina	404	Cooling water
Silver Gate[c]	3	Cooling water
Station "B"[c]	1.5	Cooling water
South Bay[c]	392	Cooling water
Total	7425	
Industrial Outfalls		
Chevron USA, Gaviota	no flow	Process water
Chevron USA, Carpinteria	0.6	Process water
Chevron USA, El Segundo	6.2	Refinery cooling and waste
Shell/Western Huntington Beach	2.5	Process water
Total	9.2	

[a] See Appendix 1 for proper facility names
[b] mgd = million gallons per day
[c] Discharged into harbor or tidal prism

Table 2. Annual mean effluent concentrations for selected wastewater treatment plants in 1987.

Constituents	Wastewater Treatment Plants					
	Goleta[a]	Santa Barbara	Terminal Is	Aliso	Escondido[b]	San Elijo[b]
Flow (mgd)	7	9	20	13	13.7	3
Suspended solids (mg/l)	50	10	15	10	10.9	57
Settleable solids (ml/l)	-	0.1	-	3	0.3	0.4
BOD (mg/l)	60	8	20	5	23.7	116
Oil and Grease (mg/l)	10	10	5	-	1.2	-
NH_3-N (mg/l)	20	16	5	-	13.8	-
Cyanide (μg/l)	20	6	13	19	<12	-
Phenol (μg/l)	-	60	-	--	<13	-
Non-chlorinated	-	-	-	<100	-	-
Chlorinated	-	-	-	<10	-	-
Turbidity NTU	-	3	12	4	3.2	-
Toxicity TU	-	2	0	-	0.56	-
Ag (μg/l)	20	10	3	3	7	<16
As (μg/l)	10	2	5	<0.5	4	2
Cd (μg/l)	20	10	11	6	24	3
Cr (μg/l)	40	10	41	-	19	20
Cr^{+6} (μg/l)	-	-	-	6	-	-
Cu (μg/l)	170	15	20	47	60	55
Hg (μg/l)	1.1	<0.2	0.3	<0.5	<0.4	1
Ni (μg/l)	40	40	50	43	34	18
Pb (μg/l)	140	7	60	70	13	15
Zn (μg/l)	90	70	130	77	193	80
Total DDT (μg/l)	-	<0.1	<.02	ND[c]	ND	-
Total PCB (μg/l)	-	<0.3	<0.1	ND	ND	-

[a] See Appendix 1 for proper plant names and locations.
[b] Escondido (Hale Avenue facility) and San Elijo plants discharge through the San Elijo outfall.

sions of trace metals were about 5% of the larger group's, with the exception of lead which was about 10% of the gross emissions. DDT and PCB concentrations were below the detection limits in all the samples analyzed.

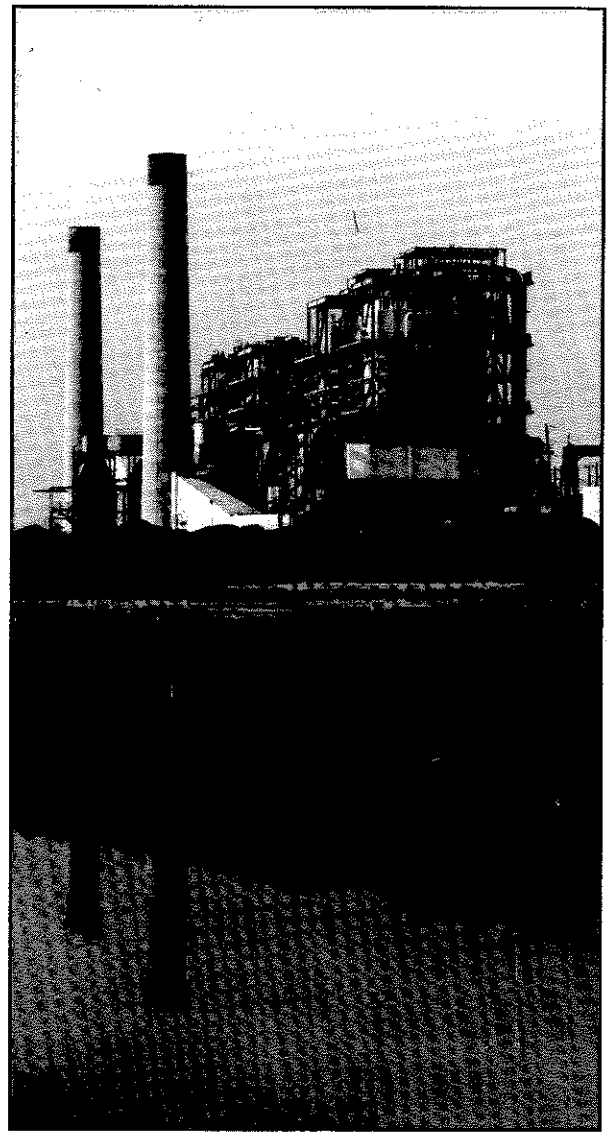
The trace contaminant data summarized in Table 2 must be viewed with some caution because the frequency of effluent analysis for trace contaminants is linked to the sources of sewage and the volume of the discharge of each facility. For instance, the smaller facilities that mainly treat domestic sewage measure trace contaminants in one-day composite samples either quarterly, semi-annually, or annually, which may result in only one to four measurements per year for some contaminants. However, two facilities do monitor trace constituents monthly: Goleta Sanitation District, a primary treatment facility, and the City of Los Angeles Terminal Island Wastewater Treatment Plant, which treats 60% commercial and industrial influent.

