ATTACHMENT 2

NPDES 1998 Receiving Water Monitoring Reports for El Segundo and Scattergood Generating Stations. Los Angeles County, California. Prepared by MBC Applied Environmental Sciences

98-EA-02

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
1998 RECEIVING WATER MONITORING REPORT
EL SEGUNDO AND SCATTERGOOD GENERATING STATIONS
LOS ANGELES COUNTY, CALIFORNIA

1998 Survey

Prepared for:

Los Angeles Department of Water and Power
Southern California Edison Company
and El Segundo Power L.L.C.

Prepared by:

MBC *Applied Environmental Sciences*
3000 Redhill Avenue
Costa Mesa, California 92626

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EXECUTIVE SUMMARY

The 1998 National Pollutant Discharge Elimination System (NPDES) marine monitoring program for the El Segundo and Scattergood Generating Stations was conducted in winter on 10 April and in Summer on 11 August 1998. Impingement studies were also conducted periodically throughout the year. All studies were preformed in accordance with specifications set forth by the California Regional Water Quality Control Board, Los Angeles Region (LARWQCB) in NPDES Permit Nos. CA0001147 for the El Segundo Generating Station and CA0000370 for the Scattergood Generating Station, and as modified in letters from the LARWQCB to Southern California Edison Company (SCE) and the Los Angeles Department of Water and Power (LADWP) dated 21 July 1998.

The El Segundo Generating Station, formerly owned by Southern California Edison Company, was purchased by El Segundo Power L.L.C. on April 4, 1998. SCE will continue to provide operational support under contract to El Segundo Power L.L.C.

The 1998 NPDES monitoring studies included physical and chemical monitoring of the receiving waters and sediments, and biological monitoring of the infaunal and fish and macroinvertebrate assemblages. In accordance with the LARWQCB agreements, only water quality sampling was conducted in the winter and a modified sampling program, including water quality, sediment, and biology sampling, was conducted in summer. Results of the 1998 surveys were compared among stations and with data from past studies to determine if the beneficial uses of the receiving waters continue to be protected.

WATER QUALITY MONITORING

The 1998 water quality measurements indicated that the cooling water discharged from the El Segundo and Scattergood Generating Stations did not have an adverse effect on receiving waters in the study area. During winter, only minor fluctuations of temperature, dissolved oxygen (DO), and pH were detected in the surface and mid-water depths. A cold water mass indicating upwelling was detected near the bottom at the offshore stations. Temperature, DO, and pH values were slightly lower than normal near the bottom, where the cold water mass was detected. During summer, surface temperatures were typically higher than in winter with seasonal stratification apparent throughout the study area. A thermal plume was detected slightly inshore of the discharges during the winter survey. All temperature, DO, and pH values were within the normal ranges for the area and season.

SEDIMENT MONITORING

Sediment Grain Size

Sediments at the four stations sampled in 1998 consisted primarily of sand (average 93%) with a mean grain size of 3.11 phi (very fine sand). Sediments were generally finer and better sorted offshore than nearshore. This pattern is likely attributable to the greater turbulence nearshore. Sediments were finest at nearshore Station B2, upcoast of the Scattergood and El Segundo discharges, and coarest at nearshore Station B3 downcoast of the discharges. Sediment composition and distribution in the study area was primarily affected by natural causes unrelated to the operation of the generating stations. Particle size characteristics were similar to those in most surveys since 1990.

Sediment Chemistry

Sediment concentrations of all metals were highest at nearshore Station B2. Lowest concentrations of chromium, copper, and zinc were detected at nearshore Station B3, while the lowest nickel concentration was measured at offshore Station B7. Highest metal concentrations (which correlate with high concentrations of fines) occurred at Station B2 where higher amounts of silt and clay were found. Sediment metal concentrations in the study area were within the range found in sediments throughout the Southern California Bight and continue to be below levels determined to be potentially toxic to benthic organisms. No adverse effects from the operation of the El Segundo and Scattergood Generating Stations were detected from the 1998 sampling.

BIOLOGICAL MONITORING

Benthic Infauna

The benthic infauna community sampled in 1998 was similar in composition to that of previous years. Species richness averaged 43 species per station, which is below the average from 1990 to 1997. Abundance averaged 402 individuals per station (10,040 individuals/m^2), which is higher than in past surveys. These differences were primarily influenced by the fewer number of stations sampled during this year's survey. Polychaete annelids were the most abundant organisms, followed by Malacostraca arthropods and bivalve mollusks. In general, species richness was greater offshore than nearshore. Abundance was greatest nearshore, due to the predominance of a single species, *Apoprionospio pygmaea*. No pattern in species composition or abundance was attributed to the operation of the El Segundo or Scattergood Generating Stations.

Fish Impingement

There were noticeable differences between the El Segundo and Scattergood Generating Stations in the species of fish and macroinvertebrates impinged in 1998. Due to plant operations, El Segundo conducted fewer heat treatment than Scattergood during 1998, which would likely account for many of these differences. All of the species common to both El Segundo and Scattergood were typical in the offshore habitat. All but one of the species taken in 1998 has been found at both generating stations in the past. That species, a bullseye puffer taken at both El Segundo and Scattergood Generating Stations, was taken previously at Redondo and San Onofre Generating Stations in 1985 following the 1982-1984 El Niño. The occurrence of these species throughout the Southern California Bight, and their continued abundance and high species diversity at both generating stations, indicated that operation of the El Segundo and Scattergood Generating Stations is not having an appreciable adverse effect on the diverse fish and macroinvertebrate populations in the study area.

CONCLUSION

The overall results of the 1998 NPDES monitoring program indicated that operation of the El Segundo and Scattergood Generating Stations had no detectable adverse effects on the beneficial uses of the receiving waters.

INTRODUCTION

This report presents and discusses the results of the 1998 winter and summer 1998 receiving water monitoring studies conducted at the El Segundo and Scattergood Generating Stations (ESGS/SGS). Winter sampling consisted of water quality profiles only, while summer sampling included water quality profiles, biological, sediment chemistry and grain size sampling. All studies were conducted by MBC Applied Environmental Sciences (MBC). All data were analyzed, interpreted, and reported by MBC for Southern California Edison Company (SCE) and El Segundo Power L.L.C.'s El Segundo Generating Station and for the Los Angeles Department of Water and Power's (LADWP) Scattergood Generating Station. Physical oceanographic and biological studies were conducted to determine if the beneficial uses of the receiving water in and around the El Segundo and Scattergood Generating Stations discharges are being protected.

The El Segundo Generating Station, formerly owned by Southern California Edison Company (SCE), was purchased by El Segundo Power L.L.C. on April 4, 1998. SCE will continue to provide operational support under contract to El Segundo Power L.L.C.

The results of the present surveys were compared to those of thermal effect studies done for ESGS in 1971-1972 (Lockheed Aircraft Service Company 1973) and National Pollutant Discharge Elimination System (NPDES) surveys conducted for SGS and ESGS in 1978, 1980, 1986, 1988, and 1990 by Lockheed Center for Marine Research and Intersea Research Corporation (1979), Intersea Research Corporation (1981), and Occidental College, Vantuna Research Group (1987, 1989, 1990), and MBC (1990 - 1997).

Specifications for the studies are described by the California Regional Water Quality Control Board, Los Angeles Region (LARWQCB), in the Monitoring and Reporting Program portion of NPDES Permit Nos. CA0001147 (ESGS) and CA0000370 (SGS), as adopted on 5 December 1994 for ESGS and 27 February 1995 for SGS. Relevant portions of the Permit are presented in Appendix A.

In letters to SCE and LADWP, dated 21 July 1998, the Los Angeles Regional Water Quality Control Board allowed SCE and LADWP to reduce their level of normal receiving water monitoring in exchange for assisting the Southern California Bight 1998 Regional Marine Monitoring Survey (Bight 1998) sampling program by either funding or conducting a portion of the studies. As the funding or assistance given by SCE and LADWP was for sampling water quality, benthic infauna, and trawl caught fish, the LARWQCB agreed that monitoring those portions of their respective permits could be reduced or eliminated for the 1998 monitoring year. Therefore, 1998 winter sampling consisted of water quality monitoring only, while the 1998 summer sampling consisted of a sub-portion of the normal monitoring program for summer as described in the NPDES permits.

DESCRIPTION OF GENERATING STATIONS

El Segundo Generating Station

Southern California Edison's El Segundo Generating Station (ESGS) is located at the western boundary of the City of El Segundo. It consists of four fossil-fuel, steam-electric generating units. Units 1 & 2 are rated at 175 Megawatts (Mw) each and Units 3 & 4 at 335 Mw each. The total station rating is 1,020 Mw; however, the plant operated at only 12.64% of total capacity in 1998 (R. Harnsberger 1998, pers. comm.).

Seawater for cooling is supplied to Units 1 & 2 via a 10-ft (3.0 m) inside diameter (ID) concrete conduit which extends approximately 790 m offshore to a depth of -30 ft Mean Lower Low Water (MLLW). Approximately 144,000 gallons per minute (gpm) are supplied to the units through a screening structure at the plant end of the intake conduit. The screens remove trash, algae, and marine organisms which enter with the cooling water. After passing the screens, the cooling water is pumped to each of two steam condensers, one per turbine. The water temperature is increased

22°F (12.2°C) when the units are operated at full capacity. The heated water is discharged through a 10-ft-ID conduit, which terminates approximately 1,900 ft (500 m) offshore at a water depth of -26 ft MLLW.

The cooling water system for Units 3 & 4 is separate from Units 1 & 2 but is essentially the same. Dimensional differences are: (1) 12-ft (3.6 m) ID intake and discharge conduits, extending 2,600 (-30 ft MLLW) and 2,100 ft (640 m) offshore, respectively; (2) the cooling water flow is 295,000 gpm; and (3) temperature rise across the condensers at full load is 22°F (12.2°C).

During the winter sampling on 10 April 1998, no circulating pumps were operating during any part of the day at Units 1 & 2; however, 168.4 mgd were discharged by two circulating pumps at Units 3 & 4. The ambient temperature was 63.4°F (17.4°C) at the intake depth of both Units 1 & 2 and 3 & 4, and the discharge temperature was 67.5°F (19.7°C), 4.1°F (2.3°C) above ambient at Units 3 & 4. During summer sampling on 11 August 1998, 103.7 mgd were discharged by three circulating pumps at Units 1 & 2 and 389.3 mgd were discharged by four circulating pumps at Units 3 & 4. The discharge temperature was 84.1°F (28.9°C) at Units 1 & 2, 14.1°F (7.8°C) above ambient and it was 87.2°F (30.7°C) at Units 3 & 4, 18.6°F (10.3°C) above ambient (R. Harnsberger 1998, pers. comm.).

Scattergood Generating Station

The Los Angeles Department of Water and Power's Scattergood Generating Station (SGS) is located in the City of Los Angeles at the western boundary of the City of El Segundo, approximately one-half mile north of the El Segundo Generating Station. It is comprised of three fossil-fueled, steam-electric generating units. Units 1 & 2 are rated at 185 Mw each and Unit 3 at 460 Mw. Units 1 & 2 have been on-line since 1958-1959 and Unit 3 since 1974. The total capacity of the plant is 830 Mw; however, the plant operated at only 15% of capacity in 1998 (F. Mofidi 1998, pers. comm.).

Cooling water is drawn from Santa Monica Bay, at a maximum rate of 344,000 gallons per minute (gpm), through a single 12-ft (3.6 m) ID conduit, which extends approximately 500 m offshore. Seawater enters the system through a 17.5-ft (5.3 m) ID vertical riser. The flow is directed horizontally to the inlet conduit through a 32.5-ft (9.9 m) diameter velocity cap which is suspended 5 ft (1.5 m) above the vertical riser. Seawater is drawn from near mid-depth at an elevation of -15 ft MLLW; the seafloor at this location is approximately -30 ft MLLW. Water enters the plant approximately 150 m inland via a walled forebay containing a screen array and pumping chamber. The design temperature increase for Units 1 & 2 is 18°F (10°C); Unit 3 operates at a temperature increase of 14°F (7.8°C).

Cooling water is discharged through a single 12-ft (3.6 m) ID conduit that runs parallel to the intake conduit. The discharge riser is also 17.5 ft (5.3 m) ID and has a lip at -15 ft MLLW. The discharge riser is located approximately 365 m offshore from the mean high tide line. Depth of the seafloor at this location is approximately -27 ft MLLW.

During the winter sampling on 10 April 1998, 181 million gallons daily (mgd) were discharged by six circulating pumps. The discharge temperature was 72°F (22.2°C), 8°F (4.4°C) warmer than the intake temperature of 64°F (17.8°C). On 11 August 1998, eight circulators pumped 436 mgd; the discharge temperature was 92°F (33.3°C), 20°F (11.1°C) above the ambient intake temperature of 72°F (22.2°C) (F. Mofidi 1998, pers. comm.).

DESCRIPTION OF STUDY AREA

Location

The study area is located in Santa Monica Bay between latitudes 33°56'N and 33°52'N; and longitudes 118°25'W and 118°28'W (Figure 1). The Standard Oil Company of California - El Segundo Refinery is located between the two generating stations. The Hyperion Treatment Plant, with its deep-water discharge, is approximately 450 m upcoast of the Scattergood Generating Station. Farther north is Marina del Rey Harbor and the mouth of Ballona Creek. Manhattan Beach Pier and the southernmost set of survey stations are downcoast of both generating stations.

Physiography

The general orientation of the coastline between Point Conception and the Mexican border is from northwest to southeast. The continental margin has been slowly emerging over geological time, resulting in a predominantly cliffed coastline which is broken by plains in the vicinity of Oxnard-Ventura, Los Angeles, and San Diego. Most of the coastal region drains via short streams which flow only during rain storms. However, only a small part of the storm drainage reaches the ocean directly; most is impounded by dams or diverted for other uses.

The eight islands offshore southern California influence water circulation and oceanographic characteristics along the mainland coast. The mainland shelf is narrow along the coast, ranging from less than 1.6 to more than 15 km wide, and averaging approximately 7 km. Seaward of the shelf is an irregular, geologically complex region known as the continental borderland, comprising basins and ridges which extend from near the surface to depths in excess of 2,400 m.

Oceanographic conditions in the study area are largely a function of offshore water masses, but these are modified by local conditions, especially local submarine topography. Santa Monica Bay is characterized by a gently sloping (about 0.5°) continental shelf. At water depths of about 80 m ft the shelf steepens as it approaches Santa Monica Basin (Terry et al. 1956). Within the Bay the continental shelf ranges in width from a few hundred meters to about 19 km, forming a large central plateau which is dissected by submarine canyons.

Santa Monica Submarine Canyon comes to within 11 km of shore offshore at Ballona Creek and the head of Redondo Submarine Canyon comes to within a few hundred meters of King Harbor in Redondo Beach. The shelf is broadest in the vicinity of the study area, where the El Segundo and Scattergood Generating Stations discharge. Submarine canyons often cause anomalies in current direction and velocity; they may also enhance the transport of bottom water and act as migratory corridors for fish and invertebrates. In 1969, the predominant flow in Redondo Submarine Canyon was up-canyon, at an average speed of about 2.5 cm/s (Shepard and Marshall 1973).

Prior to development, the coast between Santa Monica and the Palos Verdes Peninsula consisted primarily of sand dunes, although wetlands were present adjacent to Ballona Creek. At present, about 50% of the shore comprises sandy beaches. Offshore the seafloor is composed largely of unconsolidated sediments which are generally finer with increasing distance from shore. Most nearshore sediments are olive green sands which form an elongate bed off Manhattan Beach and a large patch on the central plateau (Terry et al. 1956). Silty sand is found at mid-depths over much of the central plateau. Clay was a minor sediment constituent in the 1950s, but was more common in the 1970s (Bascom 1978).

Reduced wave intensity in summer allows sand and finer materials to accumulate nearshore; in winter, storms move them offshore to deep water (Grant and Shepard 1939). Nearshore sands typically move parallel to shore by longshore drift and may be transported into the heads of submarine canyons. Sand from the study area is expected to move southward into Redondo

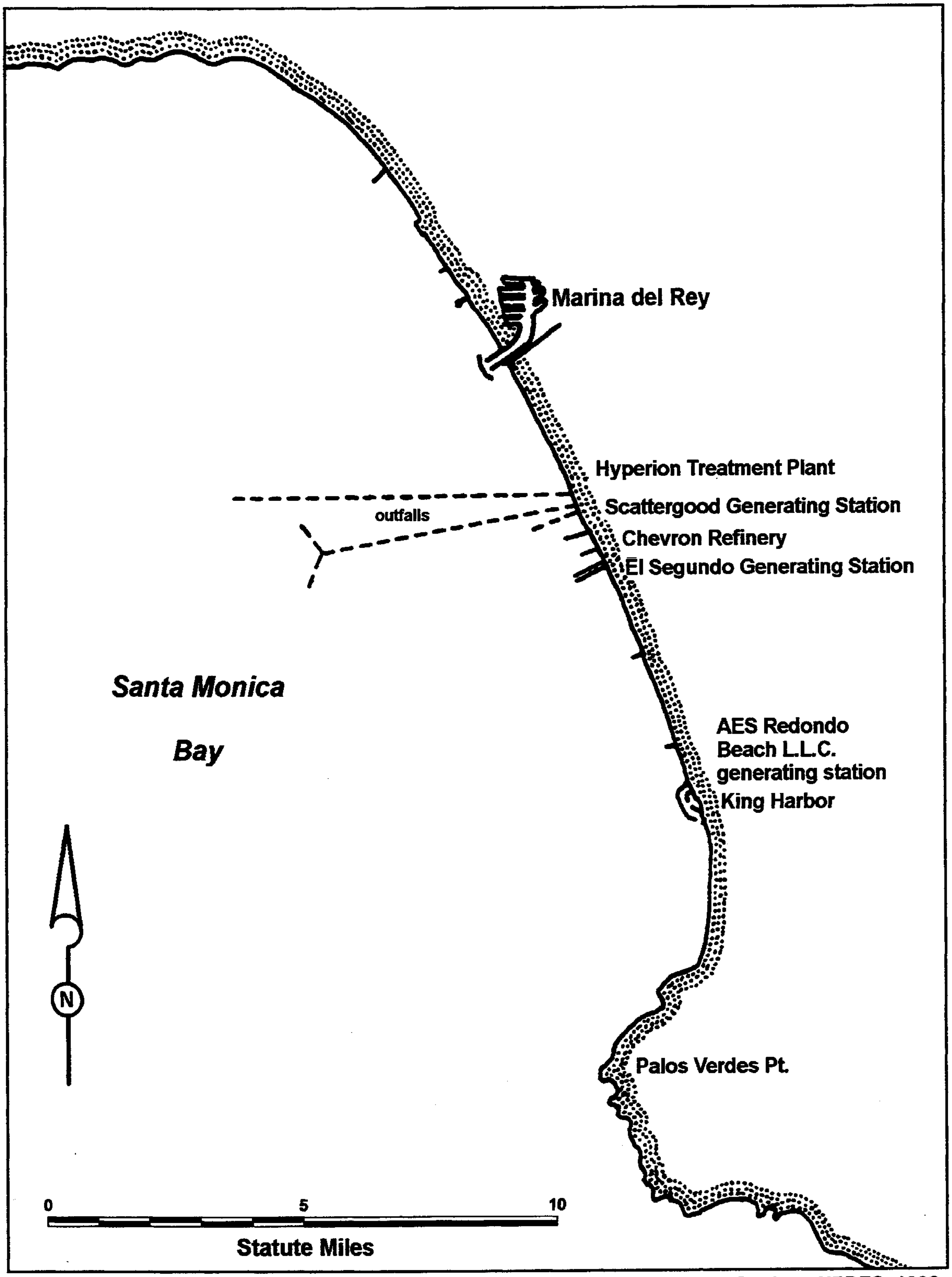


Figure 1. Location of the study area. El Segundo and Scattergood Generating Stations NPDES, 1998.

Submarine Canyon. Dikes, groins, and jetties have been constructed to interfere with littoral drift to aid in sand retention. In addition, beach nourishment, whereby sand is transported to the beach, is practiced. Since the Ballona Creek drainage was channelized in the 1930s, there has been little sediment input from the coastal plain; the major source of sand is now via runoff from the Santa Monica Mountains and the Santa Clara River (MBC 1988). Sediment moves downcoast from the Santa Clara River, around Point Dume, and into the northern portion of Santa Monica Bay during years of high runoff.

Climate

Southern California lies in a climatic regime broadly defined as Mediterranean, which is characterized by short, mild winters and warm, dry summers. Long-term annual precipitation near the coast averages about 46 cm, of which 90% occurs between November and April. Sea breezes are caused by differential heating between land and sea. During the summer, these breezes combine with the prevailing winds that blow out of the northwest to produce strong onshore winds. They typically start around noon and may continue through late afternoon, with speeds reaching 40 km per hour. In late fall and winter, reverse pressure systems frequently develop, causing coastal offshore winds from the southeast from November through February, typically between 1300 and 2000 hrs. Monthly mean air temperatures along the coast range from 8.3°C in winter to 20.6°C in summer, with the minimum dropping slightly below freezing and the maximum rising above 37°C.

Currents

Water in the northern Pacific Ocean is driven eastward by prevailing westerly winds until it impinges on the western coast of North America, where it divides to flow both north and south. The southern component is the California Current, a diffuse and meandering water mass which generally flows to the southeast (Jones 1971). No fixed western boundary to this current is defined; more than 90% of the bulk water transport is within 725 km of the California coast.

South of Point Conception, the California Current diverges; one branch turns northward and flows inshore of the Channel Islands as the Southern California Countercurrent (Jones 1971). Surface speed in the countercurrent ranges from 5 to 10 cm/s. The general flow is complicated by small eddies around the Channel Islands and fluctuates seasonally, being well developed in summer and autumn, and weak or even absent in winter and spring. Generalized surface water circulation off southern California is shown in Figure 2. Currents near the coast are strongly influenced by a combination of wind, tide, and topography. When wind-driven currents are superimposed on the tidal motion, a strong diurnal component is usually apparent. Therefore, short-term observations of currents near the coast may often vary considerably in both direction and speed.

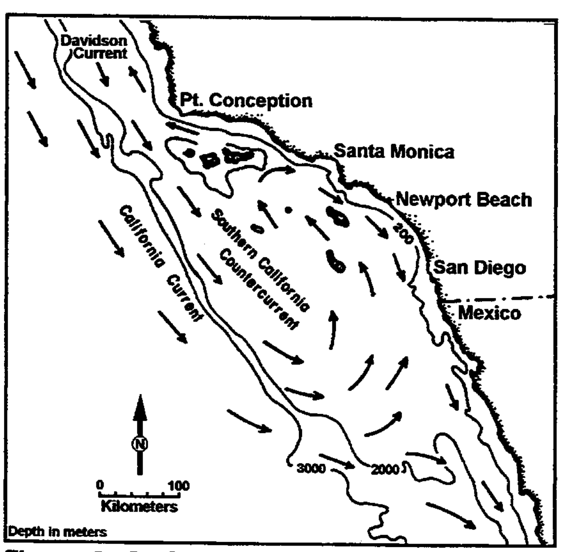


Figure 2. Surface circulation in the Southern California Bight (from Jones 1971). El Segundo and Scattergood Generating Stations NPDES, 1998.

Water generally enters Santa Monica Bay from the south and moves in a slow counterclockwise eddy. However, during winter a clockwise gyre may develop, with longshore flow of 2 cm/s (SCCWRP 1973, Hendricks 1980). Recent studies suggest that the clockwise gyre may be the dominant pattern on the shelf and that it reverses for a few days at a time due to tidal action. Tidal currents in Santa Monica Bay were slowest at the head of Redondo Submarine Canyon and greatest over the central parts of the broad shelf (Allan Hancock Foundation 1965).

Tides

Tides along the California coast are mixed semi-diurnal, with two unequal highs and two unequal lows during each 25-hr period. In the eastern North Pacific Ocean, the tide wave rotates in a counterclockwise direction. As a result, flood tide currents flow upcoast and ebb tide currents flow downcoast.

Upwelling

The predominantly northwesterly winds along the California coast are responsible for large-scale upwelling. From about February to October these winds induce offshore movement of surface water, which is replaced by the upwelling of deeper ocean waters near the coast. The upwelled water is colder, more saline, lower in oxygen, and higher in nutrient concentrations than surface waters. Thus, upwelling not only alters the physical properties of the surface waters, but also affects biological productivity by providing nutrients for the surface phytoplankton.

RECEIVING WATER CHARACTERISTICS

Water quality at El Segundo and Scattergood Generating Stations is affected by hydrology, currents, storm water runoff, industrial discharges, and ship traffic. In addition, climatological parameters such as solar radiation, humidity, and wind influence the condition of the receiving water.

The capacity of the marine environment to assimilate heated effluent depends on its ability to dilute and disperse the thermal discharge. The extent to which these functions are accomplished depends on the quantity and temperature of the thermal effluent relative to normal ocean temperature, ocean current patterns, and dispersion characteristics of the receiving waters. The following discussion focuses on natural ocean temperatures along the southern California coast and in Santa Monica Bay and addresses other physical and chemical oceanographic characteristics that influence the local marine biota.

Temperature

Natural water temperatures fluctuate throughout the year in response to seasonal and diurnal variations in currents, meteorological conditions such as wind, air temperature, relative humidity, and cloud cover, and other parameters such as ocean waves and turbulence. Natural temperature is defined by the California State Water Resources Control Board as "the temperature of the receiving water at locations, depths, and times which represent conditions unaffected by any elevated temperature waste discharge."

On the average natural surface water temperatures may be expected to vary diurnally 1°C to 2°C in summer and 0.3°C to 1°C in winter (EQA/MBC 1973). Factors which contribute to rapid daytime warming of the sea surface include weak winds, clear skies, and warm air temperatures. Conversely, overcast skies, moderate air temperatures, and the mixing of surface waters by winds and waves limit the daily warming. Natural surface water temperatures in Santa Monica Bay range from 11.7°C to 22.2°C annually (EQA/MBC 1973).

When there is a large difference between surface and bottom water temperatures, a steep temperature gradient between adjacent water layers of different temperatures (a thermocline) may develop. Natural thermoclines are formed when absorption of solar radiation elevates the temperature of surface water which then remains separated from the subsurface layer. Artificial thermoclines may result when warm water from a thermal discharge overlies cooler receiving waters. Off southern California, a reasonably sharp natural thermocline normally develops during the summer months; winter thermoclines are weakly defined.

Salinity

Salinity is a measure of the concentration of dissolved salts and is relatively constant in the open ocean. In coastal environments it fluctuates as a result of the introduction of freshwater runoff, direct rainfall, and evaporation. Salinities in Santa Monica Bay are relatively uniform, ranging from 33.0 to 34.0 parts per thousand (ppt) (Allan Hancock Foundation 1965).

Density

Seawater density varies inversely with temperature and directly with salinity. Water temperature is the major factor influencing density stratification in southern California since salinity is relatively uniform. As a result, density gradients are most pronounced in spring and summer. Thermoclines are often present during these parts of the year.

Dissolved Oxygen

Dissolved oxygen (DO) is utilized by aquatic plants and animals for respiration. It is replenished by gaseous exchange with the atmosphere and as a by-product of photosynthesis. Concentrations of DO in the surface waters of Santa Monica Bay range from approximately 5 to 12 mg/l (Allan Hancock Foundation 1965). High DO values can result from increased photosynthetic activity and low values result from the decomposition of organic matter and mixing of surface waters with oxygen-poor subsurface waters.

Hydrogen Ion Concentration

The hydrogen ion concentration (pH) in the Southern California Bight varies narrowly around a mean of approximately 8.0 and decreases slightly with depth. Normal pH values in Santa Monica Bay range between 8.0 and 8.6 (Allan Hancock Foundation 1965).

BENEFICIAL USES OF RECEIVING WATERS

The State Water Resources Control Board (1978) enumerated 10 beneficial uses of coastal and tidal waters in the nearshore zone of the Pacific Ocean. Of these, nine were specifically identified with the El Segundo-Scattergood area:

Industrial Service Supply

Uses which do not depend primarily on water quality such as mining, cooling water, hydraulic conveyance, gravel washing, fire protection, and oil well repressurization.

Water Contact Recreation

Includes all recreational uses involving body contact with water, such as swimming, wading, water skiing, skin diving, surfing, sportfishing, use in therapeutic spas, or other uses where ingestion of the water is reasonably possible.

Non-contact Water Recreation

Recreational uses which involve the presence of water, but do not necessarily require body contact, such as picnicking, sunbathing, hiking, beachcombing, camping, pleasure boating, tidepool and marine life study, hunting, and general aesthetic enjoyment.

Ocean Commercial and Sportfishing

Includes the commercial collection of fish and shellfish, including those collected for bait, plus sportfishing in the ocean, bays, estuaries, and similar non-freshwater areas.

Marine Habitat

Provides for the preservation of the marine ecosystem, including the propagation and sustenance of fish, shellfish, marine mammals, waterfowl, and marine vegetation.

Preservation of Rare and Endangered Species

Provides an aquatic habitat necessary, at least in part, for the survival of certain species established as being rare or endangered.

Navigation

Includes commercial and ocean shipping, and military (naval) operation.

Shellfish Harvesting

The collection of shellfish such as clams, oysters, abalone, shrimp, crab, and lobster for sport or commercial purposes.

Fish Spawning

Provides high quality aquatic habitat especially suitable for fish spawning.

MATERIALS AND METHODS

SCOPE OF THE MONITORING PROGRAM

As specified by the LARWQCB, receiving water monitoring offshore of the El Segundo and Scattergood Generating Stations was conducted during both winter and summer of 1998 by MBC. As referenced in letters to LADWP and SCE from the LARWQCB dated 21 July 1998, portions of the winter and summer oceanographic and biological sampling were deleted from the 1998 sampling program (Appendix A-1 and A-2). The oceanographic and biological sampling was designed to determine if the beneficial uses of the receiving waters described above are being protected.

STATION LOCATIONS

The 1998 monitoring program was conducted by MBC Applied Environmental Sciences (MBC). Water quality sampling was conducted during both winter and summer. Sampling of the physical and biological oceanographic environment was conducted during summer 1998 at the monitoring stations described in Appendix A and shown in Figure 3.

WATER COLUMN MONITORING

Temperature (°C), dissolved oxygen (DO), and hydrogen ion concentration (pH) were measured throughout the water column during the winter and summer surveys. Sampling was conducted on both flood and ebb tides at each of the 12 receiving water monitoring stations (Figure 3). Data were obtained *in situ* using a SeaBird water quality monitoring system, and averaged at 1.0 m intervals. In the field, the data were transferred from the SeaBird to floppy disk for storage. In the laboratory, data were processed using SeaBird proprietary software (SeaSoft ver. 4.35). The resulting information was imported into MS Excel spreadsheets for further reduction and analysis. Temperature and dissolved oxygen profiles were plotted using SigmaPlot (ver. 5.0 software).

SEDIMENT MONITORING

Sediment samples for grain size and metal chemical analyses were collected during the summer survey at four benthic stations (B2, B3, B6 and B7) by biologist-divers. Grain size samples were collected using a 15-cm-long, 3.5-cm-diameter, plastic core tube . Sediment samples were collected at the same time infauna samples were taken, and were transferred to jars or plastic bags for later laboratory analysis.

Sediment Grain Size

The size distributions of sediment particles were determined using two techniques: standard sieving for gravel and sand, and the hydrometer method for the silt-clay fraction. Laboratory data were entered into a computer program which automatically calculates mean grain size, sorting, skewness, and kurtosis, and plots size-distribution curves. Additional details are provided in Appendix B.

Sediment Chemistry

Sediment cores collected for chemical analyses were placed on ice in the field and maintained at approximately 4°C until laboratory procedures began. Sediments were analyzed for total percent solids and four metals: chromium, copper, nickel, and zinc. EPA method 160.3 was used to determine percent solids and EPA method 6010 for metals.

BIOLOGICAL MONITORING

The biological monitoring program consisted of benthic infauna sampling by biologists using diver-operated box corers at four (B2, B3, B6, and B7) stations during the summer survey, and sampling of fish and macroinvertebrate populations from heat treatment impingement operations at the screenwells at the El Segundo Generating Station and at the Scattergood Generating Station.

Benthic Infauna

Infaunal sampling was conducted at the four benthic stations (Figure 3), using a hand-held, diver-operated box corer (Figure 4) which collects a bottom sample of 10 cm x 10 cm x 10 cm for a total sample volume of 1.0 liter. The box corer is pushed into the sediment and a closing blade is swung across the mouth of the box. The core is then withdrawn from the sediment and sealed by a neoprene lid for transport to the surface.

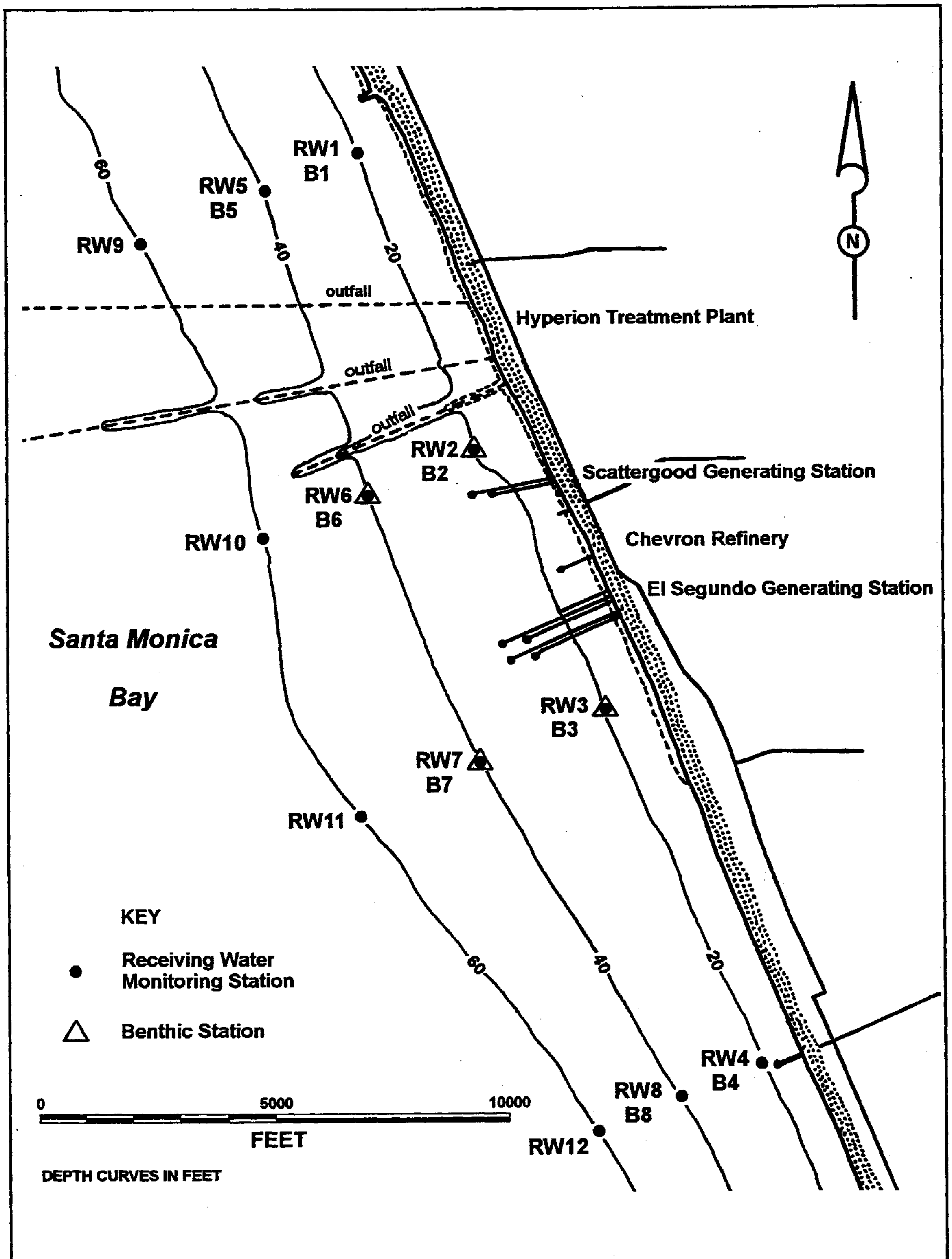


Figure 3. Location of the monitoring stations. El Segundo and Scattergood Generating Stations NPDES, 1998.

Samples were washed in the field using a 0.5 mm stainless-steel mesh screen, labeled, and fixed in buffered 10% Formalin-seawater. In the laboratory, samples were re-screened through a 0.25 mm sieve, transferred to 70% isopropyl alcohol, sorted to major taxonomic groups, identified to the lowest practical taxonomic level, and counted. Representative specimens were added to MBC's reference collection.

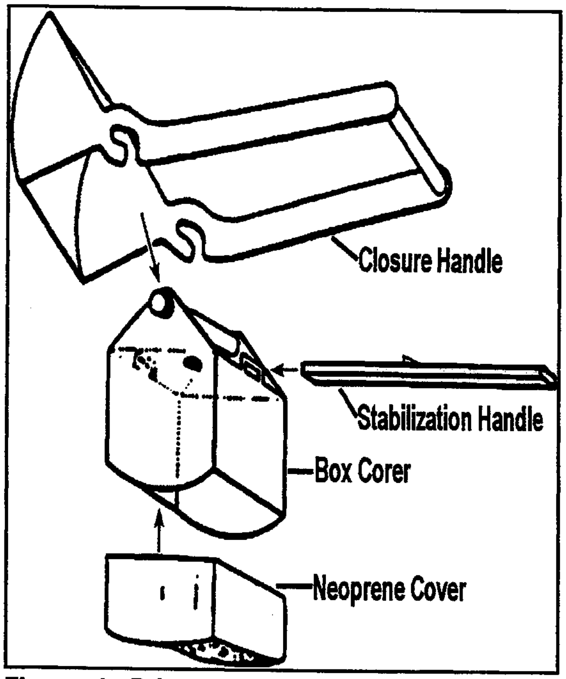


Figure 4. Driver-operated box corer used to collect infaunal samples. El Segundo and Scattergood Generating Stations NPDES, 1998.

Following identification, the weight of organisms in the major taxonomic groups in each replicate was obtained. Specimens were placed on small, pre-weighed mesh screens which had been submersed in 70% isopropyl alcohol, blotted on a paper towel, and air-dried for five minutes. Total wet weight minus screen tare weight provided the wet weight of the organisms. Large organisms were weighed separately.

