NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
2009 RECEIVING WATER MONITORING REPORT
RRI ENERGY ORMOND BEACH GENERATING STATION
VENTURA COUNTY, CALIFORNIA

2009 Survey

Prepared for:

RRI Energy Ormond Beach, Inc.

Prepared by:

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

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EXECUTIVE SUMMARY

The 2009 National Pollutant Discharge Elimination System (NPDES) marine monitoring program for the Ormond Beach Generating Station owned and operated by RRI Energy was conducted in accordance with specifications set forth by the California Regional Water Quality Control Board, Los Angeles Region (LARWQCB) in NPDES Permit No. CA0001198 dated 28 June 2001. The 2009 studies included physical monitoring of the receiving waters and underlying sediments and biological sampling of benthic infaunal assemblages and mussels. Fish and macroinvertebrate impingement studies were also conducted periodically throughout the year. Results of the 2009 surveys were compared among stations and with previous studies to determine if the beneficial uses of the receiving waters continue to be protected.

WATER COLUMN MONITORING

In winter 2009, water quality characteristics indicated a well mixed water column in the survey area. Water column temperature profiles were similar throughout the area during both tides, with slightly higher temperatures found during the later ebb tide sampling period. In summer, a warm water surface lens was noted in the vicinity of the discharge stations on both tides, indicating the presence of a warm water surface lens in the vicinity of the thermal discharge. Warm surface waters near the thermal discharge have been observed in the area in previous surveys and the resulting parameters were similar to natural conditions found commonly throughout the study area. Even in areas influenced by the thermal field, surface temperatures were typical of the area and within the range of natural variability observed during previous surveys. Dissolved oxygen (DO) concentrations were consistent during both seasons, with values similar to those found commonly in previous studies and well above the level of biological concern. Higher DO concentrations in the study area later in the day were noted during both seasons, a result of increased photosynthetic activity. Salinity and pH were similar during both surveys at levels consistent with seasonal results observed previously and natural conditions found commonly throughout the study area.

With the exception of the warm water plume near the discharge in summer, variations in water quality parameters observed in 2009 can be attributed to natural physical and biological processes. Water quality measurements indicated that in 2009 the cooling water discharge from the Ormond Beach Generating Station did not have an adverse effect on receiving waters in the study area.

SEDIMENT CHARACTERISTICS

Sediment Grain Size

In 2009, sediments were analyzed from six stations offshore the Ormond Beach Generating Station. Sediment composition was similar among stations, consisting primarily of sand with lesser amounts of fine material (silt and clay) and mean grain sizes in the fine and very fine sand categories. In 2009, slightly coarser sediments found at the discharge station appeared to have been influenced by turbulence associated with the cooling water discharge, a pattern noted during some previous surveys. The degree of influence of the discharge on local sediments varies from year to year, suggesting a localized and transitory effect near the discharge. Other than the coarser sediments found in the discharge area, sediment characteristics offshore of the Ormond Beach Generating Station discharge in 2009 were similar to those found previously in the area and appear to be affected primarily by natural causes.

Sediment Chemistry

In 2009, sediments at six stations off the Ormond Beach Generating Station were analyzed for the presence and concentration of chromium, copper, nickel, and zinc. Highest chromium, nickel and zinc concentrations were found at the station 1,000 ft upcoast of the generating station discharge, where percentages of fine material in the sediments were greatest, though slightly higher copper levels suggest that localized input might be associated with the discharge in 2009. Lowest chromium and nickel concentrations were found at the discharge, while lowest copper and zinc occurred 1,000 ft downcoast of the discharge. Sediment metal concentrations in 2009 were slightly higher than levels reported commonly in recent years, especially for zinc. Still, sediment metal concentrations have remained relatively consistent in the area since 1990 and concentrations in 2009 were lower than mean values found in regional monitoring of sediments in shallow coastal waters of southern California. While metal levels typically vary slightly from year to year, and concentrations of some metals in 2009 appeared to be somewhat related to the percent of fine material in the sediments, no long-term patterns of metal concentrations relative to the discharge were apparent. As in previous surveys, sediment metal levels were well below concentrations determined to be potentially toxic to marine organisms. Concentrations of sediment metals in 2009 did not appear to be adversely influenced by the operation of the Ormond Beach Generating Station.

MUSSEL BIOACCUMULATION

Over the last several years of monitoring the availability resident mussels in the vicinity of the Ormond Beach Generating Station discharge has been inconsistent. Because of this, in 2009 live bay mussels (*Mytilus galloprovincialis*) were purchased from a commercial supplier in Carlsbad, California and transplanted to a mooring near the Ormond Beach discharge where the mussels were allowed to acclimate for a period of 133 days, after which the mussels were retrieved and returned to the laboratory for chemical analysis. Results were compared with those from mussels collected at the source site at the time of the transplant and to mussels collected from the Manhattan Beach Pier in Santa Monica Bay, which served as a reference site.

In 2009, concentrations of metals decreased from levels reported commonly in previous surveys and were among the lowest reported in mussels from the Ormond Beach discharge. Metal levels were also reduced in source mussels and in mussels from the reference site, and, in general, levels were comparable among the sites. However, chromium at the discharge and at the reference site exceeded values considered elevated by the State Mussel Watch Program, while copper was found to be highly elevated at the reference site. The similarity of tissue metal levels among sites to previous studies, and to other areas in southern California suggests that the operation of the Ormond Beach Generating Station is not elevating metal concentrations above background levels.

BENTHIC INFAUNA

The infauna community in the study area in 2009 was composed primarily of small annelid worms, nematode worms, clams, and arthropods. A total of 150 species was collected, with species richness averaging 63 species per station. Species diversity (H') averaged 2.51 per station. Abundance, at a mean density for the area of 19,454 individuals/m^2, was four times that in 2008, and was the third highest seen for the area since 1978. Mean species richness was also considerably greater than both in 2008 and the long-term mean. Species diversity was below that in 2008 and was also slightly below the long-term mean, due to relatively low values at three stations. Abundance was highest but species diversity was lowest near the generating station discharge, due to moderately low species richness and strong dominance of the community by two taxa, the annelid *Armandia brevis* and nematodes. Otherwise, infaunal parameter values generally were similar among stations, and appeared to be somewhat related to sediment characteristics. Abundance was quite high and species richness was highest immediately upcoast of the discharge where sediments were finest. Southern California Benthic Response Index values indicated that all communities were undisturbed, or healthy, except near the discharge, where the value fell at the low end of the range for Response Level 2, suggesting some loss of biodiversity at that location. Sediment contaminants probably were not responsible for the community composition leading to the unusually high BRI values, as levels of four sediment metals were all far below their ERLs at all stations, including near the discharge. The somewhat atypical community found near the discharge may have been due in part to the coarse sediments and the substantial amount of mussel-shell debris found there.

Except at the discharge, composition of the infaunal communities was similar to those in the past. The polychaete annelid *Apoprionospio pygmaea* was the most abundant species overall, but it was scarce near the discharge. A similar pattern was seen with several other abundant species, including the annelids *Chone eiffelturris*, *Mediomastus acutus*, and *Spiophanes bombyx*, the clams *Siliqua lucida* and *Tellina modesta*, and the amphipods *Photis macinerneyi* and *Ampelisca agassizi*. As noted above, *Armandia brevis* and nematodes were most abundant near the discharge, as was the annelid *Notomastus tenuis*. Community constituents included many rapid-burrowing species, such as *A. brevis*, the two clams mentioned above, the cumacean *Diastylopsis tenuis*, and the amphipods *Rhepoxynius abronius* and *R. menziesi*, that are well adapted to the nearshore sandy habitat. Overall, the communities found in 2009 were typical of the shallow subtidal habitat throughout the Southern California Bight. Other than a localized difference in community dominants, likely due to a variation in grain size characteristics in the vicinity of the discharge, no effects of the generating station discharge on the benthic infauna were apparent.

IMPINGEMENT

Nine normal operation impingement surveys were completed at Ormond Beach Generating Station in 2009. No heat treatments were conducted. Based on these surveys, an estimated total of 786 fish representing 21 species and weighing 349 kg were impinged during the operation of the cooling water system with abundance dominated by bay pipefish (*Syngnathus leptorhynchus*) and speckled sanddab (*Citharichthys stigmaeus*). In addition, an estimated 5,559 macroinvertebrates representing 10 species and weighing 252 kg were impinged during the study year. Blackspotted bay shrimp (*Crangon nigromaculata*), yellow crab (*Metacarcinus anthonyi*), and Pacific rock crab (*Romaleon antennarius*) combined to account for 77% of the total macroinvertebrate abundance.

Generally, fish species impinged in 2009 were similar to those collected in recent surveys, but were less abundant than recorded in most annual surveys since 1990, which may be partially attributable to the lack of heat treatments in 2009. Macroinvertebrate composition in 2009 was also similar to previous years, although abundances were slightly higher than that reported in 2007 and 2008. The similarity of species composed primarily of frequently occurring and long-term dominant species indicates a nearshore assemblage typical of southern California regulated by natural forces.

CONCLUSIONS

The overall results of the 2009 NPDES monitoring program indicated that operation of the Ormond Beach Generating Station had no detectable adverse effects on the beneficial uses of the receiving waters.

CHAPTER 1 — INTRODUCTION

This report presents and discusses the results of the 2009 receiving water monitoring studies conducted for the Ormond Beach Generating Station, which is owned and operated by RRI Energy. The 2009 monitoring program was conducted in accordance with specifications set forth in National Pollutant Discharge Elimination System (NPDES) Monitoring and Reporting Program No. 5619 (Permit No. CA0001198) issued by the California Regional Water Quality Control Board, Los Angeles Region (LARWQCB) on 28 June 2001 (Appendix A). Results of the 2009 surveys were compared among locations in the study area and with past physical and biological studies to determine any effects the generating station discharge is having on the marine environment, and if the beneficial uses of the receiving waters are being protected. Sampling included physical and chemical monitoring of receiving waters and sediments, and biological monitoring of infaunal and fish and macroinvertebrate assemblages.

DESCRIPTION OF THE GENERATING STATION

The Ormond Beach Generating Station is located on the coast of California, approximately 3.7 kilometers (km) southeast of the entrance to Port Hueneme in Ventura County (Figure 1-1). The station consists of two steam-electric, gas-fueled generating units, rated at 750 megawatts (Mw) each. At full load, the boiler of each unit produces 2.6 million kilograms (kg) of steam per hour which is supplied to tandem compound turbines at a temperature of 555.6°C.

Cooling water is supplied to the station through a 4.0-meter (m) inside-diameter (ID) concrete conduit at a maximum flow rate of about 475,000 gallons per minute (gpm). The intake structure is located 640 m offshore at a water depth of about 10 m Mean Low Lower Water (MLLW); the port is 2 m above the bottom and is covered by a raised velocity cap. Seawater enters the conduit at a velocity of about 82 centimeters per second (cm/s) and passes through a screening facility in the plant to remove marine life, trash, and other debris.

After passing through the screenwell, cooling water is pumped to two condensers (one per unit), where its temperature is elevated approximately 16.7°C when the plant is operating at full capacity. The heated effluent is returned to the ocean through a 4.3-m-ID conduit which terminates 457 m offshore at a bottom depth of 9 m (MLLW). The discharge water is directed vertically upward and exits the conduit at a depth of 6 m (MLLW) at a speed of about 87 cm/s.

Approximately 20,000 gpm of the main flow is diverted to three auxiliary heat exchangers that cool treated distilled water for other plant equipment. The temperature of this water is elevated approximately 5.6°C before it is returned to join the main stream in the discharge conduit.

During the 11 March 2009 survey, none of the four circulator pumps were operating. Intake and discharge temperatures registered 14.4°C and 23.1°C, respectively. During the 21 July 2009 survey, the generating station operated four of four circulator pumps, discharging 644.98 mgd, with an intake temperature of 15.2°C and discharge temperature of 28.6 °C. The Ormond Beach Generating Station operated at 3.23% of total operating capacity (Kahle 2009, pers. comm.).

DESCRIPTION OF THE STUDY AREA

The Ormond Beach Generating Station is located on the coastal plain of the Ventura Basin which is defined by two coastal features: the barrier beaches at Point Mugu (11.3 km to the south) and the delta of the Ventura River (20.9 km to the north) (Figure 1-1). Prominent natural features of this portion of the Southern California Bight include the dunes along Mandalay Beach, the marshes and lagoon on the naval reservation near Point Mugu, and the straight, sandy beaches interrupted by the Ventura Marina, Channel Islands Harbor, and the harbor at Port Hueneme.

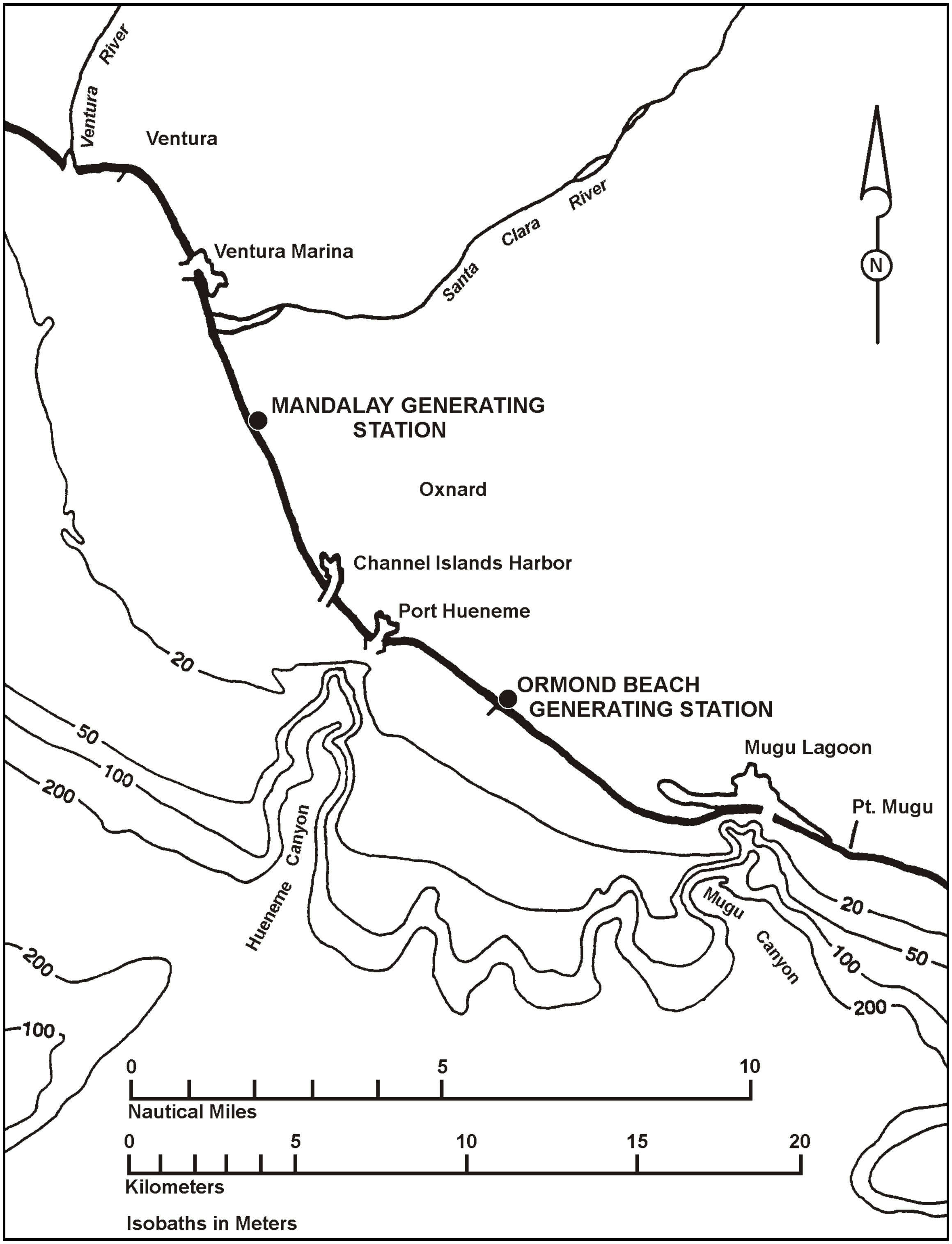


Figure 1-1. Location of the study area. Ormond Beach Generating Station NPDES, 2009.

The physiography, climate, and general oceanography of the southern California coastal region all contribute to the general character of the study area. The fate of any thermal discharges into coastal waters is influenced by the complex interactions of the above factors. The plume in turn may alter the nature of the biota present in the area. All of these factors have long- and short-term cycles as well as non-periodic components. Winds, tides, and currents are particularly important since they determine to the greatest extent the actual fate of the thermal effluent.

Physiography

The general orientation of the coast from Point Conception to the Mexican border is northwest to southeast. The continental margin has been slowly emerging over geological time, resulting in a predominantly cliffed coastline, although it is broken by coastal plains in the vicinity of Oxnard-Ventura, Los Angeles, and San Diego.

The eight islands offshore from the southern California mainland strongly influence water circulation and oceanographic conditions throughout the Bight. The mainland shelf along the coast is narrow, ranging from less than two to almost 20 km in width, but averaging about 7 km. Seaward of the shelf is an irregular and geologically complex region known as the continental borderland. The bottom here comprises a series of basins and ridges which extend in depth from near-surface to depths in excess of 2,400 m.

Hydrography

The ocean floor of the Ventura Basin is characterized by three distinct areas: a broad and gently sloping area directly in front of the Ormond Beach Generating Station, and two submarine canyons (Hueneme and Mugu) at either edge (Figure 1-1 and IRC 1973). At Ormond Beach, the 20 fathom contour is within 7 km of shore, while to the north at Mandalay it is no closer than 13 km.

General nearshore circulation in the area is affected by the two canyons, Port Hueneme, Channel Islands Harbor, the Ventura Marina, and the Santa Clara River. However, there is little evidence that these features significantly affect circulation in the immediate study area.

Climate

Southern California is a climatic regime defined broadly as Mediterranean, which is characterized by short, mild winters and warm, dry summers. Monthly mean air temperatures along the coast range from 8°C in winter to 21°C in summer, with daily minima dropping slightly below freezing and maxima reaching above 37°C.

Annual precipitation near the coast averages about 46 cm, 90% of which occurs between November and April. Drainage of the coastal region is largely by way of many short streams which normally flow only during rainstorms. Only a small part of the storm runoff actually reaches the ocean, most being impounded by dams and used for other purposes.

Sea breezes, which develop from differences in heating between land and sea, combine with prevailing coastal winds (which blow out of the northwest in summer) to produce strong onshore winds. In summer the sea breezes usually begin at mid-day and may continue through the late afternoon, with speeds reaching 37 km/hour. In late fall and winter, reverse pressure systems frequently develop. Coastal winds tend to be from the southeast from November through February and typically blow from early afternoon to 2000 hours (hr).