The calculated 1987 mass emissions (mean annual flow multiplied by the mean annual concentration) are reported in metric tons (t) and kilograms per year in Table 3.

In 1973 there were 19 municipal facilities with marine outfalls in southern California. At that time, the five largest facilities discharged 984 mgd and 270,000 t of suspended solids, while the other 14 facilities discharged 51 mgd and 7,000 t of solids. By comparison, in 1987, the City of Los Angeles Hyperion Treatment Plant, Los Angeles County Sanitation Joint Water Pollution Control Plant,

Encina	Oceanside	Avalon	Montecito
20	9	1	1.1
52	24	62	7
-	0.5	6.6	-
63	36	28	2.5
7	2	3	3.0
20.7	21	-	<1
1	4	5	<50
-	-	<2700	
-	-	-	-
-	-	-	-
34	12	15	1
1	1	93%sur	1
5	4	22	<100
1	8	<50	<50
8	5	16	<10
<20	6	20	<50
-	-	-	-
40	42	44	<100
<1	<0.5	<2	<2
20	43	120	<100
9	30	280	<50
100	34	74	<100
ND	ND	<50	<.001
-	-	<5	<.003

[c] Not detected.



County Sanitation Districts of Orange County, City of San Diego Point Loma Treatment Plant, and the City of Oxnard Perkins Wastewater Treatment Plant discharged 1,196 mgd (a 22% increase) and 162,000 t of solids (a 40% decrease), while the remaining 11 facilities discharged 123 mgd (a 141% increase) and 3,500 t of solids (a 50% decrease). These disproportionate changes in effluent flow reflect the increasing upstream reclamation carried out by some of the large sanitation systems and the rapid population growth of the smaller coastal cities during this period. The similarities in solids reductions relate to source control and the higher quality of treatment provided by all facilities.

Additional municipal marine outfalls discharge into the Southern California Bight in Mexico. The cities of Tijuana and Ensenada discharge secondary and primary effluent respectively, and a new wastewater treatment plant is being constructed in Rosarito Beach. Only limited monitoring data are available from Mexican dischargers, but current information indicates that effluent flows from Tijuana amount to about 35 mgd and 6,000 t of solids emissions annually. The Ensenada facility discharges about 14 mgd and 5,000 t of solids per year. The expected flow from the Rosarito facility is estimated to be about 6 mgd. Unsewered discharges in channels and streams also contribute substantial runoff into the Mexican portion of the Bight.

The marine outfalls with the largest volume of flow

Table 3. Estimated annual mass emissions for selected wastewater treatment plants in 1987.

Constituents	Wastewater Treatment Plants					
	Goleta[a]	Santa Barbara	Terminal Is	Aliso	Escondido	San Elijo
Annual flow (liters x 10^9)	8	13	28	18	19	4
Suspended solids (t)	410	130	420	170	206	230
BOD (t)	500	100	560	91	450	480
Oil and Grease (t)	83	130	130	0	23	-
NH_3-N (t)	170	210	-	310	260	580
Cyanide (kg)	170	76	360	340	<240	-
Phenol (kg)	-	760	0	0	<250	0
Non-chlorinated	-	-	-	-	-	-
Clorinated	-	-	-	-	-	-
Ag (kg)	170	130	84	54	132	-
As (kg)	83	25	140	-	<20	-
Cd (kg)	170	130	310	110	454	-
Cr (kg)	330	130	1140	-	360	-
Cr^{+6} (kg)	-	-	-	110	-	-
Cu (kg)	1400	190	560	850	1140	-
Hg (kg)	9	<10	8	<9	<8	-
Ni (kg)	330	510	1400	780	640	-
Pb (kg)	1200	89	1700	1300	250	-
Zn (kg)	740	890	3600	1400	3700	-
Total DDT (kg)	-	<1	-	-	ND[b]	-
Total PCB (kg)	-	<3.8	-	-	ND	-