Fish Impingement

Fish impingement sampling was conducted by MBC biologists during heat treatment operations at ESGS and SGS. A heat treatment is a operational procedure conducted at the generating stations designed to eliminate mussels, barnacles, and other fouling organisms which grow in the intake conduits. Heated effluent water from the discharge conduit is re-entrained via cross-connecting tunnels to the intake conduit until the water temperature rises to slightly over 100°F (37°C). A temperature in excess of 100°F (37°C) is maintained for at least one hour, during which time all barnacles, mussels, other fouling organisms, and incidental fish and invertebrates living within the intake and forebay succumb to the heated water. These are subsequently impinged onto the traveling screens and removed from the forebay.

All fish and macroinvertebrates impinged during heat treatments were separated from incidental debris, sorted to species, identified, and counted. Fish were measured to standard length (mm), and total length (depending on species), and examined for external parasites, anatomical anomalies, and other abnormalities. Aggregate weights were taken by species for both fish and invertebrates.

Unusual specimens and those of uncertain identity were preserved in 10% Formalin-seawater and returned to the laboratory for positive species determination and, if warranted, retention in the MBC collection of voucher specimens.

STATISTICAL ANALYSES

Summary statistics developed from the biological data included the number of individuals (expressed as both number per grab and density), number of species and Shannon-Wiener (Shannon and Weaver 1962) species diversity (H') index.

The diversity equation is as follows:

$$H' = -\sum_{j=1}^{S} \frac{n_j}{N} \ln \frac{n_j}{N}$$ Shannon-Wiener

where: n_j = number of individuals in the j^{th} species
S = total number of species
N = number of individuals

Infauna data were subjected to classification (clustering) analysis using the SYSTAT clustering module (SYSTAT ver. 5.0, Systat, Inc., Evanston, IL). Two classification analyses were performed on abundance and species data sets; in one (normal analysis) the sites are grouped on the basis of the species which occurred in each, and in the other (inverse analysis) the species are grouped according to their distribution among the sites. Each analysis involves three steps. The first is the calculation of an inter-entity distance (dissimilarity) matrix using Euclidean distance (Clifford and Stephenson 1975) as the measure of dissimilarity:

$$D = \left[\sum_{1}^{n} (x_1 - x_2) \right]^{1/2}$$ Clifford and Stephenson

D = Euclidean distance between two entities
x_1 = score for one entity
x_2 = score for other entity
n = number of attributes

The second procedure, referred to as sorting, clusters the entities into a dendrogram based on their dissimilarity. The group average sorting strategy is used in construction of the dendrogram (Boesch 1977). In step three, the dendrograms from both the site and species classifications are combined into a two-way coincidence table. The relative abundance values of each species are replaced by symbols (Smith 1976) and entered into the table. In the event of extreme high abundance of a single species, infauna abundance data are transformed using a natural log transformation [ln(x)].

RESULTS

FIELD OPERATIONS

The 1998 NPDES surveys at El Segundo and Scattergood Generating Stations were conducted on 10 April and 11 and 13 July 1998. Loran C and latitude and longitude coordinates for water quality and benthic stations are given in Table 1.

Water quality data were collected during ebb and flood tides in both winter and summer. Winter flood tide was sampled on 10 April 1998 between 0727 and 0910 hr; ebb tide, between 1019 and 1154 hr (Figure 5). Skies were partly cloudy all day with some late morning clearing. Winds changed from northeast 5 to west 4 kn during sampling. Seas were west 2 to 4 ft throughout the day. Tides ranged from a low of +0.5 ft Mean Lower Low Water (MLLW) at 0335 hr to a high of +4.4 ft MLLW at 0936 hr, and back to a low of +0.4 ft MLLW at 1538 hr. Summer flood tide was sampled on 11 August 1998 between 1053 and 1217 hr, and ebb tide between 1336 and 1458 hr (Figure 6). Seas were southwest 1 to 3 ft, with winds southwest 3 to 8 kn. Skies were clear during sampling. The tide ranged from a low of +0.1 ft MLLW at 0628 hr to a high of +4.9 ft MLLW at 1255 hr, and back to a low of +1.4 ft MLLW at 1850 hr.

Table 1. Loran C and latitude/longitude coordinates of sampling stations. El Segundo and Scattergood Generating Stations NPDES, 1998.

Stations					
Water Quality	Benthic	Loran C	Coordinates	Latitude	Longitude
RW1	-	28176.0	41108.6	33°56.23'	118°26.60'
RW2	B2	28176.4	41102.2	33°55.20'	118°26.14'
RW3	B3	28176.5	41096.7	33°54.27'	118°25.58'
RW4	-	28176.8	41093.3	33°53.67'	118°25.33'
RW5	-	28174.7	41110.1	33°56.19'	118°27.04'
RW6	B6	28175.0	41104.4	33°55.09'	118°26.63'
RW7	B7	28175.0	41098.7	33°54.09'	118°26.10'
RW8	-	28175.5	41095.0	33°53.53'	118°25.84'
RW9	-	28173.3	41111.8	33°56.14'	118°27.64'
RW10	-	28173.2	41106.3	33°54.92'	118°27.11'
RW11	-	28173.4	41100.9	33°53.82'	118°26.64'
RW12	-	28174.1	41097.4	33°53.40'	118°26.21'

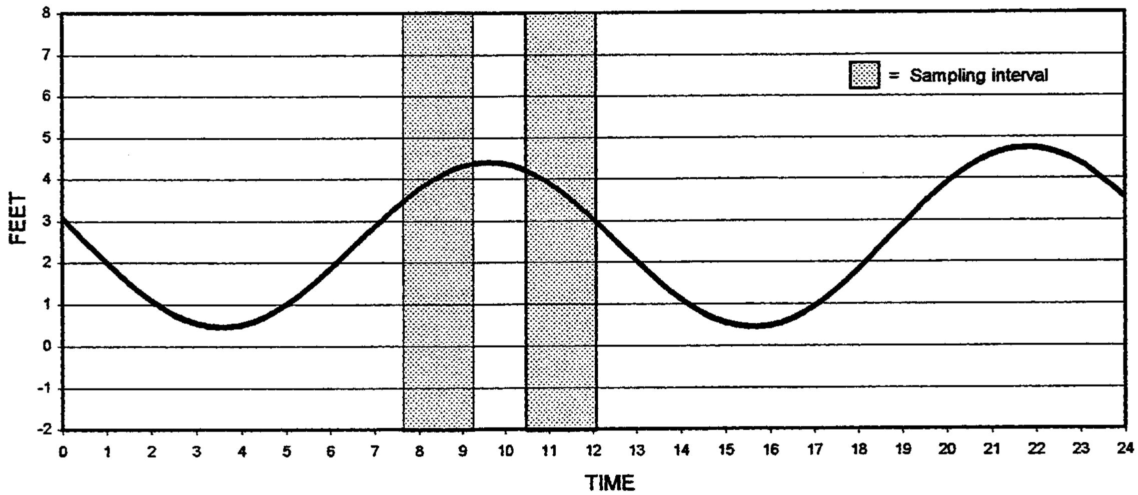
Infauna, grain size and sediment chemistry samples were collected by biologist-divers between 0950 and 1245 hr on 13 August 1998. Seas were from the west at 1 to 2 ft, with west winds 6 to 8 kn. Skies were mostly cloudy in the morning with some clearing by mid-day.

During the winter survey, no oil films, grease, red tide, or turbidity was observed. Drift wood, plastic, and algae were observed throughout the study area. Western gulls (*Larus occidentalis*) were observed at Stations RW6, RW8, RW9, RW11, and RW12, and Heermann's gulls (*Larus heermanni*) were seen at Stations RW4, RW5, and RW6. Surf scoters (*Melanitta perspicillata*) were seen at Stations RW2 and RW3; western grebes (*Aechmophorus occidentalis*) at Stations RW3, RW4, and RW7; and an unidentified tern (*Sterna* sp.) at Station RW6. California sea lions (*Zalophus californianus*) were seen at Stations RW6 and RW10. California brown pelicans (*Pelecanus occidentalis californicus*) were seen at Stations RW2, RW4, RW6, RW8, and RW9. No California least terns (*Sterna antillarum browni*) were observed during any component of the winter survey.

During the summer surveys, no oil films or grease, turbidity, or red tide was observed. Floating plant and terrestrial debris were seen at Station RW3. Heermann's gulls were observed at Stations RW1, RW6, RW9, RW10, and RW11; western gulls were seen at Stations RW4 and RW6; and unidentified gulls at Stations RW8 and B4. A Brandt's cormorant (*Phalacrocorax penicillatus*) was seen at Station RW5; a Caspian tern (*Sterna caspia*) at Station RW2; and unidentified terns (*Sterna* spp.) at Station RW8. A California sea lion was seen at Station B7. California brown pelicans were seen at Stations RW2, RW4, and RW5. No California least terns were observed during any component of the summer survey.

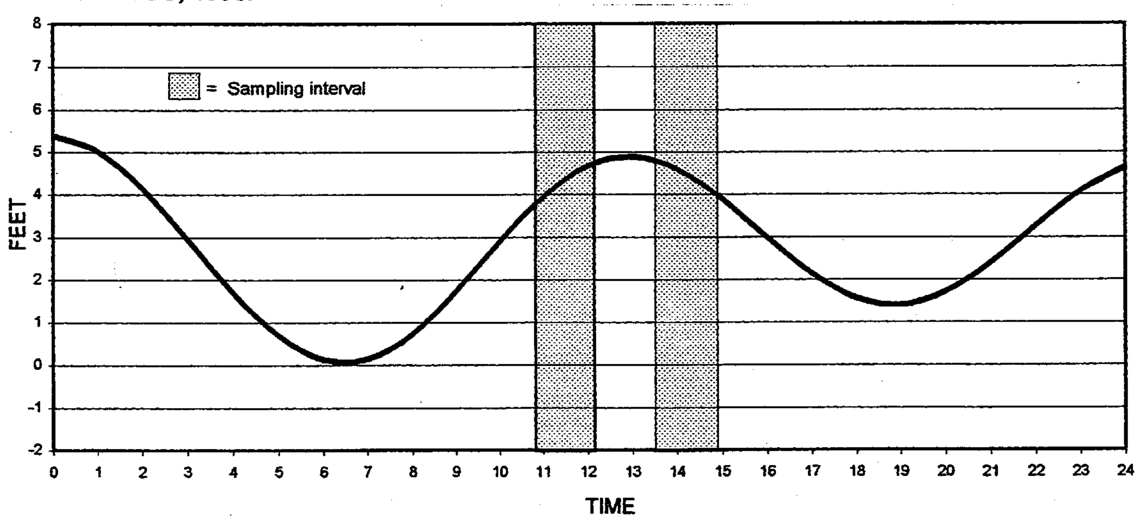
WATER COLUMN MONITORING

Receiving water monitoring stations are shown in Figure 3. Water quality data for ebb and flood tide are provided for each survey in Figures 7 through 12 and are summarized in Table 2. Raw data are presented in Appendix C.



Pacific Daylight Time Friday 10 April 1998				High Water		Low Water	
	Rise	Transit	Set	Time	Height	Time	Height
Sun	0630	1256	1922	0936	4.41	0335	0.46
Moon	1830	-	0603	2149	4.74	1538	0.44

Figure 5. Tidal rhythms during winter water column sampling. El Segundo and Scattergood Generating Stations NPDES, 1998.



Pacific Daylight Time Tuesday 11 August 1998				High Water		Low Water	
	Rise	Transit	Set	Time	Height	Time	Height
Sun	0613	1259	1945	-	-	0628	0.08
Moon	2226	0352	1005	1255	4.89	1850	1.40

Figure 6. Tidal rhythms during summer water column sampling. El Segundo and Scattergood Generating Stations NPDES, 1998.

Table 2. Summary of water quality parameters during ebb and flood tides. El Segundo and Scattergood Generating Stations NPDES, 1998.

	Temp. (°C)		D.O. (mg/l)		pH		Temp. (°C)		D.O. (mg/l)		pH	
						Winter						
	Surface						Bottom					
	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood
Mean	16.49	16.25	8.60	8.50	8.18	8.19	14.02	14.62	6.62	7.02	7.97	8.04
Minimum	16.26	15.91	8.00	8.08	8.12	8.14	12.53	12.64	4.38	4.49	7.82	7.83
Maximum	16.90	16.59	9.12	8.88	8.22	8.22	15.76	16.15	8.68	8.43	8.17	8.21
						Summer						
	Surface						Bottom					
	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood
Mean	22.30	21.74	8.19	8.15	8.15	8.17	17.20	17.19	8.26	8.18	8.05	8.08
Minimum	21.66	20.75	7.84	7.91	8.11	8.13	15.13	15.13	7.92	7.93	8.00	8.02
Maximum	22.83	22.21	8.48	8.41	8.18	8.20	21.97	20.68	8.46	8.47	8.11	8.14

Temperature

In winter, mean surface water temperature during flood tide was 16.25°C; temperatures ranged from 15.91°C at Station RW9 to 16.59°C at Station RW8 (Table 2). Mild to strong temperature gradients were present at all stations on flood tide except Stations RW4, RW5, and RW6. All gradients began below two to three meters (Figure 7). The gradients were most pronounced at the four deeper stations, usually between 10 to 14 meters depth. During ebb tide, mean surface water temperature was 16.49°C; temperatures ranged from 16.26°C at Station RW3 to 16.90°C at Stations RW4 and RW8. Compared to flood tide, temperatures during ebb tide were warmer at the surface and colder at the bottom at most stations. Six stations (Stations RW4, RW6, RW7, RW8, RW11 and RW12) showed sharply colder temperatures in the lower 2 to 8 meters of the water column during ebb tide than during flood tide. The mean bottom temperature during flood tide was 14.62°C and during ebb tide was 14.02°C. Bottom temperatures ranged from 12.64°C at Station RW10 to 16.15°C at Station RW4, and from 12.53°C at Station RW10 to 15.76°C at Station RW2, during flood and ebb tides, respectively. The maximum surface-to-bottom difference recorded was at Station RW10 during both flood tide (3.66°C) and ebb tide (4.01°C). The greatest change per meter of depth occurred between 11 and 14 meters at Station RW10 during both flood tide (0.84°C) and ebb tide (0.83°C).

In summer, mean surface water temperature during flood tide was 21.74°C; temperatures ranged from 20.75°C at Station RW10 to 22.21°C at Station RW12 (Table 2). Mild to strong temperature gradients were present at most stations during flood tide, with the gradients beginning below one to three meters (Figure 8). During ebb tide, mean surface water temperature was 22.30°C; temperatures ranged from 21.66°C at Station RW6 to 22.83°C at Station RW12. Temperature profiles on ebb tide were similar to those seen on flood tide, with slightly warmer water at the surface. Temperatures decreased with depth at all stations, except RW1, which had a slight increase at the bottom. The maximum surface-to-bottom difference recorded was at Station RW12; 7.08°C during flood tide and 7.53°C during ebb tide. The greatest change per meter of depth occurred between 3 and 6 meters at Station RW4 during both flood tide (2.78°C) and ebb tide (2.79°C). The mean bottom temperature during flood tide was 17.19°C and during ebb tide was 17.20°C. Bottom temperature ranged from 15.13°C at Station RW12 to 20.68°C at Station RW1, and from 15.13°C at Station RW11 to 21.97°C at Station RW1, during flood and ebb tides, respectively.

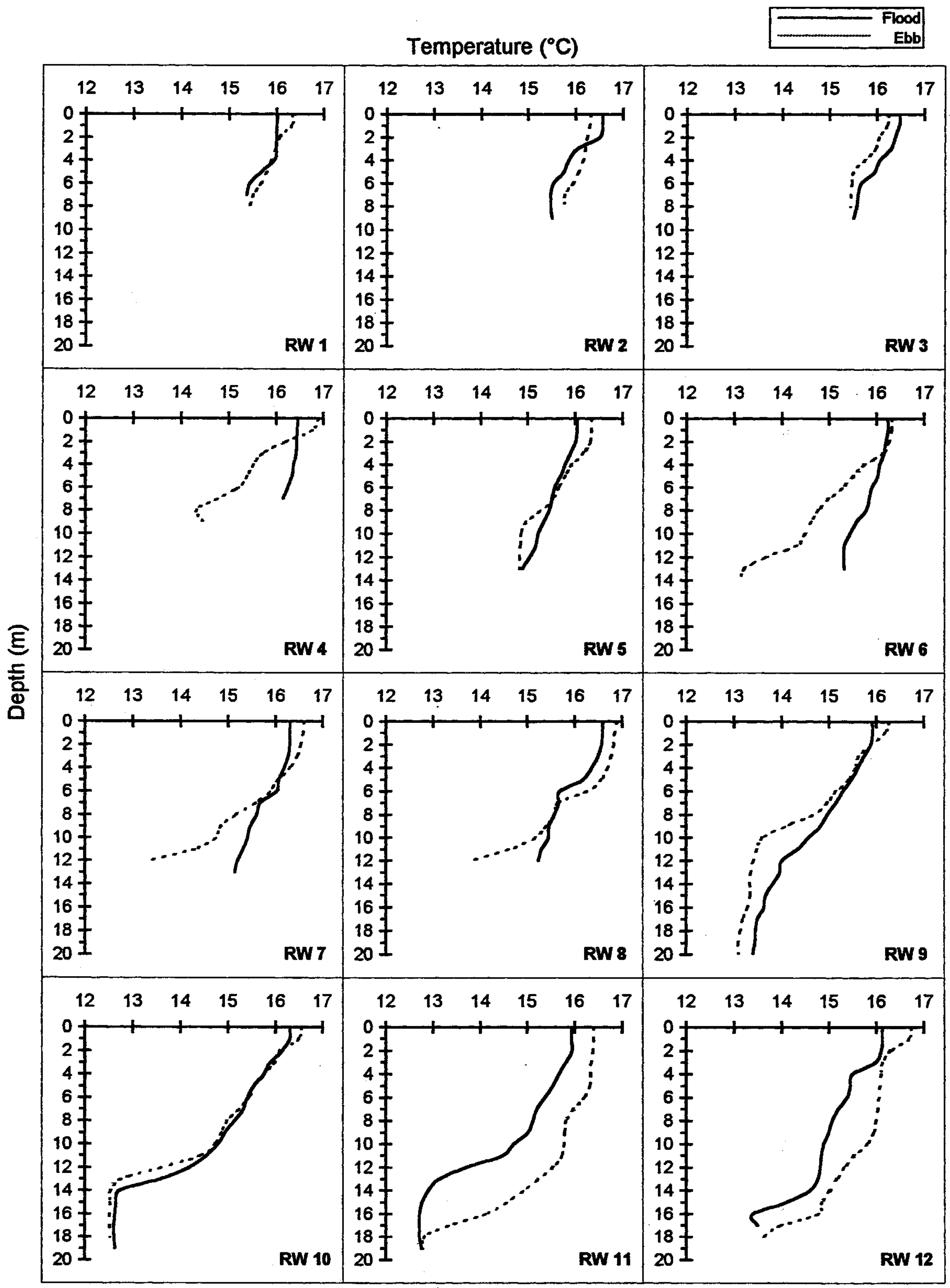


Figure 7. Temperature vertical profiles during flood and ebb tides, winter survey. El Segundo and Scattergood Generating Stations NPDES, 1998.

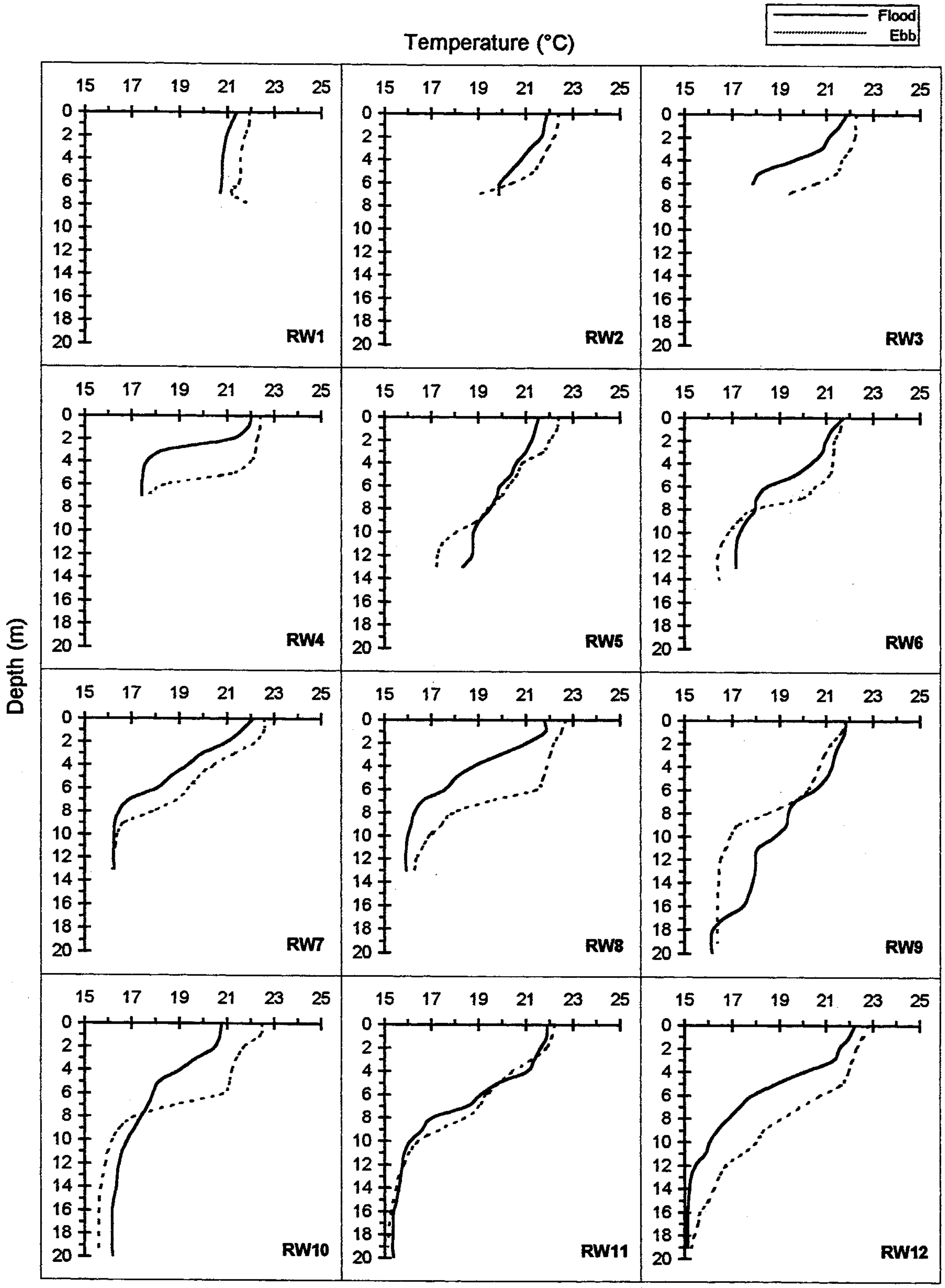


Figure 8. Temperature vertical profiles during flood and ebb tides, summer survey. El Segundo and Scattergood Generating Stations NPDES, 1998.

Dissolved Oxygen

In winter, surface dissolved oxygen (DO) concentrations averaged 8.50 mg/l during flood tide, ranging from 8.08 mg/l at Station RW8 to 8.88 mg/l at Station RW5 (Table 2). During ebb tide, the mean surface DO concentration was 8.60 mg/l; ranging from 8.00 mg/l at Station RW4 to 9.12 mg/l at Station RW9. During flood tide, DO concentrations generally decreased with depth, with a mid-water maximum value between 3 and 7 meters depth (Figure 9). At the four, offshore, deeper stations, there was a sharp decrease in DO below 10 m depth, with an average decrease of 3.18 mg/l from 10 m to the bottom. The mean bottom DO during flood tide was 7.02 mg/l and during ebb tide was 6.62 mg/l. The lowest bottom values both occurred at Station RW10, 4.49 mg/l on flood and 4.38 mg/l on ebb tide. The highest values were 8.43 mg/l at Station RW7, and 8.68 mg/l at Station RW1, on flood and ebb tides, respectively. During ebb tide, DO profiles were similar to those seen during flood tide, except for sharp drops in DO values below 6 to 8 m depth at Stations RW4, RW5, RW6, and RW7. The maximum surface-to-bottom difference was 4.09 mg/l at Station RW11 during ebb tide, and 4.27 mg/l at Station RW10 during flood tide.

In summer, mean surface DO concentrations were 8.15 mg/l during flood tide and 8.19 mg/l during ebb tide. During flood tide, surface DO values ranged from 7.91 mg/l at Station RW2 to 8.41 mg/l at Station RW10. During ebb tide, surface DO ranged from 7.84 mg/l at Station RW3 to 8.48 mg/l at Station RW6 (Table 2). Ebb tide surface DO values were similar to flood tide measurements (Figure 10). During both tides, DO values were highest in the water column, between 2 and 9 m depth, with the greatest change only about 1 mg/l. The average surface to bottom change was 0.33 mg/l and 0.25 mg/l, during flood and ebb tide, respectively. Nearshore and intermediate depth stations generally increased between surface and the bottom on both tides, while the four offshore stations and intermediate depth Station RW6, decreased in value. Nearshore Station RW1 decreased in value to the bottom on ebb tide.

Hydrogen Ion Concentration

In winter, hydrogen ion concentration (pH) at the surface averaged 8.19 during flood tide, fluctuating 0.08 units or less at all stations (Table 2). During ebb tide, mean surface pH was 8.18, with values fluctuating 0.10 units or less at all stations. Values were fairly uniform throughout the water column during flood tide at the nearshore and intermediate depth stations, with the four offshore stations showing a decrease of about 0.3 units below 10 m depth. Profiles of pH during ebb tide were similar to those of flood tide at each station, except at intermediate depth stations where the colder, lower DO, water was present in the afternoon (Figure 11). The maximum surface-to-bottom difference was 0.35 during flood tide at Station RW10, and 0.36 during ebb tide at Station RW9.

In summer, mean surface pH was 8.17 and 8.15 during flood and ebb tide, respectively, with values fluctuating 0.07 or less on each tide (Table 2). At all stations, pH levels were nearly identical with very little change with depth (Figure 12). The maximum surface-to-bottom difference was 0.14 units during both tides; at Station RW12 on flood tide and at Station RW11 on ebb tide.

SEDIMENT MONITORING

Sediment Grain Size

Particle size distribution curves for each station are presented in Appendix D and sediment grain size parameters are summarized in Table 3. Grain size is expressed in phi (ϕ) units, which are inversely related to grain diameter in millimeters (mm).

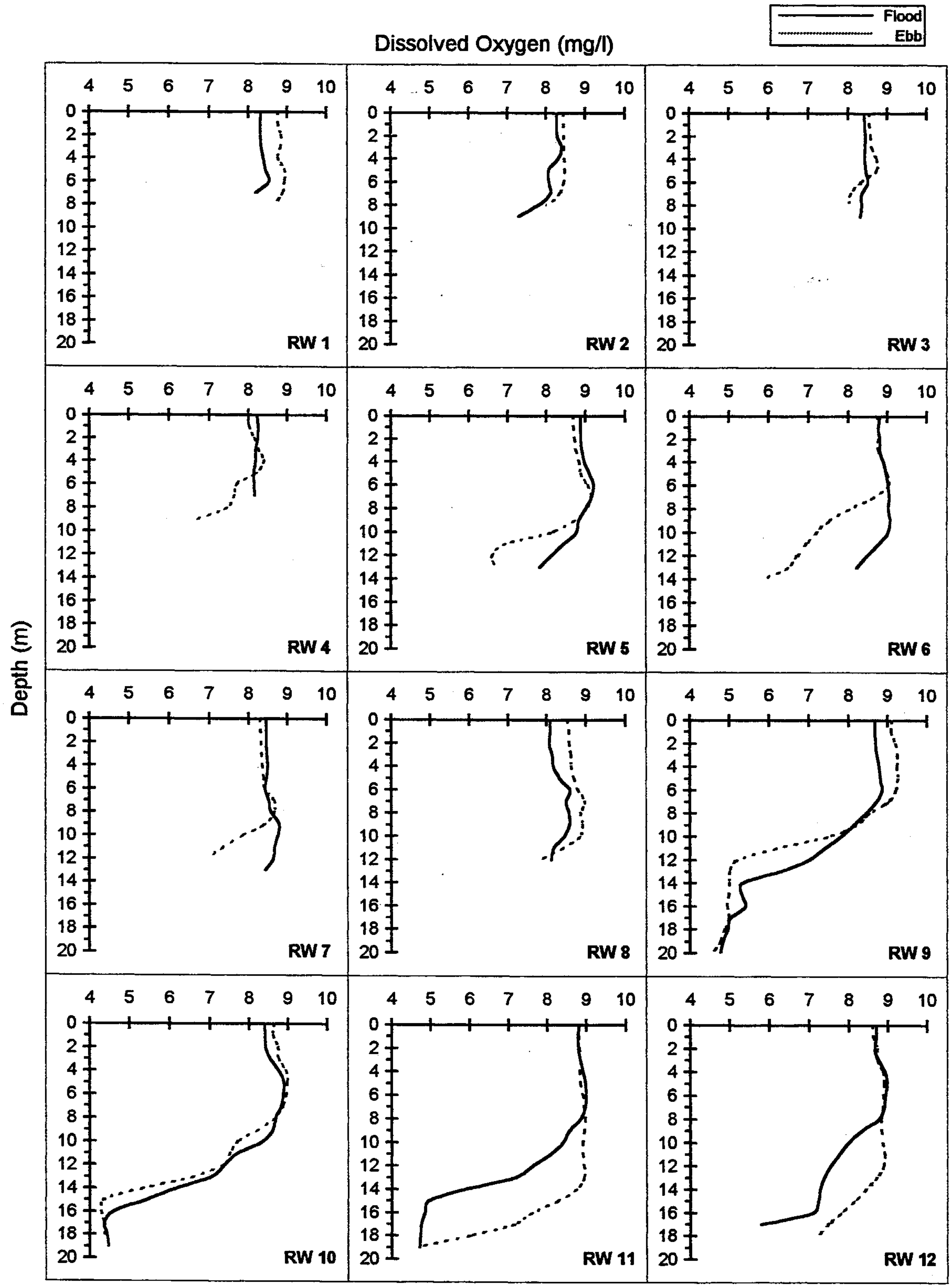


Figure 9. Dissolved oxygen vertical profiles during flood and ebb tides, winter survey. El Segundo and Scattergood Generating Stations NPDES, 1998.

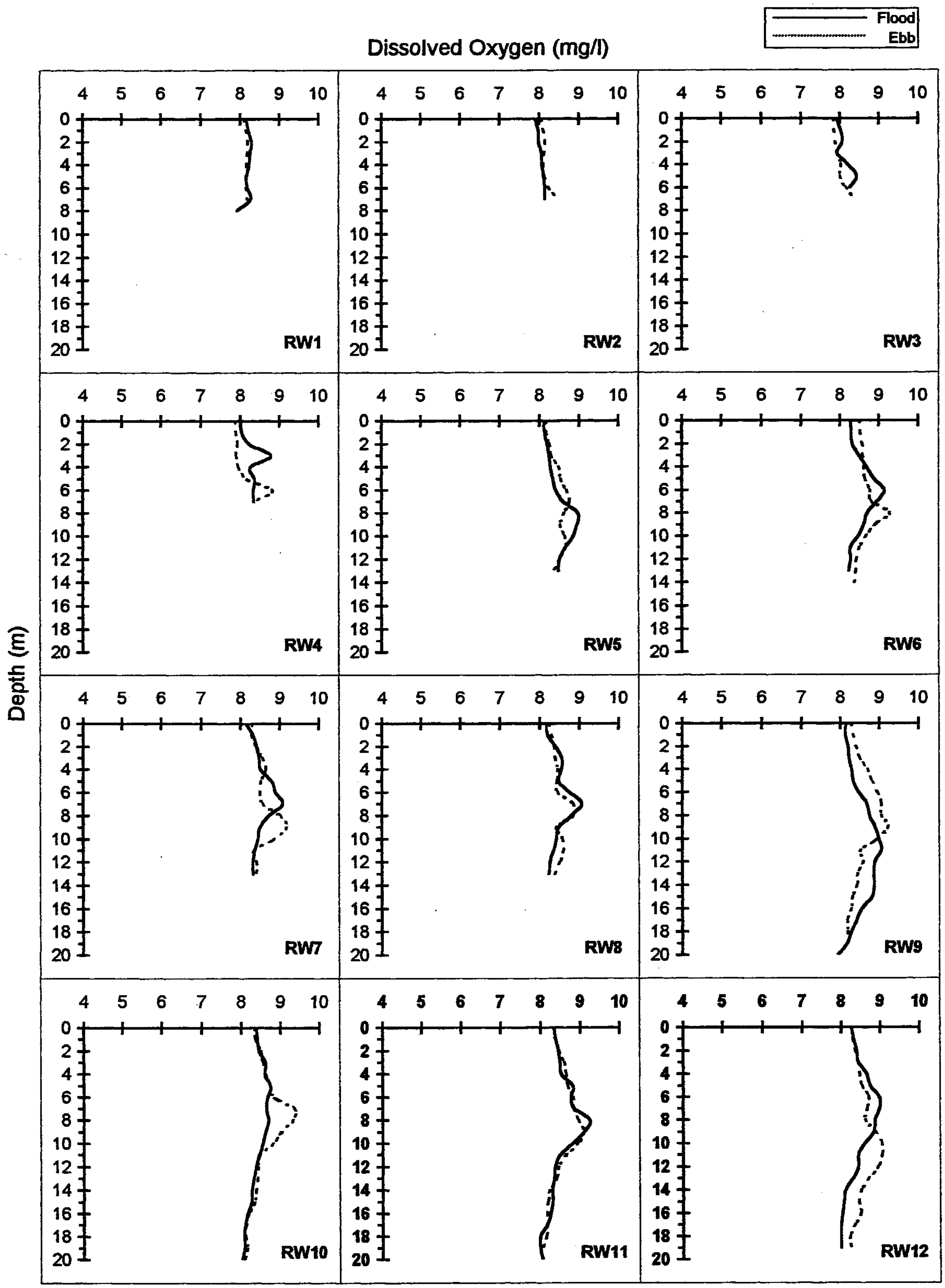


Figure 10. Dissolved oxygen vertical profiles during flood and ebb tides, summer survey. El Segundo and Scattergood Generating Stations NPDES, 1998.

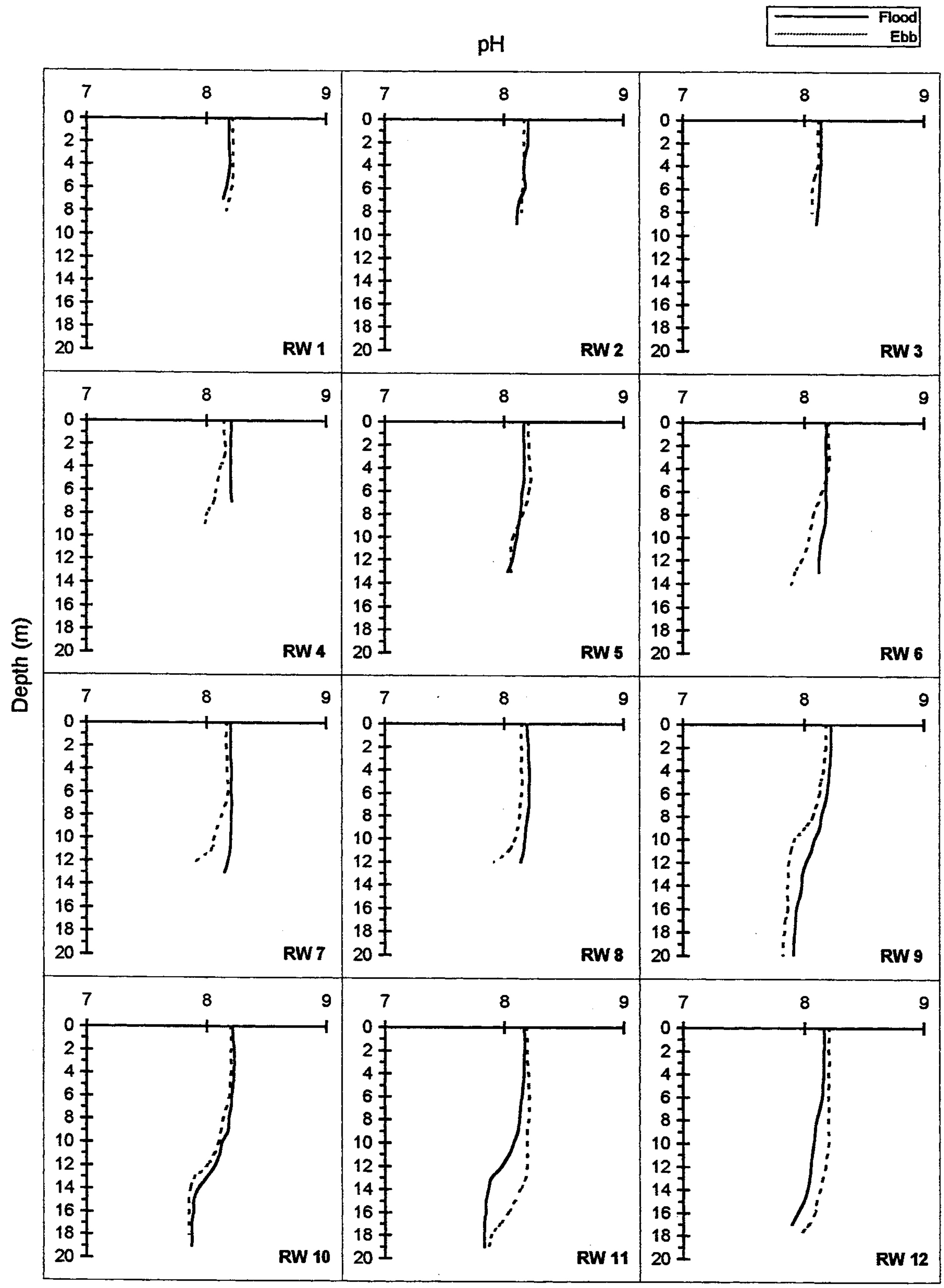


Figure 11. Hydrogen ion concentration (pH) vertical profiles during flood and ebb tides, winter survey. El Segundo and Scattergood Generating Stations NPDES, 1998.