Currents

Water in the northern Pacific Ocean is driven eastward by prevailing winds until it impinges on the western coast of North America where it divides and flows both north and south. The southern component is the California Current, a diffuse and meandering water mass which generally flows to the southeast. There is no fixed western boundary to this current, but more than 90% of its 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, forming the Southern California Countercurrent. Surface speed in the countercurrent ranges between 5 and 10 cm/s. The general flow pattern is complicated by eddies in the Channel Islands region and it fluctuates seasonally. It is more strongly developed in summer and autumn and weak or occasionally absent in winter and spring. Generalized surface water circulation off southern California is shown in Figure 1-2.

Nearshore, coastal currents are strongly influenced by a combination of wind, tides, and local topography. When wind-driven currents are superimposed on tidal motions, a strong diurnal pattern is usually apparent. Therefore, short-term observations of currents near the coast often vary in both direction and speed.

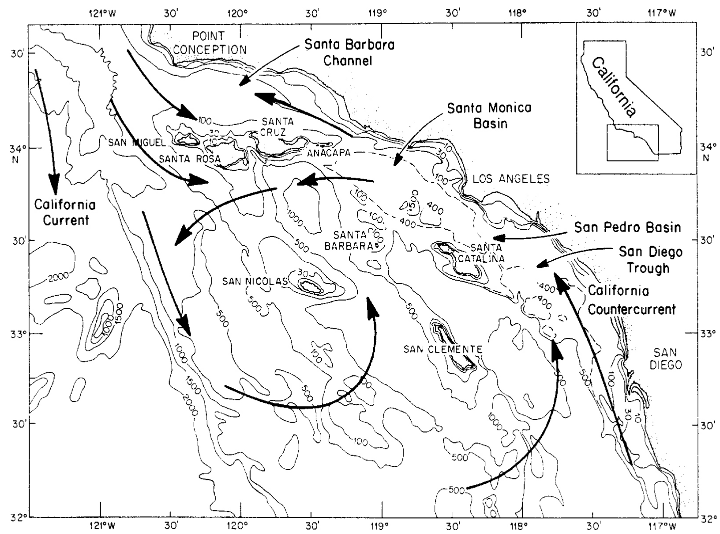


Figure 1-2. Surface circulation in the Southern California Bight (from Hickey 1992). Ormond Beach Generating Station NPDES, 2009.

Longshore Drift

In response to longshore currents, sand typically moves parallel to shore, then into the heads of submarine canyons. In the Hueneme area, the net littoral sediment transport is downcoast in the range of 600,000 to 900,000 m^3 per year. The construction of the harbor entrance effectively trapped much of the normal supply to Ormond Beach; that which was not trapped was diverted into the head of Hueneme Canyon. Erosion downstream of the harbor-entrance jetties is about 900,000 m^3 per year. To offset these losses, slightly more than 1,500,000 m^3 are dredged biannually and deposited to intertidal and subtidal habitats at Ormond Beach. This deposition can have a detrimental impact on the nearshore biota. Erosion southeast of the jetties continues at the rate of 1,500,000 m^3 per year.

Tides

Tides along the California coast are mixed, with two unequal highs and two unequal lows during each 25 hr period. The tide is a long-period wave that is a combination of semidiurnal components (each having nearly 12 hr periods) and diurnal components with nearly 25 hr periods. In the eastern North Pacific Ocean, the tide wave rotates in a counterclockwise direction so that tidal extremes occur progressively later in the day northwards along the coast. As a result, flood tide currents flow upcoast and ebb tide currents flow downcoast.

Upwelling

The predominant northwesterly winds are responsible for large scale upwelling along the California coast. From about February to October, these winds induce offshore movement of surface water which is replaced by the upwelling of deeper ocean waters. 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.

RECEIVING WATER CHARACTERISTICS

The capacity of the marine environment to assimilate waste heat depends on its ability to dilute and disperse it. The assimilation capacity depends on the ambient water temperature as well as the amount and temperature of the thermal discharge. Dispersion is largely determined by local wind, wave, tide, and current patterns. The following summary concerns general patterns of natural ocean temperatures off southern California as well as other physical characteristics of the nearshore water mass.

Temperature

Natural seawater temperature fluctuates throughout the year as a result of seasonal and diurnal variations in meteorological conditions such as wind, air temperature, insolation, cloud cover, and relative humidity as well as oceanographic conditions such as currents, tides, turbulence, and vertical mixing. The California State Water Resource Control Board defines natural temperature as "the temperature of the receiving water at locations, depths, and times which represent conditions unaffected by any elevated temperature waste discharge" (SWRCB 1975).

Previous studies have shown that natural surface temperatures may vary several degrees in a single day, depending upon time of day, time of year, and prevailing oceanographic and meteorological conditions. Temperatures offshore Ormond Beach range from monthly means of 13.3°C in February and March to 16.7°C in August. Mean maximum natural surface temperatures are 14.4°C during the winter and 22.2°C in the summer (MBC 1975).

When there are large differences between surface and bottom temperatures, a thermocline may develop (a thermocline is an area of rapid temperature change between two layers of water). Natural thermoclines are formed when absorption of solar radiation at the surface produces a heated surface layer which is not mixed vertically. Artificial thermoclines may result from the discharge of warm water above cooler waters and the lack of vertical mixing. Off southern California, a reasonably sharp thermocline usually develops in summer at depths up to 30 m. Only very weak thermoclines appear in winter.

Salinity

Salinity is a measure of the concentration of salts in water which can be expressed as a weight of salts dissolved in a volume of water. Typically, the concentration of salts in the ocean is roughly 35 grams per kilogram of water and can be expressed as 35 parts per thousand (ppt). Although relatively constant in the open ocean, salinity varies in the nearshore as a result of freshwater runoff and evaporation. Mean surface salinities at the Ventura Marina between 1965 and 1971 ranged from 24.1 ppt during a period of high storm runoff to a high of 33.9 ppt (IRC 1973). Yearly averages were about 33.5 ppt.

Dissolved Oxygen

Dissolved oxygen (DO) is used by plants and animals in normal respiration and metabolic processes. It is replenished in seawater by gaseous exchange with the atmosphere and through photosynthesis by plants. Concentrations in surface waters off Ormond Beach between July 1970 and January 1973 ranged from 7.3 to 11.0 mg/l (IRC 1973). The high values were probably a result of active photosynthetic processes and the low values a result of mixing with oxygen-depleted subsurface water.

Hydrogen Ion Concentration

The hydrogen ion concentration (pH) in southern California surface waters varies narrowly around a mean of approximately 8.1 and decreases slightly as the water becomes more acidic with depth. However, values will naturally approach 8.6 during phytoplankton blooms, which rapidly metabolize carbonates in the surface waters. Values can also drop below 7.9, although this generally occurs in waters below 100 m, or in confined water ways such as harbors, where organic decomposition and reduced circulation will lead to an accumulation of acidic byproducts. Maximum pH values recorded during four quarterly surveys offshore Ormond Beach between December 1973 and September 1974 were 8.0 to 8.6 (EQA/MBC 1975).

BENEFICIAL USES OF RECEIVING WATERS

The Water Quality Control Plan for the Santa Clara River Basin adopted by the California Regional Water Quality Control Board (1994) lists beneficial uses of waters in the nearshore and offshore zones of the Santa Clara-Calleguas Hydrographic Unit, which includes Ormond Beach and the study area. These uses are:

Industrial Service Supply (IND) - Uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well re-pressurization.

Navigation (NAV) - Uses of water for shipping, travel, or other transportation by private, military, or commercial vessels.

Water Contact Recreation (REC-1) - Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs.

Non-contact Water Recreation (REC-2) - Uses of water for recreational activities involving proximity to water, but not normally involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.

Commercial and Sport Fishing (COMM) - Uses of water for commercial or recreational collection of fish, shellfish, or other organisms including, but not limited to, uses involving organisms intended for human consumption or bait purposes.

Marine Habitat (MAR) - Uses of water that support marine ecosystems including, but not limited to, preservation or enhancement of marine habitats, vegetation such as kelp, fish, shellfish, or wildlife (e.g., marine mammals, shorebirds).

Wildlife Habitat (WILD) - Uses of water that support terrestrial ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.

Preservation of Biological Habitats (BIOL) - Uses of water that support designated areas or habitats, such as Areas of Special Biological Significance (ASBS), established refuges, parks, sanctuaries, ecological reserves, or other areas where the preservation or enhancement of natural resources requires special protection.

Rare, Threatened, or Endangered Species (RARE) - Uses of water that support habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under state or federal law as rare, threatened, or endangered.

Migration of Aquatic Organisms (MIGR) - Uses of water that support habitats necessary for migration, acclimatization between fresh and salt water, or other temporary activities by aquatic organisms, such as anadromous fish.

Spawning, Reproduction, and/or Early Development (SPWN) - Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish.

Shellfish Harvesting (SHELL) - Uses of water that support habitats suitable for the collection of filter-feeding shellfish (e.g., clams, oysters, and mussels) for human consumption, commercial, or sport purposes.

Although all of the above are not directly associated with the receiving waters of the Ormond Beach Generating Station at all times, they may be reasonably assumed to constitute occasional beneficial uses of the nearshore waters in the study area.

SCOPE OF THE MONITORING PROGRAM

The 2009 monitoring program for the Ormond Beach Generating Station was conducted by MBC Applied Environmental Sciences (MBC) in accordance with specifications set forth in the NPDES Monitoring and Reporting Program (Appendix A). The monitoring program included winter and summer water column profiling, summer sediment sampling for grain size and chemistry, mussel sampling for bioaccumulation, summer biological sampling for benthic infauna, and periodic impingement sampling of fish and macroinvertebrates.

STATION LOCATIONS

The locations of the monitoring stations are described in Appendix A and shown in Table 1-1 and Figure 1-3. The 2009 monitoring program included nine water quality (RW) stations, and six sediment and benthic infauna (B) stations.

Table 1-1. Latitude/longitude coordinates of sampling stations. Ormond Beach Generating Station NPDES, 2009.

Stations			
Water Quality	Benthic	Latitude	Longitude
RW1	B1	34°07.70'	119°10.98'
RW2	B2	34°07.51'	119°10.68'
RW3	B3	34°07.44'	119°10.46'
RW4	B4	34°07.33'	119°10.34'
RW5	B5	34°07.10'	119°10.06'
RW6	B6	34°07.50'	119°10.38'
RW7		34°07.17'	119°10.72'
RW8		34°06.52'	119°09.34'
RW9		34°08.16'	119°11.78'

FIELD OBSERVATIONS

The NPDES water quality monitoring surveys were conducted on 11 March and 21 July, and benthic sampling was conducted on 22 July 2009. Latitude and longitude coordinates for all receiving water (RW) and benthic (B) stations are listed in Table 1-1.

During the winter water quality survey, no oil sheens, grease, apparent red tide (plankton bloom) or floatables were observed at any of the receiving water stations. The water appeared slightly turbid throughout the survey area. Western gulls (*Larus occidentalis*) were seen at Stations

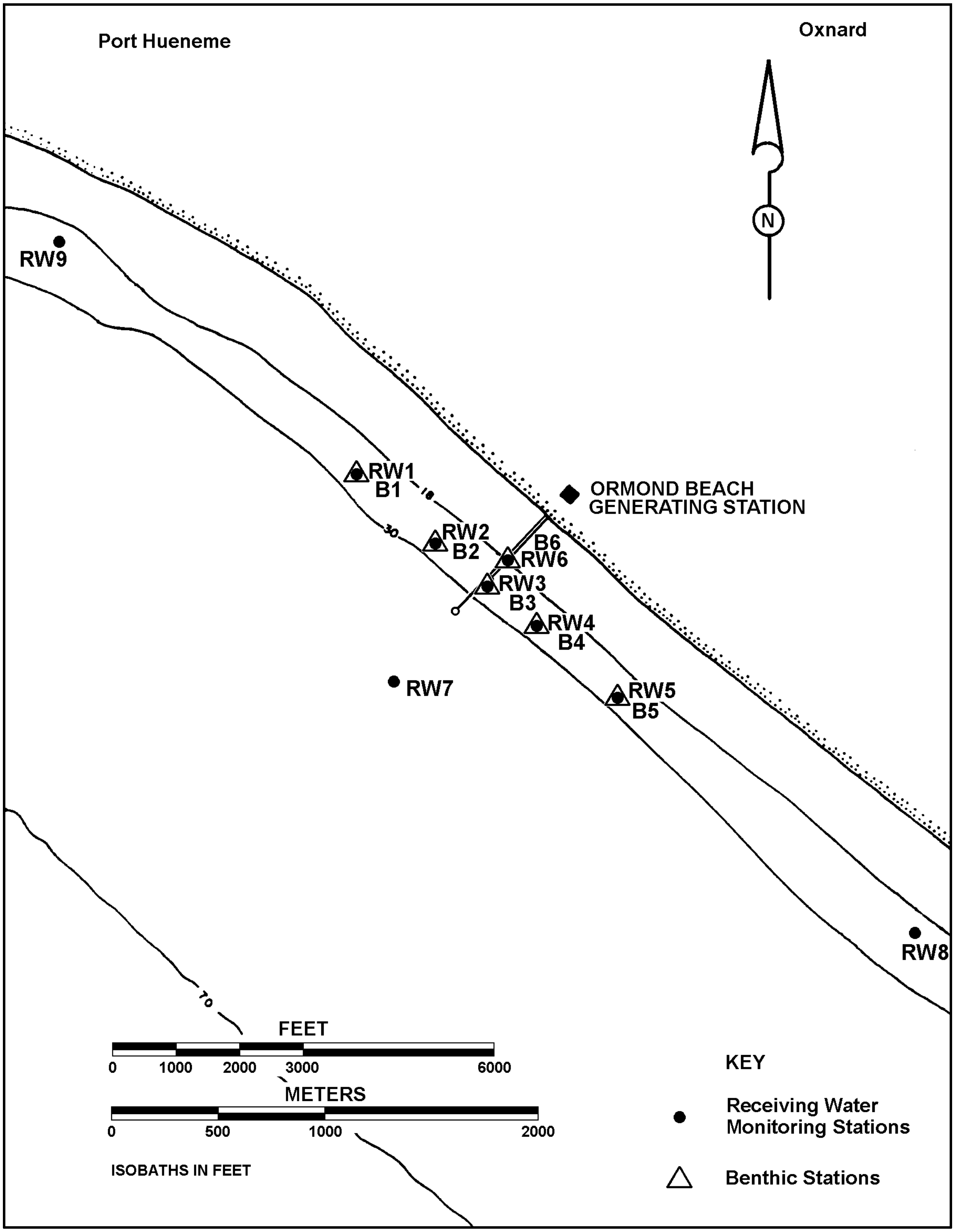


Figure 1-3. Location of the monitoring stations. Ormond Beach Generating Station NPDES, 2009.

RW1 and RW4, western grebes (*Aechmophorus occidentalis*) were observed at Stations RW4 and RW5, and a cormorant (*Phalacrocorax* sp) was seen at Station RW3. California brown pelicans (*Pelecanus occidentalis californicus*) were observed at Stations RW1, RW6, and RW9. No California least terns (*Sternula antillarum browni*) were observed during the winter survey.

During the summer surveys, no oil sheens, grease or red tide were observed at any of the stations. The water appeared slightly turbid at all stations during water quality monitoring (21 July) with the exception of Stations RW5 and RW9 where no turbidity was noted. During benthic sampling (22 July) the water appeared slightly to moderately turbid at all stations. Drift kelp was noted at receiving water Stations RW6, RW7, and RW9. Small pods of bottlenose dolphins (*Tursiops truncatus*) were observed at Stations RW4, RW5, and B6. Western gulls were seen at most stations during both surveys, while western grebes were observed at Stations RW1 and RW7, cormorants were seen at Stations RW1, B4, and B6, and terns (Laridae) were observed at Stations RW1, RW2, RW8, B3, and B6. California brown pelicans were observed at water quality monitoring Stations RW2, RW 5, and RW6, and at benthic Stations B1, B2, B3, and B6. No California least terns were observed during any of the surveys.

STATISTICAL ANALYSES

Summary statistics developed from the biological data included the number of individuals (expressed as per standard area), number of species and Shannon-Wiener (Shannon and Weaver 1962) species diversity (H') index. The diversity equation is as follows:

Shannon-Wiener

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

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

The Southern California Benthic Response Index (BRI) is an abundance-weighted average pollution tolerance of species occurring in a sample, and is a measure of the condition of marine and estuarine benthic communities (Smith et al. 2003). It classifies benthic communities as "reference" (i.e., undisturbed) or one of four levels of response to increased disturbance. The index formula is:

Benthic Response

$$BRI_S = \frac{\sum_{i=1}^{n} \sqrt[4]{a_{si} p_i}}{\sum_{i=1}^{n} \sqrt[4]{a_{si}}}$$

where: BRI_s = BRI value for sampling unit s_i
n = number of species with pollution tolerance scores in s_i
p_i = pollution tolerance of species *i*
a_{si} = abundance of species *i* in *s*

Species pollution tolerances p_i were determined during BRI development as the position of the abundance distribution of species *i* on a gradient between the most and least disturbed sites. Species without pollution tolerance values are not included in the calculation. Pollution tolerance values were not assigned to species if the data were insufficient to assign a value. The index was developed for benthic samples that were sieved through a 1-mm mesh screen. Pollution tolerance scores were derived for coastal shelf samples for shallow (10-30 m deep), mid-depth (>30-120 m deep), and deep (>120-324 m deep) habitats, and for bay and harbor habitat samples, northern (Point Conception to Newport Bay) and southern (Dana Point to the U.S.-Mexico border). The species names for which scores are available are based on Edition 5 of the Southern California Association of Marine Invertebrate Taxonomists (SCAMIT) list of invertebrate species (SCAMIT 2008).

Evenness (J') is a measure of the degree to which a sampled community is dominated by one or a few species. Values of evenness range from 1.0 (all species with identical abundances) to 0 (Pielou 1977). The evenness equation is as follows:

$$J' = \frac{H'}{\ln S}$$

where: J' = Evenness
H' = Shannon-Wiener Index
S = number of species within the community

Infauna data were subjected to log transformations (when necessary) and classified (clustered) using NCSS 2000 Hierarchial Clustering (Hintze 1998). Cluster analysis provides a graphic representation of the relationship between species, their individual abundance, and spatial occurrence among the stations sampled. In theory, if physical conditions were identical at all stations, the biological community would be expected to be identical as well. In practice this is never the case, but it is expected that the characteristics of adjacent stations would be more similar than those distant from one another. The dendrogram shows graphically the degree of similarity (and dissimilarity) between observed characteristics and the expected average. The two-way analysis utilized in this study illustrates groupings of species and stations, as well as their relative abundance, expressed as a percent of the overall mean. Two classification analyses are performed on each set; 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.

Euclidean distance

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

where: 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, abundance data are transformed using a natural log transformation [ln(x)].