[a] See Appendix 1 for proper facility names and locations.
[b] Not detected.

in southern California belong to the coastal electric generating stations where seawater is used to cool the generators. The resulting heated seawater or "waste heat" is returned to the ocean through these outfalls. Though waste heat, rather than contaminants, is the principal discharge, some metals from equipment decay and chlorine (added to control biofouling) can be found in the emissions. No facilities have been built at new locations since SCCWRP conducted its first survey (SCCWRP 1973), but San Onofre Nuclear Generating Station Units 2 and 3 began commercial operation in 1983 and 1984.

In addition to cooling water, small amounts of liquid wastes produced during operations at the generating stations may be added to the cooling water. Supernate from the process water that is held in retention basins is diluted with the cooling water and discharged; solids are landfilled. Preliminary estimates using data from three stations that use 20% of the total cooling water indicate that combined inputs from all generating stations input 7 mgd of cooling waters. Suspended solids, oil, and grease, ammonia, and methylene blue active substances (MBAS) emission estimates for the combined generating stations are between 0.02% and 0.04%of the wastewater emissions estimates. Metals emissions may be slightly more significant with silver, arsenic, cadmium, chromium, copper, nickel, lead, and zinc constituting 0.1% to 2% of the municipal wastewater discharges.

Heat input from the seven coastal discharging electric generating stations was estimated in 1973 to be equivalent to the solar and atmospheric radiation absorbance of 20 km^2 of surface waters (8 x 10^{16} g-cal/yr). This estimate should expand to about 25 km^2 based on 1987 flow rates (Table 1).

Encina	Oceanside	Avalon	Montecito	Total
27	12	1	1	132
1400	299	49	0.7	3340
1700	445	22	0.3	4360
180	28	3	0.3	580
250	-	-	<0.1	1600
27	49	4	<5	1030
0	0	0	<270	760
-	-	-	-	-
-	-	-	-	-
140	49	17	<10	770
27	99	<40	<5	370
220	62	13	<1	1460
<20	74	16	<5	2050
-	-	-	-	-
1100	517	35	<10	5890
<27	<6	<2	<0.2	17
550	530	95	<5	4830
250	369	222	<10	5270
2700	419	59	<10	13500
-	-	<40	<0.0001	-
-	-	<4	<0.0003	-

Industrial discharges into open coastal waters are limited to petroleum-related processing. The two categories of petroleum-associated discharges are process water (water associated with petroleum-bearing sediments) and refinery cooling and wastewater. Three industrial facilities discharged into the ocean in 1987 (Table 1); the Gaviota Chevron processing facility was not yet in operation.

The total flow of treated process water from all three industrial facilities in 1987 was about 3 mgd, with oil and grease emissions of 40 t. The 1987 discharge total was substantially less than the 1973 discharge of 6 mgd of processed water and 100 t of oil and grease emissions.

The cooling and refinery waste emissions discharged by the Chevron USA El Segundo Refinery were about 6 mgd and 60 t of oil and grease in 1987. These data also indicate a major reduction in emissions from the 72 mgd and 1,290 t of oil and grease from several industrial sources reported in 1973.

Discussion

During the past twenty years, southern California has experienced rapid human population growth, resulting in increasing concern for waste inputs into coastal waters. Increases in municipal effluent flows (up 27% since 1973 with an additional 200 mgd reclaimed upstream) reflect the growing coastal population. Reductions in solids (reduced 40% between 1973 and 1987 and 40% between 1987 and 1988) and their associated contaminants reflect the increasing concern for marine inputs. The improvements in effluent quality have been extensively monitored and documented, and it is hoped that corresponding improvements in the marine environment will be detected in the future.

SCCWRP is continuing its efforts to update and improve estimates of inputs from both monitored point sources and unmonitored nonpoint sources to the Southern California Bight by collecting available monitoring data and conducting studies on inputs that are not presently monitored.

Literature Cited

SCCWRP. 1973. Ecology of the Southern California Bight: Implications for water quality management. Southern California Coastal Water Research Project, Long Beach, CA.

Appendix 1. Proper names of wastewater treatment plants, power plants, industrial facilities, and their ocean outfalls.