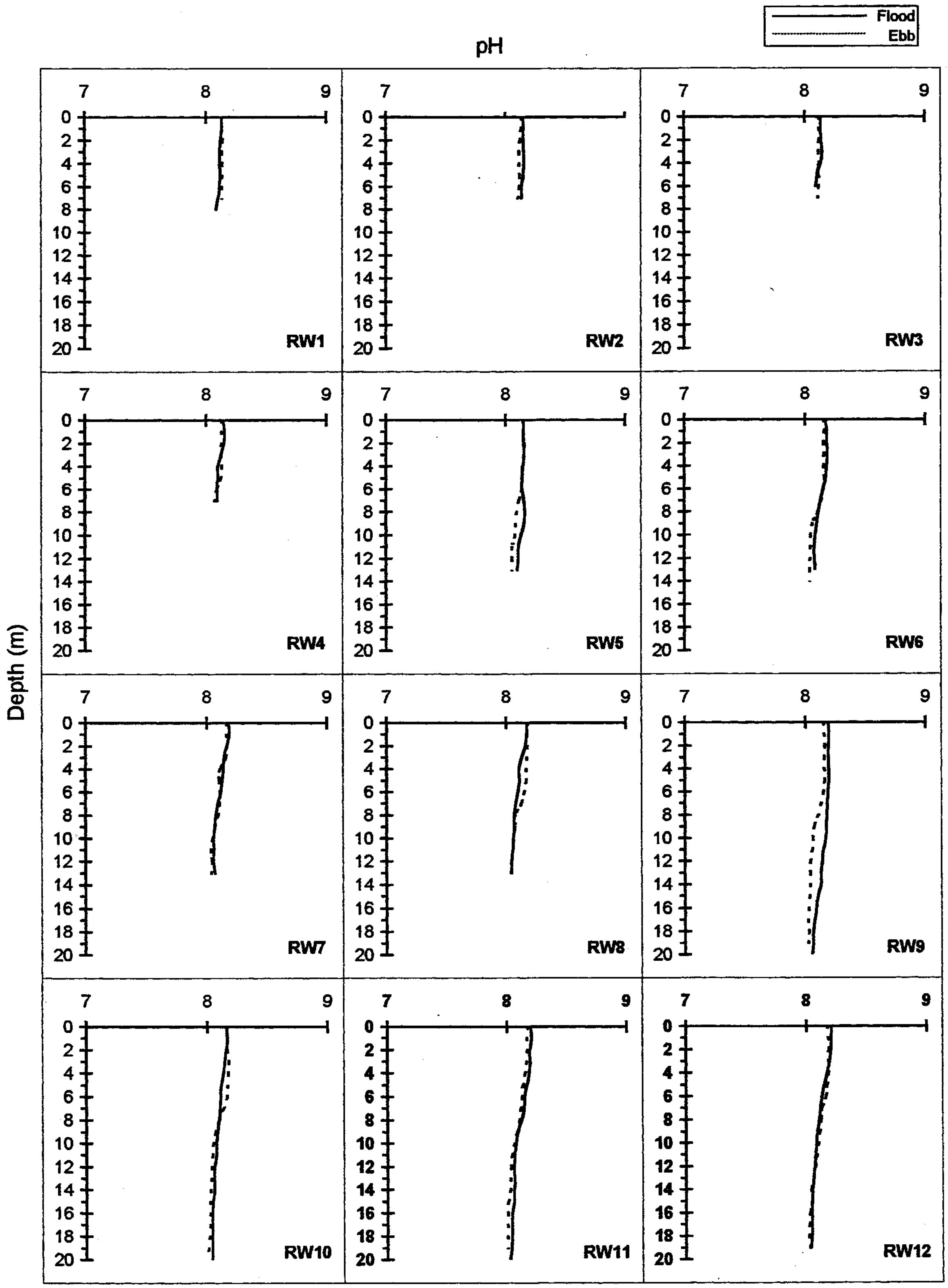


Figure 12. Hydrogen ion concentration (pH) vertical profiles during flood and ebb tides, summer survey. El Segundo and Scattergood Generation Stations NPDES, 1998.

Table 3. Sediment grain size parameters. El Segundo and Scattergood Generating Stations NPDES, 1998.

Parameter	Nearshore			Offshore			Overall	
	B2	B3	Mean	B6	B7	Mean	Mean	S.D.
% Gravel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Sand	81.67	100.00	90.84	94.08	95.03	94.56	92.70	6.75
% Silt	16.76	0.00	8.38	4.86	4.09	4.48	6.43	6.24
% Clay	1.57	0.00	0.79	1.06	0.87	0.97	0.88	0.57
Mean Grain Size								
phi	3.45	2.30	2.88	3.32	3.38	3.35	3.11	0.47
µm	92	203	136	100	96	98	115.6	46.5
Sorting (%)*	58.08	65.70	61.9	70.21	76.74	73.5	67.7	6.8
Skewness	0.30	-0.01	0.15	0.09	0.08	0.09	0.12	0.11
Kurtosis	1.39	0.92	1.16	1.46	1.29	1.38	1.27	0.21

* Sharp and Fan (1963), based on 25 intervals.

Sediment samples were collected from four stations in 1998. Sediments at Stations B2, B6, and B7 were composed primarily of sand with smaller amounts of silt and clay (Table 3). Sediments at Station B3, however, were composed entirely of sand. Overall, samples from the four stations averaged 93% sand, 6% silt, and 1% clay, with an average mean grain size of 3.11 phi (116 µm, very fine sand). Sediments were finest at nearshore Station B2 (located upcoast of the Scattergood discharge), where mean grain size was 3.45 phi (92 µm). Coarsest sediments were collected from nearshore Station B3 (located downcoast of the El Segundo discharge structures), where mean grain size was 2.30 phi (203 µm). Sediments at the two nearshore stations averaged 90.8% sand with a mean grain size of 2.88 phi (136 µm) while sediments at the two offshore stations averaged 92.7% sand with a mean grain size of 3.35 phi (98 µm).

Sorting, a measure of the spread of the particle distribution curve, average 67.7% overall (Table 3). Sorting values ranged from 58% (moderately well sorted) at nearshore Station B2 to 77% (well sorted) at offshore Station B7. The two offshore stations were better sorted (a narrower range of particle sizes) than the nearshore stations.

Sediments at all stations were slightly skewed; average skewness was 0.12 (Table 3). Lowest skewness was -0.01 at Station B3, indicating an excess of coarse material, while highest skewness was at Station B2 (0.30, indicating an excess of fine material).

Kurtosis is a measure of the peakedness of the particle distribution curve. A kurtosis value of 1.00 represents a normal particle distribution curve. Kurtosis values at Stations B2, B6, and B7 were greater than 1.00, indicating leptokurtic (excessively peaked) distributions, with dominance by a narrow range of particle sizes (Table 3). The kurtosis value at Station B3 (0.92) indicates a platykurtic (flattened) distribution, with better sorting in the tails of the curve. Kurtosis values were similar between the offshore stations, while kurtosis differed considerably between the two nearshore stations.

Sediment Chemistry

Concentrations of metals found in sediments at each station are presented in Appendix E and are summarized in Table 4. In 1998, concentrations of all metals were highest at nearshore Station B2 (Table 4). Lowest concentrations of chromium, copper, and zinc were detected at nearshore Station B3, while the lowest concentration of nickel was found at offshore Station B7. Overall, chromium concentrations ranged from 8.5 to 20 mg/kg, copper from 2.8 to 8.5 mg/kg, nickel from 2.5 to 7.5 mg/kg, and zinc ranged from 15 to 42 mg/kg.

Table 4. Sediment metal concentrations (mg/dry kg). El Segundo and Scattergood Generating Stations NPDES, 1998.

	Nearshore			Offshore			Overall		Detection
Metal	B2	B3	Mean	B6	B7	Mean	Mean	S.D.	Limit
Chromium	20.0	8.5	14.3	14.0	15.0	14.5	14.4	4.4	1.6
Copper	8.5	2.8	5.7	4.7	3.9	4.3	5.0	2.3	1.6
Nickel	7.5	3.5	5.5	5.4	2.5	4.0	4.7	2.0	1.6
Zinc	42.0	15.0	28.5	22.0	18.0	20.0	24.3	11.3	7.9

BIOLOGICAL MONITORING

Benthic Infauna

Results of infaunal analyses are presented by station and replicate in Appendix F and are summarized in Tables 5, 6, and 7.

Species Composition. A total of 1,607 infaunal organisms representing 100 species and 10 phyla was collected during the summer survey (Table 5, Appendix F-1). Annelida was the most abundant and diverse phylum, accounting for almost 64% of the individuals and 40% of the species. The phylum Mollusca was second most abundant, accounting for 22% of the individuals and 21% of the species. Arthropoda was the third most abundant phylum comprising almost 10% of individuals. While mollusks were more abundant, arthropods were more speciose. The seven remaining phyla represented only 5% of the individuals and 14% of the species. Three phyla, Chordata, Nematoda, and Phorona, only had one representative species, while three others, Echinodermata, Platyhelminthes, and Cnidaria were each represented by two species. The remaining phylum Nemertea had five representative species (Appendices F-1 and F-2). Annelids and mollusks were generally more abundant at nearshore stations while arthropods were found in greater numbers at the offshore stations. Of the remaining seven phyla, five had greater numbers at nearshore stations, six were more numerous at offshore stations and one had equal numbers in nearshore and offshore stations (Table 5).

The 15 most abundant species, those which each comprised 1% or more of the total abundance, accounted for 81% of all the organisms collected (Table 6). The three most abundant species, the polychaete annelids *Apoprionospio pygmaea* and *Polydora cirrosa*, and the bivalve mollusk *Solen sicarius* together comprised 60% of the abundance. Both *A. pygmaea* and *S. sicarius* occurred primarily at the nearshore stations, while *P. cirrosa* occurred only at offshore stations. Three species, *S. sicarius, Armandia brevis,* and *Rhepoxynius menziesi* were captured only from nearshore stations while three others, *Diastylopsis tenuis, Aoroides inermis*, and *Chaetozone setosa* Cmlx were obtained only from offshore stations.

Number of Species. Species richness averaged 42.8 species per station and ranged from 29 species at Station B3 to 61 species at Station B6 (Table 7). In general, species richness was higher at offshore stations (an average of 51.0 species per station) than at nearshore stations (an average of 34.5 species).

Abundance and Density. Abundance averaged 401.8 individuals per station and ranged from 187 individuals at Station B7 to 891 individuals at Station B2 (Table 7). Density averaged 10,040 individuals/m^2, and ranged from 4,680 individuals/m^2 to 22,280 individuals/m^2. On average, 14,100 individuals/m^2) than offshore (an average of 239.5 individuals per station, or 5,990 individuals/m^2). The high abundance at Station B2 was due to large numbers of the polychaete annelid *Apoprionospio pygmaea* which occurred in high numbers in all four replicates of that station. Excluding this species, the remaining abundance at Station B2 was 315 individuals (a value much closer to, though still higher than, those at the other stations).

Table 5. Number of infaunal individuals and species by major phylum. El Segundo and Scattergood Generating Stations NPDES, 1998.

Parameter	Nearshore B2	Nearshore B3	Offshore B6	Offshore B7	Total	Percent Total
Number of Individuals						
Annelida	640	156	158	67	1021	63.5
Mollusca	223	28	59	42	352	21.9
Arthropoda	7	37	42	67	153	9.5
Others (6)	15	11	18	10	54	3.4
Echinodermata	6	5	15	1	27	1.7
Total	891	237	292	187	1607	
Number of Species						
Annelida	16	10	28	20	40	40.0
Arthropoda	4	7	16	8	25	25.0
Mollusca	13	4	8	6	21	21.0
Echinodermata	2	2	1	1	2	2.0
Others (6)	5	6	8	6	12	12.0
Total	40	29	61	41	100	

Table 6. The 15 most abundant infaunal species. El Segundo and Scattergood Generating Stations NPDES, 1998.

Phy	Species	Nearshore B2	Nearshore B3	Nearshore Mean	Offshore B6	Offshore B7	Offshore Mean	Total	Percent Total	Cum. Percent
AN	*Apoprionospio pygmaea*	576	115	345.5	4	13	8.5	708	44.1	44.1
MO	*Solen sicarius*	151	20	85.5	-	-	-	171	10.6	54.7
AN	*Polydora cirrosa*	1	-	0.5	76	13	44.5	90	5.6	60.3
MO	*Tellina modesta*	6	1	3.5	25	13	19.0	45	2.8	63.1
MO	*Cooperella subdiaphana*	8	-	4.0	5	23	14.0	36	2.2	65.3
AN	*Mediomastus acutus*	11	7	9.0	12	6	9.0	36	2.2	67.6
AR	*Diastylopsis tenuis*	-	-	-	11	24	17.5	35	2.2	69.8
AN	*Armandia brevis*	14	20	17.0	-	-	-	34	2.1	71.9
MO	*Tresus nuttallii*	24	-	12.0	8	-	4.0	32	2.0	73.9
AR	*Rhepoxynius menziesi*	-	23	11.5	-	-	-	23	1.4	75.3
AR	*Aoroides inermis*	-	-	-	8	13	10.5	21	1.3	76.6
AN	*Chaetozone setosa* Cmplx	-	-	-	17	4	10.5	21	1.3	77.9
EC	*Dendraster excentricus*	1	3	2.0	15	1	8.0	20	1.2	79.2
AN	*Owenia fusiformis*	5	5	5.0	4	3	3.5	17	1.1	80.2
PL	*Pseudoceros* sp.	6	5	5.5	3	2	2.5	16	1.0	81.2

Phylum Key: AN = Annelida; AR = Arthropoda; EC = Echinodermata; MO = Mollusca; PL = Platyhelminthes

Table 7. Summary of infaunal community parameters. El Segundo and Scattergood Generating Stations NPDES, 1998.

Parameter	Nearshore			Offshore			Overall
	B2	B3	Mean	B6	B7	Mean	Mean
Number of Species							
Total	40	29	34.5	61	41	51.0	42.8
Rep. Mean	23.8	14.5	19.1	25.3	18.0	24.2	21.7
Rep. S.D.	4.0	3.3	3.7	5.3	3.6	4.4	4.1
Number of Individuals							
Total	891	237	564.0	292	187	239.5	401.8
Rep. Mean	222.8	59.3	141.0	73.0	46.8	59.9	100.4
Rep. S.D.	41.7	6.2	24.0	48.6	13.7	31.2	27.6
Diversity (H')							
Total	1.49	2.09	1.79	1.56	3.13	2.34	2.07
Rep. Mean	1.40	1.86	1.63	1.34	2.45	1.90	1.76
Rep. S.D.	0.17	0.27	0.22	0.39	0.28	0.34	0.28
Biomass (g)							
Total	2.28	1.18	1.73	2.21	1.33	1.77	1.75
Rep. Mean	0.57	0.30	0.43	0.55	0.33	0.44	0.44
Rep. S.D.	0.39	0.14	0.27	0.29	0.26	0.27	0.27

Species Diversity. Shannon-Wiener species diversity index (H') values averaged 2.07 per station, and ranged from 1.49 at Station B2 to 3.13 at Station B7 (Table 7). The value at Station B2 was much lower than at any other station due to the excessive numbers of *A. pygmaea*. The offshore station average (2.34) was higher than the nearshore station average (1.79).

Biomass. Biomass averaged 1.75 g per station, or 44 g/m^2. Biomass was highest at Station B2 (2.28 g, or 57 g/m^2), though the amount of biomass collected from Station B6 was only slightly less (2.21 g, or 55 g/m^2) (Table 7, Appendix F-3). The nearshore station average for biomass (1.73 g, or 43 g/m^2) was virtually identical to the offshore station average (1.77 g, or 44 g/m^2).

Cluster Analysis. Results of cluster analysis (classification) of the 15 most abundant infaunal species (Table 6) are presented in Figure 13.

Normal (site) analysis clustered the four stations into two groups. Group I consists of the two nearshore stations while Group II includes the two offshore stations.

Inverse (species) analysis clustered the dominant species into three species groups. The polychaete annelid *A. pygmaea* (Group A) was unique, as it occurred in numbers much higher than for any other species. The species in Groups B, *S. sicarius, A. brevis,* and *R. menziesi*, differed from all other species in that they were found only at nearshore stations. Group C contained the remaining abundant species.

Fish Impingement

Results from heat treatment surveys of fish entrained and impinged at the El Segundo (ESGS) and the Scattergood Generating Stations (SGS) during the 1998 sampling year (1 October 1997 to 30 September 1998) are presented below. Data are summarized in Tables 8 through 11 and presented in their entirety in Appendix G. Fish and macroinvertebrate data are presented separately for each generating station.

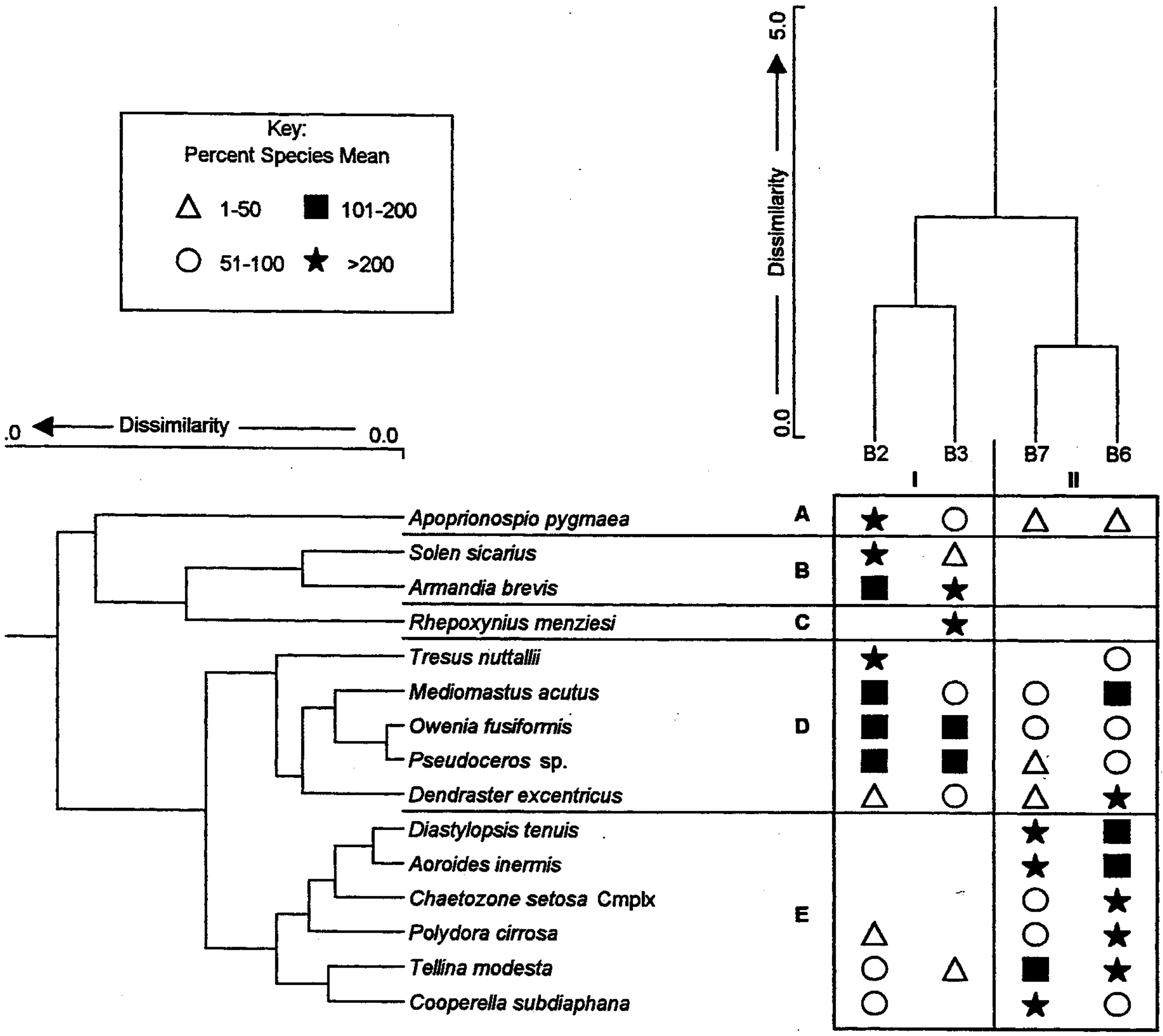


Figure 13. Two-way coincidence table resulting from normal (station) and inverse (species) classification dendrograms for the 15 most abundant infaunal species. El Segundo and Scattergood Generating Stations NPDES, 1998.

Fish

Species Composition. In total, at least 58 species representing two classes and 30 families of fish were taken during 10 heat treatment operations at the generating stations (Appendix G-1). Abundances for each species are listed in Appendix G-2.

El Segundo. Heat treatment surveys at ESGS Units 3 & 4 yielded 38 species of fish representing two classes and 24 families (Table 8, Appendix G-1). Four families of cartilaginous fish (Elasmobranchiomorphi = Chondrichthyes) and 20 families of bony fish (Osteichthyes) were dominated by six species of croakers in the family Sciaenidae and four species of surfperch in the family Embiotocidae. No heat treatments were performed at Units 1 & 2 during the sample year.

Table 8. Numbers of individuals and biomass (kg) and the 15 most abundant fish species impinged. El Segundo and Scattergood Generating Stations NPDES, 1998.

Species	Scattergood No.	Scattergood Wt. (kg)	El Segundo No.	El Segundo Wt. (kg)	Total Abundance	Percent Total	Cumulative Percent	Total Biomass
queenfish	16178	352.680	1049	14.696	17227	45.0	45.0	367.376
white croaker	5288	387.942	29	26.130	5317	13.9	58.9	414.072
Pacific sardine	3555	121.599	207	12.048	3762	9.8	68.7	133.647
topsmelt	3042	133.524	22	0.862	3064	8.0	76.7	134.386
salema	1593	42.639	1031	15.840	2624	6.9	83.6	58.479
jacksmelt	1262	142.679	1194	104.724	2456	6.4	90.0	247.403
yellowfin croaker	261	77.999	4	0.236	265	0.7	90.7	78.235
sargo	452	91.449	204	92.322	656	1.7	92.4	183.771
black croaker	272	26.699	177	16.493	449	1.2	93.6	43.192
barred sandbass	325	91.942	3	1.580	328	0.9	94.4	93.522
walleye surfperch	339	9.324	38	11.890	377	1.0	95.4	21.214
kelp bass	171	19.210	46	7.500	217	0.6	96.0	26.710
California corbina	110	9.284	23.55	6.943	134	0.3	96.3	16.227
white seabass	98	26.428	18	2.445	116	0.3	96.6	28.873
spotted turbot	82	11.574	21.55	4.203	104	0.3	96.9	15.777
Survey Totals	33829	1780.62	4454	406.838	38283			2187.458
Total Species	56		38		58			

Scattergood. Heat treatment surveys at SGS yielded 56 species of fish, representing two classes and 28 families (Table 8, Appendix G-1). Seven families of cartilaginous fish and 21 families of bony fish were dominated by six species of croakers and six species of surfperch.

Abundance. A total of 38,282 individual fish was taken at the two generating stations; 33,829 fish (88.4%) were taken from SGS and 4,453 (11.6%) from ESGS (Table 8, Appendix G-2). All of the 15 overall most abundant species occurred at both stations; 14 of those species were among the 15 most abundant species at SGS, and nine were among the top 15 at ESGS.

Queenfish (*Seriphus politus*) was the most abundant species overall, accounting for 45% (17,227) of the individuals; it was the most abundant species at SGS with 47.8% of the abundance, but was second in abundance at ESGS with 23.6% of the total (Table 8). The second most abundant fish overall (13.9% of the total) was white croaker (*Genyonemus lineatus*), which ranked second at SGS but was much less abundant at ESGS. The third, fourth, and fifth most abundant species overall, accounting for a combined total of 24.7%, were Pacific sardine (*Sardinops sagax*), topsmelt (*Atherinops affinis*), and salema (*Xenistius californiensis*), respectively. While Pacific sardine was ranked third in abundance at SGS, it was fourth at ESGS; topsmelt was ranked fourth and eighteenth, respectively; and salema was fifth at SGS, but third at ESGS. Jacksmelt (*Atherinopsis californiensis*), sargo (*Anisotremus davidsonii*), yellowfin croaker (*Umbrina roncador*), black croaker (*Cheilotrema saturnum*), and walleye surfperch (*Hyperprosopon argenteum*), were the sixth through tenth, respectively, most abundant fish overall. These five species accounted for 10.9% of the combined abundance

At SGS, barred sand bass (*Paralabrax nebulifer*) was among the ten most abundant species. At ESGS, senorita (*Oxyjulis californica*), Pacific butterfish (*Peprilus semillimus*), black surfperch (*Embiotoca jacksoni*), and kelp bass (*Paralabrax clathratus*) were among the ten most abundant species.

El Segundo. There were 3,957 individuals taken during the three heat treatments at Units 3 & 4, while no heat treatments were conducted at Units 1 & 2 (Table 9, Appendix G-3). Catch per heat treatment at the Units 3 & 4 screenwell averaged 1,319 individuals and 18 species, and ranged from 43 individuals and ten species (2 June 1998) to 2,524 individuals (15 November 1997) and 25 species (10 October 1997) (Appendix G-4). Combined with the estimated 497 individuals and 13 species taken during normal operations, a total of 4,454 individuals and 38 species were taken at ESGS. The 10 most abundant species at ESGS accounted for 89.5% of all individuals taken (Appendix G-3).

Table 9. Number of species, number of individuals, and biomass (kg) of fish impinged during heat treatments at the El Segundo Generating Station. El Segundo and Scattergood Generating Stations NPDES, 1998.

Date	Number: Species	Number: Individuals	Biomass
Units 1 & 2	No heat treatments occurred		
Units 3 & 4			
10 Oct 97	25	1390	186.66
15 Nov 97	20	2524	128.44
2 Jun 98	10	43	20.77
Total	35	3957	335.87
Mean	18	1319	111.96
Overall			
Total	35	3957	335.87
Mean	18	1319	111.96

Scattergood. Seven heat treatments were conducted at SGS, with the catch per heat treatment averaging 4,833 individuals and 30 species (Table 10). The catch ranged from 603 individuals (10 February 1998) and 26 species (10 September 1998) to 9,720 individuals and 38 species (7 April 1998) (Appendix G-5).

The 10 most abundant species at SGS, representing six families, accounted for 95.5% of all the individuals taken at the station (Table 8). The remaining 46 species totaled 1,523 individuals and accounted for only 4.5% of the abundance.

Biomass. Biomass totaled 2,187.41 kg for fish impinged at both stations (Table 8, Appendix G-2). Biomass was unevenly distributed between the two stations, with SGS accounting for 81.4% of the overall total and ESGS accounting for 18.6%. White croaker accounted for 18.9% of the total biomass; this species and five others, queenfish (16.8%), jacksmelt (11.3%), sargo (8.4%), topsmelt (6.1%), and Pacific sardine (6.1%) accounted for 67.7% of the biomass and weighed 1,480.66 kg.

Table 10. Number of species, number of individuals, and biomass (kg) of fish impinged during heat treatments at the Scattergood Generating Station. El Segundo and Scattergood Generating Stations NPDES, 1998.

Date	Number: Species	Number: Individuals	Biomass
20 Nov 97	33	4479	149.24
15 Jan 98	30	9443	424.03
10 Feb 98	30	603	36.67
7 Apr 98	38	9720	496.89
4 Jun 98	31	5963	267.63
25 Jul 98	20	2005	210.15
10 Sep 98	26	1616	196.01
Total	56	33829	1780.62
Mean	30	4833	254.37

El Segundo. Fish biomass totaled 335.87 kg during the heat treatment surveys at ESGS Units 3 & 4 in 1998 (Table 9, Appendix G-4). Combined with normal operation surveys, fish biomass totaled 406.84 kg at ESGS in 1998 (Appendix G-3). The five species ranked highest in biomass at ESGS were jacksmelt, sargo, white croaker, black croaker, and salema. Three of these species (jacksmelt, sargo, and white croaker) were also highly ranked overall. Collectively, these five species amassed a weight of 270.11 kg, 66.4% of the biomass at ESGS (Appendix G- 3). Biomass at Units 3 & 4 heat treatments averaged 111.96 kg, and ranged from 20.77 kg (2 June 1998) to 186.66 kg (10 October 1997) (Table 9).

Scattergood. In 1998, fish biomass totaled 1,780.62 kg during the seven heat treatment surveys at SGS (Table 10). Biomass averaged 254.37 kg per survey and ranged from 36.67 kg (10 February 1998) to 496.89 kg (7 April 1998) (Appendix G-7). White croaker accounted for 21.8% of the biomass; this and the next four ranking species (queenfish, jacksmelt, topsmelt, and Pacific sardine) accounted for 63.9% (1138.42 kg) of the total biomass (Table 8).

Size (Length). Standard length (SL), total length (TL), or disk width (DW), where appropriate, were measured in mm for the first 200 individuals of each species impinged during heat treatment surveys.

Population Structure. Length-frequency histograms (Figures 14 to 17) were constructed of two of the more abundant forage species, queenfish and sargo, and of two species of sport fishing importance, kelp bass and barred sand bass. These species were sufficiently abundant at one or both of the stations to construct meaningful histograms, which were utilized to determine if the intake selectively entrained particular size classes. These histograms do not necessarily reflect the composition of the offshore population.

Queenfish was the most numerous fish taken for 1998 and was most frequently entrained at the 110 to 130 mm SL size range at SGS with a second mode at 80 to 90 mm SL, whereas the size distribution at ESGS indicated entrained and impinged fish were bimodally distributed at the 70 and 110 mm SL size ranges (Figure 14).

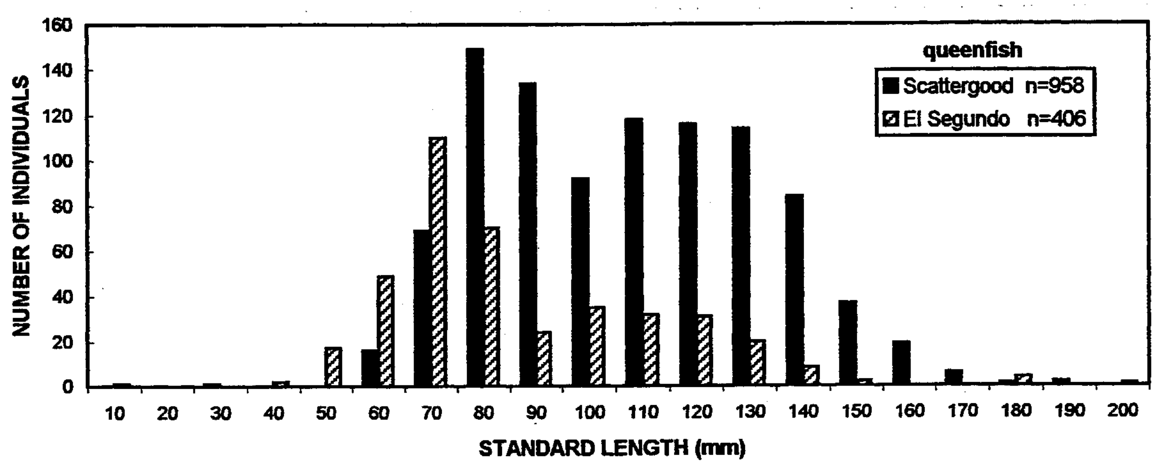


Figure 14. Length-frequency distribution of queenfish (*Seriphus politus*) taken during impingement surveys. El Segundo and Scattergood Generating Stations NPDES, 1998.

Sargo was the seventh most abundant species for 1998. The sargo population at SGS ranged from 50 to 350 mm SL with multiple peaks at 100, 180, and 270 mm SL; at ESGS the population ranged from 60 to 350 mm SL, and had peaks at 80, 150, 190, and 260 mm SL (Figure 15).

Kelp bass size distribution indicated a trimodal population at SGS with peaks at 50, 160, and 210 mm SL; at ESGS, the population was bimodal with peaks noted at 120 and 220 mm SL (Figure 16).

Size distribution of the barred sand bass population at SGS showed peaks at 70, 150, and 260 mm SL, with the majority of the entrained individuals between 200 and 270 mm SL; at ESGS, there were peaks at 130 and 220 mm SL (Figure 17).

Diseases and Abnormalities. No diseases were noted on any fish caught during the impingement surveys. However, one kelp bass at SGS had a deformed caudal fin, and one pile perch at ESGS had a deformed spine. Two species of parasitic fish lice, *Nerocila acuminata* and *Lironeca vulgaris*, occurred on individuals of walleye surfperch, queenfish, kelp bass, yellowfin croaker, California corbina (*Menticirrhus undulatus*), and jacksmelt.

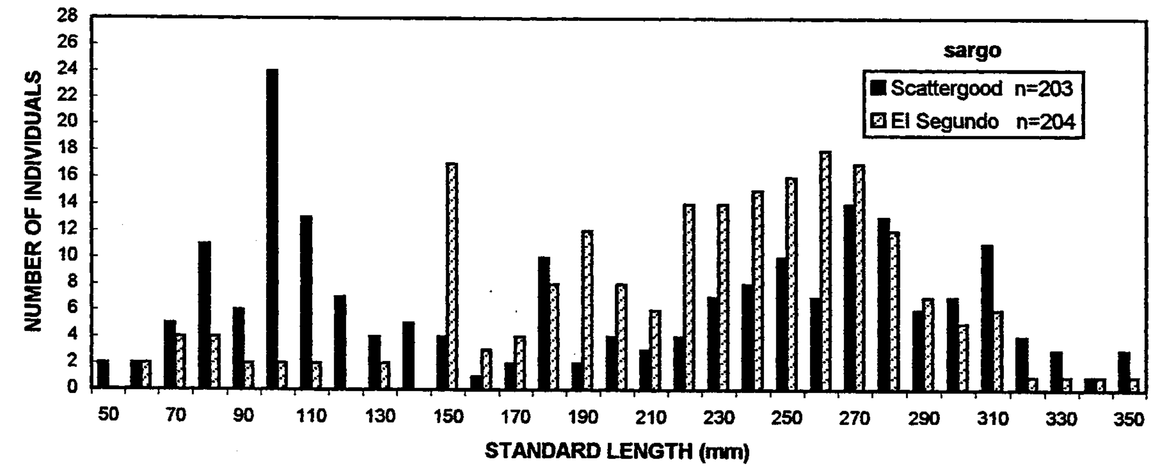


Figure 15. Length-frequency distribution of sargo (*Anisotremus davidsonii*) taken during impingement surveys. El Segundo and Scattergood Generating Stations NPDES, 1998.

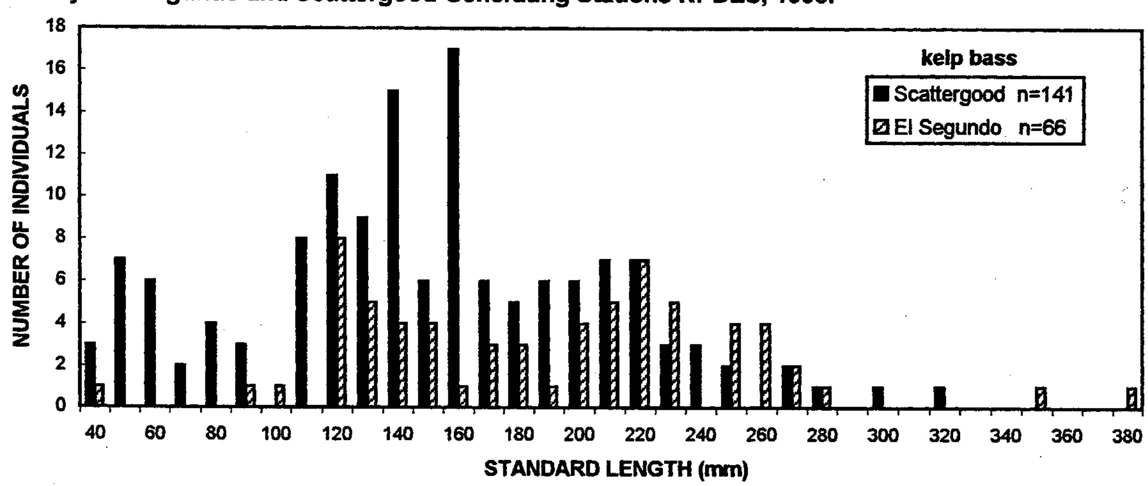


Figure 16. Length-frequency distribution of kelp bass (*Paralabrax clathratus*) taken during impingement surveys. El Segundo and Scattergood Generating Stations NPDES, 1998.

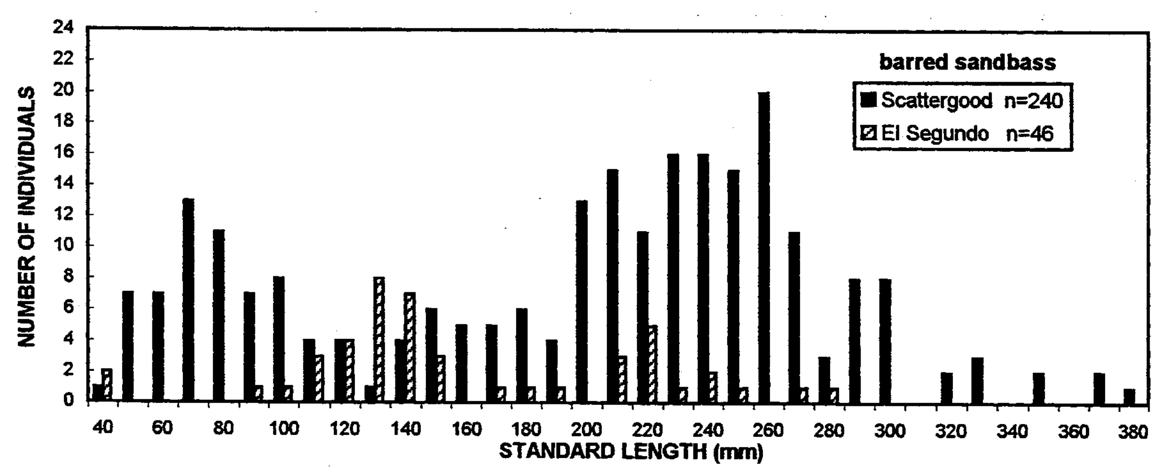


Figure 17. Length-frequency distribution of barred sandbass (*Paralabrax nebulifer*) taken during impingement surveys. El Segundo and Scattergood Generating Stations NPDES, 1998.

Macroinvertebrates

A total of 19 motile macroinvertebrate species with a total biomass of 350.4 kg were collected during heat treatment impingement surveys at SGS and ESGS (Table 11, Appendices G-8 through G-13). These species represented three phyla and 13 families, and included 15 species of crustaceans, two echinoderms, and two mollusks (Appendix G-1).

Table 11. Numbers of individuals and biomass (kg) of the nine most abundant macroinvertebrates impinged. El Segundo and Scattergood Generating Stations NPDES, 1998.