Community importance for benthic infaunal species and trawled fish and macroinvertebrates was tested using the Index of Relative Importance (IRI): IRI = Rank (Rank of abundance + Rank of Frequency of Occurrence) (Stephens and Zerba 1981, Stephens et al. 1994). Spearman's rank correlation was used to test for similarities in the distribution of IRI ranks between the annual surveys.

DETECTION / REPORTING LIMITS

Detection/reporting limits used in reporting chemistry results are interpreted as the smallest amount of a given analyte that can be measured above the random noise inherent in any analytical tool. Thus, any value below the detection/reporting limits cannot be considered a reliable estimate of analyte concentration. Therefore, where a test for a given analyte results in a level below the detection/reporting limit, a “none detected” (ND) value has been assigned. The complication of what numerical value to substitute for ND in statistical calculations is addressed by the Environmental Protection Agency (EPA 1989, Section 5.3.3). When values for a given analyte are ND for all stations, then means and standard deviations will also be considered ND. However, when an analyte is detected at some stations and not at others, statistical calculations can be made by substituting ND values with either (a) zero, (b) one-half the average detection limit, or (c) the average detection limit (EPA 1989). Determining which substitution to use is based on whether or not substantial information exists to support the historical presence or absence of a given analyte at the station location. Since chemistry analyses have repeatedly resulted in ND values at the same stations through past surveys, ND values have been replaced with zeros in performing statistical calculations. As the ability to detect chemicals in increasingly smaller concentrations has improved greatly with time, detection/reporting limits differ in virtually all past surveys; this would confound any yearly comparison if options (b) or (c) from above were used.

CHAPTER 2 — WATER COLUMN MONITORING

Water column measurements of physical and chemical characteristics of seawater such as temperature, dissolved oxygen (DO), hydrogen ion concentration (pH), and salinity are important components of a discharge monitoring program. Because biological communities exist in equilibrium in the marine environment, changes in seawater characteristics can result in potentially adverse impacts to these communities. As the physical/chemical properties of the receiving waters can vary naturally on a relatively small scale, water quality sampling is designed to assess these parameters in a way that helps determine the scale of seasonal and tidally driven oceanographic influences with respect to the point of discharge. Long-term monitoring of these parameters can help determine whether deviations from expected patterns exist that may indicate impacts from the discharge on local biological communities and to determine whether the beneficial uses of the receiving water remain protected.

MATERIALS AND METHODS

Temperature, DO, pH, and salinity were measured throughout the water column at nine stations during the winter and summer surveys. Sampling was conducted on both flood and ebb tides at each of the receiving water monitoring stations (Figure 2-1). Data were obtained *in situ* using an SBE 25 water quality profiling system (Sea-Bird), and averaged at 1.0-m intervals. In the field, the data were transferred from the Sea-Bird to floppy disk for storage. In the laboratory, data were processed using Sea-Bird proprietary software (SeaSoft). The resulting information was imported into Microsoft Excel spreadsheets for reduction and analysis.

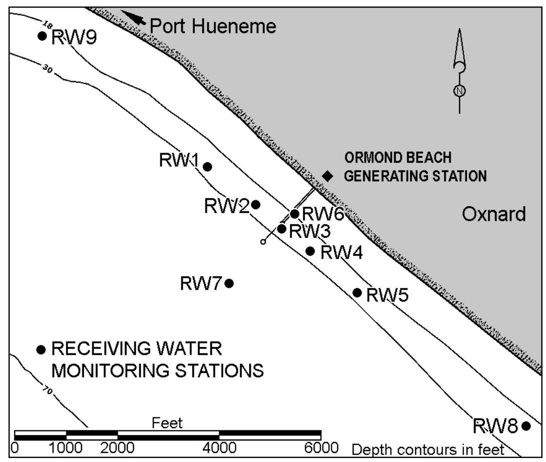


Figure 2-1. Location of the water column sampling stations. Ormond Beach Generating Station NPDES, 2009.

Winter water quality was monitored at Stations RW1 through RW9 on 11 March 2009 during flood and ebb tides. Flood tide was sampled between 0830 and 0930 hours (hr) and ebb tide was sampled between 1345 and 1500 hr (Figure 2-2). On the day of monitoring, the tide rose from a low of +0.1 ft Mean Lower Low Water (MLLW) at 0416 hr to a high of +5.4 ft MLLW at 1018 hr, then fell to a low of -0.2 ft MLLW 1632 hr. Skies were mostly cloudy (80 to 95% cloud coverage) with winds from the northeast at 3 to 5 knots during the morning to west at 2 to 3 knots by the afternoon. Sea were west at 2 to 3 ft.

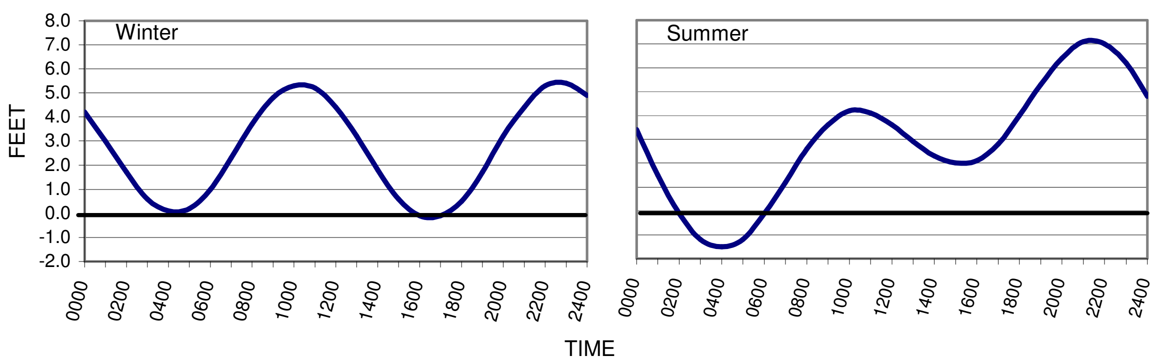


Figure 2-2. Tidal rhythms during water column sampling, winter and summer surveys. Ormond Beach Generating Station NPDES, 2009.

Summer water quality was monitored at Stations RW1 through RW9 on 21 July 2009 during flood and ebb tides. Flood tide was sampled between 0730 and 0830 hr and ebb tide was sampled between 1300 and 1400 hr (Figure 2-2). On the day of monitoring, the tide rose from a low of -1.5 ft MLLW at 0358 hr to a high of +4.2 ft MLLW at 1025 hr, then fell to a low of +1.9 ft MLLW at 1513 hr. Skies were partly cloudy (40 to 50% coverage) during the morning and clear by the afternoon. Winds were from the west at 5 to 7 knots and seas were west at 2 to 4 ft.

RESULTS

Water quality monitoring was conducted during flood and ebb tide, in winter and summer, offshore of the Ormond Beach Generating Station to determine potential effects of the generating station discharge on receiving waters. Receiving water monitoring stations are shown in Figure 2-1. During both seasons, flood tide was sampled in the morning, while ebb tide was sampled early to mid afternoon. During the winter sampling no circulating pumps were in operation (Kahle 2009, pers. comm.). On the day of the summer sampling all four circulating pumps were in operation with a flow of 645 mgd and a discharge temperature of 28.6°C, 13.4°C above the intake temperature. Seasonal water quality data for flood and ebb tides are presented in Figures 2-3 through 2-6 and summarized in Table 2-1. Raw data are presented in Appendix B.

Table 2-1. Summary of water quality parameters during flood and ebb tides. Ormond Beach Generating Station NPDES, 2009.

	Winter								Summer							
	Temp. (°C)		D.O. (mg/l)		pH		Salinity (psu)		Temp. (°C)		D.O. (mg/l)		pH		Salinity (psu)	
	Surface								Surface							
	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb
Mean	12.89	13.55	8.54	9.97	7.97	8.06	33.45	33.45	15.15	16.71	7.67	8.17	7.89	7.91	33.49	33.49
Minimum	12.80	13.35	8.05	9.18	7.93	8.00	33.44	33.44	14.67	15.85	7.42	7.66	7.87	7.86	33.48	33.48
Maximum	13.03	13.68	8.85	10.43	8.00	8.08	33.46	33.45	15.55	18.26	7.88	8.75	7.92	7.97	33.49	33.49
	Bottom								Bottom							
	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb
Mean	12.66	12.74	7.94	8.71	7.91	7.93	33.47	33.46	13.80	14.84	7.07	7.85	7.84	7.87	33.50	33.51
Minimum	12.12	12.47	6.45	7.83	7.80	7.86	33.43	33.43	13.43	14.19	6.75	7.56	7.82	7.85	33.48	33.50
Maximum	12.94	13.02	8.55	9.54	7.96	7.98	33.54	33.49	14.28	16.03	7.33	8.30	7.86	7.91	33.51	33.52

Temperature

During the winter survey, surface water temperatures averaged 12.89°C during morning flood tide and 13.55°C during afternoon ebb tide (Table 2-1 and Figure 2-3). Surface temperatures were similar among stations during each tide in winter, varying by less than 0.4°C among stations during either tidal cycle. During flood tide, surface temperatures ranged from 12.80°C at Station RW9, 7,920 ft upcoast of the discharge to 13.03°C at Station RW8, 7,920 ft downcoast of the discharge, both stations at a depth of 30 ft. During ebb tide, surface temperatures ranged from 13.35°C at Station RW9 to 13.68°C at Station RW4 1,000 ft downcoast of the discharge at 30 ft. Surface temperatures at each station increased an average of about 0.7°C between the morning and afternoon tides, with the greatest difference found at Station RW5, 3,000 ft downcoast of the discharge at a depth of 30 ft, where surface temperature was 0.8°C warmer on ebb tide (Appendix B-1). Temperatures on flood tide were consistent throughout the water column, decreasing by 0.7°C or less with depth to the bottom, with no strong thermal gradients at any station (Figure 2-3). The greatest surface-to-bottom difference on flood tide of occurred at Station RW5 (Appendix B-1). Temperatures on ebb tide were more variable in the upper water column than during flood tide, with mild thermal gradients between the surface and about 4m depth (Figure 2-3). On ebb tide, the greatest surface-to-bottom difference of 1.18°C was found at Station RW7, offshore of the discharge at a depth of 40 ft (Appendix B-1). Near bottom temperatures at each station were generally similar

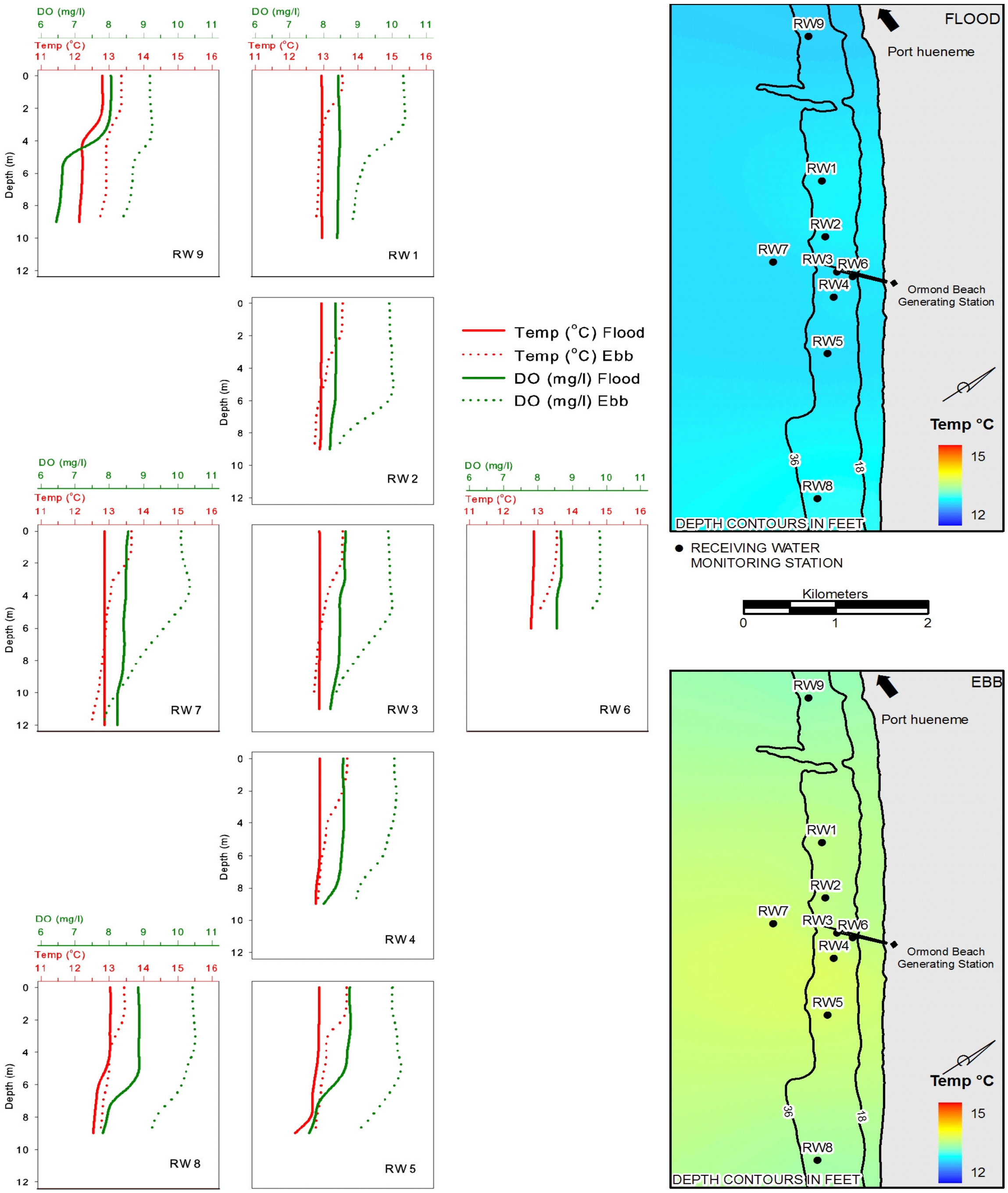


Figure 2-3. False color surface temperature contour plots and temperature and dissolved oxygen vertical profiles during flood and ebb tides, winter survey. Ormond Beach Generating Station NPDES, 2009.

between tides, with an average difference of less than 0.1°C between tides, and lower bottom temperatures at several stations on ebb tide than reported during the earlier flood tide. Bottom water temperatures averaged 12.66°C during flood tide and 12.74°C during ebb tide (Table 2-1). Flood tide near-bottom temperatures ranged from 12.12°C at Station RW9 to 12.94°C at Station RW1, 3,000 ft upcoast of the discharge at 30 ft. During ebb tide, near-bottom temperatures ranged from 12.47°C at Station RW7 to 13.02°C at Station RW6, inshore of the discharge at a depth of 20 ft.

During the summer survey, surface temperatures averaged 15.15°C during the morning flood tide and 16.71°C during the later ebb tide (Table 2-1 and Figure 2-4). Surface temperatures varied by less than 0.9°C among stations during flood tide, while on ebb tide surface temperatures varied by about 2.4°C among stations. Flood tide surface temperatures ranged from 14.67°C at Station RW5 to 15.55°C at Station RW2, 1,000 ft upcoast of the discharge at a depth of 30 ft. Surface temperatures during ebb tide ranged from 15.85°C at Station RW9 to 18.26°C at Station RW3, at the discharge on the 30-ft isobath. Surface temperatures varied by about 1.6°C between tides, and were warmer during the later ebb sampling. The greatest difference between tides was found at Station RW3, where surface temperature was 2.7°C warmer on ebb tide (Appendix B-2). Highest surface temperatures were found at and upcoast of the discharge on flood tide and at, inshore and downcoast of the discharge on ebb tide (Figure 2-4 and Appendix B-2). During flood tide, temperatures decreased consistently with depth throughout the water column, with moderate thermal gradients between 2 and 5 m depth at most stations, and the greatest surface-to-bottom difference was 1.83°C at Station RW7. Temperatures were warmer throughout the water column on ebb tide at all stations, with the greatest surface-to-bottom difference of 2.86°C found at Station RW3, at the discharge. Thermoclines exceeding 1°C temperature change within 1 m of depth were not observed during the summer sampling, though a relatively strong thermal gradient was observed between depths of 1 and 2 m at the discharge station on ebb tide. Bottom water temperatures in 2009 averaged 13.80°C during flood tide and 14.84°C during ebb tide. Flood tide water temperatures ranged from 13.43°C at Station RW7 to 14.28°C at Station RW6 (Table 2-1). Ebb tide bottom water temperatures ranged from 14.19°C at Station RW7 to 16.03°C at Station RW6.

Dissolved Oxygen

In winter, surface dissolved oxygen (DO) concentrations during flood tide averaged 8.54 mg/l and ranged from 8.05 mg/l at Station RW9 to 8.85 mg/l at Station RW8 (Table 2-1 and Figure 2-3). During ebb tide, surface DO concentrations averaged 9.97 mg/l and ranged from 9.18 mg/l at Station RW9 to 10.43 mg/l at Station RW8. Dissolved oxygen was relatively consistent with depth to the bottom during flood tide at the stations nearest and those upcoast of the discharge, while at the three stations downcoast of the discharge DO concentrations were consistent in the upper column to a depth of about 6 m then decreased with depth to bottom. At Station RW9, the reduction in DO concentration with depth was greater than at the other stations, particularly between 3 and 6 m, resulting in the greatest flood tide surface-to-bottom difference of 1.60 mg/l (Appendix B-1). During the afternoon ebb tide, dissolved oxygen concentrations were higher throughout the water column at all stations, increasing by more than 1.4 mg/l on average between tides (Table 2-1 and Figure 2-3). Dissolved oxygen concentrations were also more variable through the water column than on flood tide, with subsurface maxima values found in the upper 4 m at each station. Below these maxima, DO concentrations declined with depth to the bottom at all stations. The surface-to-bottom DO differential on ebb tide averaged 1.8 mg/l, with the maximum difference of 2.27 mg/l found at Station RW7. Near-bottom DO values averaged 7.94 mg/l during flood tide, and 8.71 mg/l during ebb tide.