Wastewater Treatment Plants and Outfalls

Goleta Sanitary District Wastewater Treatment Plant

City of Santa Barbara El Estero Wastewater Treatment Plant

Montecito Sanitary District

Summerland Sanitary District

City of Oxnard - Perkins Wastewater Treatment Plant

City of Los Angeles - Hyperion Wastewater Treatment Plant

County Sanitation Districts of Los Angeles County - Joint Water Pollution Control Plant

City of Los Angeles - Terminal Island Wastewater Treatment Plant

County Sanitation Districts of Orange County Wastewater Treatment Plants 1 and 2

Aliso Water Management Agency Outfall
- Joint Regional Water Reclamation Facilities
- Coastal Treatment Plant
- Los Alisos Wastewater Treatment Plant
- El Toro Wastewater Treatment Plant

South East Regional Reclamation Authority Outfall (SERRA)
- Jay B. Latham Regional Wastewater Treatment Plant
- City of San Clemente Wastewater Treatment Plant
- Capistrano Beach Wastewater Treatment Plant
- Santa Margarita Water District Wastewater Treatment Plant

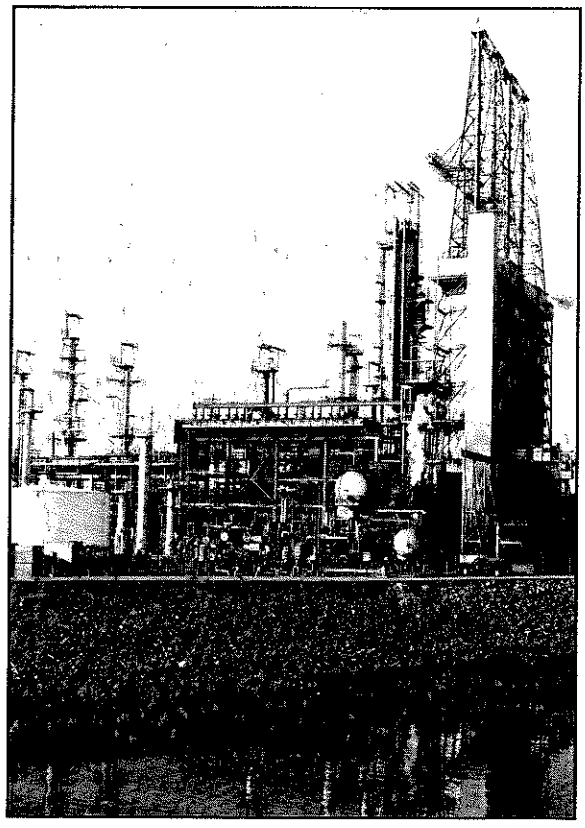
City of Oceanside Outfall
- La Salina Wastewater Treatment Plant
- San Luis Rey Wastewater Treatment Plant

Encina Outfall
- Encina Water Pollution Control Facility
- Meadow Lark Water Reclamation Plant
- Shadow Ridge Water Reclamation Plant
- Gafner Water Reclamation Plant

San Elijo Outfall
- San Elijo Water Pollution Control Facility
- Escondido Hale Avenue Wastewater Treatment Facilities

Point Loma Outfall
- Point Loma Sewage Treatment Plant

City of Avalon Wastewater Treatment Plant Outfall



Power Generating Plants

Mandalay Generating Station (SCE[a])

Ormond Beach Generating Station (SCE)

Scattergood Generating Station (LADWP[b])

El Segundo Generating Station (SCE)

Redondo Generating Station (SCE)

Harbor Generating Station (LADWP)

Long Beach Generating Station (SCE)

Haynes Generating Station (LADWP)

Los Alamitos Generating Station (SCE)

Huntington Beach Generating Station (SCE)

San Onofre Nuclear Generating Station (SCE)

Encina Generating Station (SDGE[c])

Silver Gate Generating Station (SDGE)

Station "B" Power Generating Station (SDGE)

South Bay Generating Station (SDGE)

Industrial Facilities and Outfalls

Chevron USA, Inc. - Gaviota Wastewater Treatment Plant Outfall

Chevron USA, Inc. - Carpinteria Wastewater Treatment Plant Outfall

Chevron USA, Inc. - El Segundo Refinery Wastewater Outfall

Shell/Western E and P, Inc. - Huntington Beach Oil Production Field Outfall

[a] Southern California Edison Company
[b] Los Angeles Department of Water and Power
[c] San Diego Gas and Electric Company