	Scattergood		El Segundo		Total	Percent	Cumulative	Total
Species	Abund.	Biomass	Abund.	Biomass	Abundance	Total	Percent	Biomass
Cancer antennarius	191	4.385	4220	138.068	4411	47.7	47.7	142.453
Cancer anthonyi	943	5.500	1165	55.341	2108	22.8	70.5	60.841
Cancer gracilis	925	4.400	-	-	925	10.0	80.5	4.400
Lysmata californica	647	1.01	53	0.077	700	7.6	88.1	1.087
Portunus xantusii	405	2.839	34	0.779	439	4.7	92.8	3.618
Pyromaia tuberculata	337	0.447	22	0.259	359	3.9	96.7	0.706
Panulirus interruptus	135	75.670	9	7.000	144	1.6	98.3	82.670
Octopus bimaculatus/bimaculoides	43	13.372	39	34.570	82	0.9	99.2	47.942
Pachygrapsus crassipes	21	0.053	30	0.331	51	0.6	99.7	0.384
Survey Totals	3671	113.952	5573	236.425	9244			350.377
Total Species	18		9		19			

The top three most abundant invertebrate species were members of the rock crab family Cancridae, and accounted for 80.5% of all invertebrates taken and almost 59.3% of the biomass (Table 11, Appendix G-8). Red rock shrimp (*Lysmata californica*) was the fourth most abundant invertebrate (7.6%) and Xantus' swimming crab, (*Portunus xantusii*) was fifth (4.7%) in abundance, with these two species contributing 1.3% of the biomass. Together, these five species accounted for almost 93% of the invertebrates taken. California spiny lobster (*Panulirus interruptus*) and two-spotted octopus (*Octopus bimaculatus/bimaculoides*) each contributed less than 1% of the abundance, but they accounted for 23.6% and 13.7% of the biomass, respectively.

The eight species in common to the two generating stations comprised over 89% of the total abundance (Appendix G-8). Twice as many species occurred at SGS as at ESGS, but most of the species that occurred uniquely at either station were represented by few individuals and collectively accounted for only slightly more than 10% of the abundance and 1% of the biomass. There were, however, substantial differences in abundance and biomass between the two stations, with ESGS accounting for almost 67% of the biomass and 60% of the abundance.

Because of the sport and commercial importance of California spiny lobster, carapace lengths (CL) were measured to determine the size frequency of entrained individuals. This species was sufficiently abundant to construct a length-frequency histogram of catches from both ESGS and SGS (Figure 18). Abundance of entrained and impinged California spiny lobster was greater at SGS than at ESGS. There was a large mode from 60 to 100 mm CL in the overall population for the two stations with a peak at 90 mm CL; while the SGS lengths had a bimodal distribution, with a small peak at 10 mm CL and a large mode from 60 to 100 mm CL, the ESGS lengths had a single peak at 90 mm CL.

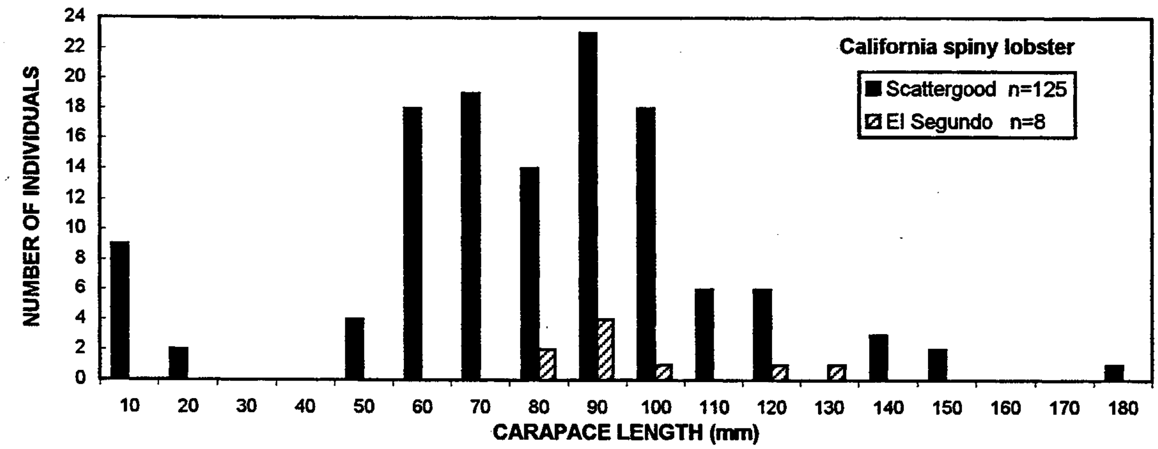


Figure 18. Length-frequency distribution of California spiny lobster (*Panulirus interruptus*) taken during impingement surveys. El Segundo and Scattergood Generating Stations NPDES, 1998.

DISCUSSION

WATER COLUMN MONITORING

In winter, there was little thermal enhancement of the receiving waters due to the operation of the El Segundo and Scattergood Generating Stations. The two monitoring stations closest to the discharge sites (Station RW2 upcoast of the Scattergood Generating Station discharge and Station RW3 downcoast of the El Segundo Generating Station discharge) were well within the range of values recorded from all the stations. No strong pattern of thermal enhancement could be established.

During winter, surface temperatures varied slightly less than 1 °C during both ebb and flood tide. During flood tide, the water column at shallow and intermediate depth stations showed a decrease with depth, and differed less than 1.4°C from the surface-to-bottom. At the four offshore stations, the water column was stratified, with thermoclines below 10 to 14 m depth and decreases greater than 2.5°C through the water column, indicating an upwelling water mass. After the tide changed, this upwelling cold water mass moved inshore and downcoast, and was detected at the intermediate depth stations (except upcoast Station RW5) and the downcoast inshore station. An offshore deeper cold water mass has been seen in this area during previous surveys, and all temperatures fell within ranges found in previous surveys (MBC 1990-1997).

In summer, surface temperatures were typically higher than in winter. With the exception of Station RW10 during flood tide, surface temperatures varied less than 1 °C between both tides. At all stations, ebb and flood tide profiles were similar, with the afternoon ebb tide water slightly warmer throughout the upper 6 to 8 m of the water column, except at Station RW9, where the surface was warmer on flood tide (Figure 8). The greatest temperature stratification during both tides was at downcoast and inshore Station RW4, far from the influence of the discharges. The highest surface temperatures for both ebb and flood tides were observed at Station RW12, downcoast and offshore of the El Segundo Generating Station discharge. Mean surface temperatures (ebb and flood tides) in 1998 were within the range of those recorded in past years (MBC 1990-1997). Without any thermal enhancement at stations near the discharges, differences among surveys were most likely due to seasonal changes and were not related to the generating stations.

In winter, dissolved oxygen values showed a well-mixed water column above about 10 m depth. Below 10 to 14 m, DO values dropped sharply. On flood tide, the cold, upwelling water mass was present only at the four offshore stations. During ebb tide, this water moved inshore, and downcoast, and was detected at most of the intermediate depth stations and at the furthest downcoast inshore station. Dissolved oxygen concentrations at the bottom of the cold water mass were slightly lower (less than 1 mg/l) than previously reported values but within the range of values from other nearshore southern California areas (MBC 1990-1997).

In summer, dissolved oxygen profiles were similar among most stations and surface DO concentrations were very similar among all stations for both tides. Surface and near-bottom values were similar, with a peak value in the water column between 3 and 9 m depth. This peak generally corresponded in depth with the coldest water at the bottom of the thermocline. Summer dissolved oxygen concentrations were well within the range of previously reported values (MBC 1990-1997). There were no apparent effects which could be attributed to the generating station discharges.

Hydrogen ion concentration (pH) varied only slightly with depth, especially during summer, and in winter decreased only in the cold, low-DO water mass near the bottom in deeper water. Values were within ranges considered normal in previous reports (MBC 1990-1997).

SEDIMENT MONITORING

Sediment Grain Size

In 1998, sediments were analyzed from four stations in the study area (two nearshore and two offshore), in contrast to recent surveys where sediments from eight stations were collected and analyzed (MBC 1990-1994, 1997). In 1998, sediments were finest and more poorly sorted at Station B2, located upcoast of the discharges on the 20-ft isobath, while coarsest sediments occurred at Station B3, downcoast of the discharges on the 20-ft isobath. Sediments at the offshore stations were better sorted than sediments nearshore.

Sediment grain size characteristics in 1998 were very similar to those in some previous surveys (MBC 1991, 1993-1994, 1997), but differed from those in 1992, when very coarse sediments occurred at Station B2 (Table 12) (MBC 1992). Sediments in the study area are typically coarsest nearshore; greater turbulence and currents nearshore suspend finer particles which are redeposited further offshore in calmer water. However, fine sediments have also been found nearshore. Second finest sediments of the survey occurred at Station B1 in 1994 and at Station B2 in 1991, 1993, and 1997.

Table 12. Average sediment mean grain size and sorting, 1990-1998. El Segundo and Scattergood Generating Stations NPDES, 1998.

	Year						
Parameter	1990	1991	1992	1993	1994	1997	1998*
Mean grain size (phi)							
All stations	2.53	3.26	2.61	3.38	3.32	3.30	3.11
Nearshore stations	1.78	3.13	2.02	3.24	3.19	3.11	2.88
Offshore stations	3.29	3.40	3.40	3.52	3.45	3.48	3.35
Sorting (%)							
All stations	67	67	65	71	70	68	68
Nearshore stations	58	63	60	68	65	65	62
Offshore stations	75	71	70	74	75	72	74

* = Four stations sampled in 1998.

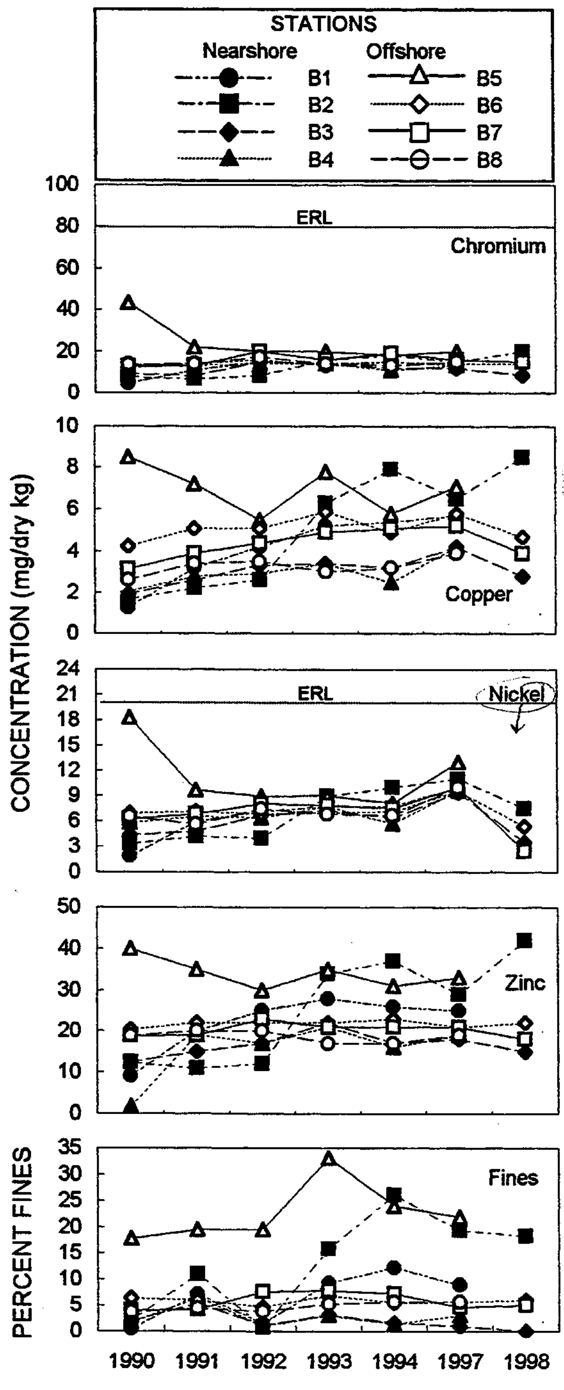


Figure 19. Comparison of sediment metal concentrations and percent fines by station, 1990-1998. El Segundo and Scattergood Generating Stations NPDES, 1998.

Sediment composition and distribution in the study area are likely primarily affected by natural causes, such as sediment transport, deposition from Ballona Creek, which enters Santa Monica Bay approximately two miles north of Station B1, and nearshore currents. Littoral currents in the study area move up to eight feet per second, and are capable of transporting beach sediments alongshore (Drake and Gorsline 1973). Dikes, groins, and jetties in the study area were constructed to facilitate sand accumulation; otherwise, beach sands tend to move toward Redondo Canyon and offshore (MBC 1988). Results from the 1998 survey indicate no apparent patterns in sediment grain size relative to the discharges for the El Segundo and Scattergood Generating Stations.

Sediment Chemistry

Highest concentrations of chromium, copper, nickel, and zinc occurred at Station B2 in 1998. Lowest concentrations of chromium, copper, and zinc were found at Station B3, while the lowest concentration of nickel occurred at Station B7. Since 1990, highest metal levels have generally occurred at Stations B2 and B5 (Figure 19).

Differences in metal concentrations among sites are often directly related to the amount of fine-grained material in the sediment. Fine-grained sediments may contain higher amounts of metals due to the greater available surface area (Ackermann 1980, de Groot et al. 1980). Therefore, comparisons should take into account the relative amounts of fine and coarse sediments.

From 1990 to 1993, both percentages of fine sediments and metal levels were highest at Station B5, upcoast of Station B6 (Figure 19). In 1993, the percentage of "fines" (silt and clay combined) increased at Station B2, and consequently the metal levels at Station B2 increased from among the lowest to levels typical at Station B5. In 1994, the highest percentage of fine sediments and, in general, the highest levels of metals were found at Station B2. To a lesser degree, percent fines and metals at Station B1, upcoast of Station B2, followed a similar pattern of increase from 1993 to 1997. In 1997, the highest percentage of fines and the corresponding comparatively high level of metals occurred at Station B5, and in 1998, highest metal concentrations occurred at Station B2, the station with the largest fines fraction. Highest zinc concentration since monitoring began in 1990 was detected at Station B2 in 1998. However, metal concentrations at the remainder of the stations have remained relatively constant since 1990.

All values observed in 1998 were within the range found in sediments within the Southern California Bight and were lower than or comparable to levels found by the National Oceanographic and Atmospheric Administration (NOAA) at other sandy, offshore sites in southern California (NOAA 1991a). Concentrations of metals in the study area have also been consistently below levels determined to be potentially toxic to benthic organisms. Ranges of potential toxicity were developed by NOAA (NOAA 1991b) and later updated (Long et al. 1995) using data from spiked sediment bioassays, sediment-water equilibrium partitioning, and the co-occurrence of adversely affected fauna and contaminant levels in the field. Chemical concentrations believed to be associated with adverse biological effects from the various independent studies were compared for each parameter and the lower 10 percentile was designated as the "Effects Range-Low" (ERL). Except at Station B5 in 1990, metal concentrations in the study area have been less than half the determined concentrations for low effects, which are 81 mg/kg for chromium, 34 mg/kg for copper, 20.9 mg/kg for nickel and 150 mg/kg for zinc.

The wide distribution of metals in the study area does not appear to be related to the generating station discharges; more likely it is due to non-point discharges (NOAA 1991c). There are several other sources of metals in the vicinity, such as boating-related activities in Marina del Rey, the nearby oil refineries and wastewater treatment plant, and storm drains which carry street runoff into Santa Monica Bay (MBC 1993b). Ballona Creek, to the north, could be a source of fine sediments and their associated metal contaminants. In 1998, little difference was seen between metal levels found at nearshore and offshore stations, and no extremely high or low values were noted in sediments at stations nearest the discharges, suggesting that the generating stations have not had a noticeable effect on metal concentrations in the sediments.

BIOLOGICAL MONITORING

Benthic Infauna

The benthic infaunal species were most abundant at station B2, nearshore and upcoast of Scattergood and El Segundo Generating Stations. The polychaete *Apoprionospio pygmaea* accounted for 65% of that station's infaunal count. It was also captured in relatively high numbers at Station B3. Predominantly a nearshore species, *A. pygmaea* is found in clean sand at the 12 to 40 ft depth range, which is consistent with the findings of this survey where more than 40 times more *A. pygmaea* were found at the nearshore stations than at the offshore stations. The second most abundant species, the bivalve mollusk *S. sicarius*, also tends to prefer clean sandy habitats in the 12 to 40 ft depth range. Accounting for more than 10% of the total abundance, the clam was found only at the nearshore stations in this survey. The third most common species, *P. cirrosa* differed from the first two in that it was obtained only from the offshore stations where wave effects are less severe.

As would be expected, species richness was higher at the offshore stations. The shallower nearshore environment off Scattergood and El Segundo Generating Stations tends to be a high energy habitat with constant wave action. Also, the sediment type tends not to vary much. The Intermediate Disturbance Hypothesis predicts that areas with moderate amounts of physical disturbance will support a higher species richness than an area with a high amount of disturbance (Connell 1978). The findings of this survey are consistent with this hypothesis. On average, the offshore stations had almost twice the number of species as the nearshore stations. Other factors that contribute to the higher species richness offshore are grain size and organic content of the sediment. The benthos at the offshore stations supports a more diverse community, because it tends to have finer sediments, which often contain more organic matter. On average sediments were finer offshore than nearshore in this year's survey.

From a phyletic perspective, the polychaete annelids were the most species rich group with 40 species represented. Polychaetes are highly successful in virtually all marine habitats, including the type of environment found off Scattergood and El Segundo Generating Stations. An equally successful class of animals is the Malacostraca arthropods which were the second most species rich group in this survey with 22 species represented. The arthropods which dominate the survey site are, for the most part, burrowing deposit feeders though some have the ability to swim. With 14 species represented, the molluscan class Bivalvia was the third most species rich group. The bivalves are typically filter feeders. All other represented classes had five or fewer species accounted for in this year's survey.

Results of the 1998 survey were similar to those of previous NPDES summer surveys from 1990 through 1994 and 1997, though direct comparisons to prior surveys is inappropriate due to significant differences in this year's sampling program (MBC 1990–1994, 1997). Only two nearshore and two offshore stations were sampled in 1998 (as opposed to four nearshore and four offshore stations in previous surveys), thus reducing the chance of capturing uncommon and rare species. It is therefore not surprising that fewer numbers of animals were obtained in 1998 than in other years (with the exception of 1997 which had the lowest total number of species since the 1990 survey). In turn, the reduction in overall numbers contributed to a lower total species richness in 1998.

Despite the survey differences, some general patterns can be seen when compared with previous years. For example, average values of species richness, abundance, and diversity per station can provide some comparisons between years. In past surveys, average abundance was highest in 1994 (390.9 animals per station) and lowest in 1991 (172.5 animals per station); the 1998 survey yielded an average of 401.8 animals per station, higher than in any other year (Table 13). The greatest measure of species richness per station was in 1994 (52.1 species per station) and the lowest was in 1992 (36.6 species per station). The present survey yielded a mean of 42.8 species per station. The highest measure of mean species diversity was in 1990 (3.01) and lowest in 1994 (2.45); mean diversity in 1998 was 2.07, lower than in any other year. The low diversity of this year's survey was due to high numbers of a single species, *A. pygmaea*, at all stations. This phenomenon has been observed in past surveys, though not to the extent seen in the present survey. At the stations surveyed in 1998, species richness and diversity were greater offshore, a pattern consistent in all surveys since 1990. Abundance at the offshore stations was intermediate between Stations B2 and B3.

Table 13. Comparison of infaunal community parameters, 1990-1998. El Segundo and Scattergood Generating Stations NPDES, 1998.

Year	Abundance		Richness		Diversity	
	Total	Mean	Total	Mean	Total	Mean
1990†	1438	179.8	147	44.0	n.a.	3.01
1991†	1380	172.5	152	44.6	n.a.	3.00
1992†	1750	218.8	132	36.6	n.a.	2.50
1993†	1970	246.3	151	46.9	n.a.	2.76
1994†	3127	390.9	176	52.1	n.a.	2.45
1997†	1512	189.0	155	50.6	n.a.	2.81
1998*	1607	401.8	100	42.8	n.a.	2.07

† = eight stations

* = four stations

The pattern of species distribution, abundance, richness, and diversity for the 1998 infaunal analysis appears to be the result of natural processes. The Scattergood and El Segundo Generation Stations' discharges do not appear to have adversely impacted the nearshore or offshore infaunal communities.

Fish Impingement

Fish

Seven heat treatments were conducted at SGS and three at ESGS from 1 October 1997 to 30 September 1998. Almost 50% more species were impinged at Scattergood, with 5 to 8 times higher abundance and biomass, than at El Segundo. Biomass at both ESGS and SGS was lower than the 19-year average and the 12-year average, respectively. Compared to prior years, when there were typically eight heat treatments at ESGS, impingement was about 20% of 'normal'. Fifty-eight species were taken overall: 56 at SGS, and 38 at ESGS. The 15 most abundant species in 1998 were present at both stations and accounted for almost 97% of the combined abundance (Appendix G-2). All of the 22 species that occurred at only one station are common species in impingement catches and have occurred at both generating stations in the past. The bullseye puffer (*Sphoeroides annulatus*) is a warm water fish and rare in California. It had been taken previously at San Onofre Nuclear and Redondo Generating Stations in 1985 following the 1982-1984 El Niño. Likewise, the two new records, one from El Segundo in February 1998, and one from Scattergood in April 1998, follow the largest El Niño of the century which ended in March 1998.

Abundance at SGS was much higher than that at ESGS. Although several species were similarly abundant at the two stations, they made up much different compositions of the catch. Jacksmelt and salema, for instance, were almost identically abundant at each generating station, and each comprised over 23% of the abundance at ESGS, but were less than 5% at SGS. Conversely, white croaker accounted for almost 15% of the catch at SGS, but was less than 1% at ESGS. These differences are most likely a result of the fewer number of heat treatments at ESGS, and different water flow volumes into the generating stations.

Queenfish was the most abundant species in 1998 and was also most abundant overall in impingement catches during seven of the past nine years (Table 14). They are also a major portion of trawl catches in the nearshore Southern California Bight (MBC unpubl. trawl data). Queenfish is a schooling species abundant over sandy bottoms, and is most common at depths of 10 m (Allen 1982), which coincides with the depth of the intake structures. They form quiescent schools near the bottom in daytime, and disperse and feed in the water column at night (Love 1991), when they become susceptible to the intake currents.

White croaker was the second most abundant species in 1998, and was fourth in overall abundance for the last nine years (Table 14). White croaker is an important constituent of commercial and sport fisheries in California. Most of the commercial catch is sold as fresh fish, although a small amount is used for live bait. White croaker is common from British Columbia to Baja California, in loose schools from the surf zone to depths of 600 ft, and in shallow bays, sloughs, and lagoons (Leet et al. 1992). They are primarily nocturnal and tend to occur inshore during the day in resting schools, remaining nearshore at night to feed on bottom-dwelling polychaetes and crustaceans (Ware 1979, Allen 1982).

Pacific sardine was the third most abundant species in 1998. Pacific sardines have made a remarkable comeback after a disastrous decline in the fisheries in the early 1950s. Although impingement catches were sporadically monitored in the 1960s and broad scale monitoring commenced in the 1970s, it was not until 1993 that large numbers of sardines appeared in the impingement catches at ESGS and SGS. They have continued to be visitors near the power plants as evidenced by their regular impingement at the power plants since 1990 (MBC 1990-1994, 1997). They were twelfth in abundance overall since 1990, and have ranked among the top ten species since 1993 (Table 14). This parallels their recent rise in abundance in California waters as their population expands (Love 1991).

Table 14. Ranking of the most abundant fish species impinged during heat treatments, 1990-1998. El Segundo and Scattergood Generating Stations NPDES, 1998.

Species	Year									Average
	1990	1991	1992	1993	1994	1995	1996	1997	1998	
queenfish	1.0	1.0	5.0	1.0	4.0	1.0	1.0	1.0	1.0	1.8
topsmelt	4.0	2.0	2.0	6.0	6.0	3.0	3.0	5.0	4.0	3.9
salema	7.0	3.0	10.0	4.0	8.0	4.5	8.0	4.0	5.0	5.9
jacksmelt	12.0	17.0	6.0	3.0	2.0	6.0	5.0	2.0	6.0	6.6
white croaker	8.0	14.0	11.0	15.0	5.0	4.5	4.0	8.0	2.0	7.9
walleye surfperch	9.0	10.0	3.0	9.0	12.0	7.0	9.0	7.0	10.0	8.4
kelp bass	3.0	9.0	7.0	10.0	14.0	12.0	15.0	10.0	12.0	10.2
barred sandbass	6.0	8.0	9.0	14.0	9.0	14.0	11.0	12.0	11.0	10.4
blacksmith	2.0	5.0	4.0	8.0	11.0	11.0	18.0	16.0	22.0	10.8
sargo	5.0	7.0	8.0	5.0	10.0	21.0	20.0	15.0	7.0	10.9
yellowfin croaker	17.0	19.0	13.0	19.0	13.0	10.0	7.0	6.0	8.0	12.4
Pacific sardine	36.5	49.5	23.5	2.0	3.0	2.0	2.0	9.0	3.0	14.5
black croaker	18.0	15.0	17.0	18.0	15.0	17.0	17.0	13.0	9.0	15.4
northern anchovy	24.0	4.0	1.0	43.0	49.0	9.0	6.0	3.0	18.0	17.4
California grunion	10.0	12.0	-	17.0	33.0	8.0	36.0	11.0	17.0	16.0
white seaperch	16.0	11.0	15.0	13.0	20.0	20.0	12.0	14.0	42.0	18.1
Pacific butterfish	13.0	13.0	28.0	12.0	19.0	33.0	14.0	31.0	21.0	20.4
halfmoon	14.0	22.5	16.0	20.0	17.0	24.0	28.0	25.0	34.0	22.3
black perch	15.0	22.5	20.0	33.0	27.0	19.0	16.0	24.0	24.5	22.3
chub mackerel	50.0	46.5	12.0	7.0	7.0	13.0	13.0	26.0	35.0	23.3

Topsmelt and jacksmelt, from the Family Atherinidae, were abundant, ranking fourth and sixth, respectively, in 1998. They were, on average, second and fourth in abundance, respectively, for the last nine years (Table 14). Both species occur in great abundance in the inshore waters of Santa Monica Bay and are especially attracted to the discharge structures because of foraging opportunities (Stephens 1977). These two species are active during the day and quiescent at night; they have been observed in the impingement catch in great numbers immediately following tunnel reversal operations occurring during heat treatments conducted during daylight (Curtis, MBC, pers. obs.). Both species are frequently caught in the sportfishery, and are important prey items for several marine birds, but are seldom targeted by the commercial fish industry (Leet et al. 1992). Jacksmelt form larger, denser schools than topsmelt, and range over much of the inshore area of California (Leet et al. 1992).

Barred sand bass and kelp bass are important sportfish and are of concern to the resource agencies charged with their management. Barred sand bass are found near and on the bottom near the margins of reefs to which they are attracted as focal points for feeding, mating, and living area (Helvey and Smith 1985). Although barred sand bass populations are probably equally abundant in the ESGS and SGS areas, the single intake and discharge structures at SGS are the only focal points for the population in the vicinity, and they, therefore, attract a greater portion of the available nearshore population. The preponderance of focal points surrounding the ESGS area, such as the beach erosion groins, the Chevron discharge structure, and the two intake and discharge structures at ESGS, reduces the population pressure on any single area by attracting only a portion of the available population. Therefore, fewer individuals are attracted to the more risky areas near the intakes.

Kelp bass, on the other hand, are attracted to high-relief patch reefs, not as a focal point, but because prey availability is maximized at high current areas surrounding reefs and also at the intakes. The higher density of structures near the ESGS area probably attracts more kelp bass than the area near SGS because of the greater abundance of fish and invertebrates (all potential prey) associated with the increase in available niches. This species also actively swims in the water column, maintaining positive rheotaxis to the current flow, a behavior which exposes a greater portion of the population to the intake flow.

Four other typically abundant species were salema (*Xenistius californiensis*), walleye surfperch (*Hyperprosopon argenteum*), blacksmith (*Chromis punctipinnis*), and sargo (Table 14). Salema are mid-water schooling fishes found in shallow water (Love 1991). Walleye surfperch are nocturnal feeding species which form schools during the daylight hours (Love 1991). Blacksmith is a species that associates with reef structures, such as the intake, for foraging and shelter (Love 1991). Sargo are generally associated with reef structures, and forage for food near the sand margin (Love 1991). All four of these species have ranked among the top ten species at least four of the last nine years.

Length-frequency histograms of the queenfish, sargo, and kelp and barred sand bass populations indicated similar populations impinged at both SGS and at ESGS. Most histograms were relatively smooth curves, indicating that the intake is impinging a cross section of the population found in the nearshore waters.

The queenfish population distribution histogram was bimodal at both SGS and ESGS, with relatively fewer larger fish at ESGS. Queenfish were most abundant in the impingement catch at 80 mm SL at SGS, corresponding to young-of-the-year (YOTY) indicating the presence of a spring spawn. A second mode at 120 mm SL corresponds to two-year-old fish (Love 1991). At ESGS, queenfish were most abundant at 70 mm SL or one-year-old fish (Love 1991). These are probably the same age cohorts as the YOTY entrained earlier in the year at SGS. The lack of any heat treatments in the spring likely explains the lower abundance of larger fish at ESGS.

The majority of the sargo population at ESGS was centered around 250 mm SL, whereas, at SGS the population centered near 180 mm SL. Most of the fish at ESGS were greater than two years old, and mostly composed of age-four fish (Love 1991). The population distribution at SGS indicated the presence of a new year class as the YOTY were turning age-one (120 mm), with a large group of age-four fish as well. The differences between the two power plants probably is a result of the different timing of the heat treatment schedules, rather than an effect of the selectivity of the intake structure.

Entrained and impinged kelp bass and barred sand bass population ranged from YOTY to six-year-old individuals (50 to 300 mm SL) (Hulbrock 1974, Love 1991). At ESGS most of the fish of both species were age-one or older, with very few YOTY. At SGS, the kelp bass were mostly age-one to age-three (100 to 170 mm), while the barred sand bass were mostly age-three to age-six (200 to 300 mm). Other than the greater representation of YOTY, indicating a strong recruitment for both species, the population distributions for both species have been almost identical for the last eight years, indicating there have been no discernable effects on the populations offshore by the generating stations (MBC 1990-1994, 1997).

Abundant species were ranked for each of the last five years and ranks were then averaged to determine the most abundant species for the nine-year period (Table 14). At least 15 of these 20 most abundant species over the last nine years have occurred among the 20 most abundant during each year; all 20 of those species were present in 1998. This recurring core group of species demonstrates the stability of the community and suggests that the populations present offshore are not unduly stressed by the relatively minor loss due to entrainment.

Heat treatment data from ESGS Units 1 & 2 and Units 3 & 4 are available from 1979 to 1998 and from SGS from 1986 to 1998 (Table 15). Impingement biomass for 1998 at ESGS was about 50% of its long term mean, and at SGS it was only 85% of its long-term mean. Impingement data from SGS indicate that fish biomass was lowest in 1993, which was part of a trend of declining catches from a high in 1986. The large increase noted in 1994 and again in 1996 appears to be related to the chance increase in impingement of the larger pelagic schooling species such as jack mackerel, jacksmelt, and Pacific sardine. As these and other species increase in abundance, the catches appear to be increasing slightly.

Table 15. Biomass (kg) of fish impinged, 1979-1998. El Segundo and Scattergood Generating Stations NPDES, 1998.

	El Segundo			Scattergood
Year	1 & 2	3 & 4	Total	
1979	1440.83	2248.46	3689.29	NA
1980	1353.74	2455.43	3809.17	NA
1981	1269.96	2612.56	3882.52	NA
1982	579.83	1980.86	2560.69	NA
1983	1357.23	1366.87	2724.1	NA
1984	239.93	515.91	755.84	NA
1985	351.89	465.38	817.27	NA
1986	99.65	1615.39	1715.04	3224.05
1987	215.97	328.76	544.73	1698.68
1988	210.71	55.15	265.86	1722.23
1989	274.86	9.12	283.98	1289.27
1990	109.33	614.87	724.2	1447.22
1991	380.48	20.26	400.74	2028.61
1992	48.53	358.85	407.38	931.23
1993	51.51	1022.71	1074.22	828.82
1994	0.53	760.45	760.98	5902.55
1995	70.41	667.99	738.40	1092.18
1996	15.11	209.48	224.59	4178.14
1997	13.54	1712.60	1726.14	1005.58
1998	0.00	406.84	406.84	1780.62
Mean	404.20	971.40	1375.60	2086.86

NA = Data not available

The decrease in fish biomass at ESGS continues a trend seen beginning in 1984. Fish biomass at ESGS during the period from 1979 to 1983 averaged 3,333 kg per year, but since 1984, it has remained relatively low, averaging only 723 kg per year. The more than three-fold decrease in impingement was due to the decreased demand for power from ESGS following completion of Units 2 & 3 at San Onofre Nuclear Generating Station (SONGS) in 1983-1984. During this same period, SGS continued operating at normal levels. With increased capacity at SONGS, many of Southern California Edison's generating stations (including ESGS) have operated at much lower capacity and, more importantly for fish impingement, with fewer circulators running which has resulted in decreased flows at the intake and an exponential decline in impingement (Curtis, MBC, pers. obs.).

Macroinvertebrates

Macroinvertebrate catches were slightly greater at ESGS than at SGS. Rock crabs and red striped shrimp were the most abundant species at both generating stations. Abundances of two-spot octopus were similar between the two generating stations, but California spiny lobsters were much more abundant at SGS. Almost all of the California spiny lobsters at ESGS, and most of those at SGS, were greater than the legal size limit (approximately 83 mm carapace length) (CFD&G 1997). Overall species diversity was slightly lower compared to prior years, although abundance and biomass were higher this year than since 1992 (MBC 1990-1994, 1997). This may be a result of higher recruitment and greater growth rates during the warm water El Niño conditions present during most of 1997.

CONCLUSIONS

Water quality measurements indicated that the cooling water discharged from the El Segundo and Scattergood Generating Stations did not have an adverse effect on receiving waters in the study area. Only minor fluctuations of temperature, DO, and pH were detected in the surface and mid-water, all most likely due to temporal and spatial variations. Near the bottom at the offshore mid-water, all most likely due to temporal and spatial variations. Near the bottom at the offshore stations, all parameters decreased due to a seasonal upwelling of a cold, low DO water mass.

Sediments in the study area were mostly sand, with a mean grain size in the very fine sand category. Sediments were coarsest at nearshore Station B3, downcoast of the El Segundo discharge structures, and finest at nearshore Station B2, upcoast of the Scattergood discharge. No spatial patterns were apparent that would suggest effects from the Scattergood or El Segundo Generating Stations.

The distribution of metals in the sediments of the study area did not appear to be related to the generating station discharges. Highest concentrations were upcoast of the discharges and were related to the amount of fine material in the sediments. Concentrations of all metals were within ranges found in sediments in the Southern California Bight and below levels determined to be potentially toxic to benthic organisms.

The benthic infaunal community in the study area was similar to that of previous years. Species richness was below the average while abundance was above the average for the 1990 to 1997 surveys. However, this comparison is greatly influenced by the differences between this year's sampling program and that of past surveys. No pattern in species composition or abundance could be attributed to the Scattergood and El Segundo Generating Stations' discharges.

High diversity and abundance of the fish population entrained by the SGS and ESGS intakes suggest that a variety of niches are available near the discharge and intake structures. Continued high diversity and abundance of core species, as evidenced by impingement data from the last eight years, indicated that impingement at the Scattergood and El Segundo Generating Stations is not unduly influencing the fish and macroinvertebrate communities in the nearshore.

Overall, the results of the 1998 monitoring study indicate that the beneficial uses of the receiving water in the vicinity of the El Segundo and Scattergood Generating Stations continue to be maintained and protected.

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APPENDIX A

Receiving water monitoring specifications
El Segundo and Scattergood Generating Stations NPDES, 1998

California Regional Water Quality Control Board

Los Angeles Region

Peter M. Rooney
Secretary for Environmental Protection

Internet Address: http://www.swrcb.ca.gov
101 Centre Plaza Drive, Monterey Park, California 91754-2156
Phone (213) 266-7500 FAX (213) 266-7600

Pete Wilson
Governor

July 21, 1998

Mr. Kevin Herbinson
Environmental Affairs
Southern California Edison
P.O. Box 800
Rosemead, CA 91770

REVISION OF MONITORING AND REPORTING PROGRAMS FOR:
MANDALAY GENERATING STATION (CA0001180, M2093)
ORMOND BEACH GENERATING STATION (CA0001198, M5619)
EL SEGUNDO GENERATING STATION (CA0001147, M4667)
REDONDO GENERATING STATION (CA0001201, M0536)
LONG BEACH GENERATING STATION (CA0001171, M5764)
ALAMITOS GENERATING STATION (CA0001139, M6113)

As you know, staff from your agency, the Los Angeles Regional Board, and several other interested agencies have been working cooperatively over the past year to design the Southern California Bight 1998 Regional Marine Monitoring Survey (Bight'98). To allow your agency to participate in the Bight'98 survey, the United States Environmental Protection Agency and the Los Angeles Regional Water Quality Control Board have agreed to redirect a substantial portion of your normal receiving water monitoring effort for the current year towards this regional effort. Edison has agreed to provide a cash contribution of $85,556 to help fund the coastal ecology component of the Bight'98 survey. Please forward a check in this amount payable to the Southern California Coastal Water Research Project (7171 Fenwick Lane, Westminster, CA 92683).

The following receiving water monitoring requirements shall be modified for the current sampling year to allow participation in the Bight'98 regional monitoring survey:

MANDALAY GENERATING STATION

1) Discontinue water quality sampling at 12 shoreline/nearshore stations, 4 trawling stations (2 replicates) and 2 benthic infaunal stations during the summer sampling period. Eliminate sampling during the winter sampling period.

2) Retain summer sampling for compliance monitoring purposes at 6 shoreline/nearshore stations (RW1, RW2, RW5, RW16, RW11, RW17) and 3 benthic infaunal stations (B1, B2, B3).

ORMOND BEACH GENERATING STATION

1) Discontinue water quality sampling at 5 shoreline/nearshore stations and 3 benthic infaunal stations during the summer sampling period. Eliminate sampling during the winter sampling period.

2) Retain summer sampling for compliance monitoring purposes at 4 shoreline/nearshore stations (RW2, RW3, RW4, RW6) and 3 benthic infaunal stations (B2, B3, B4), and maintain bimonthly fish impingement monitoring.

EL SEGUNDO GENERATING STATION

1) Discontinue water quality sampling at 8 shoreline/nearshore stations and 4 benthic infaunal stations during the summer sampling period. Eliminate sampling during the winter sampling period.