During summer, surface DO concentrations during flood tide averaged 7.67 mg/l and ranged from 7.42 mg/l at Station RW3 to 7.88 mg/l at Station RW7 (Table 2-1and Figure 2-4). During ebb tide, surface DO concentrations averaged 8.17 mg/l and ranged from 7.66 mg/l at Station RW6 to 8.75 mg/l at Station RW7. In general, dissolved oxygen concentrations were higher throughout the water column on ebb tide except at Stations RW4 and RW9, where ebb tide values were to similar to flood tide levels in the upper 4 m, below which values exceeded those reported during flood tide, and at Station RW6, where DO levels in the upper water column were slightly

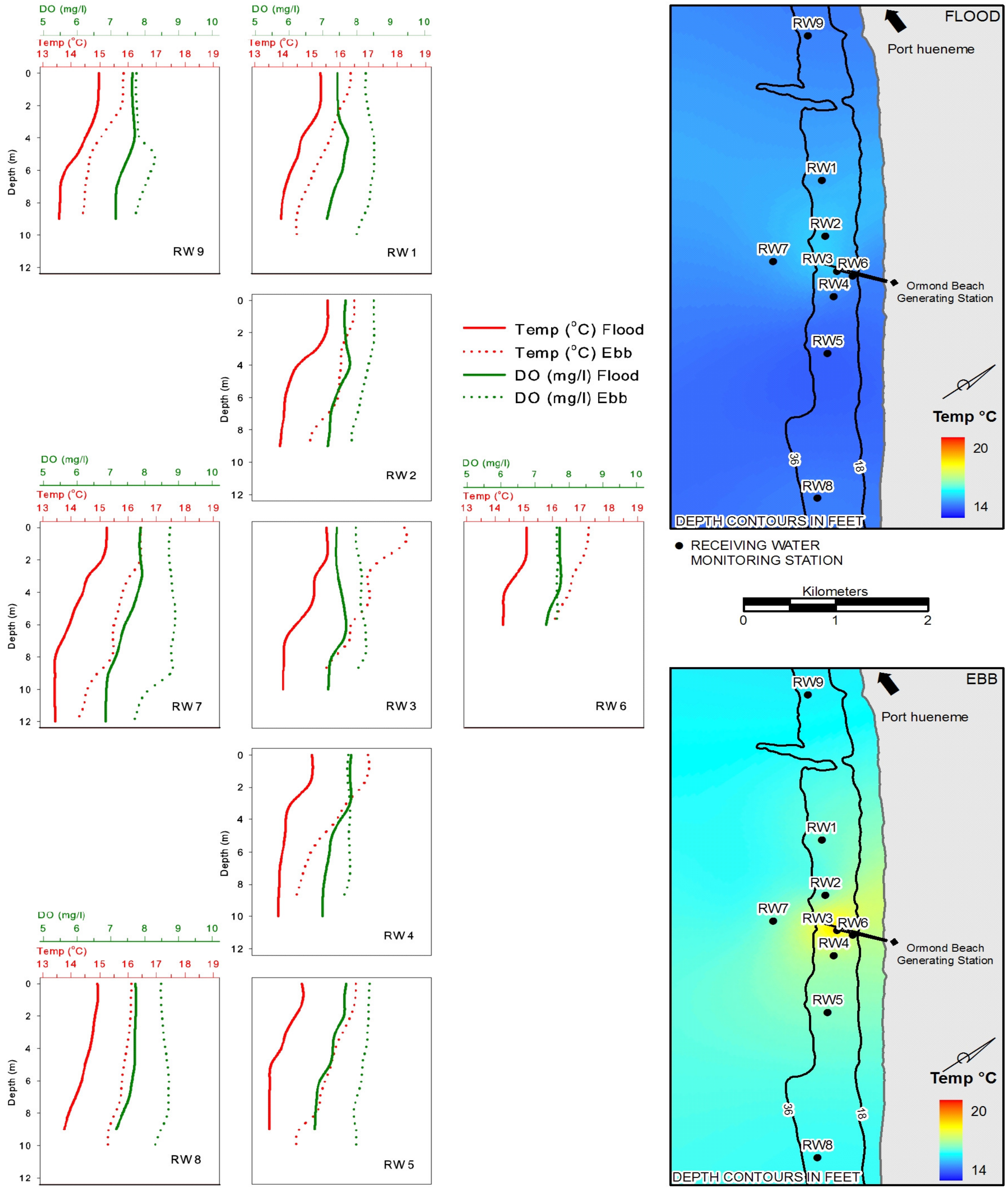


Figure 2-4. False color surface temperature contour plots and temperature and dissolved oxygen vertical profiles during flood and ebb tides, summer survey. Ormond Beach Generating Station NPDES, 2009.

lower during ebb tide and concentrations were generally similar between tides and with depth. During both tides, DO concentrations increased with depth to a subsurface maxima, then decreased with further depth to the bottom. Maximum surface-to-bottom DO differentials occurred at Station RW7 where DO concentration decreased by more than 1.0 mg/l during both tides (Appendix B-2). Near-bottom DO values averaged 7.07 mg/l on flood tide, and 7.85 mg/l on ebb tide.

Hydrogen Ion Concentration

In winter, surface hydrogen ion concentrations (pH) averaged 7.97 during flood tide and 8.06 during ebb tide (Table 2-1and Figure 2-5). Flood tide pH values ranged from 7.93 at Station RW9 to 8.00 at Station RW8. Ebb tide pH values ranged from 8.00 at Station RW9 to 8.08 at Station RW8. Bottom pH values averaged 7.91 during flood tide and 7.93 on ebb tide. Near-bottom pH

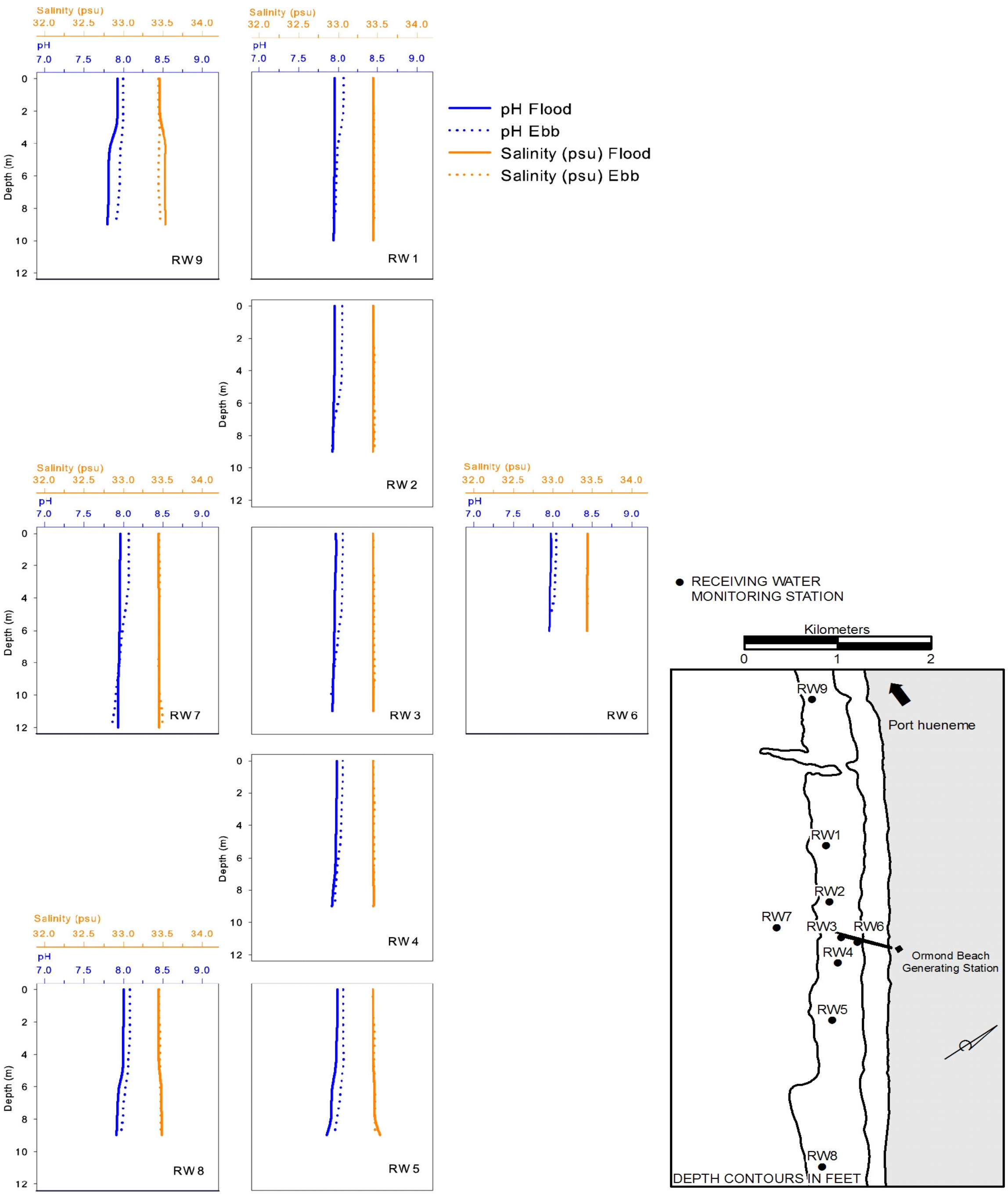


Figure 2-5. Hydrogen ion concentration (pH) and salinity vertical profiles during flood and ebb tides, winter survey. Ormond Beach Generating Station NPDES, 2009.

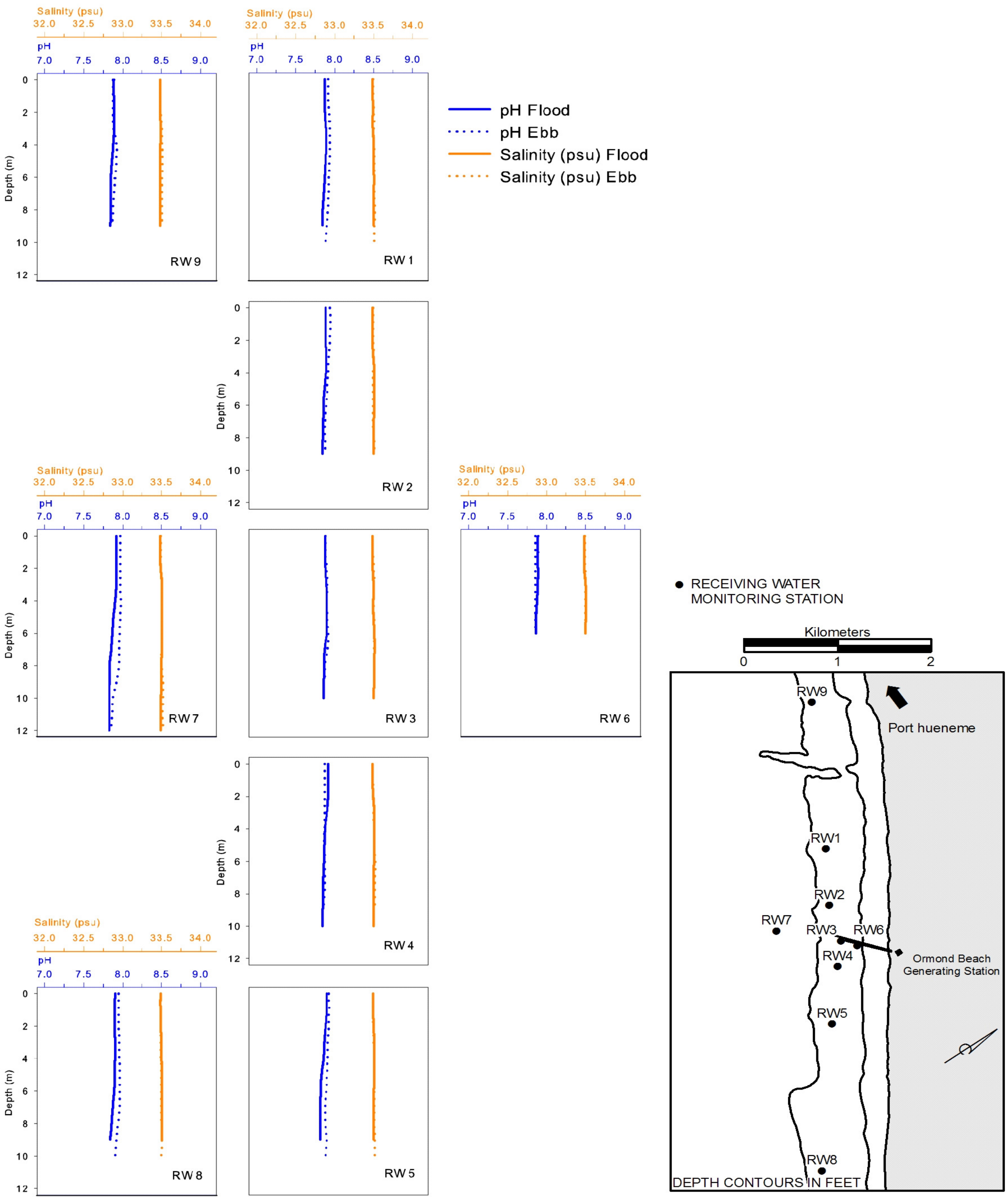


Figure 2-6. Hydrogen ion concentration (pH) and salinity vertical profiles during flood and ebb tides, summer survey. Ormond Beach Generating Station NPDES, 2009.

values during flood tide ranged from 7.80 at Station RW9 to 7.96 at Station RW6. Ebb tide bottom pH values ranged from 7.86 at Station RW7 to 7.98 at Station RW6. Hydrogen ion concentrations during both tides decreased slightly with depth at all stations, but otherwise ranged narrowly, varying by about 0.2 units among stations and depths an during the morning tide (Appendix B-1). Hydrogen ion values were more variable, varying by 0.22 units during the afternoon ebb tide, with slightly higher pH values found throughout the water column at all stations (Table 2-1 and Figure 2-5).

Surface pH values in the summer averaged 7.89 during flood tide and 7.91 during ebb tide (Table 2-1 and Figure 2-6). Flood tide pH values ranged from 7.87 at Station RW1 to 7.92 at Stations RW4 and RW7. Ebb tide pH values ranged from 7.86 at Station RW6 to 7.97 at Station RW7. Bottom pH values averaged 7.84 during flood tide and 7.87 on ebb tide. Flood tide bottom values ranged from 7.82 at Station RW5 to 7.86 at Stations RW3 and RW6. Ebb tide bottom pH values ranged from 7.85 at Stations RW4 and RW7 to 7.91 at Station RW8. Hydrogen ion values were relatively consistent throughout the water column, although slightly higher on ebb tide. In summer, pH varied by 0.15 units among stations, between tides and with depth (Appendix B-2).

Salinity

Winter surface salinities averaged 33.45 practical salinity units (psu) during both tides (Table 2-1 and Figure 2-5). Bottom salinities averaged 33.47 psu on flood tide and 33.46 psu on ebb tide. Salinities remained relatively consistent during both tides and increased slightly with depth. In winter, salinity varied by 0.11 psu among stations, between tides and with depth (Appendix B-1).

Summer surface salinity averaged 33.49 psu during both tides (Table 2-2 and Figure 2-6). Salinity generally increased with depth during the survey, with near-bottom averages of 33.50 psu on flood tide and 33.51 psu on ebb tide. Salinity was relatively uniform during summer sampling, varying by 0.4 psu among stations, between tides and with depth (Appendix B-2).

DISCUSSION

Water quality monitoring was conducted on two tides each during winter and summer to determine potential influence of the Ormond Beach Generating Station discharge on the receiving waters. During the winter sampling, no circulating pumps were in operation at the Ormond Beach Generating Station (Kahle 2009, pers. comm.). During flood tide, surface temperatures were similar throughout the study area, varying by less than 0.25°C among stations. At most stations, temperatures were also consistent with depth, with only slight decreases from surface to bottom. At the two downcoast stations nearest the discharge slight thermal gradients were noted at depths of about 4 to 8 m. A moderate gradient was also noted below a depth of 3 m at the station farthest upcoast of the discharge, where bottom temperature was coldest during the flood tide sampling. Surface temperatures increased by about 0.7°C between the morning and afternoon tides, with slightly higher surface temperatures found at the two nearest downcoast stations on ebb tide The warmer surface water temperatures found throughout the study area in the early afternoon were likely a result of solar insolation, resulting in more variability in the upper water column and mild thermal gradients between the surface and about 5 m depth at most stations. Near bottom temperatures were similar between tides except at the station farthest upcoast, where bottom temperature was more comparable to bottom temperatures reported at the other stations than was found on flood tide. Temperatures in winter 2009 indicated a well-mixed water column throughout most of the study area. The colder near bottom water found on flood tide at the station farthest upcoast suggests the presence of a cooler, near-bottom water mass in that area, which likely moved farther offshore during the afternoon ebb tide. In 2009, winter water column temperatures were typical of the area and within the range of natural variability observed during previous surveys (MBC 1986, 1988, 1990, 1994-2004a, 2005, 2006a, 2007, 2008a; Ogden 1991-1993).

During the summer water quality sampling all four circulating pumps were in operation at the Ormond Beach Generating Station with a cooling water flow of 645 mgd and a discharge temperature of 28.6°C, 13.4°C above intake water temperature (Kahle 2009, pers. comm.). Surface temperatures were slightly cooler than reported in 2008 but similar to levels reported in 2007 and were typical of summer surveys in the area (MBC 1986, 1988, 1990, 1994-2004a, 2005, 2006a, 2007, 2008a; Ogden 1991-1993). Temperatures during the morning flood tide were consistent in the upper water column to a depth of about 2 to 5 m where moderate thermal gradients were noted, below which temperatures decreased slightly with depth to the bottom. Surface temperatures varied by about 1.6°C between tides, and were warmer during the later ebb sampling. The greatest difference between tides was found at the discharge station, where surface temperature was 2.7°C warmer on ebb tide. Temperatures at all stations were warmer throughout the water column during the afternoon ebb tide, likely due to solar insolation. Temperatures on ebb tide declined moderately with depth to the bottom except at the discharge where a relatively strong thermal gradient was observed between a depth of 1 and 2 m. Despite surface warming, near-bottom water temperatures were similar among the 30-ft stations on ebb tide, though near-bottom temperatures were slightly elevated at the shallow, inshore station compared to the remaining stations. During the summer sampling, highest near surface temperatures were found at and upcoast of the discharge on flood tide and at, inshore and downcoast of the discharge on ebb tide. These observations indicated the presence of a warm water surface lens in the vicinity of the thermal discharge. These spatial patterns of warm surface water have been observed in previous surveys and reflect tidal influences on the thermal discharge from the generating station on the day of sampling. Even in areas influenced by the thermal field, surface temperatures were typical of the area and within the range of natural variability observed during previous surveys. Other than at the inshore station on ebb tide, the thermal field did not contact the seafloor.

The concentration of DO in seawater is affected by physical, chemical, and biological variables. High DO levels may be the result of cool water temperatures (solubility of oxygen in water inversely correlates with temperature), active photosynthesis, and/or mixing at the air-water interface (Sverdrup et al. 1942). Conversely, low concentrations may result from high water temperatures, high rates of organic decomposition, and/or extensive mixing of surface waters with oxygen-poor subsurface waters. Dissolved oxygen concentrations typically fluctuates in the nearshore temperate environment around 7.5 mg/l (Kennish 2001), with a threshold of biological concern of 5 mg/l.