2) Retain summer sampling for compliance monitoring purposes at 4 shoreline/nearshore stations (RW2, RW3, RW6, RW7) and 4 benthic infaunal stations (B2, B3, B6, B7), and maintain bimonthly fish impingement monitoring.

REDONDO GENERATING STATION

1) Discontinue water quality sampling at 9 shoreline/nearshore stations, 4 trawling stations (2 replicates) and 2 benthic infaunal stations during the summer sampling period. Eliminate sampling during the winter sampling period.

2) Retain summer sampling for compliance monitoring purposes at 7 shoreline/nearshore stations (RW1, RW2, RW4, RW10, RW11, RW14) and 4 benthic infaunal stations (B1, B2, B4, B6).

LONG BEACH GENERATING STATION

1) Discontinue water quality sampling at 5 shoreline/nearshore stations, 3 trawling stations (2 replicates) and 3 benthic infaunal stations during the summer sampling period. Eliminate sampling during the winter sampling period.

2) Retain summer sampling for compliance monitoring purposes at 3 shoreline/nearshore stations (RW5, RW7, RW11H) and 3 benthic infaunal stations (B8, B9, B10), as well as 3 intertidal/subtidal survey stations.

ALAMITOS GENERATING STATION

1) Discontinue water quality sampling at 7 shoreline/nearshore stations, 6 trawling stations (2 replicates) and 5 benthic infaunal stations during the summer sampling period. Eliminate sampling during the winter sampling period.

2) Retain summer sampling for compliance monitoring purposes at 5 shoreline/nearshore stations (RW1, RW2, RW10, RW11, RW12) and 3 benthic infaunal stations (B1, B2, B3, B4).

Upon completion of the Bight'98 regional survey, you will be required to resume your normal receiving water monitoring program, as previously agreed. Of course, after the results from the Bight'98 survey have been evaluated, we may decide to modify the existing monitoring programs or repeat regional surveys periodically.

We appreciate your participation in the planning and implementation of a comprehensive regional monitoring program for the Southern California Bight's marine coastal waters. The data obtained from the Bight'98 survey should prove very useful to all parties involved in the protection of water quality, resources and beneficial uses of our ocean.

If you have any questions about the changes to your monitoring program, please contact Michael Lyons, Coastal Waters Program, at (323) 266-7616.

DENNIS A. DICKERSON
Executive Officer

California Regional Water Quality Control Board

Los Angeles Region

Peter M. Rooney
Secretary for Environmental Protection

Internet Address: http://www.swrcb.ca.gov
101 Centre Plaza Drive, Monterey Park, California 91754-2156
Phone (213) 266-7500 FAX (213) 266-7600

Pete Wilson
Governor

July 21, 1998

Ms. Susan Damron
Environmental Affairs Officer
City of Los Angeles, Department of Water & Power
111 North Hope St., Room 1116
Los Angeles, CA 90012

REVISION OF MONITORING AND REPORTING PROGRAMS FOR:
HAYNES GENERATING STATION (CA0000353, M2769)
SCATTERGOOD GENERATING STATION (CA0000370, M1886)
HARBOR GENERATING STATION (CA0000361, M2020)

As you know, staff from your agency, the Los Angeles Regional Board, and several other interested agencies have been working cooperatively over the past year to design the Southern California Bight 1998 Regional Marine Monitoring Survey (Bight'98). To allow your agency to participate in the Bight'98 survey, the United States Environmental Protection Agency and the Los Angeles Regional Water Quality Control Board have agreed to redirect a substantial portion of your normal receiving water monitoring effort for the current year towards this regional effort. We understand that you will arrange to have samples collected and analyzed by the City of Los Angeles' Environmental Monitoring Division to fulfil your commitment to the Bight'98 survey.

The following receiving water monitoring requirements shall be modified for the current sampling year to allow participation in the Bight'98 regional monitoring survey:

HAYNES GENERATING STATION

1) Discontinue water quality sampling at 7 shoreline/nearshore stations, 6 trawling stations (2 replicates) and 5 benthic infaunal stations during the summer sampling period.

2) Retain sampling for compliance monitoring purposes at 5 shoreline/nearshore stations (RW1, RW2, RW10, RW11, RW12) and 4 benthic infaunal stations (B1, B2, B3, B4).

SCATTERGOOD GENERATING STATION

1) Discontinue water quality sampling at 8 shoreline/nearshore stations and 4 benthic infaunal stations during the summer and winter sampling periods.

2) Retain sampling for compliance monitoring purposes at 4 shoreline/nearshore stations (RW2, RW3, RW6, RW7) and 4 benthic infaunal stations (B2, B3, B6, B7), as well as bimonthly fish impingement monitoring.

HARBOR GENERATING STATION

1) Discontinue water quality sampling at 2 shoreline/nearshore stations, 2 trawling stations (2 replicates) and 2 benthic infaunal stations during the summer and winter sampling periods.

2) Retain sampling for compliance monitoring purposes at 1 shoreline/nearshore station (RW1) and 1 benthic infaunal station (B1).

Upon completion of the Bight'98 regional survey, you will be required to resume your normal receiving water monitoring program, as previously agreed. Of course, after the results from the Bight'98 survey have been evaluated, we may decide to modify the existing monitoring programs or repeat regional surveys periodically.

We appreciate your participation in the planning and implementation of a comprehensive regional monitoring program for the Southern California Bight's marine coastal waters. The data obtained from the Bight'98 survey should prove very useful to all parties involved in the protection of water quality, resources and beneficial uses of our ocean.

If you have any questions about the changes to your monitoring program, please contact Michael Lyons, Coastal Waters Program, at (323) 266-7616.

DENNIS A. DICKERSON
Executive Officer

cc: Fazi Mofidi, City of Los Angeles, Department of Water and Power

Monitoring and Reporting Program No. 1886 CA0000370
Scattergood Generating Station

III. RECEIVING WATER MONITORING

A. Regional Monitoring Program

1. Pursuant to the Code of Federal Regulation [40 CFR §122.41(j) and §122.48(b)], the monitoring program for a discharger receiving a National Pollutant Elimination System (NPDES) permit must determine compliance with NPDES permit terms and conditions, and demonstrate that State water quality standards are met.

2. Since compliance monitoring focuses on the effects of point source discharge, it is not designed to assess impacts from other sources of pollution (e.g., non-point source run-off, aerial fallout) nor to evaluate the current status of important ecological resources on a regional basis.

Several efforts are underway to develop and implement a comprehensive regional monitoring program for the Southern California Bight. These efforts have the support and participation from regulatory agencies, dischargers, and environmental groups. The goal is to establish a regional program to address public health concerns, monitor trends in natural resources and nearshore habitats, and assess regional impacts from all contaminant sources.

3. A pilot regional monitoring program was conducted during the summer of 1994 to test an alternative sampling design that combines elements of compliance monitoring with a broader regional assessment approach. This pilot program was designed by USEPA, the State Water Resources Control Board, and three Regional Water Quality Control Boards (Los Angeles, Santa Ana, San Diego) in conjunction with the Southern California Coastal Water Research Project and participating discharger agencies.

4. The results of the pilot program will be evaluated and used to redesign the current monitoring program and to develop a comprehensive regional monitoring program for the Southern California Bight. At the same time, the monitoring programs conducted by other dischargers and agencies will be integrated into this regional program. If predictable relationships among the biological, water quality, and effluent monitoring variables can be demonstrated, it may be appropriate to decrease the sampling effort. Conversely, the monitoring program may be intensified if it appears that the objectives cannot be achieved through the existing monitoring program. In general, the goal is a more efficient monitoring program that can be used for both compliance and regional bight-wide assessments.

5. Substantial changes to the compliance monitoring program for this generating station may be required over the next few years to fulfill the goals of regional monitoring, while retaining the compliance monitoring component required to evaluate the potential impacts from the NPDES discharge. Revisions to the existing program will be made under the discretion of the USEPA and the Los Angeles Regional Board as necessary to accomplish this goal; and may include a reduction or increase in the number of parameters to be monitored, the frequency of monitoring, or the number, type, and location of samples collected.

B. Regional Database

1. Development and implementation of an information management system to support integrated analysis and transfer of monitoring program data is required so that management decisions for the protection of beneficial uses and public resources can be based on an evaluation of all available information. This represents one significant component of the action plan developed for the Santa Monica Bay Restoration Project. The Los Angeles Regional Board supports this goal and plans to move forward by establishing a Regional Database containing discharger monitoring data and other pertinent information submitted to or collected by the Regional Board and other agencies.

2. Southern California Edison (SCE) and the City of Los Angeles Department of Water and Power (DWP) have indicated a desire to assist the Regional Board in establishing this regional database system. This could be accomplished by diverting a portion of the resources normally dedicated to the power plant's annual receiving water monitoring programs into the creation of a database and associated analytical tools.

3. USEPA and the Los Angeles Regional Board believe that the existing monitoring programs for SCE's and DWP's generating stations will be substantially revised when these programs are integrated into a comprehensive regional monitoring program. These revisions are expected to be implemented within the next two years.

4. Although the monitoring conducted over the past several years has demonstrated an increase in temperature in the receiving waters around the discharge points of the generating stations, no adverse impacts to benthic infaunal or fish communities have been documented. Therefore, until the monitoring programs are revised for inclusion into a comprehensive regional program, USEPA and the Los Angeles Regional Board would have no objection to reducing the receiving water monitoring required for compliance monitoring purposes, provided that SCE and DWP help fund the creation of a regional database. Upon approval by the Executive Officer, SCE and DWP may implement such a plan in lieu of the Receiving Water Monitoring specified below.

C. <u>Receiving Water Sampling Stations</u>.

The receiving water monitoring program shall consist of periodic biological surveys of the area surrounding the discharge, and shall include studies of those physical-chemical characteristics of the receiving waters which may be impacted by the discharge.

This program may be performed as a joint effort with the Southern California Edison Company in connection with the receiving water monitoring program for the El Segundo Generating Station.

Location of Sampling Stations (see Attached figure)

1. Receiving water stations shall be located as follows:

   a. Station RW1 - 7,875 feet upcoast of the Scattergood discharge terminus, at a depth of 20 feet.

   b. Station RW2 - 1,000 feet upcoast of the Scattergood discharge terminus, at a depth of 20 feet.

   c. Station RW3 - 1,750 feet downcoast of the El Segundo discharge terminus, at a depth of 20 feet.

   d. Station RW4 - 9,900 feet downcoast of the El Segundo discharge terminus, at a depth of 20 feet.

   e. Station RW5 - directly offshore of Station RW1, at a depth of 40 feet.

   f. Station RW6 - directly offshore of Station RW2, at a depth of 40 feet.

   g. Station RW7 - directly offshore of Station RW3, at a depth of 40 feet.

   h. Station RW8 - directly offshore of Station RW4, at a depth of 40 feet.

   i. Station RW9 - directly offshore of Station RW1, at a depth of 60 feet.

   j. Station RW10 - directly offshore of Station RW2, at a depth of 60 feet.

k. Station RW11 - directly offshore of Station RW3, at a depth of 60 feet.

l. Station RW12 - directly offshore of Station RW4, at a depth of 60 feet.

2. Benthic stations shall be located as follows:

Stations B1 though B8 shall be located directly beneath Stations RW1 through RW8, respectively.

D. Type and Frequency of Sampling:

1. Temperature profiles shall be measured semi-annually (summer and winter) each year at Stations RW1 through RW12 from surface to bottom at a minimum of one-meter intervals. Dissolved oxygen levels and pH shall be measured semi-annually at the surface, mid-depth and bottom at each station, at a minimum. All stations shall be sampled on both a flooding tide and an ebbing tide during each semi-annual survey.

2. Impingement sampling for fish and commercially important macroinvertebrates shall be conducted at least once every two months at Intake No. 001. Impingement sampling shall coincide with heat treatments.

Fish and macroinvertebrates shall be identified to the lowest possible taxon. For each intake point, data reported shall include numerical abundance of each fish and macro-invertebrate species, wet weight of each species (when combined weight of individuals of one species exceeds 0.2 kg), number of individuals in each 1-centimeter size class (based on standard length) for each species and total number of species and individuals collected. When large numbers of a given species are collected, length/weight data need only be recorded for 50 individuals and total number and total weight may be estimated.

3. During the first year of the permit, native California mussels (Mytilus calfornianus) shall be collected during the summer from the discharge conduit, as close to the point of discharge as possible, for bioaccumulation monitoring. The mussels shall be collected and analyzed as described in Appendix A of the "California State

Mussel Watch Marine Water Quality Monitoring Program 1985-86" (Water Quality Monitoring Report No. 87-2WQ). Mussel tissue shall be analyzed for copper, chromium, nickel and zinc, at a minimum.

The first year's data will be carefully evaluated and the Executive Officer shall decide whether to continue, modify or eliminate the mussel sampling component of the monitoring program.

4. Benthic sampling shall be conducted annually during the summer at Stations B1 through B8.

   a. One liter sediment core samples shall be collected by divers at each of the benthic stations for biological examination and determination of biomass and diversity, and for sediment analyses. Four replicates shall be obtained at each station for benthic analyses, and each shall be analyzed separately. A fifth sample shall be taken at each station for sediment analyses and general description.

   b. Each benthic replicate sample shall be sieved through a 0.5 mm standard mesh screen. All organisms recovered shall be enumerated and identified to the lowest taxon possible. Infaunal organisms shall be reported as concentrations per liter for each replicate and each station. Total abundance, number of species and Shannon-Weiner diversity indices shall be calculated (using natural logs) for each replicate and each station.

   Biomass shall be determined as the wet weight in grams or milligrams retained on a 0.5 millimeter screen per unit volume (e.g., 1 liter) of sediment. Biomass shall be reported for each major taxonomic group (e.g., polychaetes, crustaceans, mollusks) for each replicate and each station.

   c. Sediment grain size analyses shall be performed on each sediment sample (sufficiently detailed to calculate percent weight in relation to phi size). During the first year of the permit, sub-samples (upper two centimeters) shall be taken from each sediment sample and analyzed for copper, chromium, nickel and zinc.

The first year's data will be carefully evaluated and the Executive Officer shall decide whether to continue, modify or eliminate the mussel sampling component of the monitoring program.

5. The following general observations or measurements at receiving water and benthic stations shall be reported.

   a. Tidal stage and time of monitoring.

   b. General water conditions.

   c. Extent of visible turbidity or color patches.

   d. Appearance of oil films or grease, or floatable material.

   e. Depth at each station for each sampling period.

   f. Presence or absence of red tide.

   g. Presence of marine life.

   h. Presence and activity of the California least tern and the California brown pelican.

SUMMARY OF RECEIVING WATER MONITORING

Parameter	Units	Stations	Type of Sample	Minimum Frequency
Temperature	°C	RW1-RW12	vertical profile	semi-annually (flood, ebb)
Dissolved oxygen	mg/l	RW1-RW12	vertical profile	semi-annually (flood, ebb)
pH	pH	RW1-RW12 units	vertical profile	semi-annually (flood, ebb)
Fish and macro invertebrates	---	Intakes No. 001	impingement	bi-monthly
Mussels	___	Discharge	tissue	annually
Benthic infauna	---	B1-B8	grab	annually
Sediments	---	B1-B8	grab	annually

E. Chlorine Residual Study

Pursuant to Section 301(g), the Discharger has applied for variance from the residual chlorine effluent limitation based on Ocean Plan objectives. If the USEPA approves the variance request, the Discharger shall conduct a study to demonstrate that there is no significant adverse impact on the receiving water as a result of the discharge of higher levels of residual chlorine. Within 90 days following the USEPA's final approval of the variance request, the Discharger shall submit a study plan to the Regional Board for approval by the Executive Officer and the Discharger shall implement the study plan within 90 days.

IV. Storm Water Pollution Prevention Plan (SWPP) Monitoring and Reporting

The discharger shall implement the attached Stormwater Monitoring and Reporting Program (Attachment 1).

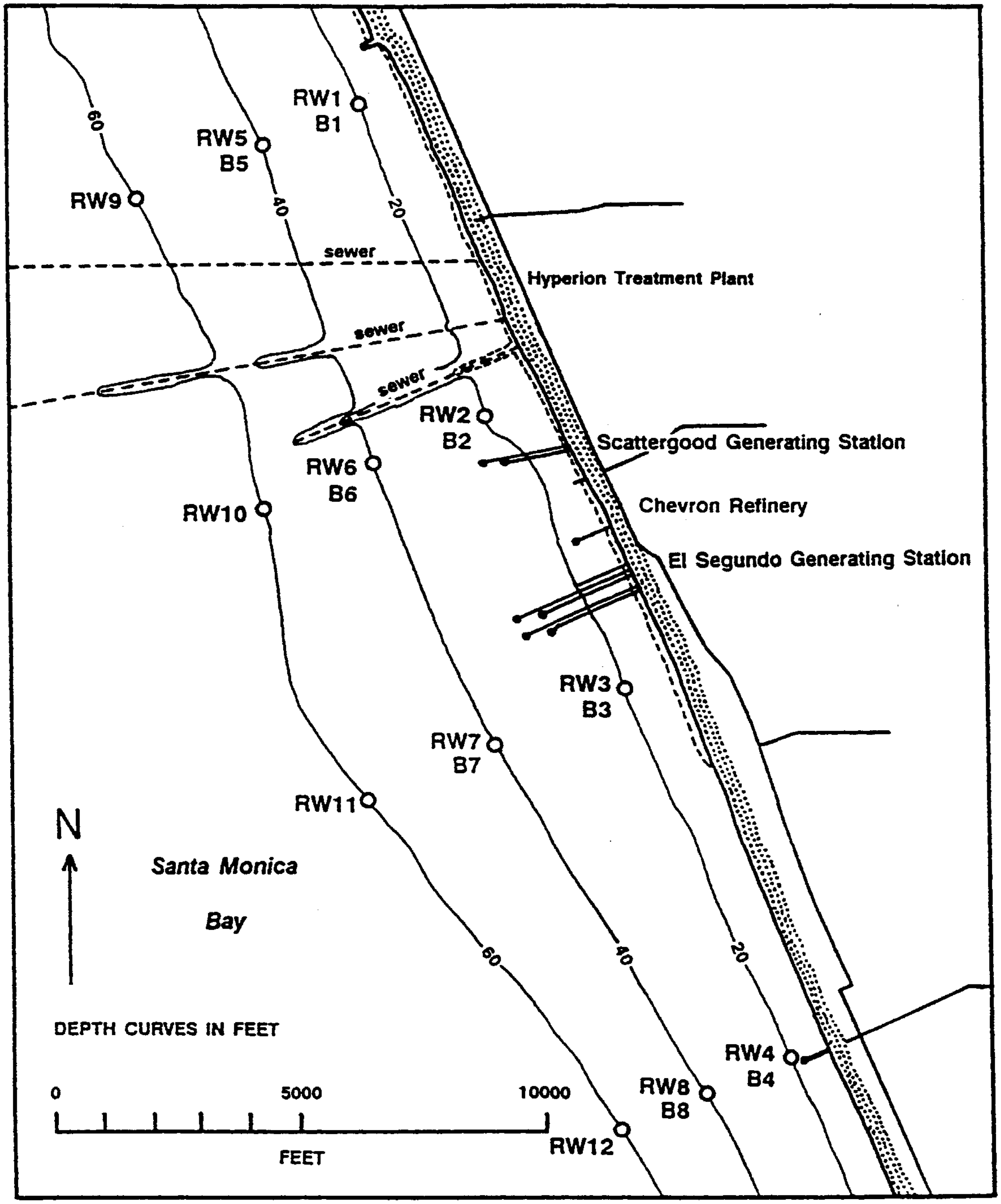
Ordered by: Robert P. Ghirelli
ROBERT P. GHIRELLI, D.Env.
Executive Officer

Date: February 27, 1995

CDS\

Appendix A-3. (Cont.).

Monitoring and Reporting Program No. 1886 CA0000370
City of Los Angeles, Dept. of Water and Power
Scattergood Generating Station



Scattergood Receiving Water Monitoring Stations.

Southern California Edison
El Segundo Generating Station
Monitoring and Reporting Program No. 4667

CA0001147

III. RECEIVING WATER MONITORING

A. Regional Monitoring Program

1. Pursuant to the Code of Federal Regulation [40 CFR §122.41(j) and §122.48(b)], the monitoring program for a discharger receiving a National Pollutant Elimination System (NPDES) permit must determine compliance with NPDES permit terms and conditions, and demonstrate that State water quality standards are met.

2. Since compliance monitoring focuses on the effects of point source discharge, it is not designed to assess impacts from other sources of pollution (e.g., non-point source run-off, aerial fallout) nor to evaluate the current status of important ecological resources on a regional basis.

   Several efforts are underway to develop and implement a comprehensive regional monitoring program for the Southern California Bight. These efforts have the support and participation from regulatory agencies, dischargers, and environmental groups. The goal is to establish a regional program to address public health concerns, monitor trends in natural resources and nearshore habitats, and assess regional impacts from all contaminant sources.

3. A pilot regional monitoring program was conducted during the summer of 1994 to test an alternative sampling design that combines elements of compliance monitoring with a broader regional assessment approach. This pilot program was designed by USEPA, the State Water Resources Control Board, and three Regional Water Quality Control Boards (Los Angeles, Santa Ana, San Diego) in conjunction with the Southern California Coastal Water Research Project and participating discharger agencies.

4. The results of the pilot program will be evaluated and used to redesign the current monitoring program and to develop a comprehensive regional monitoring program for the Southern California Bight. At the same time, the monitoring programs conducted by other dischargers and agencies will be integrated into this regional program. If predictable relationships among the biological, water quality, and effluent monitoring variables can be demonstrated, it may be appropriate to decrease the sampling effort. Conversely, the monitoring program may be intensified if it appears that the objectives cannot be achieved through the existing monitoring program. In general, the goal is a more efficient monitoring program that can be used for both compliance and regional bight-wide assessments.

5. Substantial changes to the compliance monitoring program for this generating station may be required over the next few years to fulfill the goals of regional monitoring, while retaining the compliance monitoring component required to evaluate the potential impacts from the NPDES discharge. Revisions to the existing program will be made under the discretion of the USEPA and the Los Angeles Regional Board as necessary to accomplish this goal; and may include a reduction or increase in the number of parameters to be monitored, the frequency of monitoring, or the number, type, and location of samples collected.

B. Regional Database

1. Development and implementation of an information management system to support integrated analysis and transfer of monitoring program data is required so that management decisions for the protection of beneficial uses and public resources can be based on an evaluation of all available information. This represents one significant component of the action plan developed for the Santa Monica Bay Restoration Project. The Los Angeles Regional Board supports this goal and plans to move forward by establishing a Regional Database containing discharger monitoring data and other pertinent information submitted to or collected by the Regional Board and other agencies.

2. Southern California Edison (SCE) and the City of Los Angeles Department of Water and Power (DWP) have indicated a desire to assist the Regional Board in establishing this regional database system. This could be accomplished by diverting a portion of the resources normally dedicated to the power plant's annual receiving water monitoring programs into the creation of a database and associated analytical tools.

3. USEPA and the Los Angeles Regional Board believe that the existing monitoring programs for SCE's and DWP's generating stations will be substantially revised when these programs are integrated into a comprehensive regional monitoring program. These revisions are expected to be implemented within the next two years.

4. Although the monitoring conducted over the past several years has demonstrated an increase in temperature in the receiving waters around the discharge points of the generating stations, no adverse impacts to benthic infaunal or fish communities have been documented. Therefore, until the monitoring programs are revised for inclusion into a comprehensive regional program, USEPA and the Los Angeles Regional Board would have no objection to reducing the receiving monitoring required for compliance monitoring purposes, provided that SCE and DWP help fund the creation of a regional database. Upon approval by the Executive Officer, SCE and DWP may implement such a plan in lieu of the Receiving Water Monitoring specified below.

C. Receiving Water Monitoring

The receiving water monitoring program shall consist of periodic biological surveys of the area surrounding the discharge, and shall include studies of those physical - chemical characteristics of the receiving waters which may be impacted by the discharge.

This program may be performed as a joint effort with the City of Los Angeles' Department of Water and Power in connection with the receiving water monitoring program for the Scattergood Generating Station.

Location of Sampling Stations (see Attached Figure 3):

Southern California Edison
El Segundo Generating Station
Monitoring and Reporting Program No. 4667

CA0001147

1. Receiving water stations shall be located as follows:

   a. RW1 - 7,875 feet upcoast of the Scattergood discharge terminus, at a depth of 20 feet.

   b. RW2 - 1,000 feet upcoast of the Scattergood discharge terminus, at a depth of 20.

   c. RW3 - 1,750 feet downcoast of the El Segundo discharge terminus, at a depth of 20 feet.

   d. RW4 - 9,900 feet downcoast of the El Segundo discharge terminus, at a depth of 20 feet.

   e. RW5 - directly offshore of Station RW1, at a depth of 40 feet.

   f. RW6 - directly offshore of Station RW2, at a depth of 40 feet.

   g. RW7 - directly offshore of station RW3, at a depth of 40 feet.

   h. RW8 - directly offshore of Station RW4, at a depth of 40 feet.

   i. RW9 - directly offshore of Station RW1, at a depth of 60 feet.

   j. RW10 - directly offshore of Station RW2, at a depth of 60 feet.

   k. RW11 - directly offshore of Station RW3, at a depth of 60 feet.

   l. RW12 - directly offshore of Station RW4, at a depth of 60 feet.

2. Benthic stations shall be located as follows:

   Stations B1 through B8 shall be located directly beneath Stations RW1 through RW8, respectively.

D. Type and Frequency of Sampling:

1. Temperature profiles shall be measured semi.annually (summer and winter) each year at Stations RW1 through RW12 from surface to bottom at a minimum of on-meter intervals. Dissolved oxygen levels and pH shall be measured semi-annually at the surface, mid-depth and bottom at each station, at a minimum. All stations shall be sampled on both a flooding tide and an ebbing tide during each semi-annual survey.

2. Impingement sampling for fish and commercially important macroinvertebrates shall be conducted at least once every two months at Intake Nos. 001 and 002. Impingement sampling shall coincide with heat treatments.

   Fish and macroinvertebrates shall be identified to the lowest possible taxon. For each intake point, data reported shall include numerical abundance of each fish and macroinvertebrate species, wet weight of each species (when combined weight of individuals in each species exceeds 0.2 kg), number of individuals in each 1-centimeter size class (based on standard length) for each species and total number of species are collected. When large numbers of given species are collected, length/weight data need only be recorder for 50 individuals and total number and total weight may be estimated.

3. Native California mussels (Mytilus Calfornianus) shall be collected during the summer from the discharge conduit, as close to the point of discharge as possible, for bioaccumulation monitoring. The mussels shall be collected and analyzed as described in Appendix A of the "California State Mussel Watch Marine Water Quality Monitoring Program 1985-86" (Water Quality Monitoring Report No. 87-2WQ). Mussel tissue shall be analyzed for copper, chromium, nickel and zinc at a minimum.

4. Benthic sampling shall be conducted annually during the summer at Stations B1 through B8.

   a. One liter sediment core samples shall be collected by divers at each of the benthic stations for biological examination and determination of biomass and diversity, and for sediment analyses. Four replicates shall be obtained at each station for benthic analyses, and each shall be analyzed separately. A fifth sample shall be taken at each station for sediment analyses and general description.

b. Each benthic replicate sample shall be sieved through a 0.5 mm standard mesh screen. All organisms recovered shall be enumerated and identified to the lowest taxon possible. Infaunal organisms shall be reported as concentrations per liter for each replicate and each station. Total abundance, number of species and Shannon-Weiner diversity indices shall be calculated (using natural logs) for each replicate and each station.

   Biomass shall be determined as the wet weight in grams or milligrams retained on a 0.5 millimeter screen per unit volume (e.g., 1 liter) of sediment. Biomass shall be reported for each major taxonomic group (e.g., polychaetes, crustaceans, mollusks) for each replicate and each station.

c. Sediment grain size analyses shall be performed on each sediment sample (sufficiently detailed to calculate percent weight in relation to phi size). Sub samples (upper two centimeters) shall be taken from each sediment sample and analyzed for copper, chromium, nickel and zinc.

5. The following general observations or measurements at the receiving water and benthic stations shall be reported.

   a. Tidal stage and time of monitoring.

   b. General water conditions.

   c. Extent of visible turbidity or color patches.

   d. Appearance of oil films or grease, or floatable material.

   e. Depth at each station for each sampling period.

   f. Presence or absence of red tide.

g. Presence of marine life.

h. Presence and activity of the California least tern and the California brown pelican.

6. During periodic maintenance of the intake structures and discharge of calcareous material to the receiving waters, the following observations or measurements shall be recorded and reported in the next monitoring report:

   a. Date and times of discharge(s).

   b. Estimate of volume and weight of discharge(s).

   c. Composition of discharge(s).

   d. General water conditions and weather conditions.

   e. Appearance and extent of any oil films or grease, floatable material or odors.

   f. Appearance and extent of visible turbidity or color patches.

   g. Presence of marine life.

   h. Presence and activity of the California least tern and the California brown pelican.

SUMMARY OF RECEIVING WATER MONITORING

Constituents	Units	Station No.	Type of Sample	Minimum Frequency of Analysis
Temperature	°C	RW1-RW12	vertical profile	semi-annually (flood, ebb)
Dissolved oxygen	mg/l	RW1-RW12	vertical profile	semi-annually (flood, ebb)
pH	pH units	RW1-RW12	vertical profile	semi-annually (flood, ebb)
Fish and macro invertebrates	---	Intakes No. 001 and 002	impingement	bi-monthly
Mussels	---	Discharge	tissue	annually
Benthic infauna	---	B1-B8	grab	annually
Sediments	---	B1-B8	grab	annually

E. Chlorine Residual Study

Pursuant to Section 301(g), the discharger has applied for a variance from the residual chlorine effluent limitation based on Ocean Plan objectives. If the USEPA approves the variance request, the discharger shall conduct a study to demonstrate that there is no significant adverse impact on the receiving water as a result of the discharge of higher levels of residual chlorine. Within 90 days following the USEPA's final approval of the variance request, the discharger shall submit a study plan for approval by Executive officer and the Discharger shall implement the approved study within 90 days of approval.

IV. STORM WATER MONITORING AND REPORTING

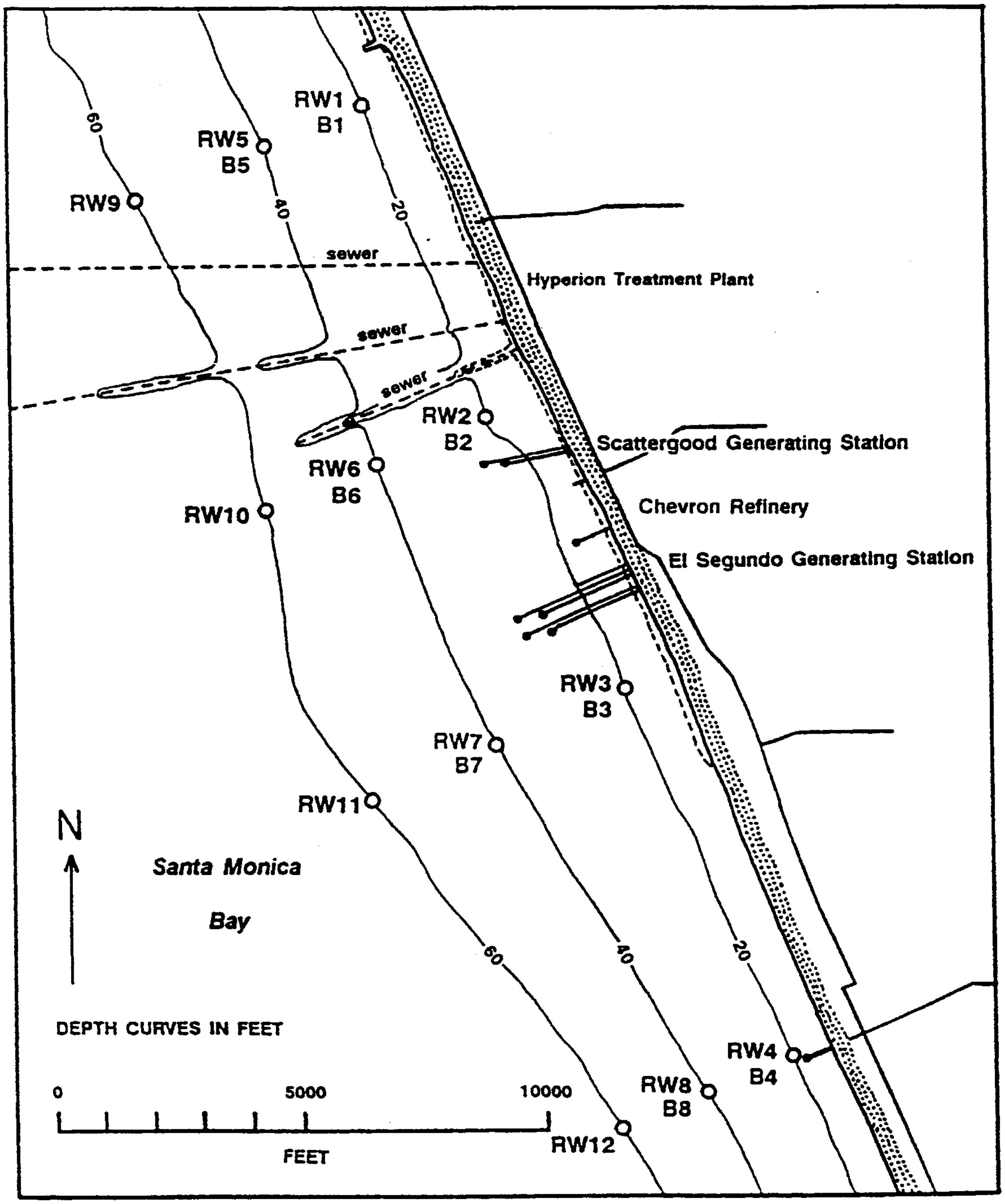
The discharger shall implement the attached Storm Water Monitoring and Reporting Program (Attachment 1).

Ordered By: [signature]
ROBERT P. GHIRELLI, D.Env.
Executive Officer

Date: December 5, 1994

/RNA

Monitoring and Reporting Program No. 4667 CA0001147
Southern California Edison
El Segundo Generating Station



El Segundo Receiving Water Monitoring Stations.

APPENDIX B

Grain size techniques
El Segundo and Scattergood Generating Stations NPDES, 1998

Appendix B. Grain size techniques.

Sediment Grain Size Analysis

Analysis of sediment samples for size distribution characteristics are performed using two techniques. Sediments in the sand size range (2.0 mm through 0.063 mm in diameter) are analyzed using a series of standard sieves having screen openings of 0.5 phi increments (diameter in phi units = $-\log_2$ diameter in mm, or = -ln diameter in mm ÷ ln 2). The silt-clay fraction of the sediments [4 phi through 8 phi (0.063 mm through >0.0039 mm) for silt, 8 phi and greater for clay (0.0039 mm and smaller)] is analyzed by the hydrometer method. The sample is suspended in a column of water and changes in density of the suspension (produced by the various settling rates of different size particles) is measured over time with a hydrometer.

The weight of sediment retained on each screen and density and time interval data from the hydrometer analysis are entered into a computer program which calculates and prints size-distribution characteristics and plots both interval and cumulative frequency distribution curves.

Analysis of the plotted cumulative size frequency curves is performed as described by Inman (1952). The median, 5th, 16th, 84th, and 95th percentiles (converted to phi notation) of the sediment distribution curve is used to calculate mean grain size diameter, sorting coefficient, and measures of skewness and kurtosis. Where sediment distribution coincides with a normal distribution curve, the 16th and 84th percentiles represent diameters one standard deviation on either side of the mean. The following formulas are used in the calculations:

1. Mean Diameter (M_ϕ) is the average particle size in the central 68% of the distribution.

$$M_\phi = (\phi_{16} + \phi_{50} + \phi_{84}) / 3$$

2. Sorting (σ_ϕ) measures the uniformity (or non-uniformity) of particle quantities in each size category of the sediment distribution.

$$\sigma_\phi = \frac{\phi_{84} - \phi_{16}}{4} + \frac{\phi_{95} - \phi_5}{6.6}$$

Sharp and Fan (1963) sorting is another measure of the evenness with which particles are apportioned among size classes. The index ranges from 0 to 100 (i.e., essentially a percentile measure), with 0 indicating that particles are distributed absolutely evenly among size classes and 100 being completely sorted (i.e., all particles falling within a single size class).

3. Skewness (α_ϕ) is a measure of the direction and extent of departure of the mean from the median (in a normal or symmetrical curve they coincide). In symmetrical curves, α_ϕ=0.00 with limits of -1.00 and +1.00. Negative values indicate the particle distribution is skewed toward larger particle diameters, while positive values indicate the distribution is skewed toward smaller particle diameters.

$$\alpha_\phi = \frac{\phi_{16} + \phi_{84} - 2\phi_{50}}{2(\phi_{84} - \phi_{16})} + \frac{\phi_5 + \phi_{95} - 2\phi_{50}}{2(\phi_{95} - \phi_5)}$$

4. Kurtosis (β_ϕ) is a measure of how far the sediment distribution curve departs from a normal Gaussian shape at its peak. Curves with greater than normal amounts of sediment at their modes will be sharp or leptokurtic ($\beta_\phi > 1$). Those with fatter tails and lower peaks than expected are termed platykurtic ($\beta_\phi < 1$). β_ϕ = 1.00 for a normal curve. Curve category interpretations are based on Folk (1974).

$$\beta_\phi = \frac{\phi_{95} - \phi_5}{2.44(\phi_{75} - \phi_{25})}$$

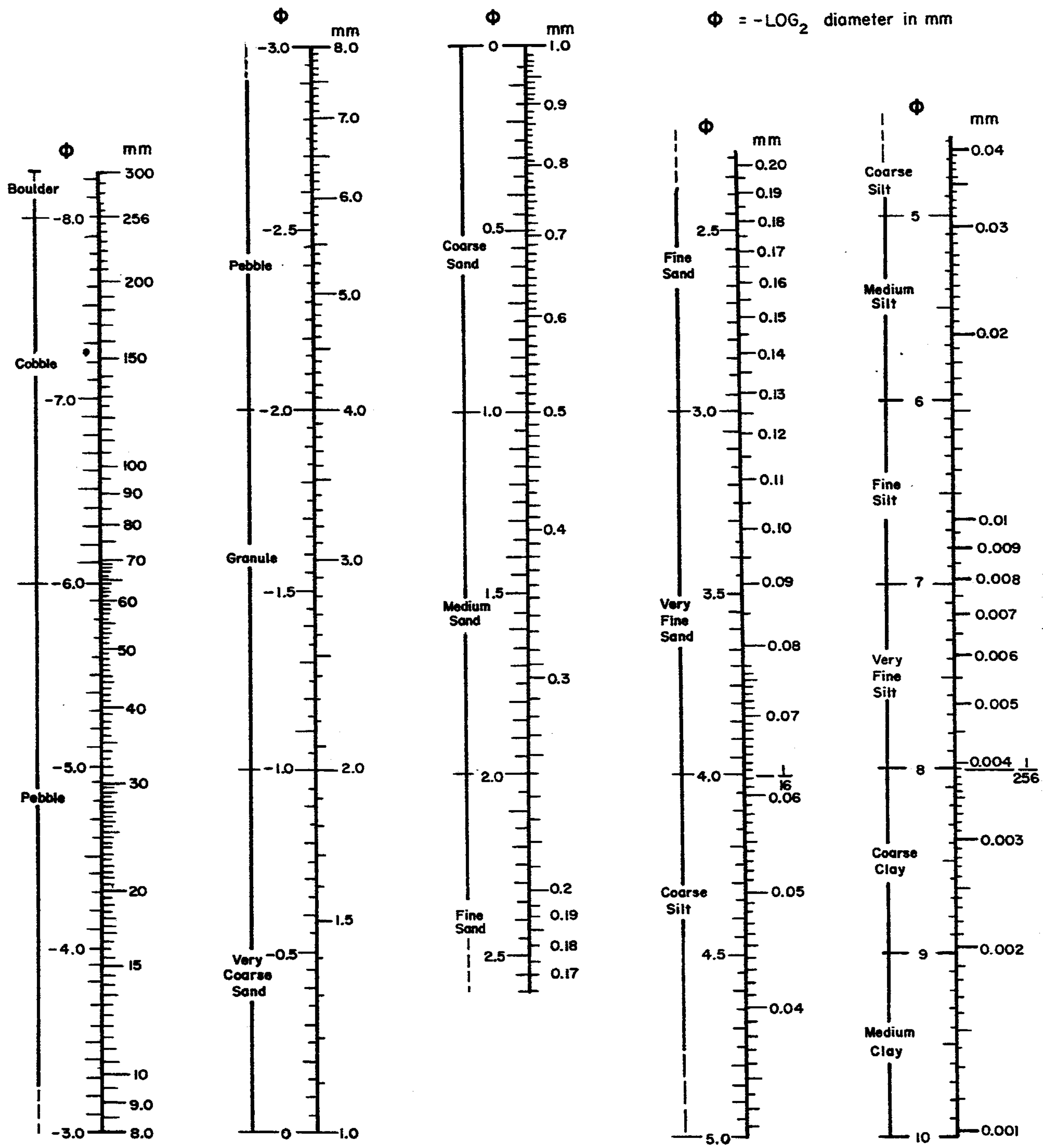
LITERATURE CITED

Folk, R. L. 1974. Petrology of sedimentary rocks. Hemphill Publishing Co., Austin, TX. 182 p.

Inman, D. L. 1952. Measures for describing the size distribution of sediments. J. Sed. Pet. 22:125-145.

Sharp, W. E., and P. F. Fan. 1963. A sorting index. J. Geology. 71(1):76-84.

Appendix B. (Cont.).



APPENDIX C

Water quality parameters at each receiving water monitoring station
El Segundo and Scattergood Generating Stations NPDES, 1998

Appendix C-1. Water quality parameters at each receiving water monitoring station during flood and ebb tides. El Segundo and Scattergood Generating Stations NPDES, winter 1998.

	Depth (m)	Temp. (°C) FLOOD	Temp. (°C) EBB	Oxygen (mg/l) FLOOD	Oxygen (mg/l) EBB	pH FLOOD	pH EBB
RW1	0	16.01	16.33	8.33	8.76	8.19	8.22
	1	16.00	16.32	8.30	8.76	8.19	8.22
	2	15.99	16.06	8.31	8.84	8.19	8.22
	3	15.99	15.98	8.33	8.84	8.19	8.22
	4	15.95	15.89	8.38	8.75	8.20	8.22
	5	15.66	15.79	8.44	8.93	8.19	8.22
	6	15.44	15.68	8.53	8.94	8.17	8.21
	7	15.37	15.51	8.19	8.90	8.14	8.19
	8		15.44		8.68		8.17
RW2	0	16.56	16.32	8.27	8.45	8.20	8.17
	1	16.56	16.30	8.27	8.45	8.20	8.17
	2	16.50	16.24	8.29	8.45	8.20	8.17
	3	16.03	16.21	8.41	8.47	8.18	8.17
	4	15.86	16.16	8.31	8.47	8.17	8.17
	5	15.74	16.07	8.06	8.47	8.17	8.17
	6	15.53	15.96	8.07	8.45	8.17	8.16
	7	15.47	15.77	8.12	8.35	8.13	8.15
	8	15.48	15.76	7.79	8.03	8.11	8.15
	9	15.51		7.28		8.11	
RW3	0	16.48	16.26	8.41	8.56	8.14	8.12
	1	16.47	16.22	8.43	8.55	8.14	8.12
	2	16.38	16.04	8.44	8.58	8.14	8.11
	3	16.29	15.98	8.44	8.61	8.14	8.12
	4	16.05	15.75	8.42	8.73	8.14	8.12
	5	15.94	15.50	8.46	8.74	8.13	8.08
	6	15.66	15.48	8.50	8.33	8.13	8.07
	7	15.60	15.45	8.34	8.07	8.13	8.07
	8	15.57	15.44	8.35	8.01	8.12	8.07
	9	15.51		8.31		8.10	
RW4	0	16.46	16.90	8.23	8.00	8.21	8.14
	1	16.44	16.78	8.25	8.01	8.21	8.15
	2	16.43	16.19	8.24	8.15	8.20	8.15
	3	16.42	15.71	8.19	8.26	8.20	8.15
	4	16.37	15.52	8.19	8.39	8.20	8.12
	5	16.33	15.39	8.14	8.21	8.20	8.10
	6	16.24	15.21	8.15	7.71	8.20	8.08
	7	16.15	14.77	8.16	7.64	8.21	8.06
	8		14.32		7.45		8.01
	9		14.46		6.73		7.99
RW5	0	16.05	16.34	8.88	8.71	8.17	8.21
	1	16.05	16.34	8.88	8.70	8.16	8.20
	2	16.01	16.32	8.88	8.72	8.17	8.21
	3	15.90	16.18	8.92	8.76	8.17	8.20
	4	15.78	15.93	8.98	8.83	8.17	8.21
	5	15.68	15.79	9.10	8.87	8.16	8.22
	6	15.57	15.66	9.22	9.05	8.15	8.21
	7	15.51	15.54	9.16	9.14	8.15	8.19
	8	15.46	15.26	8.99	9.03	8.13	8.16
	9	15.33	14.96	8.82	8.74	8.12	8.12
	10	15.22	14.86	8.77	8.12	8.10	8.08
	11	15.17	14.85	8.44	6.96	8.09	8.06
	12	15.04	14.83	8.13	6.60	8.07	8.06
	13	14.89	14.83	7.82	6.69	8.03	8.06

Appendix C-1. (Cont.).

	Depth (m)	Temp. (°C) FLOOD	Temp. (°C) EBB	Oxygen (mg/l) FLOOD	Oxygen (mg/l) EBB	pH FLOOD	pH EBB
RW6	0	16.23	16.31	8.82	8.76	8.18	8.20
	1	16.24	16.32	8.77	8.77	8.18	8.20
	2	16.19	16.26	8.81	8.77	8.18	8.20
	3	16.15	16.13	8.81	8.78	8.18	8.21
	4	16.07	15.75	8.91	8.91	8.19	8.21
	5	16.02	15.51	8.98	9.00	8.19	8.18
	6	15.91	15.28	9.03	9.04	8.18	8.15
	7	15.85	14.99	9.05	8.66	8.19	8.11
	8	15.77	14.77	9.03	8.03	8.18	8.08
	9	15.56	14.62	9.08	7.51	8.17	8.06
	10	15.44	14.47	9.01	7.22	8.15	8.04
	11	15.32	14.32	8.78	6.95	8.13	8.02
	12	15.31	13.65	8.47	6.70	8.13	7.98
	13	15.32	13.20	8.21	6.49	8.13	7.93
	14		13.15		5.82		7.89
RW7	0	16.30	16.60	8.45	8.29	8.20	8.16
	1	16.30	16.59	8.45	8.31	8.20	8.17
	2	16.30	16.54	8.45	8.33	8.20	8.16
	3	16.27	16.47	8.46	8.34	8.20	8.17
	4	16.18	16.31	8.49	8.35	8.21	8.17
	5	16.06	16.05	8.46	8.38	8.21	8.18
	6	16.03	15.88	8.42	8.40	8.21	8.18
	7	15.68	15.58	8.52	8.66	8.21	8.16
	8	15.60	15.16	8.57	8.67	8.21	8.13
	9	15.46	14.85	8.79	8.42	8.21	8.10
	10	15.42	14.73	8.76	7.86	8.20	8.06
	11	15.31	14.30	8.67	7.35	8.20	8.05
	12	15.20	13.37	8.64	6.93	8.18	7.92
	13	15.14		8.43		8.15	
RW8	0	16.59	16.90	8.08	8.53	8.19	8.14
	1	16.59	16.84	8.08	8.57	8.19	8.14
	2	16.57	16.82	8.06	8.57	8.20	8.14
	3	16.49	16.77	8.14	8.62	8.20	8.14
	4	16.36	16.70	8.18	8.63	8.21	8.14
	5	16.17	16.56	8.33	8.69	8.21	8.15
	6	15.68	16.25	8.60	8.80	8.21	8.15
	7	15.67	15.65	8.49	8.97	8.21	8.13
	8	15.57	15.57	8.58	8.87	8.19	8.13
	9	15.46	15.40	8.58	8.91	8.18	8.11
	10	15.44	15.17	8.45	8.85	8.17	8.09
	11	15.30	14.61	8.17	8.42	8.16	8.04
	12	15.23	13.82	8.11	7.81	8.14	7.92
RW9	0	15.91	16.27	8.67	9.12	8.22	8.18
	1	15.92	16.18	8.68	9.10	8.22	8.18
	2	15.87	15.88	8.69	9.20	8.22	8.18
	3	15.73	15.63	8.73	9.25	8.22	8.17
	4	15.61	15.57	8.78	9.24	8.21	8.16
	5	15.46	15.42	8.81	9.26	8.20	8.14
	6	15.28	15.14	8.87	9.21	8.19	8.13
	7	15.14	14.97	8.71	9.01	8.17	8.10
	8	14.96	14.65	8.43	8.53	8.14	8.07
	9	14.81	14.07	8.12	8.19	8.13	8.01
	10	14.55	13.59	7.80	7.46	8.08	7.92
	11	14.32	13.48	7.38	6.19	8.06	7.89
	12	14.00	13.40	6.98	5.20	8.02	7.87
	13	13.95	13.34	6.27	5.02	7.98	7.87
	14	13.81	13.32	5.32	5.00	7.98	7.86
	15	13.65	13.33	5.32	4.98	7.96	7.86
	16	13.62	13.28	5.39	4.94	7.93	7.86
	17	13.48	13.18	5.03	4.98	7.93	7.84
	18	13.45	13.12	4.96	4.89	7.92	7.84
	19	13.43	13.08	4.83	4.77	7.91	7.82
	20	13.39	13.09	4.78	4.57	7.91	7.82

Appendix C-1. (Cont.).

	Depth (m)	Temp. (°C) FLOOD	Temp. (°C) EBB	Oxygen (mg/l) FLOOD	Oxygen (mg/l) EBB	pH FLOOD	pH EBB
RW10	0	16.30	16.54	8.40	8.65	8.22	8.20
	1	16.30	16.50	8.41	8.62	8.22	8.21
	2	16.13	16.09	8.42	8.75	8.23	8.21
	3	15.89	15.99	8.54	8.75	8.23	8.20
	4	15.75	15.77	8.75	8.94	8.23	8.21
	5	15.54	15.55	8.91	8.99	8.22	8.20
	6	15.41	15.45	8.88	8.96	8.21	8.19
	7	15.32	15.23	8.83	8.88	8.21	8.17
	8	15.15	14.98	8.69	8.67	8.18	8.14
	9	14.93	14.87	8.61	8.24	8.18	8.12
	10	14.79	14.73	8.34	7.73	8.13	8.10
	11	14.54	14.43	7.70	7.51	8.11	8.07
	12	14.18	13.60	7.37	7.33	8.07	8.01
	13	13.58	12.77	7.04	6.60	8.00	7.91
	14	12.74	12.54	6.18	5.35	7.93	7.87
	15	12.65	12.53	5.45	4.38	7.89	7.86
	16	12.63	12.52	4.61	4.30	7.89	7.86
	17	12.61	12.52	4.36	4.37	7.87	7.86
	18	12.62	12.53	4.43	4.38	7.88	7.86
	19	12.64		4.49		7.87	
RW11	0	15.93	16.39	8.82	8.82	8.16	8.18
	1	15.93	16.39	8.78	8.81	8.17	8.19
	2	15.94	16.39	8.79	8.82	8.17	8.19
	3	15.80	16.35	8.85	8.85	8.16	8.19
	4	15.66	16.33	8.91	8.83	8.16	8.20
	5	15.53	16.32	8.98	8.85	8.15	8.20
	6	15.37	16.21	9.00	8.92	8.15	8.20
	7	15.20	15.98	8.97	8.93	8.13	8.20
	8	15.12	15.82	8.85	8.97	8.12	8.20
	9	15.01	15.79	8.56	8.95	8.11	8.19
	10	14.71	15.78	8.39	8.90	8.08	8.19
	11	14.48	15.74	8.07	8.90	8.03	8.19
	12	13.70	15.54	7.63	8.95	7.98	8.19
	13	13.13	15.22	7.15	8.95	7.89	8.17
	14	12.90	14.91	5.90	8.75	7.86	8.13
	15	12.77	14.56	4.96	8.27	7.84	8.08
	16	12.71	14.12	4.86	7.60	7.84	8.03
	17	12.71	13.33	4.76	7.16	7.83	7.97
	18	12.72	12.83	4.75	6.02	7.83	7.89
	19	12.76	12.79	4.73	4.62	7.83	7.87
RW12	0	16.12	16.74	8.70	8.60	8.16	8.20
	1	16.12	16.69	8.71	8.63	8.17	8.20
	2	16.10	16.30	8.67	8.73	8.16	8.20
	3	15.96	16.12	8.77	8.74	8.16	8.21
	4	15.49	16.10	8.94	8.88	8.16	8.20
	5	15.46	16.08	8.98	8.91	8.16	8.21
	6	15.38	16.06	8.94	8.89	8.15	8.20
	7	15.19	16.03	8.91	8.88	8.13	8.21
	8	15.06	15.99	8.76	8.82	8.10	8.20
	9	14.99	15.94	8.32	8.83	8.09	8.20
	10	14.88	15.82	7.97	8.87	8.08	8.21
	11	14.83	15.53	7.74	8.92	8.06	8.19
	12	14.81	15.32	7.53	8.90	8.06	8.18
	13	14.75	15.17	7.36	8.73	8.05	8.16
	14	14.59	15.01	7.27	8.44	8.03	8.13
	15	14.07	14.84	7.22	8.13	8.00	8.10
	16	13.38	14.76	7.06	7.79	7.94	8.09
	17	13.49	13.97	5.78	7.48	7.89	8.04
	18		13.60		7.20		7.95

Appendix C-2. Water quality parameters at each receiving water monitoring station during flood and ebb tides. El Segundo and Scattergood Generating Stations NPDES, summer 1998.

		Temp. (°C)		Oxygen (mg/l)		pH	
	Depth (m)	FLOOD	EBB	FLOOD	EBB	FLOOD	EBB
RW1	0	21.38	21.91	8.10	8.15	8.14	8.13
	1	21.15	21.93	8.14	8.22	8.13	8.13
	2	20.96	21.75	8.18	8.30	8.14	8.12
	3	20.87	21.62	8.18	8.25	8.14	8.12
	4	20.80	21.56	8.17	8.22	8.14	8.11
	5	20.78	21.56	8.14	8.16	8.14	8.12
	6	20.76	21.51	8.14	8.19	8.14	8.11
	7	20.68	21.16	8.17	8.26	8.14	8.10
	8		21.97		7.92		8.09
RW2	0	21.90	22.37	7.91	8.04	8.15	8.13
	1	21.78	22.35	7.99	8.10	8.15	8.13
	2	21.63	22.20	7.99	8.14	8.15	8.12
	3	21.19	21.93	8.07	8.13	8.15	8.12
	4	20.80	21.67	8.07	8.11	8.15	8.12
	5	20.33	21.30	8.11	8.13	8.15	8.12
	6	19.91	20.44	8.15	8.24	8.14	8.12
	7	19.87	18.97	8.14	8.46	8.14	8.11
RW3	0	21.85	22.28	7.92	7.84	8.13	8.11
	1	21.55	22.24	8.02	7.85	8.13	8.12
	2	21.07	22.21	8.06	7.88	8.14	8.12
	3	20.75	22.02	7.93	7.93	8.15	8.11
	4	19.60	21.66	8.21	8.02	8.13	8.12
	5	18.19	21.43	8.44	8.00	8.10	8.12
	6	17.85	20.52	8.25	8.15	8.09	8.12
	7		19.21		8.43		8.11
RW4	0	22.03	22.40	8.01	7.87	8.15	8.13
	1	21.89	22.41	8.04	7.88	8.15	8.13
	2	21.14	22.26	8.25	7.91	8.15	8.13
	3	18.36	22.20	8.79	7.90	8.12	8.13
	4	17.65	22.03	8.25	7.95	8.10	8.13
	5	17.47	21.17	8.37	8.18	8.10	8.13
	6	17.43	18.38	8.33	8.83	8.09	8.09
	7	17.41	17.69	8.34	8.34	8.09	8.07
RW5	0	21.53	22.37	8.12	8.17	8.15	8.15
	1	21.40	22.33	8.13	8.17	8.15	8.15
	2	21.25	22.01	8.20	8.25	8.15	8.16
	3	20.99	21.73	8.26	8.30	8.15	8.16
	4	20.61	20.86	8.29	8.49	8.14	8.14
	5	20.39	20.64	8.34	8.54	8.14	8.14
	6	19.91	20.29	8.41	8.69	8.14	8.14
	7	19.75	19.93	8.60	8.76	8.16	8.11
	8	19.49	19.41	8.97	8.63	8.16	8.09
	9	19.03	18.95	8.95	8.53	8.16	8.09
	10	18.79	18.06	8.85	8.63	8.13	8.08
	11	18.78	17.48	8.65	8.67	8.11	8.06
	12	18.72	17.27	8.51	8.52	8.11	8.06
	13	18.33	17.21	8.47	8.35	8.10	8.06
RW6	0	21.71	21.66	8.28	8.48	8.17	8.15
	1	21.26	21.62	8.29	8.52	8.18	8.16
	2	20.97	21.35	8.32	8.58	8.18	8.16
	3	20.81	21.34	8.50	8.58	8.18	8.16
	4	20.34	21.28	8.68	8.60	8.18	8.15
	5	19.64	21.15	8.87	8.64	8.17	8.16
	6	18.47	20.54	9.15	8.77	8.15	8.15
	7	18.03	19.94	8.96	8.79	8.13	8.13

Appendix C-2. (Cont.).

	Depth (m)	Temp. (°C) FLOOD	Temp. (°C) EBB	Oxygen (mg/l) FLOOD	Oxygen (mg/l) EBB	pH FLOOD	pH EBB
RW6 (Cont.).	8	17.97	17.92	8.71	9.28	8.11	8.10
	9	17.59	17.27	8.61	8.91	8.10	8.06
	10	17.31	16.87	8.47	8.69	8.08	8.05
	11	17.18	16.57	8.26	8.50	8.07	8.04
	12	17.17	16.41	8.28	8.42	8.08	8.04
	13	17.16	16.39	8.22	8.41	8.08	8.04
	14		16.46		8.37		8.04
RW7	0	22.06	22.58	8.15	8.30	8.19	8.17
	1	21.62	22.57	8.33	8.28	8.19	8.17
	2	20.98	22.16	8.42	8.39	8.17	8.17
	3	19.95	21.29	8.48	8.56	8.15	8.16
	4	19.36	20.43	8.51	8.64	8.14	8.11
	5	18.61	19.85	8.80	8.52	8.13	8.10
	6	18.05	19.40	8.89	8.50	8.12	8.11
	7	16.91	18.88	9.08	8.56	8.09	8.11
	8	16.48	17.86	8.71	9.02	8.08	8.10
	9	16.28	16.69	8.49	9.18	8.07	8.07
	10	16.26	16.40	8.43	8.84	8.06	8.05
	11	16.25	16.31	8.36	8.33	8.06	8.04
	12	16.25	16.24	8.31	8.41	8.06	8.04
	13	16.27	16.17	8.32	8.40	8.07	8.04
RW8	0	21.77	22.69	8.18	8.23	8.17	8.18
	1	21.81	22.52	8.20	8.30	8.17	8.18
	2	20.99	22.17	8.40	8.36	8.16	8.18
	3	19.88	22.03	8.56	8.39	8.13	8.17
	4	18.80	21.90	8.55	8.46	8.11	8.17
	5	18.03	21.74	8.48	8.45	8.11	8.17
	6	17.58	21.43	8.76	8.44	8.10	8.15
	7	16.62	19.45	9.07	8.85	8.08	8.13
	8	16.26	17.92	8.78	8.86	8.07	8.08
	9	16.16	17.44	8.47	8.42	8.07	8.08
	10	15.99	16.94	8.41	8.57	8.07	8.06
	11	15.94	16.64	8.34	8.60	8.05	8.06
	12	15.92	16.36	8.25	8.51	8.05	8.05
	13	15.93	16.28	8.22	8.37	8.04	8.04
RW9	0	21.84	21.84	8.15	8.27	8.19	8.15
	1	21.80	21.67	8.13	8.33	8.19	8.16
	2	21.54	21.22	8.20	8.40	8.19	8.16
	3	21.34	20.91	8.22	8.50	8.19	8.15
	4	21.24	20.67	8.29	8.70	8.19	8.15
	5	20.97	20.48	8.33	8.81	8.19	8.16
	6	20.46	20.18	8.46	8.95	8.18	8.15
	7	19.65	19.55	8.67	9.05	8.18	8.13
	8	19.36	18.45	8.74	9.05	8.17	8.10
	9	19.30	17.25	8.89	9.23	8.17	8.07
	10	18.78	16.94	8.99	8.95	8.17	8.06
	11	18.08	16.73	9.05	8.52	8.15	8.06
	12	17.99	16.52	8.88	8.59	8.14	8.04
	13	17.96	16.46	8.85	8.44	8.13	8.04
	14	17.85	16.44	8.86	8.42	8.13	8.04
	15	17.69	16.40	8.81	8.30	8.10	8.04
	16	17.44	16.38	8.54	8.27	8.09	8.03
	17	16.65	16.38	8.41	8.17	8.08	8.02
	18	16.19	16.38	8.28	8.18	8.06	8.03
	19	16.12	16.38	8.15	8.17	8.06	8.02
	20	16.15		7.93		8.05	

Appendix C-2. (Cont.).

	Depth (m)	Temp. (°C) FLOOD	Temp. (°C) EBB	Oxygen (mg/l) FLOOD	Oxygen (mg/l) EBB	pH FLOOD	pH EBB
RW10	0	20.75	22.46	8.41	8.35	8.16	8.17
	1	20.69	22.42	8.42	8.37	8.17	8.17
	2	20.49	21.73	8.46	8.51	8.16	8.17
	3	19.72	21.43	8.62	8.55	8.15	8.18
	4	19.02	21.21	8.59	8.63	8.14	8.16
	5	18.14	21.10	8.75	8.75	8.11	8.17
	6	17.88	20.82	8.66	8.84	8.11	8.17
	7	17.69	18.76	8.64	9.36	8.11	8.14
	8	17.41	17.14	8.69	9.32	8.10	8.10
	9	17.11	16.51	8.61	9.01	8.08	8.07
	10	16.82	16.21	8.55	8.82	8.08	8.05
	11	16.61	15.99	8.46	8.46	8.08	8.05
	12	16.47	15.89	8.37	8.43	8.06	8.04
	13	16.40	15.80	8.32	8.42	8.06	8.03
	14	16.36	15.70	8.27	8.38	8.06	8.03
	15	16.25	15.62	8.25	8.34	8.05	8.02
	16	16.18	15.61	8.17	8.19	8.04	8.02
	17	16.17	15.61	8.09	8.12	8.04	8.02
	18	16.17	15.60	8.08	8.11	8.04	8.02
	19	16.17	15.60	8.08	8.14	8.04	8.01
	20	16.19	15.61	8.03	8.07	8.04	8.00
RW11	0	21.89	22.23	8.34	8.33	8.20	8.17
	1	21.87	22.10	8.39	8.38	8.21	8.17
	2	21.60	21.86	8.45	8.47	8.19	8.17
	3	21.34	21.23	8.49	8.60	8.19	8.17
	4	21.04	20.41	8.52	8.64	8.19	8.15
	5	19.80	19.82	8.82	8.67	8.17	8.13
	6	19.06	19.31	8.76	8.82	8.14	8.13
	7	18.50	19.03	8.86	8.82	8.14	8.12
	8	17.01	18.42	9.24	8.95	8.12	8.11
	9	16.60	17.33	9.09	9.10	8.09	8.08
	10	16.10	16.41	8.80	8.95	8.08	8.06
	11	15.84	16.06	8.49	8.65	8.06	8.04
	12	15.75	15.82	8.35	8.46	8.06	8.03
	13	15.70	15.60	8.35	8.41	8.07	8.03
	14	15.60	15.49	8.30	8.23	8.06	8.03
	15	15.51	15.37	8.31	8.18	8.06	8.01
	16	15.37	15.28	8.26	8.16	8.04	8.01
	17	15.35	15.20	8.15	8.16	8.04	8.01
	18	15.35	15.15	7.99	8.14	8.04	8.01
	19	15.34	15.13	7.99	8.04	8.04	8.01
	20	15.37		8.05		8.02	
RW12	0	22.21	22.83	8.26	8.27	8.20	8.17
	1	21.97	22.55	8.32	8.29	8.21	8.18
	2	21.55	22.29	8.39	8.35	8.20	8.19
	3	21.28	22.09	8.44	8.44	8.19	8.18
	4	20.04	21.95	8.65	8.46	8.17	8.18
	5	18.83	21.67	8.74	8.53	8.15	8.17
	6	17.81	20.71	8.97	8.71	8.13	8.16
	7	17.29	19.84	8.99	8.66	8.12	8.13
	8	16.83	19.03	8.87	8.62	8.10	8.12
	9	16.37	18.31	8.84	8.87	8.09	8.11
	10	16.04	18.01	8.59	9.04	8.08	8.10
	11	15.88	17.39	8.44	9.05	8.07	8.09
	12	15.46	16.70	8.44	8.96	8.07	8.07
	13	15.27	16.44	8.30	8.71	8.06	8.06
	14	15.20	16.22	8.10	8.52	8.05	8.04
	15	15.16	16.01	8.06	8.45	8.04	8.05
	16	15.14	15.64	8.02	8.50	8.04	8.03
	17	15.13	15.55	7.99	8.35	8.04	8.03
	18	15.13	15.41	7.98	8.22	8.04	8.02
	19	15.13	15.30	7.98	8.24	8.03	8.03

APPENDIX D

Size frequency distribution and sediment statistical parameters
El Segundo and Scattergood Generating Stations NPDES, 1998

Appendix D. Size frequency distribution and sediment statistical parameters. El Segundo and Scattergood Generating Station NPDES, 1998.

Station B2

FREQUENCY DISTRIBUTION TABLE

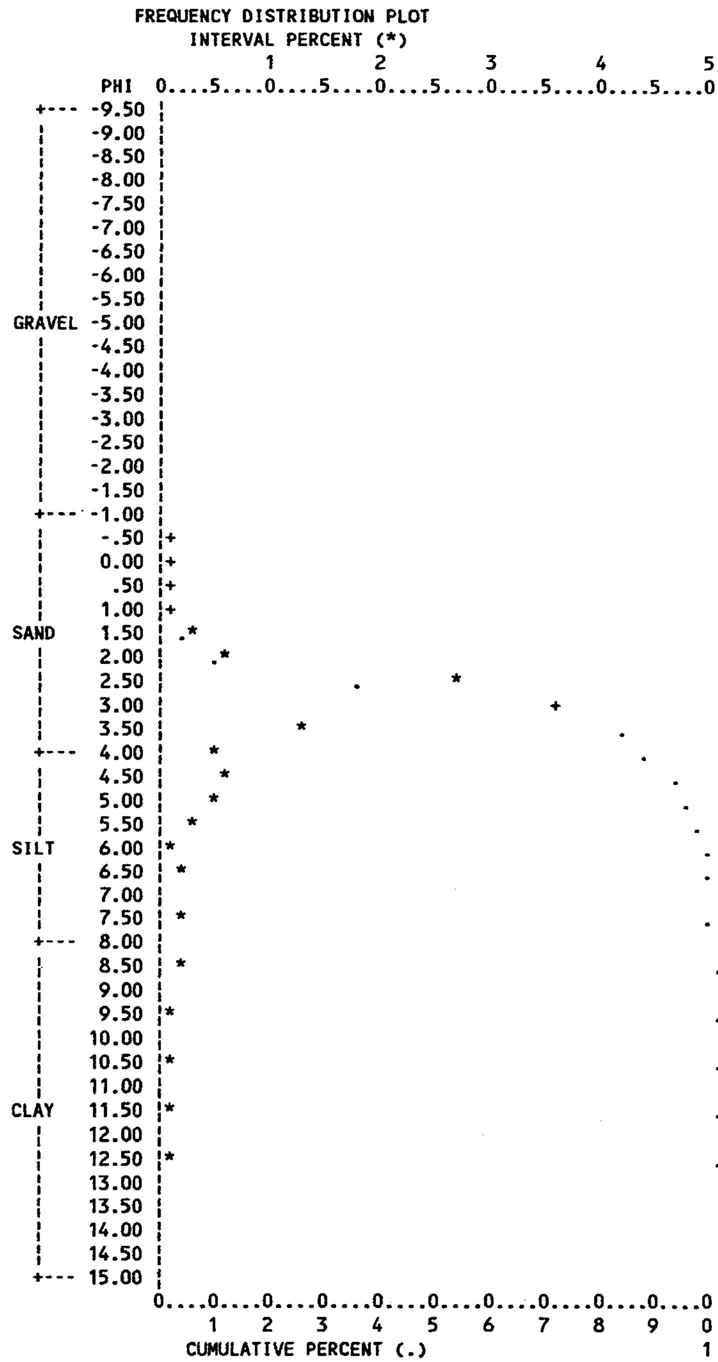
MEAN PHI INTERVAL	INTERVAL PERCENT	CUMULATIVE PERCENT
-0.25	0.02	0.02
0.25	0.03	0.04
0.75	0.04	0.08
1.25	0.49	0.57
1.75	2.38	2.95
2.25	5.43	8.38
2.75	26.35	34.73
3.25	35.26	70.00
3.75	11.67	81.67
4.16	4.37	86.05
4.53	5.37	91.41
4.99	3.58	94.99
5.47	1.79	96.78
5.94	0.36	97.14
6.67	0.76	97.90
7.67	0.64	98.54
8.67	0.53	99.07
9.67	0.41	99.47
10.67	0.29	99.77
11.67	0.18	99.94
12.67	0.06	100.00

% GRAVEL = 0.00
% SAND = 81.67
% SILT = 16.76
% CLAY = 1.57

SEDIMENT DISTRIBUTION PARAMETERS (MOMENT)

MEAN	DISPERSION	SKEWNESS	KURTOSIS
3.45	0.79	0.30	1.39

SHARP & FAN SORTING INDEX
BASED ON 15 INTERVALS = 50.1688
BASED ON 25 INTERVALS = 58.07687



ONE PHI INTERVAL PERCENT TOTAL SEDIMENT WEIGHT DISTRIBUTION

-10 =< -9	0.00	-5 =< -4	0.00	0 =< 1	0.06	5 =< 6	3.76	10 =< 11	0.07
-9 =< -8	0.00	-4 =< -3	0.00	1 =< 2	2.87	6 =< 7	0.13	11 =< 12	0.44
-8 =< -7	0.00	-3 =< -2	0.00	2 =< 3	31.78	7 =< 8	1.29	12 =< 13	0.03
-7 =< -6	0.00	-2 =< -1	0.00	3 =< 4	46.94	8 =< 9	0.11	13 =< 14	0.06
-6 =< -5	0.00	-1 =< 0	0.02	4 =< 5	11.57	9 =< 10	0.87	14 =< 15	0.00

Appendix D. (Cont.).

Station B3

FREQUENCY DISTRIBUTION TABLE

MEAN PHI INTERVAL	INTERVAL PERCENT	CUMULATIVE PERCENT
-0.19	0.20	0.20
0.31	0.58	0.78
0.81	2.19	2.97
1.31	9.96	12.92
1.81	24.58	37.50
2.31	24.76	62.26
2.81	24.43	86.69
3.31	11.11	97.81
3.81	2.19	100.00

% GRAVEL = 0.00
% SAND = 100.00
% SILT = 0.00
% CLAY = 0.00

SEDIMENT DISTRIBUTION PARAMETERS (MOMENT)

MEAN	DISPERSION	SKEWNESS	KURTOSIS
2.30	0.69	-0.01	0.92

SHARP & FAN SORTING INDEX
BASED ON 4 INTERVALS = 20.36625
BASED ON 25 INTERVALS = 65.70363

```
                FREQUENCY DISTRIBUTION PLOT
                    INTERVAL PERCENT (*)
                         1         2         3         4         5
              PHI 0....5....0....5....0....5....0....5....0....5....0
       +--- -9.50 |
       |    -9.00 |
       |    -8.50 |
       |    -8.00 |
       |    -7.50 |
       |    -7.00 |
       |    -6.50 |
       |    -6.00 |
       |    -5.50 |
    GRAVEL  -5.00 |
       |    -4.50 |
       |    -4.00 |
       |    -3.50 |
       |    -3.00 |
       |    -2.50 |
       |    -2.00 |
       |    -1.50 |
       +--- -1.00 |
       |     -.50 |
       |     0.00 |+
       |      .50 |.*
       |     1.00 | .*
     SAND    1.50 |      .   *
       |     2.00 |                  .     *
       |     2.50 |                        *     .
       |     3.00 |                       *                  .
       |     3.50 |          *                                     .
       +---  4.00 | *                                               .
       |     4.50 |
       |     5.00 |
       |     5.50 |
     SILT    6.00 |
       |     6.50 |
       |     7.00 |
       |     7.50 |
       +---  8.00 |
       |     8.50 |
       |     9.00 |
       |     9.50 |
       |    10.00 |
       |    10.50 |
       |    11.00 |
     CLAY   11.50 |
       |    12.00 |
       |    12.50 |
       |    13.00 |
       |    13.50 |
       |    14.00 |
       |    14.50 |
       +--- 15.00 |
                  0....0....0....0....0....0....0....0....0....0....0
                       1    2    3    4    5    6    7    8    9    0
                     CUMULATIVE PERCENT (.)                           1
```

ONE PHI INTERVAL PERCENT TOTAL SEDIMENT WEIGHT DISTRIBUTION

-10 =< -9	0.00	-5 =< -4	0.00	0 =< 1	2.70	5 =< 6	0.00	10 =< 11	0.00
-9 =< -8	0.00	-4 =< -3	0.00	1 =< 2	31.85	6 =< 7	0.00	11 =< 12	0.00
-8 =< -7	0.00	-3 =< -2	0.00	2 =< 3	49.21	7 =< 8	0.00	12 =< 13	0.00
-7 =< -6	0.00	-2 =< -1	0.00	3 =< 4	15.98	8 =< 9	0.00	13 =< 14	0.00
-6 =< -5	0.00	-1 =< 0	0.00	4 =< 5	0.00	9 =< 10	0.00	14 =< 15	0.00

Appendix D. (Cont.).

Station B6

FREQUENCY DISTRIBUTION TABLE

MEAN PHI INTERVAL	INTERVAL PERCENT	CUMULATIVE PERCENT
0.25	0.03	0.03
0.75	0.19	0.22
1.25	0.93	1.14
1.75	1.56	2.70
2.25	1.44	4.14
2.75	21.30	25.43
3.25	52.05	77.49
3.75	16.59	94.08
4.12	1.36	95.44
4.48	1.50	96.93
4.97	0.37	97.31
5.46	0.37	97.68
6.21	0.62	98.30
7.21	0.52	98.82
8.21	0.43	99.24
9.21	0.33	99.57
10.21	0.24	99.81
11.21	0.14	99.95
12.21	0.05	100.00

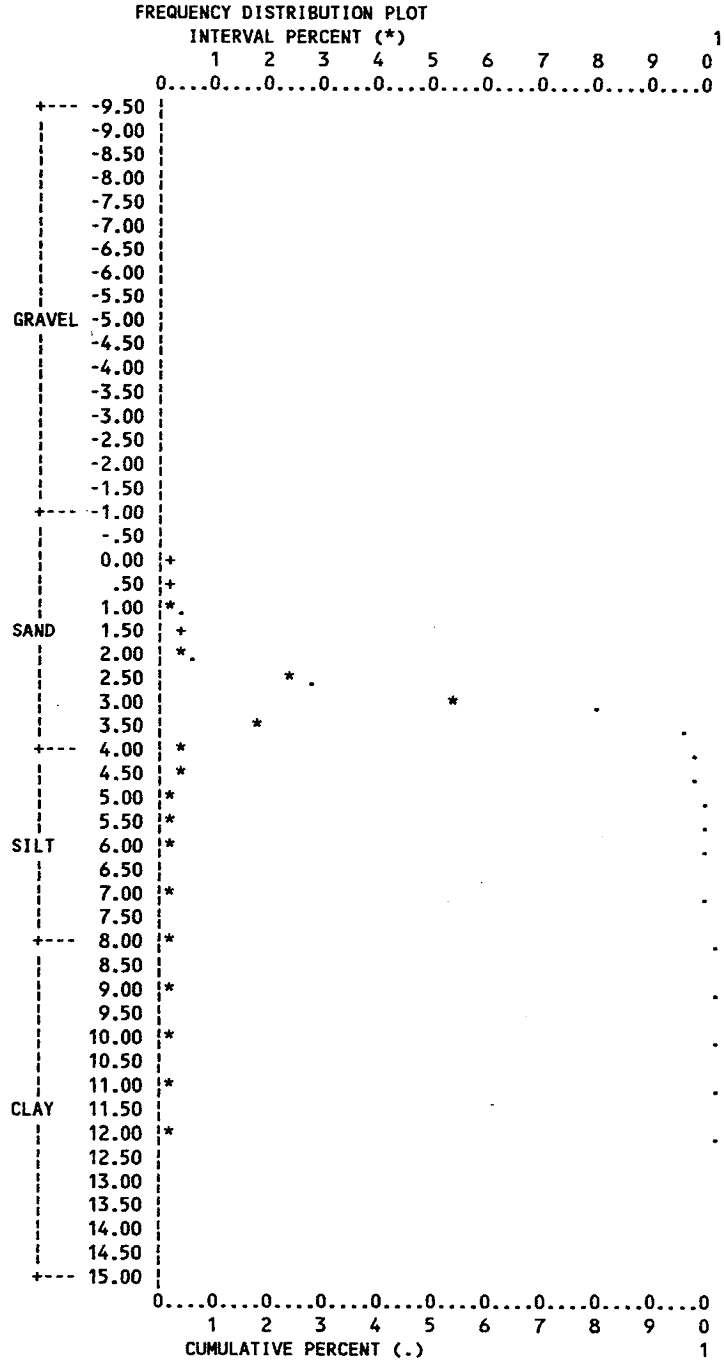
% GRAVEL = 0.00
% SAND = 94.08
% SILT = 4.86
% CLAY = 1.06

SEDIMENT DISTRIBUTION PARAMETERS (MOMENT)

MEAN	DISPERSION	SKEWNESS	KURTOSIS
3.32	0.46	0.09	1.46

SHARP & FAN SORTING INDEX
BASED ON 12 INTERVALS = 61.40808
BASED ON 25 INTERVALS = 70.20784

FREQUENCY DISTRIBUTION PLOT



ONE PHI INTERVAL PERCENT TOTAL SEDIMENT WEIGHT DISTRIBUTION

-10 =< -9	0.00	-5 =< -4	0.00	0 =< 1	0.22	5 =< 6	0.71	10 =< 11	0.17
-9 =< -8	0.00	-4 =< -3	0.00	1 =< 2	2.48	6 =< 7	0.44	11 =< 12	0.16
-8 =< -7	0.00	-3 =< -2	0.00	2 =< 3	22.73	7 =< 8	0.64	12 =< 13	0.00
-7 =< -6	0.00	-2 =< -1	0.00	3 =< 4	68.64	8 =< 9	0.30	13 =< 14	0.00
-6 =< -5	0.00	-1 =< 0	0.00	4 =< 5	3.07	9 =< 10	0.40	14 =< 15	0.00

Appendix D. (Cont.).