During the winter survey, DO was consistent with depth to the bottom at most of the upcoast stations on flood tide except the station farthest upcoast. At that station, the surface-to-bottom DO reduction was greater than at the other station, with a notable decrease between a depth of 3 and 6 m. This was consistent with the depth of the thermal gradient at that station, again suggesting the presence of a distinct subsurface water mass in the area at the time of sampling. At the three stations downcoast of the discharge, DO concentrations were consistent in the upper column to a depth of about 6 m, then decreased with depth to bottom on flood tide. During the afternoon ebb tide, dissolved oxygen concentrations were higher throughout the water column at all stations. Concentrations were also more variable through the water column than on flood tide, with subsurface maxima found in the upper 4 m at each station. Below these maxima, DO concentrations declined with depth to the bottom at all stations, with near-bottom levels generally similar between tides, particularly in the area of the discharge. Higher near surface DO levels during the afternoon sampling were consistent with replenishment by photosynthetic activity later in the day, a trend observed commonly in previous winter surveys in the area (MBC 1986, 1988, 1990, 1994-2004a, 2005, 2006a, 2007, 2008a; Ogden 1991-1993). In 2006, a red tide in winter contributed to extreme DO fluctuations in the water column at the offshore stations, with very high DO values, up to 15.55 mg/l found near surface, and some low values near 5.00 mg/l found near bottom (MBC 2006a). In 2009, all DO values from the winter survey were within the range previously found in the area and were well above the level of biological concern.

In summer, DO concentrations in surface waters and the upper water column were higher throughout the water column on ebb tide except at the stations farthest upcoast, nearest downcoast, and inshore of the discharge. At these stations values were similar between tides in the upper 4 m of the water column, below which ebb tide values exceeded those reported during flood tide. During both tides, DO concentrations generally increased with depth to a subsurface maximum, then decreased slightly with continued depth to the bottom, with near-bottom DO concentrations similar to the respective surface values at all but the deepest station. As noted above, higher DO levels during the afternoon sampling were consistent with replenishment by photosynthetic activity during the day. Dissolved oxygen concentrations were in the range previously recorded offshore the generating station (MBC 1986, 1988, 1990, 1994-2004a, 2005, 2006a, 2007, 2008a; Ogden 1991-1993) and were well above the level of biological concern.

In the open ocean, pH remains fairly constant due to the buffering capacity of sea water (Sverdrup et al. 1942). However, in nearshore areas, pH may vary due to physical, chemical, and biological influences. For instance, in areas with a large organic influx, such as bays, estuaries, and near river mouths, microbial decomposition can alter pH levels. Along with a reduction in DO, decomposition also results in the production of humic acids, which reduces pH (Duxbury and Duxbury 1984). Decreased pH values may also occur in areas of fresh water influx, since fresh water generally has a lower pH than salt water. In contrast, phytoplankton blooms, which are often associated with nearshore upwelling, may initially cause an increase in pH. High photosynthetic rates increase the removal of carbon dioxide from water, thus reducing the bicarbonate concentration, resulting in an increase in pH.

In both winter and summer, pH was very consistent throughout the water column in the survey area. Hydrogen ion values were slightly more variable in winter with slightly higher values found during ebb tide. Hydrogen ion concentrations varied by less than 0.3 units during the winter survey, while in summer pH values varied by no more than 0.2 units among stations, between tides and with depth. The greatest variability was observed in winter at the station farthest upcoast on flood tide, consistent with differences in surface and bottom water masses noted previously. In 2009 all pH values were compatible to concentrations previously recorded in the study area (MBC 1986, 1988, 1990, 1994-2004a, 2005, 2006a, 2007, 2008a; Ogden 1991-1993) and did not appear to be related to operation of the thermal discharge.

Salinity in the open ocean is generally 35 psu (ppt). However, in nearshore areas subjected to freshwater influx, salinity is usually slightly lower. In southern California, salinity values of nearshore waters are generally between 33 and 34 ppt (Dailey et al. 1993). Reductions in nearshore salinity usually result from freshwater input, while slight increases are often associated with upwelling of colder, more saline waters. Direct measurements of salinity are impractical, however, requiring the evaporation of one kilogram of seawater to obtain a final weight of salts. The most efficient measurement of salinity is determined by the electrical conductivity of seawater, which is precisely measured through the use of a CTD (conductivity-temperature-depth) instrument and is reported in “practical salinity units” (psu) which correlates one-to-one with parts per thousand (ppt).

In winter, salinities remained similar during both tides, increasing slightly with depth, although they were generally more variable during the afternoon ebb tide. The greatest variability in winter was observed at the station farthest upcoast on flood tide, with higher near-bottom concentrations, which supports previous observations. Average surface salinity values in winter were slightly lower than those found during the summer survey and varied by less than 0.2 psu among stations, between tides and with depth. During summer, salinity increased slightly with depth and was slightly higher during ebb tide. Salinity was uniform during summer sampling, varying by 0.4 psu among stations, between tides and with depth. All values reported in 2009 were typical of the nearshore waters of southern California and within values found previously in the area (MBC 2002-2004a, 2005, 2006a, 2007, 2008a).

CONCLUSION

With the exception of the warm water surface lens near the discharge in summer, variations in water quality parameters observed in 2009 can be attributed to natural physical and biological processes. Water quality measurements indicated that in 2009 the cooling water discharge from the Ormond Beach Generating Station did not have an adverse effect on receiving waters in the study area.

CHAPTER 3 — SEDIMENT CHARACTERISTICS

Marine sediment characteristics are affected by both natural and anthropogenic influences. Tides, currents, and wave action all influence sediment grain size by suspending and transporting fine-grained material, resulting in coarser sediments in dynamic areas and finer sediments in areas of reduced currents and wave action. Coastal streams and rivers contribute sediments as well as contaminants to the marine environment, with variable influence from year-to-year depending on yearly rain amounts. In coastal environments, man-made structures such as jetties and breakwaters alter water movement and may result in changes in local sediment characteristics and deposition patterns, while sand replenishment projects can influence sediment characteristics over large intertidal and subtidal areas. In addition to influencing grain size, anthropogenic inputs may contribute contaminants, including metals, to the environment which can bind to sediments. Sediment grain size and sediment chemistry trends are useful in characterizing year-to-year differences that may be related to either natural or anthropogenic influences.

MATERIALS AND METHODS

Bottom samples for sediment grain size and sediment chemistry analyses were collected at Stations B1 through B6 during the summer of 2009 (Figure 3-1). All samples were collected *in situ* by biologist-divers in conjunction with infauna sampling.

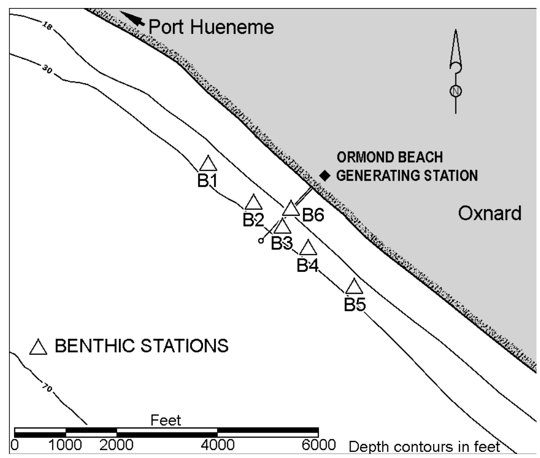


Figure 3-1. Location of the benthic sampling stations. Ormond Beach Generating Station NPDES, 2009.

Sediment Grain Size

A sample of sediments for grain size analysis was taken at each station using a 3.5-centimeter (cm)-diameter, 15-cm-long plastic core tube. The sample was transferred to a plastic bag for later laboratory analysis.

The size distributions of sediment particles were determined using two techniques: laser light diffraction to measure the amount and patterns of light scattered by a particle's surface for the sand/silt/clay fraction, and standard sieving for the gravel fraction. Laboratory data from the two methods were combined and presented in tabular format. Resulting analyses include mean and median grain size, standard deviation of the grain size, sorting, skewness, and kurtosis. Data were plotted as size-distribution curves. Additional details are provided in Appendix C-1.

Sediment Chemistry

Samples for sediment chemistry analysis were taken from the upper 2 cm of the sediments at each station. Collection jars were filled with seawater and taken to the sea floor by biologist-divers where sediment samples were collected directly with the glass jars.

Sediments were kept on ice while in the field, and maintained at approximately 4°C until laboratory procedures began. Replicate sediment samples were composited by the analytical laboratory prior to analysis and reported as station results. Sediment was analyzed for total percent solids and four metals: chromium, copper, nickel, and zinc. Standard Methods (SM) method 2540 B was used in determining total percent solids and Environmental Protection Agency (EPA) method 6020 was used for metal analysis.

RESULTS

Sediment chemistry and grain size samples were collected by biologist-divers at Stations B1 through B6 on 22 July 2009 between 0630 and 0900 hours. Skies were clear with winds from the west at 3 to 5 knots. Seas were west at 1 to 2 ft.

Sediment Grain Size

Sediment distribution curves and parameters describing sediment grain size characteristics for each station are presented in Appendix C and are summarized in Table 3-1. Grain size is expressed in phi (Φ) units, which are inversely related to grain diameter (Appendix C-1).

Sediments at the six stations in 2009 were composed primarily of sand, with smaller amounts of silt and clay (Table 3-1). Gravel was not found at any of the stations in 2009. Overall, sediments from the six stations averaged about 89% sand, 9% silt, and 2% clay, with an average mean grain size of 2.82 phi (141 µm, fine sand). Sediments were finest at Station B2, 1,000 ft upcoast of the discharge on the 30-ft isobath, where mean grain size was 3.47 phi (90 µm, very fine sand). Sediments were coarsest at Station B3, at the discharge, where mean grain size was 2.07 phi (238 µm, fine sand).

Table 3-1. Sediment grain size parameters. Ormond Beach Generating Station NPDES, 2009.

	Station							
Parameter	B1	B2	B3	B4	B5	B6	Mean	S.D.
% Gravel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Sand	91.50	80.39	91.80	92.40	86.78	93.77	89.44	5.03
% Silt	6.62	17.07	6.24	6.01	10.90	4.48	8.55	4.69
% Clay	1.88	2.54	1.96	1.59	2.32	1.75	2.01	0.36
Mean grain size								
phi	3.05	3.47	2.07	2.76	3.20	2.80	2.82	0.48
micrometers	120	90	238	147	109	143	141	52
Sorting	0.732	0.827	1.353	0.920	0.794	0.806	0.905	0.228
Skewness	-0.004	0.082	0.240	-0.073	0.174	-0.043	0.063	0.125
Kurtosis	1.346	1.596	1.185	1.119	1.333	1.472	1.342	0.177

Sorting is a measure of the spread of the particle distribution curve, with poorly-sorted sediments composed of a broad range of particle size classes, while well-sorted sediments contain fewer size classes. In 2009, sorting averaged 0.91 phi overall, representing moderately sorted sediments (Table 3-1). Sorting values ranged from 0.73 phi at Station B1, 3,000 ft upcoast of the discharge at a depth of 30 ft, to 1.35 phi at Station B3. Moderately sorted sediments occurred at all stations except the discharge where sediments were poorly sorted. Sediment distribution curves at all stations were unimodal, with a peak in the fine sand category, with variable amounts of sediments in other size categories (Appendix C-2). Though still peaking in the fine sand category, medium sand sized material contributed notably more to the sediments at the discharge station than at any other station in 2009.

Skewness and kurtosis tell how closely the grain size distribution approaches the normal Gaussian probability curve. More extreme skewness and kurtosis values indicate non-normal distributions. Skewness is a measure of the symmetry of the particle distribution curve; a value of zero indicates a symmetrical distribution of fine and coarse materials around the median of the curve, while a value greater then zero (positive) indicates an excess of fine material, and a negative value indicates an excess of coarse material. Skewness ranged from -0.004 at Station B1 (essentially symmetrically distributed) to 0.24 at Station B3 (Table 3-1). Distribution curves were skewed toward coarser material at Stations B4 and B6, 1,000 ft downcoast of the discharge at a depth of 30 ft and inshore of the discharge on the 20-ft isobath, respectively. Sediments at Stations

B2, B3 and B5 (3,000 ft downcoast of the discharge on the 30-ft isobath) skewed toward finer material.

Kurtosis is a measure of the peakedness of the particle distribution curve. A kurtosis value of 1.0 represents a normal particle distribution curve while a value greater than 1.0 indicates a leptokurtic (peaked) distribution with better sorting in the central portion of the curve than in the tails. A value less than 1.0 indicates a platykurtic (flattened) distribution and a lack of dominance by any one size category. Kurtosis ranged from 1.12 at Station B4 to 1.60 at Station B2 and averaged 1.34 (Table 3-1). Kurtosis values at all stations in 2009 were greater than 1.0, indicating leptokurtic (excessively peaked) distributions, with dominance by a narrow range of size classes.

Sediment Chemistry

Sediment samples collected at the six benthic stations were analyzed for chromium, copper, nickel, and zinc. Sediment metal concentrations are presented in Appendix D and summarized in Table 3-2 with values reported as dry weight. Metal concentrations were similar among stations. Highest values for chromium, nickel, and zinc were found at Station B2, upcoast of the discharge, while copper was highest at the discharge. Lowest levels for chromium and nickel were found at the discharge, while lowest copper and zinc levels occurred downcoast at Station B4.

Chromium. Sediment chromium concentrations averaged 8.7 mg/kg and ranged from 6.92 mg/kg at Station B3 to 10.2 mg/kg at Station B2 (Table 3-2).

Copper. Sediment copper concentrations averaged 4.36 mg/kg and ranged from 3.60 mg/kg at Station B4 to 5.53 mg/kg at Station B3 (Table 3-2).

Nickel. Sediment nickel concentrations averaged 7.16 mg/kg and ranged from 5.60 mg/kg at Station B3 to 8.25 mg/kg at Station B2 (Table 3-2).

Zinc. Sediment zinc concentrations averaged 28.3 mg/kg and ranged from 24.3 mg/kg at Station B4 to 35.5 mg/kg at Station B2 (Table 3-2).

Table 3-2. Sediment metal concentrations (mg/dry kg). Ormond Beach Generating Station NPDES, 2009.

	Station										Reporting
Metal	B1	B2	B3	B4	B5	B6	Mean	S.D.	ERL	ERM	Limits
Chromium	9.39	10.2	6.92	8.25	8.46	9.20	8.7	1.13	81	370	0.124 - 0.139
Copper	4.22	4.53	5.53	3.60	4.02	4.26	4.36	0.65	34	270	0.124 - 0.139
Nickel	7.11	8.25	5.60	6.76	7.20	8.02	7.16	0.95	20.9	51.6	0.124 - 0.139
Zinc	29.1	35.5	25.2	24.3	29.1	26.4	28.3	4.1	150	410	1.24 - 1.39

ERL = Effects Range Low
ERM = Effects Range Median

DISCUSSION

Sediment Grain Size

In 2009, sediments were analyzed from six stations offshore the Ormond Beach Generating Station. Sediment composition was similar among stations, consisting primarily of sand with lesser amounts of fine material (silt and clay) and mean grain sizes in the fine and very fine sand categories. Particle distribution curves were skewed toward coarser material at the station 1,000 ft downcoast and the station inshore of the discharge, and skewed towards finer material at the discharge and at the stations 1,000 ft upcoast and farthest downcoast of the discharge. Sediment distribution was essentially symmetrical at the station farthest upcoast. Sediments were coarsest at the discharge and finest at the nearest upcoast station. The percent contribution to the sediments by fine material (silt and clay) was lowest (6%) inshore of the discharge at 20-ft depth, while greatest percentages of fine material (20% and 13%) occurred at the nearest upcoast and farthest downcoast stations, respectively.

In 2005, mean grain size in the study area was the greatest on record, a result of the coarse sediments found at Station B2 (Figure 3-2; Appendix C-3; MBC 1979, 1981, 1986, 1988, 1990, 1994, 1997-2004a, 2005, 2006a, 2007, 2008a; Ogden 1991-1993). The coarse sediments found at Station B2 in 2005 and 2006 were likely a remnant of very coarse relict sands found in isolated patches on the Santa Barbara Shelf (AHF 1959; MBC 2005, 2006a). Relict sands represent poorly-weathered sediments historically deposited as beaches or dunes during periods of lower sea level (Emery 1952, 1960; Terry et al. 1956). Occurrence of the coarse sands during these years may also have been related to dredge and sand bypass operations that were conducted at Channel Islands Harbor in late 2004, with sand discharged just downcoast from Port Hueneme (Ryan 2006, pers. comm.), although disposal operations would likely also have affected sediments at Station B1, which was not indicated during those surveys (MBC 2005, 2006a). Since 2006, however, mean grain size has been consistent with most previous surveys; mean values were slightly finer than the long-term average in 2006 and 2008, and slightly coarser to the long-term mean in 2007 (Figure 3-2). In 2009, the mean grain size for the survey was identical to the long-term average since 1990, at a value of 2.82 phi.