Station B7

FREQUENCY DISTRIBUTION TABLE

MEAN PHI INTERVAL	INTERVAL PERCENT	CUMULATIVE PERCENT
0.75	0.02	0.02
1.25	0.04	0.05
1.75	0.11	0.16
2.25	1.08	1.24
2.75	16.94	18.18
3.25	56.71	74.89
3.75	20.14	95.03
4.11	2.14	97.17
4.71	0.46	97.63
5.46	0.46	98.09
6.20	0.51	98.59
7.20	0.43	99.02
8.20	0.35	99.38
9.20	0.27	99.65
10.20	0.20	99.84
11.20	0.12	99.96
12.20	0.04	100.00

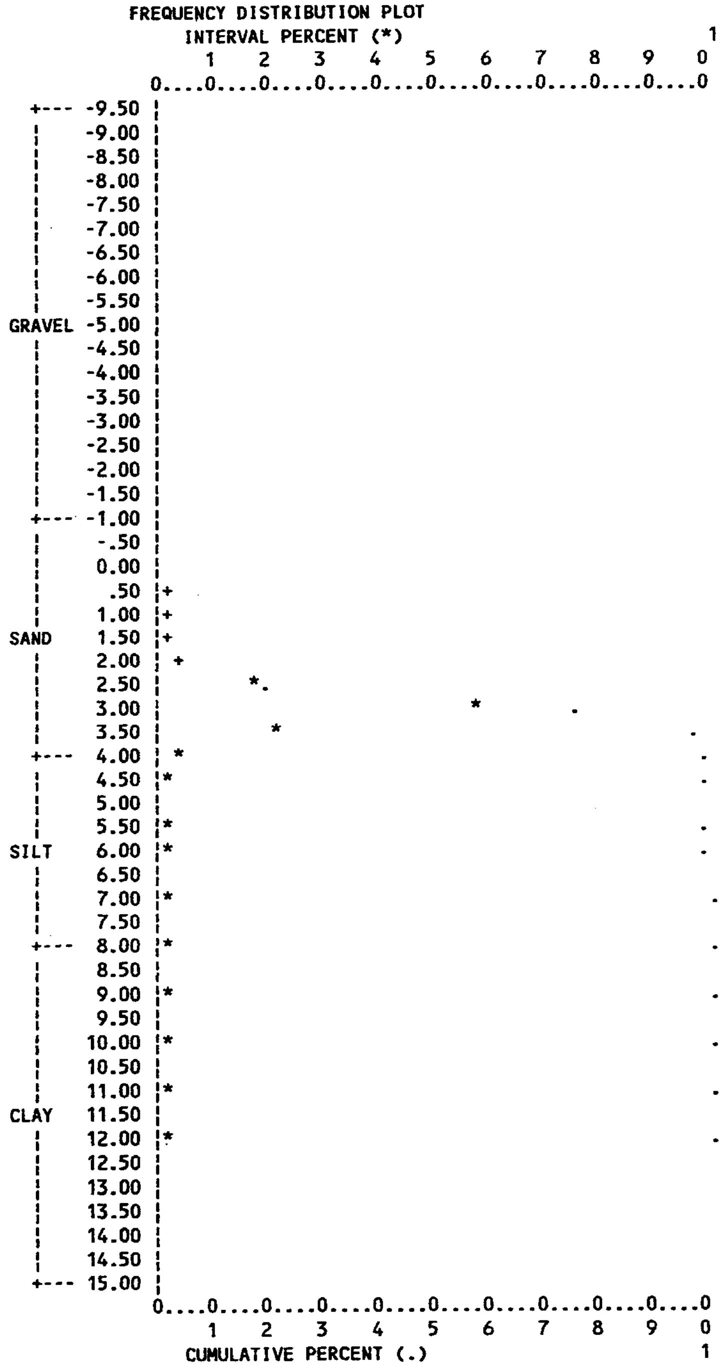
% GRAVEL = 0.00
% SAND = 95.03
% SILT = 4.09
% CLAY = 0.87

SEDIMENT DISTRIBUTION PARAMETERS (MOMENT)

MEAN	DISPERSION	SKEWNESS	KURTOSIS
3.38	0.40	0.08	1.29

SHARP & FAN SORTING INDEX
BASED ON 12 INTERVALS = 69.86916
BASED ON 25 INTERVALS = 76.73961

FREQUENCY DISTRIBUTION PLOT



ONE PHI INTERVAL PERCENT TOTAL SEDIMENT WEIGHT DISTRIBUTION

-10 =< -9	0.00	-5 =< -4	0.00	0 =< 1	0.02	5 =< 6	0.70	10 =< 11	0.14
-9 =< -8	0.00	-4 =< -3	0.00	1 =< 2	0.15	6 =< 7	0.36	11 =< 12	0.13
-8 =< -7	0.00	-3 =< -2	0.00	2 =< 3	18.02	7 =< 8	0.53	12 =< 13	0.00
-7 =< -6	0.00	-2 =< -1	0.00	3 =< 4	76.85	8 =< 9	0.25	13 =< 14	0.00
-6 =< -5	0.00	-1 =< 0	0.00	4 =< 5	2.50	9 =< 10	0.33	14 =< 15	0.00

APPENDIX E

Sediment chemistry by station
El Segundo and Scattergood Generating Stations NPDES, 1998

Appendix E. Sediment chemistry by station. El Segundo and Scattergood Generating Stations NPDES, 1998.

Del Mar Analytical

2852 Alton Ave., Irvine, CA 92606 (949) 261-1022 FAX (949) 261-1228
1014 E. Cooley Dr., Suite A, Colton, CA 92324 (909) 370-4667 FAX (909) 370-1046
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2465 W. 12th St., Suite 1, Tempe, AZ 85281 (602) 968-8272 FAX (602) 968-1338

MBC Applied Env. Sciences
3000 Redhill Avenue
Costa Mesa, CA 92626-4524
Attention: Mike Curtis

Client Project ID: 98321 Scattergood
98204 El Segundo
Sample Descript: Composite solid, B2 (I, II, III)
Lab Number: HH01641

Sampled: Aug 14, 1998
Received: Aug 14, 1998
Extracted: Aug 18-21, 1998
Analyzed: Aug 21-24, 1998
Reported: Aug 25, 1998

LABORATORY ANALYSIS

Analyte	Method	Reporting Limit mg/Kg dry weight	Sample Result mg/Kg dry weight
Chromium	EPA 6010	1.6	20
Copper	EPA 6010	1.6	8.5
Nickel	EPA 6010	1.6	7.5
Percent Solids (%)	EPA 160.3	N.A.	55
Zinc	EPA 6010	7.9	42

Analytes reported as N.D. were not present at or above the reporting limit.

DEL MAR ANALYTICAL (ELAP #1197)

Michele Harper
Project Manager

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MBC Applied Env. Sciences
3000 Redhill Avenue
Costa Mesa, CA 92626-4524
Attention: Mike Curtis

Client Project ID: 98321 Scattergood
98204 El Segundo
Sample Descript: Composite solid, B3 (I, II, III)
Lab Number: HH01642

Sampled: Aug 14, 1998
Received: Aug 14, 1998
Extracted: Aug 18-19, 1998
Analyzed: Aug 19-24, 1998
Reported: Aug 25, 1998

LABORATORY ANALYSIS

Analyte	Method	Reporting Limit mg/Kg dry weight	Sample Result mg/Kg dry weight
Chromium	EPA 6010	1.6	8.5
Copper	EPA 6010	1.6	2.8
Nickel	EPA 6010	1.6	3.5
Percent Solids (%)	EPA 160.3	N.A.	68
Zinc	EPA 6010	7.9	15

Analytes reported as N.D. were not present at or above the reporting limit.

DEL MAR ANALYTICAL (ELAP #1197)

Michele Harper
Michele Harper
Project Manager

Del Mar Analytical

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MBC Applied Env. Sciences
3000 Redhill Avenue
Costa Mesa, CA 92626-4524
Attention: Mike Curtis

Client Project ID: 98321 Scattergood
98204 El Segundo
Sample Descript: Composite solid, B6 (I, II, III)
Lab Number: HH01643

Sampled: Aug 14, 1998
Received: Aug 14, 1998
Extracted: Aug 18-19, 1998
Analyzed: Aug 19-24, 1998
Reported: Aug 25, 1998

LABORATORY ANALYSIS

Analyte	Method	Reporting Limit mg/Kg dry weight	Sample Result mg/Kg dry weight
Chromium	EPA 6010	1.6	14
Copper	EPA 6010	1.6	4.7
Nickel	EPA 6010	1.6	5.4
Percent Solids (%)	EPA 160.3	N.A.	60
Zinc	EPA 6010	7.9	22

Analytes reported as N.D. were not present at or above the reporting limit.

DEL MAR ANALYTICAL (ELAP #1197)

Michele Harper
Project Manager

Del Mar Analytical

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2465 W. 12th St., Suite 1, Tempe, AZ 85281 (602) 968-8272 FAX (602) 968-1338

MBC Applied Env. Sciences
3000 Redhill Avenue
Costa Mesa, CA 92626-4524
Attention: Mike Curtis

Client Project ID: 98321 Scattergood
98204 El Segundo
Sample Descript: Composite solid, B7 (I, II, III)
Lab Number: HH01644

Sampled: Aug 14, 1998
Received: Aug 14, 1998
Extracted: Aug 18-19, 1998
Analyzed: Aug 19-24, 1998
Reported: May 25, 1998

LABORATORY ANALYSIS

Analyte	Method	Reporting Limit mg/Kg dry weight	Sample Result mg/Kg dry weight
Chromium	EPA 6010	1.6	15
Copper	EPA 6010	1.6	3.9
Nickel	EPA 6010	1.6	2.5
Percent Solids (%)	EPA 160.3	N.A.	72
Zinc	EPA 6010	7.9	18

Analytes reported as N.D. were not present at or above the reporting limit.

DEL MAR ANALYTICAL (ELAP #1197)

Michele Harper
Project Manager

Del Mar Analytical

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MBC Applied Env. Sciences
3000 Redhill Avenue
Costa Mesa, CA 92626-4524
Attention: Mike Curtis

Method Blank

Extracted: Aug 18, 1998
Analyzed: Aug 20, 1998
Reported: Aug 25, 1998

LABORATORY ANALYSIS

Analyte	EPA Method	Reporting Limit mg/Kg dry weight	Sample Result mg/Kg dry weight
Chromium	EPA 6010	1.6	N.D.
Copper	EPA 6010	1.6	N.D.
Nickel	EPA 6010	1.6	N.D.
Zinc	EPA 6010	7.9	N.D.

Analytes reported as N.D. were not present at or above the reporting limit.

DEL MAR ANALYTICAL (ELAP #1197)

Michele Harper
Project Manager

Del Mar Analytical

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MS/MSD DATA REPORT

METHOD: METALS
Instrument: ICP
Matrix: Soil

Date Analyzed: 8/20/98

Sample: HH01039

Batch: HH18ME1S

Analyte	R1	Sp	MS	MSD	PR1	PR2	RPD	MEAN PR	Acceptance Limits	
	ppm	ppm	ppm	ppm	%	%	%	%	RPD	MPR
Antimony *	0	50	35.6	32.3	71%	65%	9.7%	68%	20	80-120
Arsenic	3.65	50	48.2	48.4	89%	90%	0.4%	89%	20	80-120
Barium **	89.6	50	107	115	35%	51%	7.2%	43%	20	80-120
Beryllium	0	50	46.1	46.5	92%	93%	0.86%	93%	20	80-120
Cadmium	0.760	50	45.4	45.2	89%	89%	0.44%	89%	20	80-120
Chromium *	17.1	50	52.4	52.9	71%	72%	0.95%	71%	20	80-120
Cobalt	7.25	50	51.8	52.7	89%	91%	1.72%	90%	20	80-120
Copper	18.3	50	61.2	62.5	86%	88%	2.10%	87%	20	80-120
Lead	10.2	50	51.8	53.9	83%	87%	3.97%	85%	20	80-120
Molybdenum	0	50	40.2	40.5	80%	81%	0.74%	81%	20	80-120
Nickel *	11.2	50	47.8	49.0	73%	76%	2.48%	74%	20	80-120
Silver	0	10.0	9.78	9.66	98%	97%	1.23%	97%	20	80-120
Thallium *	0	50	39.3	40.8	79%	82%	3.75%	80%	20	80-120
Vanadium **	38.4	50	65.0	69.1	53%	61%	6.11%	57%	20	80-120
Zinc **	47.4	50	78.7	82.1	63%	69%	4.2%	66%	20	80-120

Definition of Terms:

R1.................... Result of Sample Analysis
Sp.................... Spike Concentration Added to Sample
MS.................. Matrix Spike Result
MSD................. Matrix Spike Duplicate Result
PR1................. Percent Recovery of MS; ((MS-R1) / SP) X 100
PR2................. Percent Recovery of MSD; ((MSD-R1) / SP) X 100
RPD................. Relative Percent Difference; ((MS-MSD)/(MS+MSD)/2) X 100
Acceptance Limits..... Statistically determined on an annual basis.

DEL MAR ANALYTICAL

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LCS DATA REPORT

METHOD: METALS
Instrument: ICP

Date: 8/20/98

Batch: HH18ME1S

Analyte	St (ppm)	R1 (ppm)	PR (%)	Acceptance Limits (%)
Arsenic	1.0	0.956	96%	80-120
Barium	1.0	1.01	101%	80-120
Chromium	1.0	0.972	97%	80-120
Nickel	1.0	1.02	102%	80-120
Thallium	1.0	1.02	102%	80-120
Vanadium	1.0	1.02	102%	80-120
Zinc	1.0	1.01	101%	80-120

Definition of Terms:

St......... .... Concentration of standard added to blank.

R1........ .... Standard Result

PR........ .... Percent Recovery of R1; (R1 / St) X 100

Acceptance Limits.... Statistically determined on an annual basis.

DEL MAR ANALYTICAL

APPENDIX F

Infauna abundance and biomass by station and replicate
El Segundo and Scattergood Generating Stations NPDES, 1998

Appendix F-1. Infaunal master species list. El Segundo and Scattergood Generating Stations NPDES, 1998.

PHYLUM
- Class
  - Species

CNIDARIA
- Anthozoa
  - Actiniaria
  - Limnactiniidae sp. A SCAMIT 1989

PLATYHELMINTHES
- Turbellaria
  - *Pseudoceros* sp.
  - *Stylochoplana* sp.[1]

NEMERTEA
- Anopla
  - *Carinoma mutabilis*
  - Lineidae
  - *Tubulanus polymorphus*[2]
- Enopla
  - *Paranemertes californica*[3]
  - *Tetrastemma* sp. A SCAMIT 1995[4]

NEMATODA
  - Nematoda

MOLLUSCA
- Bivalvia
  - *Cooperella subdiaphana*
  - *Cumingia californica*
  - *Donax gouldii*
  - *Macoma nasuta*
  - *Macoma secta*
  - *Macoma yoldiformis*
  - *Mactrotoma californica*
  - *Modiolus sp.*
  - *Mysella pedroana*
  - *Rochefortia tumida*[5]
  - *Siliqua lucida*
  - *Solen sicarius*
  - *Tellina modesta*
  - *Tresus nuttallii*
- Gastropoda
  - *Crepidula naticarum*[6]
  - *Kurtziella plumbea*
  - *Olivella baetica*
  - *Rictaxis punctocaelatus*
  - *Turbonilla painei*
- Scaphopoda
  - *Gadila aberrans*[7]

ANNELIDA
- Polychaeta
  - *Amaeana occidentalis*
  - *Ampharete labrops*
  - *Aphelochaeta glandaria*[8]
  - *Apoprionospio pygmaea*[9]
  - *Aricidea (Acmira) catherinae*[10]
  - *Armandia brevis*
  - *Brania californiensis*
  - *Capitella capitata* Cmplx
  - *Chaetozone setosa* Cmplx[11]
  - *Cirriformia spirabrancha*
  - *Diopatra* sp.
  - *Diopatra tridentata*
  - *Eulalia levicornuta*

PHYLUM
- Class
  - Species

ANNELIDA
- Polychaeta (Cont.).
  - *Eusyllis transecta*
  - *Glycera convoluta*
  - *Glycera* sp.
  - *Goniada littorea*
  - *Hesionella mccullochae*
  - *Leitoscoloplos pugettensis*[12]
  - Lumbrineridae
  - *Mediomastus acutus*
  - *Mediomastus* sp.[13]
  - *Megalomma pigmentum*
  - *Monticellina cryptica*[14]
  - *Nepthys caecoides*
  - Onuphidae
  - *Owenia fusiformis*
  - *Paraprionospio pinnata*
  - *Pectinaria californiensis*[15]
  - *Phyllochaetopterus prolifica*
  - *Phyllodoce hartmanae*
  - *Podarkeopsis glabra*[16]
  - *Polydora bioccipitalis*
  - *Polydora cirrosa*
  - *Sigalion spinosus*[17]
  - *Spiophanes bombyx*
  - *Spiophanes duplex*[18]
  - *Syllis (Ehlersia) heterochaeta*
  - *Syllis (Typosyllis)* sp.
  - *Tenonia priops*

ARTHROPODA
- Cirripedia
  - *Balanus pacificus*
- Copepoda
  - Harpacticoida
- Malacostraca
  - *Ancinus granulatus*
  - *Aoroides inermis*
  - *Caprella mendax*
  - *Cerapus tubularis* Cmplx
  - *Ericthonius brasiliensis*
  - *Diastylopsis tenuis*
  - *Edotia sublittoralis*[19]
  - *Gibberosus myersi*[20]
  - *Hartmanodes hartmanae*[21]
  - *Hemilamprops californica*
  - *Lamprops quadriplicatus*
  - *Leptocuma forsmani*
  - *Listriella eriopisa*
  - *Metamysidopsis elongata*
  - *Mysidopsis intii*
  - *Parapagurodes* sp.
  - *Photis bifurcata*
  - *Photis brevipes*
  - *Pyromaia tuberculata*
  - *Rhepoxynius menziesi*[22]
  - *Rhepoxynius stenodes*
  - *Uromunna ubiquita*[23]
- Pycnogonida
  - *Anoropallene palpida*

Appendix F-1. (Cont.).

PHYLUM Class Species	PHYLUM Class Species
ECHINODERMATA	PHORONA
Echinoidea	Phoronida
Dendraster excentricus	
Ophiuroidea	CHORDATA
Amphiodia digitata	Enteropneusta[24]

The following footnote numbers indicate names used in previous surveys:

1 Platyhelminthes sp. D MBC
2 *Tubulanus* spp. or *T. pellucidus/polymorphus*
3 *Paranemertes* sp. A SCAMIT
4 *Tetrastemma* sp.
5 *Mysella tumida*
6 *Crepidula coei*
7 *Cadulus fusiformis*
8 *Apelochaeta* sp. C Dorsey 1984, *Tharyx* spp. (in part)
9 *Apoprionospio pygmaeus* or *Prionospio pygmaeus*
10 *Acmira catherinae*, *Acesta catherinae*
11 *Chaetozone setosa?* or *C. cf. Setosa*
12 *Haploscoloplos elongatus*
13 *Mediomastus ambiseta*, *M. californiensis*
14 *Tharyx* sp. A SCAMIT or *Monticellina dorsobranchialis*
15 *Pectinaria californiensis newportensis*
16 *Gyptis brevipalpa*
17 *Thalanessa spinosa* or *Eusigalion spinosa*
18 *Spiophanes missionensis*
19 *Edotea sublittoralis*
20 *Megaluropus longimerus*
21 *Monoculodes hartamae*
22 *Paraphoxus epistomus* or *Rhepoxynius epistomus*
23 *Munna* sp.
24 Hemichordata, unid.

Appendix F-2. Infaunal data by station. El Segundo and Scattergood Generating Stations NPDES, 1998.

Station B2

Phylum	Species	Replicate B2-I	B2-II	B2-III	B2-IV	Total	Percent Comp.	Number/ m2
AN	*Apoprionospio pygmaea*	169	144	137	126	576	64.6	14400
MO	*Solen sicarius*	54	37	42	18	151	16.9	3775
MO	*Tresus nuttallii*	7	10	5	2	24	2.7	600
AN	*Armandia brevis*	8	2	4	-	14	1.6	350
AN	*Mediomastus acutus*	4	2	3	2	11	1.2	275
MO	*Mactrotoma californica*	4	1	3	2	10	1.1	250
MO	*Siliqua lucida*	-	5	3	2	10	1.1	250
MO	*Cooperella subdiaphana*	3	-	3	2	8	0.9	200
AN	*Pectinaria californiensis*	3	3	2	-	8	0.9	200
AN	*Phyllochaetopterus prolifica*	2	1	1	3	7	0.8	175
PL	*Pseudoceros* sp.	2	1	1	2	6	0.7	150
MO	*Tellina modesta*	2	1	2	1	6	0.7	150
EC	*Amphiodia digitata*	2	1	1	1	5	0.6	125
AN	*Mediomastus* sp.	1	-	3	1	5	0.6	125
AN	*Owenia fusiformis*	1	1	1	2	5	0.6	125
AR	*Uromunna ubiquita*	-	-	2	2	4	0.4	100
NE	*Carinoma mutabilis*	1	-	2	-	3	0.3	75
MO	*Kurtziella plumbea*	-	1	1	1	3	0.3	75
NE	Lineidae	1	1	-	1	3	0.3	75
AN	*Nephtys caecoides*	1	2	-	-	3	0.3	75
MO	Bivalvia	1	1	-	-	2	0.2	50
MO	*Cumingia californica*	1	-	-	1	2	0.2	50
AN	*Glycera convoluta*	1	-	1	-	2	0.2	50
MO	*Macoma nasuta*	-	2	-	-	2	0.2	50
MO	*Modiolus sp.*	-	1	1	-	2	0.2	50
MO	*Olivella baetica*	1	1	-	-	2	0.2	50
AN	*Spiophanes bombyx*	1	1	-	-	2	0.2	50
AN	*Spiophanes duplex*	-	1	1	-	2	0.2	50
NE	*Tetrastemma* sp. A SCAMIT 1995	1	1	-	-	2	0.2	50
AR	*Anoropallene palpida*	-	-	1	-	1	0.1	25
AN	*Capitella capitata* Cmplx	-	1	-	-	1	0.1	25
EC	*Dendraster excentricus*	1	-	-	-	1	0.1	25
AR	*Gibberosus myersi*	-	-	1	-	1	0.1	25
AN	*Goniada littorea*	-	1	-	-	1	0.1	25
MO	*Mysella pedroana*	-	-	-	1	1	0.1	25
AR	*Parapagurodes* sp.	-	-	1	-	1	0.1	25
AN	*Paraprionospio pinnata*	-	-	1	-	1	0.1	25
AN	*Polydora bioccipitalis*	-	-	1	-	1	0.1	25
AN	*Polydora cirrosa*	-	1	-	-	1	0.1	25
PL	*Stylochoplana* sp.	-	1	-	-	1	0.1	25

Summary

Parameter	Replicate B2-I	B2-II	B2-III	B2-IV	Station Total	Mean	S.D.
Number of individuals	272	225	224	170	891	222.8	41.7
Number of species	24	27	26	18	40	23.8	4.0
Diversity (H')	1.43	1.46	1.54	1.16	1.49	1.40	0.17

Appendix F-2. (Cont.).

Station B3

Phylum	Species	Replicate B3-I	B3-II	B3-III	B3-IV	Total	Percent Comp.	Number/ m^2
AN	*Apoprionospio pygmaea*	41	20	27	27	115	48.5	2875
AR	*Rhepoxynius menziesi*	6	9	4	4	23	9.7	575
AN	*Armandia brevis*	4	2	4	10	20	8.4	500
MO	*Solen sicarius*	3	7	1	9	20	8.4	500
AN	*Mediomastus acutus*	1	-	2	4	7	3.0	175
AN	*Owenia fusiformis*	3	-	1	1	5	2.1	125
PL	*Pseudoceros* sp.	-	-	5	-	5	2.1	125
MO	*Donax gouldii*	1	1	2	-	4	1.7	100
AR	*Hartmanodes hartmanae*	1	2	1	-	4	1.7	100
EC	*Dendraster excentricus*	-	-	1	2	3	1.3	75
AN	*Gibberosus myersi*	-	2	1	-	3	1.3	75
AR	*Metamysidopsis elongata*	1	-	2	-	3	1.3	75
MO	*Olivella baetica*	-	-	2	1	3	1.3	75
EC	*Amphiodia digitata*	1	-	-	1	2	0.8	50
AN	*Cirriformia spirabrancha*	1	-	-	1	2	0.8	50
AR	*Leptocuma forsmani*	-	2	-	-	2	0.8	50
NT	Nematoda	-	-	1	1	2	0.8	50
AN	*Nepthys caecoides*	-	1	1	-	2	0.8	50
AN	*Phyllochaetopterus prolifica*	-	1	1	-	2	0.8	50
AR	*Ancinus granulatus*	-	1	-	-	1	0.4	25
NE	*Carinoma mutabilis*	1	-	-	-	1	0.4	25
AN	*Hesionella mccullochae*	-	1	-	-	1	0.4	25
NE	Lineidae	-	1	-	-	1	0.4	25
CN	Limnactiniidae sp. A SCAMIT 1989	-	-	1	-	1	0.4	25
NE	*Paranemertes californica*	-	-	1	-	1	0.4	25
AN	*Spiophanes bombyx*	1	-	-	-	1	0.4	25
AN	*Spiophanes duplex*	1	-	-	-	1	0.4	25
MO	*Tellina modesta*	-	-	1	-	1	0.4	25
AR	*Uromunna ubiquita*	-	1	-	-	1	0.4	25

Summary

Parameter	Replicate B3-I	B3-II	B3-III	B3-IV	Station Total	Mean	S.D.
Number of individuals	66	51	59	61	237	59.3	6.2
Number of species	14	14	19	11	29	14.5	3.3
Diversity (H')	1.54	1.99	2.15	1.75	2.09	1.86	0.27

Appendix F-2. (Cont.).

Station B6

Phylum	Species	Replicate B6-I	B6-II	B6-III	B6-IV	Total	Percent Comp.	Number/ m²
AN	*Polydora cirrosa*	-	-	76	-	76	26.0	1900
MO	*Tellina modesta*	3	5	8	9	25	8.6	625
AN	*Chaetozone setosa* Cmplx	10	1	-	6	17	5.8	425
EC	*Dendraster excentricus*	1	8	2	4	15	5.1	375
MO	*Crepidula naticarum*	-	-	12	-	12	4.1	300
AN	*Mediomastus acutus*	3	3	3	3	12	4.1	300
AR	*Diastylopsis tenuis*	5	3	3	-	11	3.8	275
AR	*Aoroides inermis*	-	-	8	-	8	2.7	200
CO	Enteropneusta	4	2	-	2	8	2.7	200
MO	*Tresus nuttallii*	2	2	-	4	8	2.7	200
AN	*Monticellina cryptica*	2	2	2	-	6	2.1	150
AN	*Aphelochaeta glandaria*	1	1	2	1	5	1.7	125
MO	*Cooperella subdiaphana*	-	1	1	3	5	1.7	125
AR	*Hemilamprops californica*	3	1	-	1	5	1.7	125
MO	*Macoma secta*	-	-	-	5	5	1.7	125
AN	*Amaeana occidentalis*	1	1	1	1	4	1.4	100
AN	*Apoprionospio pygmaea*	1	1	1	1	4	1.4	100
AR	*Balanus pacificus*	-	-	4	-	4	1.4	100
AN	*Owenia fusiformis*	-	4	-	-	4	1.4	100
AN	*Spiophanes bombyx*	1	1	1	1	4	1.4	100
AN	*Paraprionospio pinnata*	1	-	-	2	3	1.0	75
AN	*Phyllochaetopterus prolifica*	-	1	2	-	3	1.0	75
PL	*Pseudoceros* sp.	-	-	3	-	3	1.0	75
AN	*Diopatra* sp.	1	-	-	1	2	0.7	50
AR	*Ericthonius brasiliensis*	-	-	2	-	2	0.7	50
AR	*Gibberosus myersi*	2	-	-	-	2	0.7	50
NT	Nematoda	-	1	1	-	2	0.7	50
AN	Onuphidae	-	-	-	2	2	0.7	50
MO	*Rochefortia tumida*	-	-	1	1	2	0.7	50
AN	*Spiophanes duplex*	-	-	-	2	2	0.7	50
CN	Actiniaria	-	-	-	1	1	0.3	25
AN	*Aricidea (Acmira) catherinae*	-	-	-	1	1	0.3	25
AN	*Brania californiensis*	-	-	1	-	1	0.3	25
AR	*Caprella mendax*	-	-	1	-	1	0.3	25
NE	*Carinoma mutabilis*	-	-	-	1	1	0.3	25
AR	*Cerapus tubularis* Cmplx	1	-	-	-	1	0.3	25
AR	*Edotia sublittoralis*	-	-	-	1	1	0.3	25
AN	*Eulalia levicornuta*	-	-	1	-	1	0.3	25
AN	*Eusyllis transecta*	-	-	1	-	1	0.3	25
MO	*Gadila aberrans*	1	-	-	-	1	0.3	25
AN	*Glycera* sp.	-	-	1	-	1	0.3	25
AR	Harpacticoida	1	-	-	-	1	0.3	25
AR	*Lamprops quadriplicatus*	1	-	-	-	1	0.3	25
AN	*Leitoscoloplos pugettensis*	-	-	-	1	1	0.3	25
AR	*Listriella eriopisa*	-	-	-	1	1	0.3	25
AN	Lumbrineridae	-	-	1	-	1	0.3	25
AN	*Megalomma pigmentum*	-	-	-	1	1	0.3	25
NE	*Paranemertes californica*	-	-	-	1	1	0.3	25
PR	Phoronida	1	-	-	-	1	0.3	25
AR	*Photis brevipes*	-	-	1	-	1	0.3	25
AN	*Phyllodoce hartmanae*	1	-	-	-	1	0.3	25
AN	*Podarkeopsis glabra*	-	-	1	-	1	0.3	25
AR	*Pyromaia tuberculata*	-	-	1	-	1	0.3	25
AR	*Rhepoxynius stenodes*	-	-	1	-	1	0.3	25
AN	*Sigalion spinosus*	-	-	-	1	1	0.3	25
AN	*Syllis (Ehlersia) heterochaeta*	-	1	-	-	1	0.3	25
AN	*Syllis (Typosyllis)* sp.	-	-	-	1	1	0.3	25
AN	*Tenonia priops*	-	-	1	-	1	0.3	25
NE	*Tubulanus polymorphus*	1	-	-	-	1	0.3	25
MO	*Turbonilla painei*	-	1	-	-	1	0.3	25
AR	*Uromunna ubiquita*	-	-	1	-	1	0.3	25

Appendix F-2. (Cont.).

Summary

Parameter	Replicate B6-I	B6-II	B6-III	B6-IV	Station Total	Mean	S.D.
Number of individuals	48	40	145	59	292	73.0	48.6
Number of species	23	19	31	28	61	25.3	5.3
Diversity (H')	1.35	1.15	0.97	1.88	1.56	1.34	0.39

Appendix F-2. (Cont.).

Station B7

Phylum	Species	Replicate B7-I	B7-II	B7-III	B7-IV	Total	Percent Comp.	Number/ m^2
AR	*Diastylopsis tenuis*	-	8	16	-	24	12.8	600
MO	*Cooperella subdiaphana*	3	4	7	9	23	12.3	575
AR	*Aoroides inermis*	12	1	-	-	13	7.0	325
AN	*Apoprionospio pygmaea*	3	4	-	6	13	7.0	325
AN	*Polydora cirrosa*	13	-	-	-	13	7.0	325
MO	*Tellina modesta*	7	1	1	4	13	7.0	325
AR	*Hartmanodes hartmanae*	2	2	2	5	11	5.9	275
AR	*Ericthonius brasiliensis*	8	-	-	-	8	4.3	200
AR	*Gibberosus myersi*	-	-	6	2	8	4.3	200
AN	*Mediomastus acutus*	1	2	1	2	6	3.2	150
AN	*Chaetozone setosa* Cmplx	3	-	-	1	4	2.1	100
AN	*Sigalion spinosus*	1	-	1	2	4	2.1	100
AN	*Spiophanes bombyx*	-	2	1	1	4	2.1	100
NE	*Carinoma mutabilis*	-	1	2	-	3	1.6	75
AN	*Goniada littorea*	1	-	-	2	3	1.6	75
MO	*Macoma secta*	-	-	1	2	3	1.6	75
AN	*Owenia fusiformis*	1	1	-	1	3	1.6	75
AN	*Paraprionospio pinnata*	1	-	-	2	3	1.6	75
CO	Enteropneusta	-	1	-	1	2	1.1	50
AN	*Leitoscoloplos pugettensis*	-	1	-	1	2	1.1	50
AN	*Phyllochaetopterus prolifica*	1	-	-	1	2	1.1	50
PL	*Pseudoceros* sp.	2	-	-	-	2	1.1	50
AN	*Spiophanes duplex*	-	-	2	-	2	1.1	50
AN	*Ampharete labrops*	1	-	-	-	1	0.5	25
AN	*Aphelocaheta glandaria*	-	-	-	1	1	0.5	25
AN	*Brania californiensis*	1	-	-	-	1	0.5	25
AN	*Cirriformia spirabrancha*	1	-	-	-	1	0.5	25
AR	*Cerapus tubularis* Cmplx	-	1	-	-	1	0.5	25
EC	*Dendraster excentricus*	-	-	1	-	1	0.5	25
AN	*Diopatra tridentata*	-	-	-	1	1	0.5	25
AN	*Eusyllis transecta*	1	-	-	-	1	0.5	25
AN	*Glycera convoluta*	-	1	-	-	1	0.5	25
MO	*Macoma yoldiformis*	-	-	1	-	1	0.5	25
MO	*Mactrotoma californica*	-	1	-	-	1	0.5	25
AR	*Mysidopsis intii*	-	-	-	1	1	0.5	25
NE	*Paranemertes californica*	1	-	-	-	1	0.5	25
PR	Phoronida	-	-	-	1	1	0.5	25
AR	*Photis bifurcata*	1	-	-	-	1	0.5	25
MO	*Rictaxis punctocaelatus*	-	-	1	-	1	0.5	25
AN	*Syllis (Ehlersia) heterochaeta*	-	-	-	1	1	0.5	25
NE	*Tetrastemma* sp. A SCAMIT 1995	-	1	-	-	1	0.5	25

Summary

Parameter	Replicate B7-I	B7-II	B7-III	B7-IV	Station Total	Mean	S.D.
Number of individuals	65	32	43	47	187	46.8	13.7
Number of species	21	16	14	21	41	18.0	3.6
Diversity (H')	2.54	2.47	2.07	2.73	3.13	2.45	0.28

Appendix F-3. Infaunal wet weight biomass data (g). Scattergood and El Segundo Generating Stations NPDES, 1998.

Sta-Rep	Annelida	Arthropoda	Mollusca	Echinodermata	Other	Total
B2-I	0.268	-	0.092	0.162	<0.001	0.522
B2-II	0.121	-	1.012	0.003	0.002	1.138
B2-III	0.211	0.013	0.081	<0.001	0.007	0.312
B2-IV	0.142	0.064	0.070	0.004	0.029	0.309
TOTAL	0.742	0.077	1.254	0.169	0.038	2.280
B3-I	0.202	0.024	0.025	0.075	0.088	0.413
B3-II	0.049	0.032	0.001	-	0.011	0.093
B3-III	0.073	0.026	0.195	0.044	0.035	0.373
B3-IV	0.078	0.034	0.096	0.097	<0.001	0.305
TOTAL	0.402	0.115	0.316	0.215	0.135	1.183
B6-I	0.139	0.095	0.087	<0.001	0.472	0.792
B6-II	0.084	0.007	0.001	<0.001	0.041	0.132
B6-III	0.511	0.052	0.044	<0.001	0.028	0.635
B6-IV	0.344	0.017	0.026	<0.001	0.270	0.656
TOTAL	1.077	0.170	0.158	<0.001	0.810	2.215
B7-I	0.065	0.068	0.082	-	0.058	0.273
B7-II	0.019	0.011	0.001	-	0.202	0.232
B7-III	0.043	0.025	0.008	<0.001	0.043	0.119
B7-IV	0.048	0.019	0.039	-	0.602	0.708
TOTAL	0.175	0.123	0.129	<0.001	0.904	1.331
GRAND TOTAL	2.396	0.485	1.858	0.384	1.886	7.010

APPENDIX G

Fish and macroinvertebrate heat treatment and normal operations data
El Segundo and Scattergood Generating Stations NPDES, 1998

Appendix G-1. Fish and invertebrate heat treatment master species list. El Segundo and Scattergood Generating Stations NPDES, 1998.

PHYLUM / Class / Family / Species	Common Name
MOLLUSCA	
Gastropoda	
Aglajidae	
Navanax inermis	California aglaja (=striped sea hare)
Cephalopoda	
Octopodidae	
Octopus bimaculatus/bimaculoides	California two-spot octopus
CRUSTACEA	
Malacostraca	
Hippolytidae	
Heptacarpus palpator	tiger shrimp
Lysmata californica	red striped shrimp
Crangonidae	
Crangon nigromaculata	blackspotted bay shrimp
Palinuridae	
Panulirus interruptus	California spiny lobster
Albuneidae	
Blepharipoda occidentalis	spiny mole crab
Majidae	
Loxorhynchus crispatus	masking crab
Loxorhynchus grandis	sheep crab
Pyromaia tuberculata	tuberculate pear crab
Cancridae	
Cancer amphioetus	bigtooth rock crab
Cancer antennarius	Pacific rock crab
Cancer anthonyi	yellow rock crab
Cancer gracilis	graceful rock crab
Portunidae	
Portunus xantusii	Xantus swimming crab
Pilumnidae	
Pilumnus spinohirsutus	retiring hairy crab
Grapsidae	
Pachygrapsus crassipes	striped shore crab
ECHINODERMATA	
Echinoidea	
Strongylocentrotidae	
Strongylocentrotus purpuratus	Pacific purple urchin
Holothuroidea	
Stichopodidae	
Parastichopus parvimensis	warty sea cucumber
VERTEBRATA	
Elasmobranchiomorphi (= Chondrichthyes, Elasmobranchii)	
Heterodontidae	
Heterodontus francisci	horn shark
Scyliorhinidae	
Cephaloscyllium ventriosum	swell shark
Carcharinidae	
Mustelus californicus	gray smoothhound
Mustelus henlei	brown smoothhound
Triakis semifasciata	leopard shark
Torpedinidae	
Torpedo californica	Pacific electric ray
Rhinobatidae	
Platyrhinoidis triseriata	thornback
Rhinobatos productus	shovelnose guitarfish
Myliobatidae	
Myliobatis californica	bat ray
Urolophidae (Dasyatidae, in part)	
Urolophus halleri	round stingray
Osteichthyes (=Actinopterygii)	
Clupeidae	
Sardinops sagax	Pacific sardine
Engraulidae	
Anchoa compressa	deepbody anchovy
Engraulis mordax	northern anchovy

Appendix G-1. (Cont'd).

PHYLUM / Class / Family / Species	Common Name
VERTEBRATA cont'd.	
Ophidiidae	
Ophidion scrippsae	basketweave cusk-eel
Batrachoididae	
Porichthys myriaster	specklefin midshipman
Porichthys notatus	plainfin midshipman
Atherinidae	
Atherinops affinis	topsmelt
Atherinopsis californiensis	jacksmelt
Leuresthes tenuis	California grunion
Syngnathidae	
Syngnathus californiensis	kelp pipefish
Scorpaenidae	
Scorpaena guttata	California scorpionfish
Sebastes auriculatus	brown rockfish
Cottidae	
Scorpaenichthys marmoratus	cabezon
Serranidae	
Paralabrax clathratus	kelp bass
Paralabrax maculatofasciatus	spotted sand bass
Paralabrax nebulifer	barred sand bass
Haemulidae (=Pomadasyidae)	
Anisotremus davidsonii	sargo
Xenistius californiensis	salema
Sciaenidae	
Atractoscion nobilis	white seabass
Cheilotrema saturnum	black croaker
Genyonemus lineatus	white croaker
Menticirrhus undulatus	California corbina
Seriphus politus	queenfish
Umbrina roncador	yellowfin croaker
Kyphosidae (includes Girellidae and Scorpididae)	
Girella nigricans	opaleye
Medialuna californiensis	halfmoon
Embiotocidae	
Cymatogaster aggregata	shiner perch
Damalichthys (=Rhacochilus) vacca	pile perch
Embiotoca jacksoni	black perch
Hyperprosopon argenteum	walleye surfperch
Phanerodon furcatus	white seaperch
Rhacochilus toxotes	rubberlip seaperch
Pomacentridae	
Chromis punctipinnis	blacksmith
Hypsypops rubicundus	garibaldi
Sphyraenidae	
Sphyraena argentea	California barracuda
Labridae	
Halichoeres semicinctus	rock wrasse
Oxyjulis californica	senorita
Semicossyphus pulcher	California sheephead
Clinidae	
Heterostichus rostratus	giant kelpfish
Blenniidae	
Hypsoblennius gilberti	rockpool blenny
Scombridae	
Scomber japonicus	chub mackerel
Stromateidae	
Peprilus simillimus	Pacific butterfish
Bothidae (=Paralichthyidae)	
Citharichthys stigmaeus	speckled sanddab
Paralichthys californicus	California halibut
Pleuronectidae	
Hypsopsetta guttulata	diamond turbot
Pleuronichthys ritteri	spotted turbot
Pleuronichthys verticalis	hornyhead turbot
Tetraodontidae	
Sphoeroides annulatus	bullseye puffer

Appendix G-2. Abundance, biomass (kg), and percent occurence of fish impinged at El Segundo and Scattergood Generating Stations. El Segundo and Scattergood Generating Stations NPDES, 1998.

Species	Scattergood No.	Scattergood Wt. (kg)	El Segundo No.	El Segundo Wt. (kg)	Total Abundance	Percent Total	Cumulative Percent	Total Biomass
Seriphus politus	16178	352.680	1049	14.696	17227	45.00	45.00	367.376
Genyonemus lineatus	5288	387.942	29	26.130	5317	13.89	58.89	414.072
Sardinops sagax	3555	121.599	207	12.048	3762	9.83	68.71	133.647
Atherinops affinis	3042	133.524	22	0.862	3064	8.00	76.72	134.386
Xenistius californiensis	1593	42.639	1031	15.840	2624	6.85	83.57	58.479
Atherinopsis californiensis	1262	142.679	1194	104.724	2456	6.41	89.98	247.403
Anisotremus davidsonii	261	91.449	204	92.322	465	1.21	91.20	183.771
Umbrina roncador	452	77.999	4	0.236	456	1.19	92.39	78.235
Cheilotrema saturnum	272	26.699	177	16.493	449	1.17	93.56	43.192
Hyperprosopon argenteum	325	9.324	38	11.890	363	0.95	94.51	21.214
Paralabrax nebulifer	339	91.942	3	1.580	342	0.89	95.40	93.522
Paralabrax clathratus	171	19.210	46	7.500	217	0.57	95.97	26.710
Menticirrhus undulatus	110	9.284	24	6.943	134	0.35	96.32	16.227
Atractoscion nobilis	98	26.428	18	2.445	116	0.30	96.62	28.873
Pleuronichthys ritteri	82	11.574	22	4.203	104	0.27	96.89	15.777
Anchoa compressa	94	1.760	-	-	94	0.25	97.14	1.760
Leuresthes tenuis	87	1.250	-	-	87	0.23	97.36	1.250
Engraulis mordax	72	0.558	1	0.095	73	0.19	97.56	0.653
Oxyjulis californica	1	0.056	66	18.386	67	0.18	97.73	18.442
Paralichthys californicus	66	9.680	1	0.040	67	0.18	97.91	9.720
Peprillus simillimus	-	-	66	28.548	66	0.17	98.08	28.548
Chromis punctipinnis	39	2.729	21	0.260	60	0.16	98.23	2.989
Heterostichus rostratus	15	0.361	44	1.306	59	0.15	98.39	1.667
Platyrhinoidis triseriata	56	21.479	2	0.012	58	0.15	98.54	21.491
Urolophus halleri	53	29.741	5	3.700	58	0.15	98.69	33.441
Embiotoca jacksoni	11	3.168	47	1.186	58	0.15	98.84	4.354
Scorpaena guttata	36	4.543	21	5.660	57	0.15	98.99	10.203
Hypsoblennius gilberti	50	0.094	-	-	50	0.13	99.12	0.094
Rhacochilus toxotes	30	7.748	18	6.372	48	0.13	99.25	14.120
Cymatogaster aggregata	38	1.557	-	-	38	0.10	99.35	1.557
Heterodontus francisci	7	10.259	25	0.797	32	0.08	99.43	11.056
Porichthys notatus	2	0.265	29	11.289	31	0.08	99.51	11.554
Pleuronichthys verticalis	5	0.850	25	7.444	30	0.08	99.58	8.294
Medialuna californiensis	24	9.129	1	0.033	25	0.07	99.65	9.162
Scomber japonicus	10	1.900	9	0.935	19	0.05	99.70	2.835
Myliobatis californica	14	60.803	1	0.070	15	0.04	99.74	60.873
Sphyraena argentea	14	9.022	1	0.018	15	0.04	99.78	9.040
Halichoeres semicinctus	14	2.023	-	-	14	0.04	99.81	2.023
Damalichthys vacca	11	3.878	2	0.911	13	0.03	99.85	4.789
Girella nigricans	12	6.262	1	0.082	13	0.03	99.88	6.344
Ophidion scrippsae	8	0.118	-	-	8	0.02	99.90	0.118
Phanerodon furcatus	5	0.438	-	-	5	0.01	99.92	0.438
Citharichthys stigmaeus	4	0.068	-	-	4	0.01	99.93	0.068
Hypsopsetta guttulata	4	0.823	-	-	4	0.01	99.94	0.823
Mustelus californicus	3	5.620	-	-	3	0.01	99.95	5.620
Rhinobatos productus	3	11.750	-	-	3	0.01	99.95	11.750
Scorpaenichthys marmoratus	-	-	3	1.271	3	0.01	99.96	1.271
Sebastes auriculatus	2	1.150	1	0.461	3	0.01	99.97	1.611
Porichthys myriaster	2	0.626	-	-	2	0.01	99.97	0.626
Sphoeroides annulatus	1	1.460	1	0.050	2	0.01	99.98	1.510
Cephaloscyllium ventriosum	1	2.220	-	-	1	0.00	99.98	2.220
Hypsypops rubicundus	1	0.009	-	-	1	0.00	99.98	0.009
Mustelus henlei	1	1.500	-	-	1	0.00	99.99	1.500
Paralabrax maculatofasciatus	1	0.021	-	-	1	0.00	99.99	0.021
Semicossyphus pulcher	1	0.024	-	-	1	0.00	99.99	0.024
Syngnathus californiensis	1	0.006	-	-	1	0.00	99.99	0.006
Torpedo californica	1	18.700	-	-	1	0.00	100.00	18.700
Triakis semifasciata	1	2.000	-	-	1	0.00	100.00	2.000
Survey Totals	33829	1780.62	4454	406.838	38283			2187.458
Total Species	56		38		58			

Note: 0.00 < 0.005

Appendix G-3. Abundance and biomass (kg) of fish impinged in heat treatments (HT) and normal operations (NO) at El Segundo Generating Station. El Segundo and Scattergood Generating Stations NPDES, 1998.

	Units 3 & 4 Heat Treatment		Units 3 & 4 Monitored Normal Ops		Units 3 & 4 Extrapolated Normal Ops		Units 3 & 4 Combined NO and HT	
Species	Abund.	Biomass	Abund.	Biomass	Abund.	Biomass	Abund.	Biomass
Atherinopsis californiensis	978	94.550	10	0.472	216	10.174	1194	104.724
Seriphus politus	1027	13.920	1	0.036	22	0.776	1049	14.696
Xenistius californiensis	1031	15.840	-	-	-	-	1031	15.840
Sardinops sagax	185	11.250	1	0.037	22	0.798	207	12.048
Anisotremus davidsonii	204	92.322	-	-	-	-	204	92.322
Cheilotrema saturnum	155	13.260	1	0.150	22	3.233	177	16.493
Oxyjulis californica	66	18.386	-	-	-	-	66	18.386
Peprilus simillimus	1	0.333	3	1.309	65	28.215	66	28.548
Embiotoca jacksoni	25	0.281	1	0.042	22	0.905	47	1.186
Paralabrax clathratus	46	7.500	-	-	-	-	46	7.500
Heterostichus rostratus	44	1.306	-	-	-	-	44	1.306
Hyperprosopon argenteum	38	11.890	-	-	-	-	38	11.890
Genyonemus lineatus	29	26.130	-	-	-	-	29	26.130
Porichthys notatus	7	3.228	1	0.374	22	8.061	29	11.289
Heterodontus francisci	3	0.107	1	0.032	22	0.690	25	0.797
Pleuronichthys verticalis	3	0.590	1	0.318	22	6.854	25	7.444
Menticirrhus undulatus	2	0.800	1	0.285	22	6.143	24	6.943
Atherinops affinis	-	-	1	0.040	22	0.862	22	0.862
Pleuronichthys ritteri	-	-	1	0.195	22	4.203	22	4.203
Chromis punctipinnis	21	0.260	-	-	-	-	21	0.260
Scorpaena guttata	21	5.660	-	-	-	-	21	5.660
Atractoscion nobilis	18	2.445	-	-	-	-	18	2.445
Rhacochilus toxotes	18	6.372	-	-	-	-	18	6.372
Scomber japonicus	9	0.935	-	-	-	-	9	0.935
Urolophus halleri	5	3.700	-	-	-	-	5	3.700
Umbrina roncador	4	0.236	-	-	-	-	4	0.236
Paralabrax nebulifer	3	1.580	-	-	-	-	3	1.580
Scorpaenichthys marmoratus	3	1.271	-	-	-	-	3	1.271
Damalichthys vacca	2	0.911	-	-	-	-	2	0.911
Platyrhinoidis triseriata	2	0.012	-	-	-	-	2	0.012
Engraulis mordax	1	0.095	-	-	-	-	1	0.095
Girella nigricans	1	0.082	-	-	-	-	1	0.082
Medialuna californiensis	1	0.033	-	-	-	-	1	0.033
Myliobatis californica	1	0.070	-	-	-	-	1	0.070
Paralichthys californicus	1	0.040	-	-	-	-	1	0.040
Sebastes auriculatus	1	0.461	-	-	-	-	1	0.461
Sphoeroides annulatus	-	-	1	0.050	1	0.050	1	0.050
Sphyraena argentea	1	0.018	-	-	-	-	1	0.018
Survey Totals	3957	335.874	24	3.340	497	70.964	4454	406.838
Total Species	35		13				38	

Extrapolation based on flow data, with 237.1 operating days of flow calculated from monthly flow information.

Appendix G-4. Abundance of fish impinged in heat treatments by date at El Segundo Generating Station. El Segundo and Scattergood Generating Stations NPDES, 1998.

	Units 1 & 2	Units 3 & 4				Total
	Total	10 Oct	15 Nov	2 Jun	Total	Abundance
Xenistius californiensis	-	393	638	-	1031	1031
Seriphus politus	-	380	647	-	1027	1027
Atherinopsis californiensis	-	1	977	-	978	978
Anisotremus davidsonii	-	199	1	4	204	204
Sardinops sagax	-	-	185	-	185	185
Cheilotrema saturnum	-	118	27	10	155	155
Paralabrax clathratus	-	61	2	3	66	66
Paralabrax nebulifer	-	43	3	-	46	46
Hyperprosopon argenteum	-	25	19	-	44	44
Medialuna californiensis	-	38	-	-	38	38
Girella nigricans	-	26	-	3	29	29
Engraulis mordax	-	18	7	-	25	25
Chromis punctipinnis	-	21	-	-	21	21
Scorpaena guttata	-	20	-	1	21	21
Atractoscion nobilis	-	16	2	-	18	18
Damalichthys vacca	-	3	4	11	18	18
Scomber japonicus	-	6	3	-	9	9
Rhacochilus toxotes	-	5	2	-	7	7
Urolophus halleri	-	-	-	5	5	5
Umbrina roncador	-	4	-	-	4	4
Heterostichus rostratus	-	3	-	-	3	3
Paralichthys californicus	-	3	-	-	3	3
Porichthys notatus	-	-	-	3	3	3
Scorpaenichthys marmoratus	-	2	-	1	3	3
Embiotoca jacksoni	-	2	-	-	2	2
Myliobatis californica	-	-	-	2	2	2
Pleuronichthys ritteri	-	-	2	-	2	2
Genyonemus lineatus	-	-	1	-	1	1
Heterodontus francisci	-	1	-	-	1	1
Menticirrhus undulatus	-	1	-	-	1	1
Oxyjulis californica	-	-	1	-	1	1
Peprilus simillimus	-	-	1	-	1	1
Platyrhinoidis triseriata	-	-	1	-	1	1
Sebastes auriculatus	-	1	-	-	1	1
Sphyraena argentea	-	-	1	-	1	1
Total Abundance:	0	1390	2524	43	3957	3957
Species	0	25	20	10	35	35

No heat treatments occurred at Units 1 & 2 during the survey year.

Appendix G-5. Abundance of fish impinged during heat treatments by date at Scattergood Generating Station. El Segundo and Scattergood Generating Stations NPDES, 1998.

	1997	1998						Total
	20 Nov	15 Jan	10 Feb	7 Apr	4 Jun	25 Jul	10 Sep	Abundance
Seriphus politus	3089	3695	158	4501	4735	-	-	16178
Genyonemus lineatus	3	460	274	4391	160	-	-	5288
Sardinops sagax	4	3008	1	4	517	6	15	3555
Atherinops affinis	46	500	7	84	249	1710	446	3042
Xenistius californiensis	797	290	1	13	23	37	432	1593
Atherinopsis californiensis	4	830	4	39	111	-	274	1262
Umbrina roncador	37	60	33	14	-	72	236	452
Paralabrax nebulifer	63	90	6	58	35	30	57	339
Hyperprosopon argenteum	19	80	16	205	3	-	2	325
Cheilotrema saturnum	142	50	6	28	22	13	11	272
Anisotremus davidsonii	75	50	8	9	12	66	41	261
Paralabrax clathratus	54	30	1	7	5	39	35	171
Menticirrhus undulatus	-	2	14	85	1	1	7	110
Atractoscion nobilis	66	20	-	9	1	-	2	98
Anchoa compressa	3	80	4	7	-	-	-	94
Leuresthes tenuis	-	-	-	87	-	-	-	87
Pleuronichthys ritteri	5	45	15	14	3	-	-	82
Engraulis mordax	-	40	9	13	10	-	-	72
Paralichthys californicus	-	-	4	54	3	1	4	66
Platyrhinoidis triseriata	1	12	10	30	2	1	-	56
Urolophus halleri	1	5	-	12	30	4	1	53
Hypsoblennius gilberti	15	10	1	-	-	1	23	50
Chromis punctipinnis	16	-	11	-	3	7	2	39
Cymatogaster aggregata	-	8	4	13	13	-	-	38
Scorpaena guttata	2	25	1	3	1	-	4	36
Rhacochilus toxotes	4	15	1	5	2	3	-	30
Medialuna californiensis	20	-	-	1	-	2	1	24
Heterostichus rostratus	1	10	3	-	1	-	-	15
Halichoeres semicinctus	1	-	-	1	-	8	4	14
Myliobatis californica	-	1	-	6	3	2	2	14
Sphyraena argentea	3	-	-	-	-	1	10	14
Girella nigricans	-	10	1	-	-	-	1	12
Damalichthys vacca	1	-	1	3	5	-	1	11
Embiotoca jacksoni	1	-	2	4	-	1	3	11
Scomber japonicus	-	10	-	-	-	-	-	10
Ophidion scrippsae	-	-	-	8	-	-	-	8
Heterodontus francisci	1	1	-	-	4	-	1	7
Phanerodon furcatus	-	-	3	2	-	-	-	5
Pleuronichthys verticalis	-	5	-	-	-	-	-	5
Citharichthys stigmaeus	-	-	3	1	-	-	-	4
Hypsopsetta guttulata	1	1	-	2	-	-	-	4
Mustelus californicus	-	-	-	-	3	-	-	3
Rhinobatos productus	-	-	-	-	2	-	1	3
Porichthys myriaster	-	-	-	2	-	-	-	2
Porichthys notatus	-	-	-	-	2	-	-	2
Sebastes auriculatus	-	-	-	2	-	-	-	2
Cephaloscyllium ventriosum	-	-	-	-	1	-	-	1
Hypsypops rubicundus	1	-	-	-	-	-	-	1
Mustelus henlei	1	-	-	-	-	-	-	1
Oxyjulis californica	-	-	1	-	-	-	-	1
Paralabrax maculatofasciatus	1	-	-	-	-	-	-	1
Semicossyphus pulcher	-	-	-	-	1	-	-	1
Sphoeroides annulatus	-	-	-	1	-	-	-	1
Syngnathus californiensis	-	-	-	1	-	-	-	1
Torpedo californica	-	-	-	1	-	-	-	1
Triakis semifasciata	1	-	-	-	-	-	-	1
Total Abundance:	4479	9443	603	9720	5963	2005	1616	33829
Total Species	33	30	30	38	31	20	26	56

Appendix G-6. Biomass (kg) of fish impinged in heat treatments by date at El Segundo Generating Station. El Segundo and Scattergood Generating Stations NPDES, 1998.

	Units 1 & 2	Units 3 & 4				Total
	Total	10 Oct	15 Nov	2 Jun	Total	Biomass
Atherinopsis californiensis	-	0.180	94.370	-	94.550	94.550
Anisotremus davidsonii	-	90.280	0.042	2.000	92.322	92.322
Girella nigricans	-	23.520	-	2.610	26.130	26.130
Paralabrax clathratus	-	14.870	0.516	3.000	18.386	18.386
Xenistius californiensis	-	7.170	8.670	-	15.840	15.840
Seriphus politus	-	5.800	8.120	-	13.920	13.920
Cheilotrema saturnum	-	8.550	2.160	2.550	13.260	13.260
Medialuna californiensis	-	11.890	-	-	11.890	11.890
Sardinops sagax	-	-	11.250	-	11.250	11.250
Paralabrax nebulifer	-	7.420	0.080	-	7.500	7.500
Damalichthys vacca	-	1.065	0.657	4.650	6.372	6.372
Scorpaena guttata	-	5.450	-	0.210	5.660	5.660
Urolophus halleri	-	-	-	3.700	3.700	3.700
Rhacochilus toxotes	-	2.680	0.548	-	3.228	3.228
Atractoscion nobilis	-	2.150	0.295	-	2.445	2.445
Paralichthys californicus	-	1.580	-	-	1.580	1.580
Hyperprosopon argenteum	-	0.776	0.530	-	1.306	1.306
Scorpaenichthys marmoratus	-	0.611	-	0.660	1.271	1.271
Scomber japonicus	-	0.496	0.439	-	0.935	0.935
Embiotoca jacksoni	-	0.911	-	-	0.911	0.911
Myliobatis californica	-	-	-	0.800	0.800	0.800
Porichthys notatus	-	-	-	0.590	0.590	0.590
Sebastes auriculatus	-	0.461	-	-	0.461	0.461
Platyrhinoidis triseriata	-	-	0.333	-	0.333	0.333
Engraulis mordax	-	0.085	0.196	-	0.281	0.281
Chromis punctipinnis	-	0.260	-	-	0.260	0.260
Umbrina roncador	-	0.236	-	-	0.236	0.236
Heterostichus rostratus	-	0.107	-	-	0.107	0.107
Genyonemus lineatus	-	-	0.095	-	0.095	0.095
Heterodontus francisci	-	0.082	-	-	0.082	0.082
Oxyjulis californica	-	-	0.070	-	0.070	0.070
Peprilus simillimus	-	-	0.040	-	0.040	0.040
Menticirrhus undulatus	-	0.033	-	-	0.033	0.033
Sphyraena argentea	-	-	0.018	-	0.018	0.018
Pleuronichthys ritteri	-	-	0.012	-	0.012	0.012
Total Biomass	0	186.663	128.441	20.770	335.874	335.874

No heat treatments occurred at Units 1 & 2 during the survey year.

Appendix G-7. Biomass (kg) of fish impinged during heat treatments by date at Scattergood Generating Station. El Segundo and Scattergood Generating Stations NPDES, 1998.

	1997	1998						Total
	20 Nov	15 Jan	10 Feb	7 Apr	4 Jun	25 Jul	10 Sep	Biomass
Genyonemus lineatus	0.152	31.760	19.330	323.850	12.850	-	-	387.942
Seriphus politus	53.440	87.190	2.100	82.150	127.800	-	-	352.680
Atherinopsis californiensis	0.303	86.500	0.326	5.430	17.400	-	32.720	142.679
Atherinops affinis	1.870	23.100	0.274	0.830	8.140	81.670	17.640	133.524
Sardinops sagax	0.194	102.260	0.009	0.186	17.600	0.203	1.147	121.599
Paralabrax nebulifer	12.950	24.650	2.142	11.960	12.920	9.300	18.020	91.942
Anisotremus davidsonii	10.700	4.840	0.555	0.684	2.400	48.570	23.700	91.449
Umbrina roncador	1.680	8.430	0.810	1.459	-	14.040	51.580	77.999
Myliobatis californica	-	1.020	-	7.000	8.610	40.345	3.828	60.803
Xenistius californiensis	17.140	4.700	0.003	0.416	1.438	1.122	17.820	42.639
Urolophus halleri	0.350	2.750	-	5.750	18.290	2.051	0.550	29.741
Cheilotrema saturnum	9.310	5.600	0.527	3.300	4.680	1.827	1.455	26.699
Atractoscion nobilis	18.500	5.800	-	0.757	0.114	-	1.257	26.428
Platyrhinoidis triseriata	0.190	5.300	3.970	11.200	0.600	0.219	-	21.479
Paralabrax clathratus	7.200	0.490	0.008	1.135	0.197	4.720	5.460	19.210
Torpedo californica	-	-	-	18.700	-	-	-	18.700
Rhinobatos productus	-	-	-	-	9.390	-	2.360	11.750
Pleuronichthys ritteri	0.583	7.560	1.859	1.072	0.500	-	-	11.574
Heterodontus francisci	0.914	0.065	-	-	7.460	-	1.820	10.259
Paralichthys californicus	-	-	0.282	2.500	3.720	1.616	1.562	9.680
Hyperprosopon argenteum	0.798	5.300	0.988	2.040	0.153	-	0.045	9.324
Menticirrhus undulatus	-	0.530	0.441	5.950	0.140	0.243	1.980	9.284
Medialuna californiensis	7.400	-	-	0.530	-	0.581	0.618	9.129
Sphyraena argentea	0.147	-	-	-	-	0.175	8.700	9.022
Rhacochilus toxotes	0.971	2.800	0.219	1.929	0.910	0.919	-	7.748
Girella nigricans	-	5.050	0.435	-	-	-	0.777	6.262
Mustelus californicus	-	-	-	-	5.620	-	-	5.620
Scorpaena guttata	0.003	3.100	0.002	0.024	0.749	-	0.665	4.543
Damalichthys vacca	0.053	-	0.300	0.809	2.290	-	0.426	3.878
Embiotoca jacksoni	0.076	-	0.706	1.060	-	0.447	0.879	3.168
Chromis punctipinnis	0.214	-	0.662	-	0.429	1.025	0.399	2.729
Cephaloscyllium ventriosum	-	-	-	-	2.220	-	-	2.220
Halichoeres semicinctus	0.336	-	-	0.034	-	1.073	0.580	2.023
Triakis semifasciata	2.000	-	-	-	-	-	-	2.000
Scomber japonicus	-	1.900	-	-	-	-	-	1.900
Anchoa compressa	0.052	1.520	0.067	0.121	-	-	-	1.760
Cymatogaster aggregata	-	0.109	0.158	0.675	0.615	-	-	1.557
Mustelus henlei	1.500	-	-	-	-	-	-	1.500
Sphoeroides annulatus	-	-	-	1.460	-	-	-	1.460
Leuresthes tenuis	-	-	-	1.250	-	-	-	1.250
Sebastes auriculatus	-	-	-	1.150	-	-	-	1.150
Pleuronichthys verticalis	-	0.850	-	-	-	-	-	0.850
Hypsopsetta guttulata	0.152	0.253	-	0.418	-	-	-	0.823
Porichthys myriaster	-	-	-	0.626	-	-	-	0.626
Engraulis mordax	-	0.300	0.099	0.090	0.069	-	-	0.558
Phanerodon furcatus	-	-	0.225	0.213	-	-	-	0.438
Heterostichus rostratus	0.008	0.270	0.043	-	0.040	-	-	0.361
Porichthys notatus	-	-	-	-	0.265	-	-	0.265
Ophidion scrippsae	-	-	-	0.118	-	-	-	0.118
Hypsoblennius gilberti	0.027	0.030	0.011	-	-	0.001	0.025	0.094
Citharichthys stigmaeus	-	-	0.060	0.008	-	-	-	0.068
Oxyjulis californica	-	-	0.056	-	-	-	-	0.056
Semicossyphus pulcher	-	-	-	-	0.024	-	-	0.024
Paralabrax maculatofasciatus	0.021	-	-	-	-	-	-	0.021
Hypsypops rubicundus	0.009	-	-	-	-	-	-	0.009
Syngnathus californiensis	-	-	-	0.006	-	-	-	0.006
Total Biomass:	149.243	424.027	36.667	496.890	267.633	210.147	196.013	1780.620

Appendix G-8. Abundance, biomass (kg), and percent occurence of invertebrates impinged at El Segundo and Scattergood Generating Stations. El Segundo and Scattergood Generating Stations NPDES, 1998.

Species	Scattergood		El Segundo		Total	Percent	Cumulative	Total
	Abund.	Biomass	Abund.	Biomass	Abundance	Total	Percent	Biomass
Cancer antennarius	191	4.385	4220	138.068	4411	47.72	47.72	142.453
Cancer anthonyi	943	5.500	1165	55.341	2108	22.81	70.53	60.841
Cancer gracilis	925	4.400	-	-	925	10.01	80.53	4.400
Lysmata californica	647	1.010	53	0.077	700	7.57	88.11	1.087
Portunus xantusii	405	2.839	34	0.779	439	4.74	92.85	3.618
Pyromaia tuberculata	337	0.447	22	0.259	359	3.88	96.73	0.706
Panulirus interruptus	135	75.670	9	7.000	144	1.56	98.29	82.670
Octopus bimaculatus/bimaculoide	43	13.372	39	34.570	82	0.89	99.18	47.942
Pachygrapsus crassipes	21	0.053	30	0.331	51	0.55	99.73	0.384
Navanax inermis	8	0.008	-	-	8	0.09	99.82	0.008
Loxorhynchus grandis	7	6.074	-	-	7	0.08	99.89	6.074
Heptacarpus palpator	2	0.002	-	-	2	0.02	99.91	0.002
Pilumnus spinohirsutus	2	0.002	-	-	2	0.02	99.94	0.002
Blepharipoda occidentalis	1	0.017	-	-	1	0.01	99.95	0.017
Cancer amphoetus	1	0.001	-	-	1	0.01	99.96	0.001
Crangon nigromaculata	1	0.003	-	-	1	0.01	99.97	0.003
Loxorhynchus crispatus	1	0.024	-	-	1	0.01	99.98	0.024
Parastichopus parvimensis	1	0.145	-	-	1	0.01	99.99	0.145
Strongylocentrotus purpuratus	-	-	1	0.001	1	0.01	100.00	0.001
Survey totals	3671	113.952	5573	236.425	9244			350.377
Total species	18		9		19			

Note: 0.00 < 0.005

Appendix G-9. Abundance, biomass (kg), and percent occurrence of invertebrates impinged at El Segundo Generating Station, Units 1 & 2 and 3 & 4. El Segundo and Scattergood Generating Stations NPDES, 1998.

Species	Units 1 & 2		Units 3 & 4		Total		% Comp.	
	Abund.	Biomass	Abund.	Biomass	Abund.	Biomass	Abund.	Biomass
Cancer antennarius	28	7.633	4192	130.435	4220	138.068	75.72	58.40
Cancer anthonyi	-	-	1165	55.341	1165	55.341	20.91	23.41
Lysmata californica	-	-	53	0.077	53	0.077	0.95	0.03
Octopus bimaculatus/bimaculoides	14	27.758	26	6.812	39	34.570	0.71	14.62
Portunus xantusii	-	-	34	0.779	34	0.779	0.60	0.33
Pachygrapsus crassipes	-	-	30	0.331	30	0.331	0.54	0.14
Pyromaia tuberculata	-	-	22	0.259	22	0.259	0.39	0.11
Panulirus interruptus	-	-	9	7.000	9	7.000	0.16	2.96
Strongylocentrotus purpuratus	-	-	1	0.001	1	0.001	0.02	0.00
Survey totals	42	35.391	5531	201.034	5573	236.425		
Total species	2		9		9			

Note: 0.00 < 0.005

Appendix G-10. Abundance and biomass (kg) of invertebrates impinged in heat treatments (HT) and normal operations (NO) at El Segundo Generating Station, Units 1 & 2. El Segundo and Scattergood Generating Stations NPDES, 1998.

	Units 1 & 2 Heat Treatment		Units 1 & 2 Monitored NO		Units 1 & 2 Extrapolated NO		Units 1 & 2 Combined NO and HT	
Species	Abund.	Biomass	Abund.	Biomass	Abund.	Biomass	Abund.	Biomass
Cancer antennarius	-	-	2	0.550	28	7.633	28	7.633
Octopus bimaculatus/bimaculoides	-	-	1	2.000	14	27.758	14	27.758
Survey Totals	0	0	3	2.550	42	35.391	42	35.391
Total Species	0		2				2	

No heat treatments occurred at Units 1 & 2 during the survey year.

Extrapolation based on flow data, with 111.13 operating days of flow calculated from monthly flow information.

Appendix G-11. Abundance and biomass (kg) of invertebrates impinged in heat treatments (HT) and normal operations (NO) at El Segundo Generating Station, Units 3 & 4. El Segundo and Scattergood Generating Stations NPDES, 1998.

	Units 3 & 4 Heat Treatment		Units 3 & 4 Monitored NO		Units 3 & 4 Extrapolated NO		Units 3 & 4 Combined NO and HT	
Species	Abund.	Biomass	Abund.	Biomass	Abund.	Biomass	Abund.	Biomass
Cancer antennarius	10	0.030	194	6.050	4182	130.405	4192	130.435
Cancer anthonyi	842	47.150	15	0.380	323	8.191	1165	55.341
Lysmata californica	53	0.077	-	-	-	-	53	0.077
Octopus bimaculatus/bimaculoides	4	2.070	1	0.220	22	4.742	26	6.812
Pachygrapsus crassipes	30	0.331	-	-	-	-	30	0.331
Panulirus interruptus	9	7.000	-	-	-	-	9	7.000
Portunus xantusii	12	0.046	1	0.034	22	0.733	34	0.779
Pyromaia tuberculata	-	-	1	0.012	22	0.259	22	0.259
Strongylocentrotus purpuratus	1	0.001	-	-	-	-	1	0.001
Survey Totals	961	56.705	212	6.696	4570	144.329	5531	201.034
Total Species	8		5				9	

Extrapolation based on flow data, with 237.1 operating days of flow calculated from monthly flow information.

Appendix G-12. Abundance of invertebrates impinged during heat treatments by date at Scattergood Generating Station. El Segundo and Scattergood Generating Stations NPDES, 1998.

	1997	1998						Total
Species	20 Nov	15 Jan	10 Feb	7 Apr	4 Jun	25 Jul	10 Sep	Abundance
Cancer anthonyi	44	50	1	3	825	5	15	943
Cancer gracilis	-	-	-	-	925	-	-	925
Lysmata californica	380	150	-	4	2	87	24	647
Portunus xantusii	22	45	4	34	300	-	-	405
Pyromaia tuberculata	256	50	-	2	1	-	28	337
Cancer antennarius	2	50	-	-	130	9	-	191
Panulirus interruptus	21	-	-	10	15	19	70	135
Octopus bimaculatus/bimaculoides	1	6	6	8	4	15	3	43
Pachygrapsus crassipes	14	-	-	-	-	2	5	21
Navanax inermis	8	-	-	-	-	-	-	8
Loxorhynchus grandis	-	-	-	-	6	1	-	7
Heptacarpus palpator	2	-	-	-	-	-	-	2
Pilumnus spinohirsutus	2	-	-	-	-	-	-	2
Blepharipoda occidentalis	-	1	-	-	-	-	-	1
Cancer amphioetus	-	-	-	-	1	-	-	1
Crangon nigromaculata	-	-	1	-	-	-	-	1
Loxorhynchus crispatus	-	1	-	-	-	-	-	1
Parastichopus parvimensis	-	-	1	-	-	-	-	1
Total Abundance:	752	353	13	61	2209	138	145	3671
Species	11	8	5	6	10	7	6	18

Appendix G-13. Biomass of invertebrates impinged during heat treatments by date at Scattergood Generating Station. El Segundo and Scattergood Generating Stations NPDES, 1998.

	1997	1998						Total
Species	20 Nov	15 Jan	10 Feb	7 Apr	4 Jun	25 Jul	10 Sep	Biomass
Panulirus interruptus	13.230	-	-	5.830	5.450	12.040	39.120	75.670
Octopus bimaculatus/bimaculoides	0.177	2.500	2.667	5.300	0.219	1.726	0.783	13.372
Loxorhynchus grandis	-	-	-	-	5.450	0.624	-	6.074
Cancer anthonyi	0.238	0.030	0.015	0.022	5.125	0.049	0.021	5.500
Cancer gracilis	-	-	-	-	4.400	-	-	4.400
Cancer antennarius	0.012	0.050	-	-	4.300	0.023	-	4.385
Portunus xantusii	0.118	0.017	0.038	0.366	2.300	-	-	2.839
Lysmata californica	0.446	0.450	-	0.009	0.001	0.086	0.018	1.010
Pyromaia tuberculata	0.306	0.100	-	0.004	0.001	-	0.036	0.447
Parastichopus parvimensis	-	-	0.145	-	-	-	-	0.145
Pachygrapsus crassipes	0.036	-	-	-	-	0.012	0.005	0.053
Loxorhynchus crispatus	-	0.024	-	-	-	-	-	0.024
Blepharipoda occidentalis	-	0.017	-	-	-	-	-	0.017
Navanax inermis	0.008	-	-	-	-	-	-	0.008
Crangon nigromaculata	-	-	0.003	-	-	-	-	0.003
Heptacarpus palpator	0.002	-	-	-	-	-	-	0.002
Pilumnus spinohirsutus	0.002	-	-	-	-	-	-	0.002
Cancer amphioetus	-	-	-	-	0.001	-	-	0.001
Total Biomass:	14.575	3.188	2.868	11.531	27.247	14.560	39.983	113.952