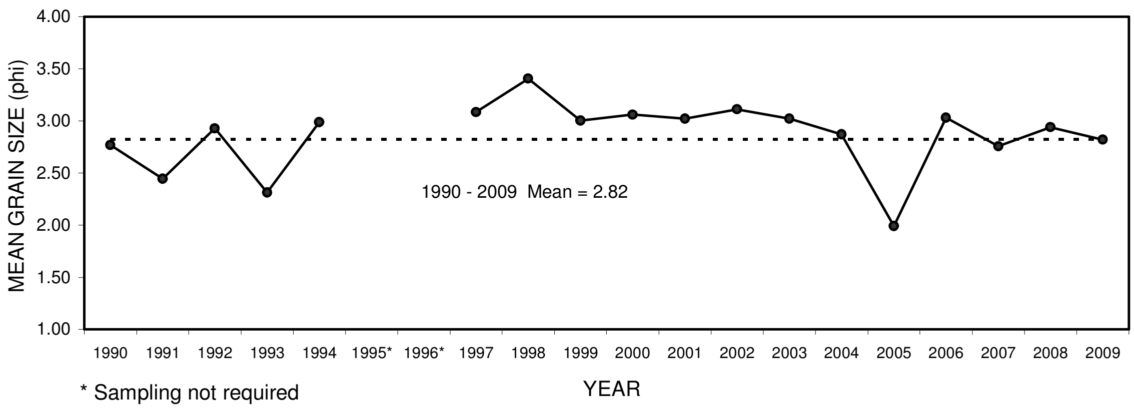
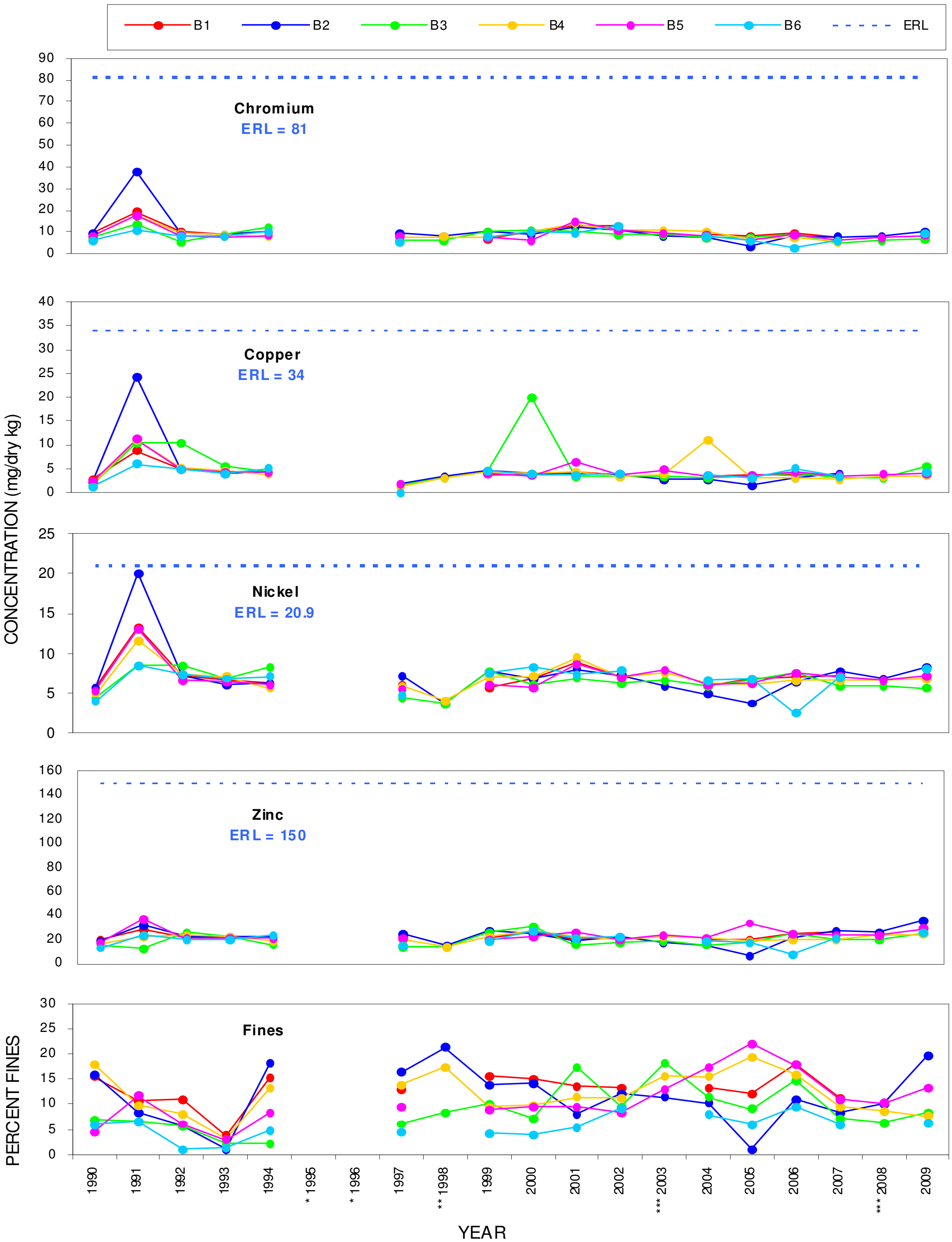


Figure 3-2. Comparison of sediment mean grain size, 1990 - 2009. Ormond Beach Generating Station NPDES, 2009.

In 2009, sediment grain sizes in the fine to very fine sand categories were typical of those commonly found offshore of the generating station (MBC 1990, 1994, 1997-2004a, 2005, 2006a, 2007, 2008a; Ogden 1991-1993). In regional sampling conducted in 2003, sediments from shallow (5-30 m) coastal stations throughout the Southern California Bight averaged 31% fines overall, considerably higher than found in the survey area in 2009 or commonly in previous surveys (Schiff et al. 2006; Figure 3-3; Appendix C-3). Despite a general similarity in sediment characteristics found in the area in 2009, there has been year-to-year variability in grain size. In the 15 surveys since 1990 (excluding 1998, 2003, and 2008 when the sampling program was limited to three or four stations), sediments were finest at the discharge twice, inshore of the discharge once, downcoast of the discharge three times, and upcoast of the discharge nine times (MBC 1990, 1994, 1997-2004a, 2005, 2006a, 2007, 2008a; Ogden 1991-1993). During the same surveys coarsest sediments occurred at the discharge eight times, upcoast four times, and inshore three times. In 2009, sediments were finest upcoast and coarsest at the discharge (Table 3-1).

In a pattern observed during some previous surveys, coarser sediments in the vicinity of the discharge in 2009 may have been influenced by turbulence associated with the cooling water



*No sampling required; ** 1998 - only three stations required; *** 2003 and 2008 only four stations required.

Figure 3-3. Comparison of sediment metal concentrations and percent fines by station, 1990 - 2009. Ormond Beach Generating Station NPDES, 2009.

discharge (which prevents finer sediments from settling) in addition to normal nearshore processes which influence grain size, such as currents, waves and sand movement. This localized influence on sediment characteristics was recently noted in 2008, 2007, 2004, and 2002 (MBC 2002, 2004a, 2007, 2008a). However, the degree of influence varies from year to year, and in 2006, 2005, 2003, and 2001 no sediment grain size patterns relative to the discharge were apparent (MBC 2001, 2003, 2004a, 2005, 2006a). The similarity of grain size characteristics at the remaining stations suggests that outside of the immediate influence of the discharge sediment distribution was primarily influenced by natural causes. Aside from a possible localized and transitory effect near the discharge, sediment characteristics offshore of the Ormond Beach Generating Station discharge in 2009 were similar to those found previously in the area and appear to be influenced primarily by natural causes.

Sediment Chemistry

In 2009, sediments at six stations off the Ormond Beach Generating Station were analyzed for the presence and concentration of chromium, copper, nickel, and zinc. Similar to 2007 and 2008, highest concentrations of chromium, nickel, and zinc were recorded 1,000 ft upcoast of the discharge (Table 3-2). While lowest concentrations of these metals were recorded at the discharge, copper levels were highest there in 2009. In general, metal levels were similar among stations in 2009, though higher than levels reported commonly in recent years, especially for zinc (Figure 3-3). For the most part, concentrations of chromium, copper, and nickel were similar to or slightly lower than long-term means at each station in 2009, though zinc levels in 2009 exceeded the long-term average at each station (MBC 1990, 1994, 1997-2004a, 2005, 2006a, 2007, 2008a; Ogden 1991-1993). Still, all metal levels in 2009 were within the range of values recorded in previous surveys.

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. 1982). Comparisons should take into account the relative amounts of fine and coarse sediments. Sediments in the study area have consistently been sandy. In previous years, the largest percentages of fines (silt and clay combined) were usually recorded at the upcoast stations or Station B5 downcoast from the discharge (Figure 3-3). Continuing this trend, the greatest percentage of fine material in 2009 was recorded at Station B2, upcoast of the discharge, followed by Station B5. Not unexpectedly, highest concentrations of chromium, nickel and zinc were found at Station B2 in 2009, though highest copper levels were found near the discharge where sediments were coarsest and percentage of fine sediments was less than one-half that found at Station B2. Still, consistent with previous surveys, sediment metal levels were similar among stations with relatively low concentrations throughout the study area (MBC 1990, 1994, 1997-2004a, 2005, 2006a, 2007, 2008a; Ogden 1991-1993).

Since 1990, metal levels in the area were highest in 1991 (Figure 3-3). In 1992, concentrations of most metals decreased substantially, and by 1993 metal concentrations were similar to levels detected in 1990. A similar pattern was recorded in sediment metal concentrations offshore the Mandalay Generating Station, located upcoast from Channel Islands Harbor (MBC 2004b). Since 1993, metal concentrations in the study area have been relatively consistent with the exception of an anomalously high copper concentration detected in 2000 at the discharge. In 2000, levels of chromium, copper, and zinc were all highest at the discharge, even though the amount of fine material there was low, suggesting the generating station as a possible source (MBC 2000). Starting in 2001, no consistent pattern of distribution of metals in sediments has been apparent in the study area (MBC 2001-2004a, 2005, 2006a, 2007, 2008a).

Despite a survey-wide increase in zinc concentrations compared to the long-term means, metal values observed in 2009 were typical of the area (Figure 3-3). Metal levels throughout the

Ormond Beach study area were still lower than or comparable to levels reported for the area by the National Oceanographic and Atmospheric Administration (NOAA) and to levels reported in three regional monitoring programs conducted throughout the Southern California Bight (Figure 3-4).

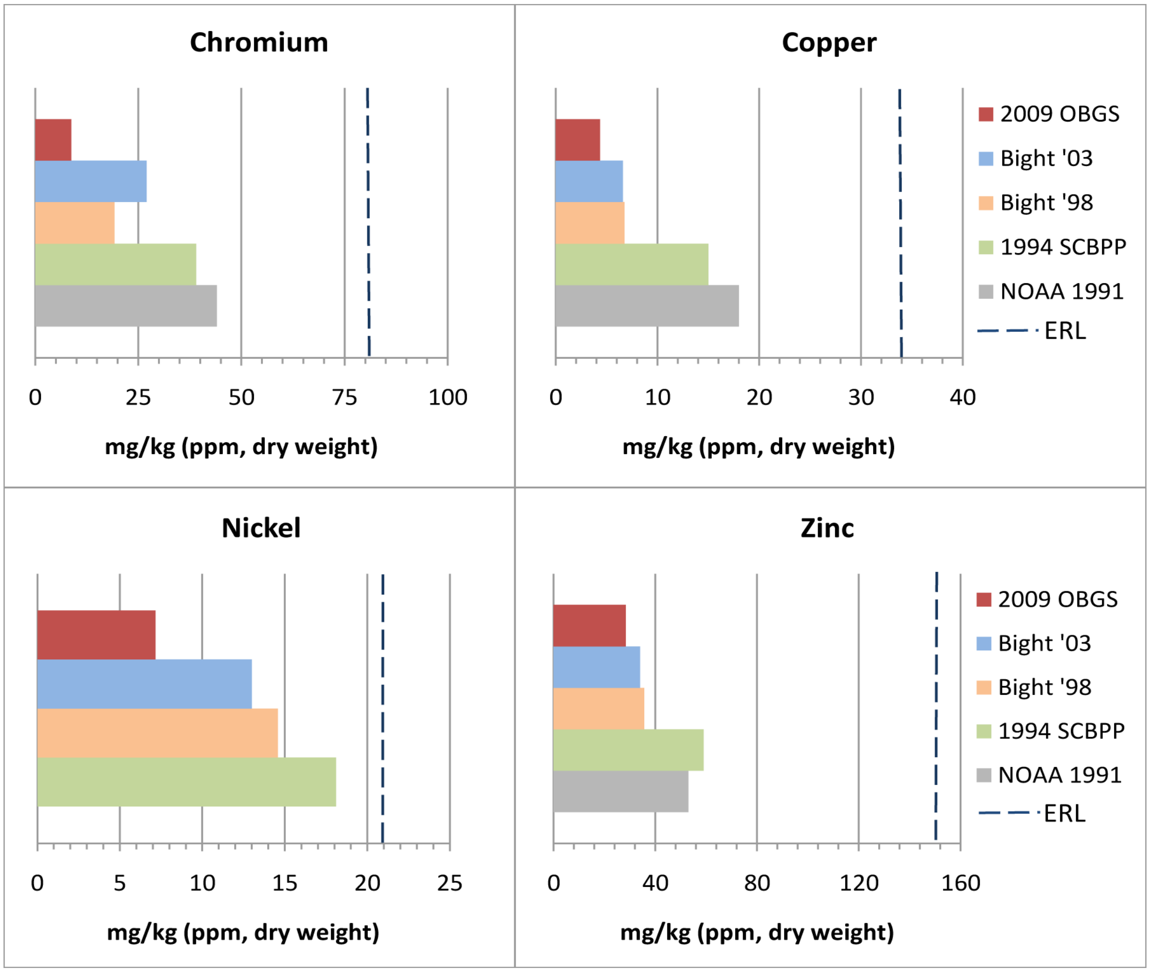


Figure 3-4. Comparison of metal concentrations off Ormond Beach Generating Station in 2009 with results from: (1) Shallow (5 to 30 m depth) stations sampled during 2003 and 1998 (Schiff et al. 2006, Noblet et al. 2003), (2) on the southern California shelf (20 to 200 m) in 1994 (Schiff and Gossett 1998), (3) on the Oxnard shelf (SCCWRP 1973, NOAA 1991a), and (4) the Effects Range Low concentration (Long et al. 1995). Ormond Beach Generating Station NPDES, 2009.

Concentrations of metals in the study area have consistently been below levels determined to be potentially toxic to aquatic 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). Concentrations below the ERL represent a minimal effects range; a range intended to estimate conditions where effects would be rarely observed (Long et al. 1995). Metal concentrations have never exceeded their respective ERLs in the study area (Figure 3-3).

Pollutants come from a variety of sources of both industrial and domestic origin. Oil and gasoline combustion releases many substances, including cadmium, copper, chromium, lead, mercury, and zinc. These and other metals are also used in paints, pigments, batteries, manufacturing, and protective coatings. Aerial fallout is a diffuse and potentially large source of contaminants derived from other sources, and may include metals, chlorinated hydrocarbons, and PAHs (SCCWRP 1973, 1986). As these contaminants accumulate on the ground, they are washed into rivers by rainfall, and are eventually deposited in the ocean.

Sediment metal concentrations have remained relatively consistent in the area since 1990. In general, metal levels were similar among stations in 2009, though slightly higher than levels reported commonly in recent years, especially for zinc. Metal concentrations were generally similar among stations and similar to results found in previous surveys and lower than levels found in similar habitats throughout southern California. Metal concentrations in 2009 appeared to be somewhat related to the percent of fine material in the sediments, with highest levels of chromium, nickel, and zinc found at the stations with the most fine material, though slightly higher levels of copper at Station B3 suggest that localized input might be associated with the discharge. Still, metal levels vary slightly from year to year and no long-term patterns of metal concentrations relative to the discharge were apparent. Concentrations of sediment metals in 2009 did not appear to be adversely influenced by the operation of the Ormond Beach Generating Station.

CONCLUSION

Sediment Grain Size

In 2009, slightly coarser sediments found at the discharge station appeared to have been influenced by turbulence associated with the cooling water discharge, a pattern noted during some previous surveys. The degree of influence of the discharge on local sediments varies from year to year, suggesting a localized and transitory effect near the discharge. Other than the coarser sediments found in the discharge area, sediment characteristics offshore of the Ormond Beach Generating Station discharge in 2009 were similar to those found previously in the area and appear to be affected primarily by natural causes.

Sediment Chemistry

In 2009 metal concentrations were generally similar among stations, though slightly higher than levels reported commonly in recent years. Sediment metal concentrations have remained relatively consistent in the area since 1990 at levels below concentrations determined to be potentially toxic to marine organisms. While metal levels typically vary slightly from year to year, no long-term patterns of metal concentrations relative to the discharge were apparent. Concentrations of sediment metals in 2009 did not appear to be adversely influenced by the operation of the Ormond Beach Generating Station.

CHAPTER 4 — MUSSEL BIOACCUMULATION

Concentrations of many toxic substances in water are often too low or transitory to be reliably detected through the analysis of water samples. Also, many toxic substances are not water-soluble, but are instead associated with sediments or organic tissues. Tissues from aquatic organisms are preferably sampled because they accumulate and concentrate toxic substances to levels which may be hundreds of times the levels found in water samples, thus facilitating the detection of pollutants. Mussels are excellent subjects for this purpose because they 1) are sessile, 2) are long-lived, 3) can be transplanted and maintained in areas were they do not occur, and 4) reliably concentrate toxic pollutants from the water (SWRCB 1995, 2000).

MATERIALS AND METHODS

Prior to 2006, mussels for tissue analysis were collected off of the Ormond Beach Generating Station discharge buoy. Replacement of the buoy in early 2006, however, eliminated this site as a mussel source. As a result, live bay mussels (*Mytilus galloprovincialis*) were purchased from a commercial mussel distributor, Carlsbad Aquafarms, for transplant near the Ormond Beach discharge. Source mussels were harvested from Agua Hedionda Lagoon in Carlsbad, California on 10 March 2009, cleaned and placed within protective enclosures that allowed unrestricted water flow to the mussels. These enclosures were transplanted to a mooring established near the Ormond Beach discharge on 11 March 2008. Additional mussels from the source site were frozen for later analysis and comparison with the transplanted mussels. On 22 July 2008 the transplanted mussels were retrieved and returned to the laboratory for chemical analysis.

Forty-five (45) transplanted bay mussels with shell lengths averaging 63 mm were collected from the mooring and returned to the laboratory for chemical analysis. Three replicate samples, each a composite of the tissue from 15 mussels, were analyzed for concentrations of the metals chromium, copper, nickel, and zinc according to methods used in the California State Mussel Watch Program (SMWP, Appendix A, and SWRCB 1986). Standard Methods (SM) method 2540B was used in determining total percent solids, and Environmental Protection Agency (EPA) method 6020 was used for metal analysis. The same methods were used with bay mussels collected from the source site and from a set of California mussels (*Mytilus californianus*) collected on 15 July 2009 from Manhattan Beach Pier in Santa Monica Bay, which served as a reference site.

During sample analysis, metals are detectable at very low concentrations. The level below which the analytical method will no longer detect the analyte is referred to as the method detection limit (MDL). However, concentrations are only reported when results can be confirmed by exceeding a confidence level, termed the reporting limit (RL). If metal concentrations are detected at a level below the RL the results cannot reliably be reported and sample results are reported as none detected (ND). Beginning in 2005, analytical reporting limits for bioaccumulated metals were lower than in previous years (MBC 2001-2004a, 2005, 2006a, 2007). As a result, in 2005 and 2006 concentrations of some metals were reported at levels lower than possible during earlier surveys. In 2007, it was determined that the extremely low reporting limits utilized in 2005 and 2006 were more sensitive than necessary to detect bioaccumulated metals. So, while reporting limits have been higher since 2007, these levels reliably report metal concentrations commonly found in local mussel tissues without reporting ND results. For QA/QC purposes, the analytical laboratory may analyze one sample twice to confirm results and provide the results from both analyses. While both replicates are usually very similar, some differences in metal concentrations are typical. When QA/QC results are provided the highest value determined during either analysis is presented in the results.

RESULTS

In 2009, chromium, copper, nickel, and zinc were detected in all mussel tissue replicates from the generating station discharge area, the source site and at a pier reference site (Table 4-1).

Chromium concentrations in mussels from the discharge ranged from 1.30 to 1.99 mg/dry kg with a mean of 1.60 mg/dry kg (Table 4-1). Mean chromium concentration at the discharge was higher than at both the source site (0.820 mg/dry kg), and the reference site (1.20 mg/dry kg).

Copper concentrations from the discharge averaged 2.17 mg/dry kg with a range from 2.14 to 2.20 mg/dry kg (Table 4-1). Copper levels were lower in the source mussels (1.13 mg/dry kg), but higher in mussels from the reference site (3.76 mg/dry kg).

Nickel levels in mussels from the discharge ranged from 0.610 to 1.01 mg/dry kg with a mean of 0.77 mg/dry kg (Table 4-1). Nickel at the discharge was higher than the mean concentration at both the source site (0.405 mg/dry kg) and the reference site (0.448 mg/dry kg).

Zinc concentrations at the discharge site ranged from 25.8 to 29.1 mg/dry kg, with a mean concentration of 27.1 mg/dry kg (Table 4-1). Zinc concentrations were lower in the source mussels with a mean concentration 25.6 mg/dry kg, but higher at the reference site with a mean of 35.5 mg/dry kg.

Table 4-1. Mussel tissue metal concentrations (dry weight and reporting limits, mg/dry kg; wet weight and EDL, mg/wet kg). Ormond Beach Generating Station NPDES, 2009.

	Dry Weight						Wet Weight						
	Replicate						Replicate						
Metal	1	2	3	Mean	SD	Reporting Limits	1	2	3	Mean	SD	EDL 85	EDL 95
Discharge													
Chromium	1.51	1.99	1.30	1.60	0.35	0.175 - 0.186	**0.81**	**1.13**	0.72	**0.89**	0.22	0.73	1.60
Copper	2.14	2.17	2.20	2.17	0.03	0.263 - 0.279	1.15	1.24	1.22	1.20	0.04	2.28	4.28
Nickel	0.691	1.01	0.610	0.77	0.21	0.0877-0.0929	0.37	0.58	0.34	0.43	0.13	0.78	1.06
Zinc	25.8	29.1	26.5	27.1	1.7	1.75 - 1.86	13.88	16.59	14.65	15.04	1.39	42.92	52.60
% Solids	53.8	57.0	55.3	55.4	1.6	0.100	-	-	-	-	-	-	-
Source Mussels													
Chromium	0.982	0.885	0.594	0.820	0.202	0.145 - 0.165	0.628	0.537	0.410	0.53	0.11	0.73	1.60
Copper	1.17	1.29	0.938	1.13	0.18	0.217 - 0.247	0.75	0.78	0.65	0.73	0.07	2.28	4.28
Nickel	0.462	0.478	0.275	0.405	0.113	0.0725-0.0824	0.30	0.29	0.19	0.26	0.06	0.78	1.06
Zinc	27.7	26.4	22.6	25.6	2.7	1.45 - 1.65	17.73	16.02	15.59	16.45	1.13	42.92	52.60
% Solids	64.0	60.7	69.0	64.6	4.2	0.100	-	-	-	-	-	-	-
Manhattan Beach Pier Reference Site													
Chromium	1.21	1.12	1.26	1.20	0.07	0.157 - 0.163	**0.77**	**0.70**	**0.77**	**0.75**	0.04	0.55	1.04
Copper	3.75	3.89	3.63	3.76	0.13	0.236 - 0.245	**2.38**	**2.42**	**2.23**	**2.34**	0.10	1.59	2.12
Nickel	0.427	0.347	0.570	0.448	0.113	0.0787 - 0.0816	0.27	0.22	0.35	0.28	0.07	0.63	0.82
Zinc	35.6	32.6	38.3	35.5	2.9	1.57 - 1.63	22.6	20.3	23.5	22.1	1.7	33.64	38.87
% Solids	63.5	62.2	61.3	62.3	1.1	0.100	-	-	-	-	-	-	-

EDL = Elevated Data Levels **Blue** values exceed EDL 85 **Red** values exceed EDL 95

DISCUSSION

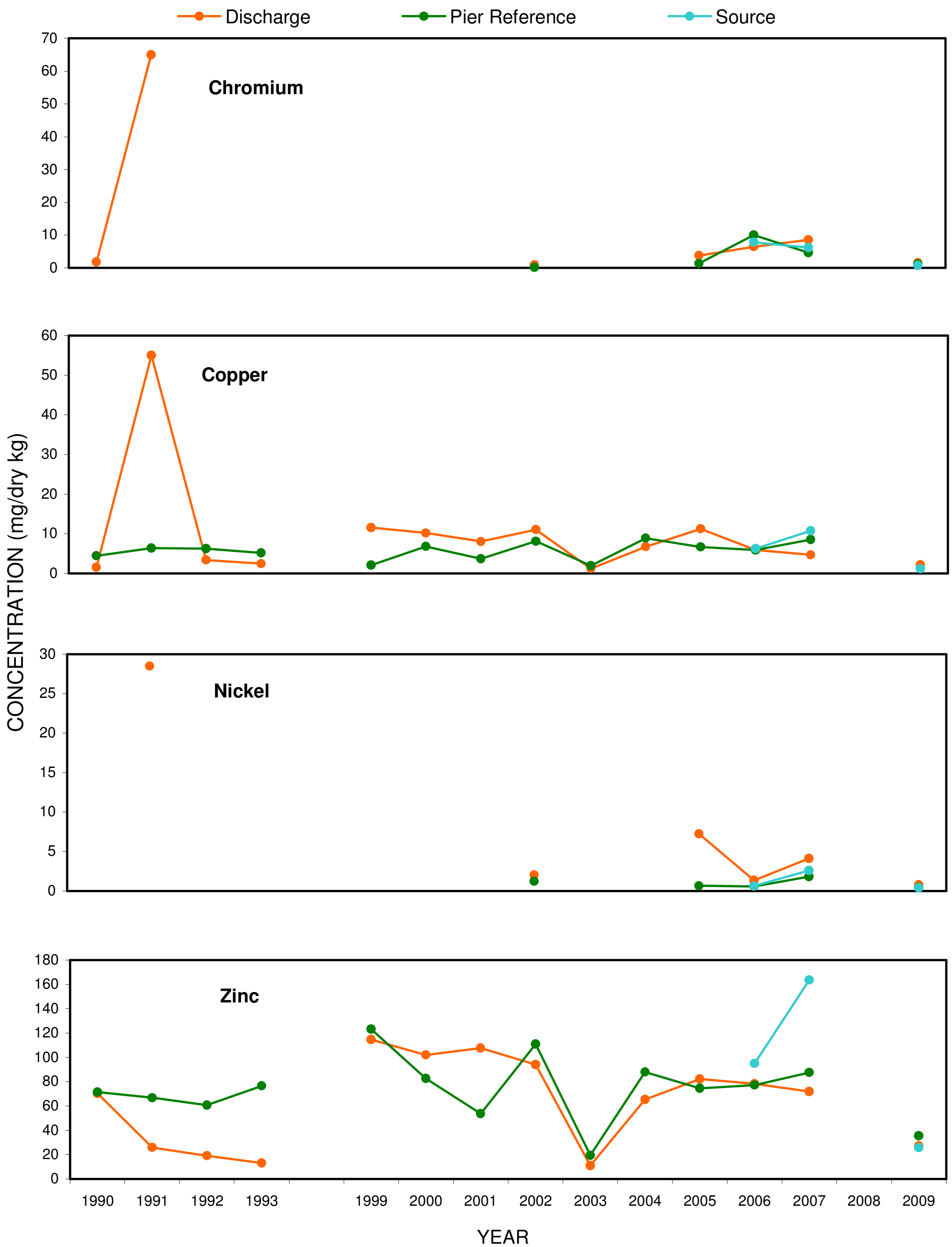
The SMWP monitors levels of metals and organic pollutants in both native California mussels and bay mussels. Bioaccumulation of pollutants by the two species was found to be comparable, although some differences were found between the mussels, likely related to habitat preference (SWRCB 1995, 2000). California mussels are preferentially used for analysis. However, a resident population of mussels is sometimes not available in an area, such as offshore of the Ormond Beach Generating Station. In that case, mussels are transplanted into the area for at least 90 days. All analytical results are reported on a dry weight basis; however, wet weight concentrations were calculated for comparison with evaluation criteria.

Water quality standards for evaluating bioaccumulation in mussel tissues are primarily based on human or animal health criteria, and several standards of comparison are currently available (SWRCB 1995, 2000). However, action levels for only a few organic chemicals have been determined. Because of this, the SMWP developed a method of comparison among samples based on elevated data levels (EDL). The EDL for any particular substance is based on a ranking of statewide tissue levels for that substance from the ongoing SMWP. Elevated data levels are determined for each species and may vary depending on whether the mussels are resident or transplanted. Elevated data levels are updated periodically based on recent data. In the EDL ranking system the 50th percentile corresponds to the median of all values rather than to a mean. The 85th percentile (EDL 85) indicates that a chemical is markedly elevated from the median. The 95th percentile (EDL 95) indicates values that are highly elevated above the median. While no studies have strictly compared these values, this information is useful in determining if a particular substance has been found in unusually high concentrations and in comparing local results to recent statewide results.

Over the last several years of monitoring the availability of resident mussels in the vicinity of the Ormond Beach Generating Station discharge has been inconsistent. Because of this, in 2009 mussels were purchased from a commercial supplier in Carlsbad, California and transplanted to a mooring near the Ormond Beach discharge where the mussels were allowed to acclimate for a period of 133 days, after which the mussels were retrieved and returned to the laboratory for chemical analysis. Results were compared with those from mussels collected at the source site at the time of the transplant and to mussels collected from the Manhattan Beach Pier in Santa Monica Bay, which served as a reference site.

In 2009, all four metals were reported in all mussels tissue replicates from the generating station discharge, in the source mussels, and at the reference site. Chromium levels at the discharge were about twice the values found in source mussels and about one third higher than reference site mussels, but notably lower than levels reported at the discharge in the previous three surveys (Table 4-1 and Figure 4-1). Tissue concentrations of chromium in mussels at the discharge in 2009 were detected at about 20% of the level reported in 2007, and at less than one-half the levels reported in both 2005 and 2006. No analysis for tissue metal concentrations was performed in 2008 as part of the resource exchange for participation in the Bight ‘08 Regional Monitoring Program (MBC 2008a). Previous to 2005, chromium was reported in mussels from the discharge at very low levels in 2002, at an extremely high level in 1991 and at a concentration similar to current levels in 1990 (Figure 4-1 and Figure 4-1; MBC 1990, 1999-2004a, 2005, 2006a, 2007, 2008a; Ogden 1991-1993). The relatively low chromium concentration found in 2009 reverses a trend of annual increases in concentrations reported in mussels from the discharge from 2005 to 2007. During this period, similar chromium concentrations were reported in source and reference mussels as well, with highest concentrations at both sites found in 2006. Like the discharge mussels, chromium levels in source and reference mussels were notably lower than those reported in the previous two years, and among the lowest reported since 1990. Still, as in 2005, 2006 and 2007, wet-weight chromium levels in mussels from the Ormond Beach discharge exceeded the EDL 85 for bay mussels, indicating that chromium was elevated in the study area (Table 4-1). Chromium levels in mussel tissue from the Manhattan Beach Pier reference site were also elevated, exceeding the EDL 85 value for resident California mussels. Wet-weight concentrations of chromium in tissues from the source site did not exceed levels considered elevated by SMWP for bay mussel.

Copper concentrations in mussels from the discharge in 2009 were also lower than reported in recent surveys at a level less than one-half those reported in 2006 and 2007, and less than 20% of the level reported in 2005 (Table 4-1 and Figure 4-1). Copper levels at the discharge



Sampling not required in years not shown. * Mussels not available in 2008.

Figure 4-1. Comparison of mean chromium, copper, nickel, and zinc concentrations in mussel tissue at discharge and at reference sites, 1990 - 2009. Ormond Beach Generating Station NPDES, 2009.

in 2009 were the third lowest found in the area since 1990. Concentrations of copper at the discharge were nearly twice the values found in source mussels, but 40% lower than concentrations reported at the reference site. Wet-weight copper levels at the discharge and at the source sites were below the EDL 85 value for bay mussels, indicating that in 2009 copper concentrations were not elevated in these areas. Copper values at the reference site, however, were highly elevated, at concentrations above the EDL 95 value for native California mussels.

Nickel concentrations in mussels from the discharge in 2009 were the lowest reported in the area, and notably lower than levels found in 2005, 2006 and 2007 (Table 4-1 and Figure 4-1). Previous to 2005, nickel occurred in tissues in 2002, and at very high levels in 1991. Since 2005 nickel has been detected at higher concentrations in mussels from the discharge compared to the source mussels and mussels from the reference site. While this trend occurred again in 2009, the levels at all sites were similarly low compared previous results. Wet-weight concentrations of nickel in mussel tissues from the discharge were below the EDL 85 value for bay mussels indicting that levels were not elevated. Nickel concentrations in mussel tissues collected from the source site and from the reference site were also below levels considered elevated by the SMWP for the respective mussel species.

Zinc concentrations from the discharge area in 2009 were lower than reported since 2003 and the fifth lowest reported in 14 years of monitoring since 1990 (Table 4-1 and Figure 4-1). Zinc levels were similar in discharge and source mussels, both of which were below the concentration found at the reference site. Wet-weight zinc concentrations from the discharge were notably lower than the EDL 85 values for bay mussels, indicating that zinc levels were not elevated near the Ormond Beach discharge. Wet-weight concentrations of zinc at both the source site and the reference site were also below levels considered elevated.

CONCLUSION

In 2009, concentrations of metals decreased from levels reported commonly in previous surveys and were among the lowest reported in mussels from the Ormond Beach discharge. Metal levels were also reduced in source mussels and in mussels from the reference site, and, in general, levels were comparable among the sites. Still, chromium at the discharge and at the reference site exceeded values considered elevated by the State Mussel Watch Program, while copper was found to be highly elevated at the reference site. The similarity of tissue metal levels among sites, to previous studies, and to other areas in southern California suggests that the operation of the Ormond Beach Generating Station is not elevating metal concentrations above background levels.

CHAPTER 5 — BENTHIC INFAUNA

The benthic infauna, invertebrates that live in the bottom sediments, are an important part of the marine ecosystem. These animals are a major food source for fish and other larger invertebrates, and contribute to nutrient recycling. Some species are highly sensitive to effects of human activities, while others thrive under altered conditions. The assessment of the benthic community is, therefore, a major component of many marine monitoring programs, which document both existing conditions and trends over time.

The benthic infaunal community offshore of the Ormond Beach Generating Station has been sampled as part of the NPDES environmental monitoring program since 1978. Benthic samples were collected in both winter and summer from 1978 to 1988, and only in summer since 1990. Six stations were sampled in all surveys except 1998 (only three stations) and 2003 and 2008 (four stations) (Figure 5-1). New in 2006 was inclusion of the Southern California Benthic Response Index (BRI), which was developed to provide a scientifically valid criterion or threshold that can be used to distinguish "healthy" and "unhealthy" benthic communities (Smith et al. 2003, SCCWRP 2009).

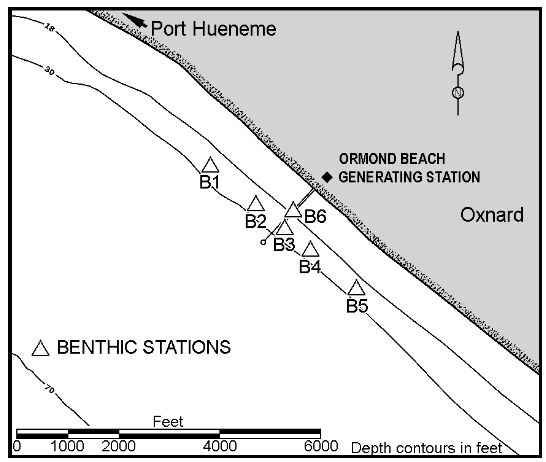


Figure 5-1 Location of the benthic sampling stations. Ormond Beach Generating Station NPDES, 2009.

MATERIALS AND METHODS

Biologist-divers collected sediment cores for analysis of infauna composition at Stations B1 through B6 on 22 July 2009 between 0630 and 0900 hr. Skies were clear with winds from the west at 3 to 5 kn, and seas were from the west at 1 to 2 ft. Four replicate cores were collected at each station using a hand-held, diver-operated box corer (Figure 5-2). The box corer collects a uniform surface area of 100.0 cm^2 to a depth of 10.0 cm for a total sample volume of 1.0 liter. The box corer is pushed into the sediments and a closing blade is swung across the mouth of the box. Upon withdrawal from the sediments, the sample is sealed in the box by a neoprene lid for transport to the surface. Samples were washed in the field using a 0.5-mm U.S. Standard Sieve, labeled, and fixed in buffered 10% formalin-seawater.

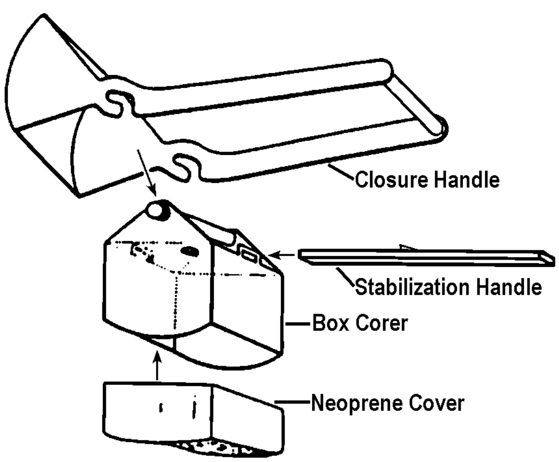


Figure 5-2. Diver-operated box corer used to collect infaunal samples. Ormond Beach Generating Station NPDES, 2009.

In the laboratory, samples were transferred to 70% isopropyl alcohol, sorted to major taxonomic groups, identified to the lowest practical taxonomic level, and counted. Identifications and nomenclature followed the usage accepted by the Southern California Association of Marine Invertebrate Taxonomists (SCAMIT 2008). Representative specimens were added to MBC's reference collection. Following identification, the weight of organisms for each major taxonomic group in each replicate was obtained. Specimens were placed on small, pre-weighed mesh screens that had been immersed in 70% isopropyl alcohol, blotted on a paper towel, and air-dried for five minutes. Large organisms, if any, were weighed separately. Data are presented by station and replicate in Appendix F.

RESULTS

Species Composition. A total of 4,669 individuals in 150 species (or taxa) and 12 phyla (major groups) were taken in the 2009 benthic infauna sampling offshore of the Ormond Beach Generating Station (Table 5-1 and Appendix F-1). Annelids (segmented worms) were the most abundant and diverse phylum, with almost 72% of the individuals and 38% of the species. Nematodes (round worms) were second most abundant, with about 10% of the individuals, but were represented by only one taxon. Arthropods were third most abundant, with 9% of the individuals, and were represented by 27% of the species in the collection. Mollusks (clams and snails), echinoderms (sand dollars and brittlestars), and nemerteans (ribbon worms) were also abundant, comprising almost 6%, 2%, and 2% of the individuals, respectively. Mollusks were represented by 17% of the species, nemerteans by almost 7%, and echinoderms by 4%. Each of the remaining seven phyla comprised less than 1% of the total abundance and was represented by only one or two species each.

Table 5-1. Number of infaunal species and individuals by phylum. Ormond Beach Generating Station NPDES, 2009.

	Station							Percent
Parameter	B1	B2	B3	B4	B5	B6	Total	Total
Number of species								
Annelida	31	35	24	28	33	21	57	38.0
Arthropoda	17	17	12	18	20	10	41	27.3
Mollusca	3	12	13	6	7	8	26	17.3
Nemertea	4	6	4	5	6	3	10	6.7
Echinodermata	1	2	1	3	3	2	6	4.0
Cnidaria	1	1	1	1	1	1	2	1.3
Platyhelminthes	-	-	-	1	1	-	2	1.3
Sipuncula	-	1	-	1	1	-	2	1.3
Brachiopoda	-	-	-	1	-	-	1	0.7
Kinorhynca	-	1	-	-	-	-	1	0.7
Nematoda	1	1	1	-	1	1	1	0.7
Phorona	1	1	-	1	1	-	1	0.7
Total	59	77	56	65	74	46	150	
Number of individuals								
Annelida	729	969	646	337	332	329	3342	71.6
Nematoda	7	9	441	-	4	1	462	9.9
Arthropoda	77	47	36	81	82	104	427	9.1
Mollusca	26	67	34	53	23	54	257	5.5
Echinodermata	4	4	1	34	10	18	71	1.5
Nemertea	16	17	7	11	14	5	70	1.5
Cnidaria	2	1	15	1	2	2	23	0.5
Phorona	2	2	-	1	5	-	10	0.2
Sipuncula	-	1	-	1	1	-	3	0.1
Platyhelminthes	-	-	-	1	1	-	2	0.0
Brachiopoda	-	-	-	1	-	-	1	0.0
Kinorhynca	-	1	-	-	-	-	1	0.0
Total	863	1118	1180	521	474	513	4669	

Species Richness. Species richness averaged 63 species per station (32 species per replicate), and ranged from 46 species at Station B6, inshore of the generating station discharge, to 77 species at Station B2, immediately upcoast of the discharge (Table 5-2). Species richness near the discharge was slightly below the mean for the study area.

Abundance. Abundance averaged 778 individuals per station (a density of 19,454 individuals/m^2) and ranged from 474 individuals at Station B5, farthest downcoast, to 1,180 individuals at Station B3, near the discharge (Table 5-2).

Table 5-2. Infaunal community parameters. Ormond Beach Generating Station NPDES, 2009.

	Station							
Parameter	B1	B2	B3	B4	B5	B6	Total	Mean
Number of species								
Total	59	77	56	65	74	46	150	63
Rep. Mean	32	40	28	30	36	27		32
Rep. S.D.	8	5	4	8	8	3		
Number of individuals								
Total	863	1118	1180	521	474	513	4,669	778
Rep. Mean	216	280	295	130	119	128		195
Rep. S.D.	73	63	193	63	49	50		
Density (Number/m^2)								19,454
Diversity (H')								
Total	2.20	2.27	1.74	2.90	3.12	2.80	3.62	2.51
Rep. Mean	2.09	2.11	1.63	2.59	2.78	2.66		2.31
Rep. S.D.	0.40	0.33	0.47	0.15	0.23	0.23		
Benthic Response Index (BRI)								
Total	22.3	24.8	36.0	20.9	20.4	21.8		24.4
Biomass (g)								
Total	0.70	1.57	1.78	2.18	1.54	1.12	8.89	1.48
Rep. Mean	0.18	0.39	0.45	0.54	0.38	0.28		0.37
Rep. S.D.	0.08	0.20	0.29	0.63	0.07	0.20		
g/m^2								37

Species Diversity. Shannon-Wiener species diversity (H') averaged 2.51 per station and ranged from 1.74 at Station B3 to 3.12 at Station B5 (Table 5-2).

Benthic Response Index. The Southern California Benthic Response Index (BRI) is the abundance-weighted average pollution tolerance of species occurring in a sample. The pollution tolerance scores (p_i) for shallow coastal shelf habitat (10 to 30 m) were used in the computations, even though the stations are shallower than the depth range recommended for application of the index. In addition, the screen mesh size used for sieving the samples from the study area (0.5 mm) was smaller than the mesh size used for the samples from which the BRI was developed. BRI values averaged 24.4 for the study area, and ranged from 20.4 at Station B5 to 36.0 at Station B3 (Table 5-2).

Biomass. Infauna biomass totaled 8.89 g for the survey and averaged 1.48 g per station (37 g/m^2) (Table 5-2). Values ranged from 0.70 g at Station B1, farthest upcoast, to 2.18 g at Station B4, immediately downcoast of the discharge. Annelids contributed 46% to the biomass, a smaller share than their proportion of the abundance. Echinoderms contributed 24% to the biomass, due to the occurrence of a moderately large brittlestar in one replicate at Station B4 and small holothuroids (sea cucumbers) in two replicates at Station B5 (Appendix F-4).

Community Composition. Fourteen species each comprised 1% or more of all individuals collected; together they totaled about 9% of the species but 81% of the individuals in the infauna collection (Table 5-3, Appendix F-2). They included seven annelids, three arthropods, two mollusks,

Table 5-3. The 14 most abundant infaunal species. Ormond Beach Generating Station NPDES, 2009.

		Station							Percent	Cum.
Phylum	Species	B1	B2	B3	B4	B5	B6	Total	Total	Percent
AN	*Apoprionospio pygmaea*	412	566	8	157	133	136	1412	30.24	30.24
AN	*Armandia brevis*	119	81	491	74	13	88	866	18.55	48.79
NT	Nematoda	7	9	441	-	4	1	462	9.90	58.68
AN	*Chone eiffelturris*	90	123	6	7	67	7	300	6.43	65.11
AN	*Mediomastus acutus*	26	41	2	29	18	16	132	2.83	67.94
MO	*Siliqua lucida*	10	22	3	20	6	24	85	1.82	69.76
MO	*Tellina modesta*	13	22	1	27	5	16	84	1.80	71.56
AN	*Spiophanes bombyx*	15	17	1	7	14	24	78	1.67	73.23
AR	*Photis macinerneyi*	9	8	1	11	12	24	65	1.39	74.62
AR	*Ampelisca agassizi*	19	4	-	7	29	3	62	1.33	75.95
AN	*Pectinaria californiensis*	3	44	-	4	-	10	61	1.31	77.25
AR	*Diastylopsis tenuis*	5	6	6	8	7	29	61	1.31	78.56
AN	*Notomastus tenuis*	-	-	60	-	-	-	60	1.29	79.85
EC	*Dendraster excentricus*	4	2	-	31	7	15	59	1.26	81.11

AN = Annelida; EC = Echinodermata; AR = Arthropoda; MO = Mollusca; NT = Nematoda

one nematode, and one echinoderm species. The polychaete annelid *Apoprionospio pygmaea* was the most abundant species overall, comprising 30% of all individuals collected. It was found at all six stations, although it was most abundant at Station B2 and least abundant at Station B3. Second most abundant was the polychaete *Armandia brevis*, which was most abundant at Station B3. Third most abundant were nematodes, which also were very abundant at Station B3 but were scarce or absent elsewhere. The annelids *Chone eiffelturris*, *Mediomastus acutus*, *Spiophanes bombyx*, and *Pectinaria californiensis*, the clams *Siliqua lucida* and *Tellina modesta*, the amphipods *Photis macinerneyi* and *Ampelisca agassizi*, and Pacific sand dollars (*Dendraster excentricus*) were moderately abundant and were scarce at or absent from Station B3, while the annelid *Notomastus tenuis* was present only at that location.

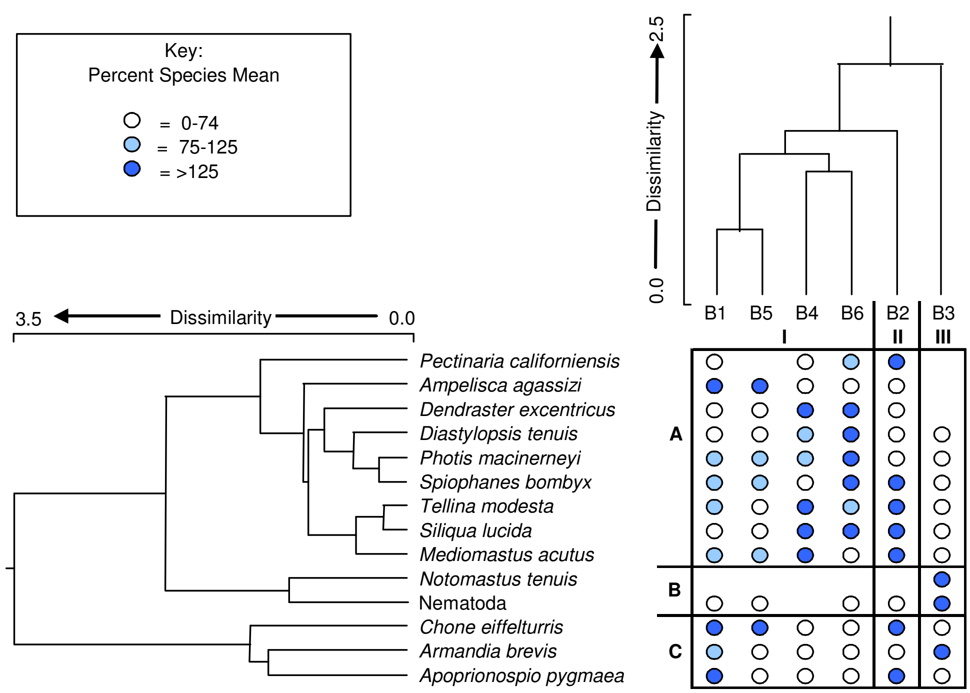


Figure 5-3. Two-way coincidence table resulting from normal (station) and inverse (species) classification dendrograms for the 14 most abundant infaunal species. Ormond Beach Generating Station NPDES, 2009.

Cluster Analyses. The 14 most abundant species were used for the normal (site-group) and inverse (species-group) cluster analyses (Figure 5-3). Stations B1 and B5 clustered most closely, indicating greatest similarity of their communities. Abundances of *Chone eiffelturris* and *Ampelisca agassizi* were higher than average at these two stations, while those of many other abundant species were below average. The communities were moderately similar between Stations B4 and B6, due to comparable abundances of several species. These four stations formed Station Group I. Station B2 (Group II) clustered with Group I; the community at that station contained the same dominant species as those in Group I, but several species (*Apoprionospio pygmaea*, *Chone eiffelturris*, *Pectinaria californiensis*, and *Mediomastus acutus*) were most abundant there. The community at Station B3 (Group III) was least like those at the other stations, and it clustered somewhat distantly with the other groups. *Armandia brevis* and nematodes were very abundant there, while *A. pygmaea* and several other species were either not abundant or not present.

The most abundant species clustered into three groups, based on their occurrences (Figure 5-3). Group A included species that were most abundant at Station B2 as well as moderately abundant at stations in Group I. Group B included the two species that were most abundant at Station B3 and scarce or absent elsewhere. Group C included the three most abundant species that occurred at all of the stations. Groups A and B clustered somewhat distantly, while Group C clustered quite distantly with the other two groups.

DISCUSSION

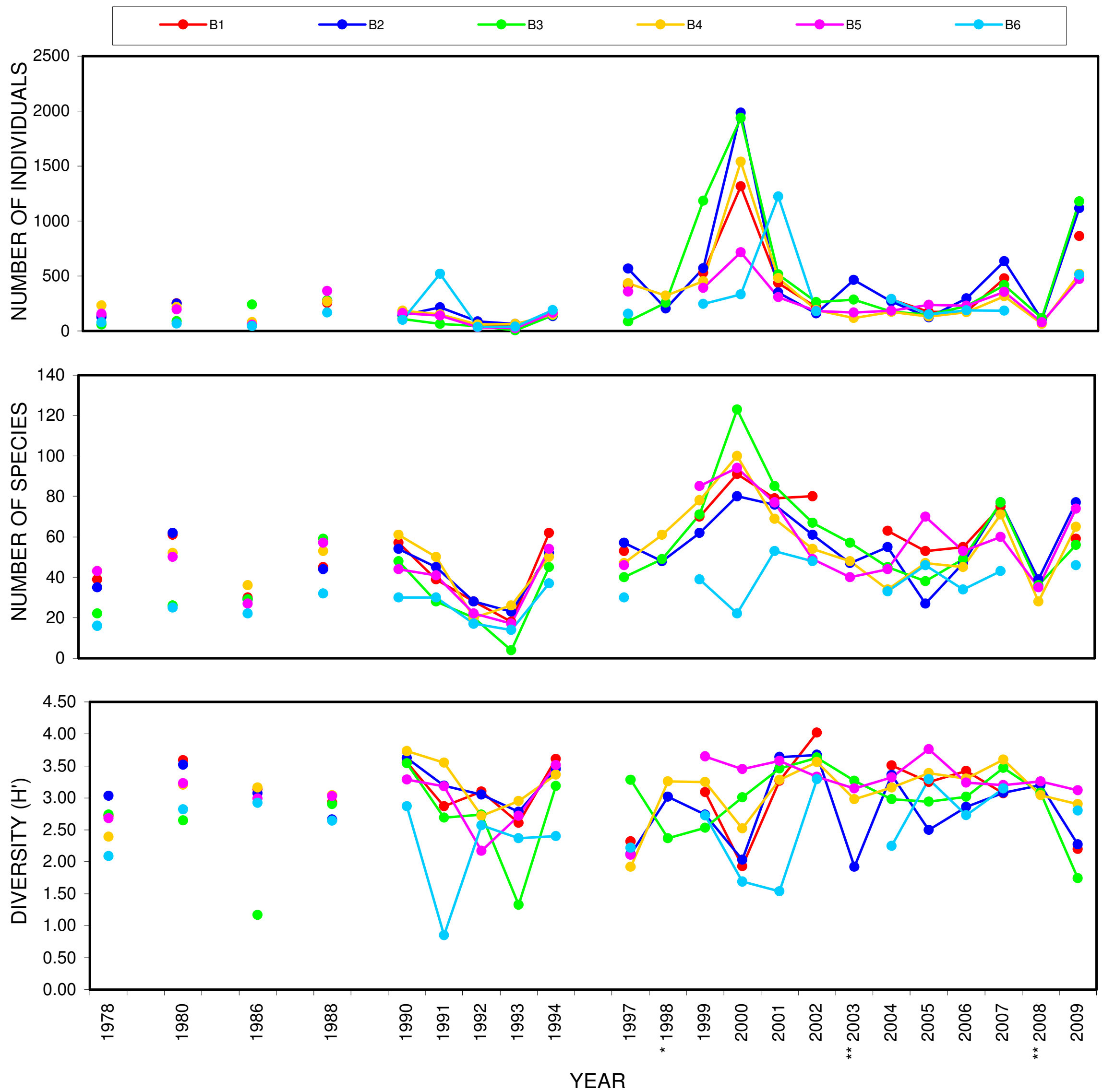
The infauna communities in the study area in 2009 were composed predominantly of small annelid worms, arthropods, clams; nematode worms were very abundant at one location, near the discharge. The community near the discharge also differed from those elsewhere in having high numbers of *Armandia brevis* but low numbers of *Apoprionospio pygmaea* and several other species that were the community dominants at the other stations. Community composition was comparable among the other five stations, with the communities farthest upcoast and downcoast of the generating station being most alike. Abundance was highest near the generating station, but species richness was below the study area mean; species diversity was quite low due to the low species richness and numerical dominance of the community by *A. brevis* and nematodes. Abundance was also much higher than average immediately upcoast of the discharge; however, species richness was highest there, while species diversity was moderately low due to the high numbers of *A. pygmaea* and *Chone eiffelturris*. Except for the high abundances of those two species, the community was somewhat similar to those every where, except near the discharge. Abundance was below average inshore of the discharge, and species richness was lowest there, but species diversity was above average as the community was not strongly dominated by a single species. Species diversity was highest farthest downcoast because abundance was lowest there and species richness was moderately high. All of the abundant species found in the study area are typical of sandy habitats on the shallow coastal shelf. The Benthic Response Index values for most of the stations were low, within the range of 0 to 25 (Reference category), indicating that the communities were undisturbed, or healthy. However, the value for the station near the discharge was at the lower end of the range of Response Level 2, suggesting some loss of biodiversity (in other words, at least 25% of the pool of species found in reference, or healthy samples, did not occur). Appendix F-5 shows that almost one-half of the species found at the other stations were absent from the discharge area.

Composition of the infauna community reflects the substrate in which it lives (Gray 1974). Particle size and sorting affect sediment stability and cohesiveness, influencing the ability of infaunal animals to burrow. The coastline at the Ormond Beach Generating Station is exposed to swell from both the south and west, and the nearshore subtidal sediments are strongly affected by both storms and normal wave activity. Sediments are relatively coarse, due to the winnowing effect of moving water, and there is little organic matter. Generally, nearshore sand faunas tend to be impoverished when compared to siltier offshore sands (Barnard 1963). Infaunal parameters in 2009 appeared to be only somewhat related to sediment grain-size characteristics. Abundance was high and species richness was highest where sediments were finest, immediately upcoast of the discharge, but highest abundance was found where sediments were coarsest, near the discharge. In addition to being coarse, sediments at that location were the most poorly sorted, with an enormous amount of mussel (*Mytilus*) shells that had been ejected from the discharge.

Species occupying the nearshore habitat are adapted to the relatively coarse sediments and to nearly constant disruption of the substrate (Oliver et al. 1980). Although small, these organisms are capable of reburying themselves quickly after the upper layers of sediment in which they live are disturbed by a passing wave or swell, or they tend to burrow deeper into the sediment and are therefore less affected by disturbance. Many of these species' life history strategies, including frequent and abundant production of young, also allow them to rapidly repopulate a habitat severely disrupted during winter storms. When conditions are calm, the environment is more stable and finer sediments accumulate, in which deposit-feeding species, such as some annelids and amphipods, can live in permanent tubes (Barnard 1963, Oliver et al. 1980). The efficient burrowers abundant in the infauna communities in 2009 included foremost *Armandia brevis* and nematodes, most numerous where sediments were coarsest, as well as the clams *Siliqua lucida* and *Tellina modesta*, and the cumacean *Diastylopsis tenuis*, an efficient swimmer.

Parameters for the infauna communities in 2009 were somewhat similar to those found in previous summer surveys conducted in the study area since 1978 (MBC 1979, 1981, 1986, 1988, 1990, 1994, 1997-2004a, 2005, 2006a, 2007, 2008a; Ogden 1991-1993). However, mean abundance was more than four times that in 2008, and was higher than in all other years except 1997 and 2000 (Appendix F-5). The high abundances in those years were due to extremely high numbers of nematodes near the discharge in 1997, and high numbers of the annelid *Owenia collaris* at most of the stations in 2000 (in Figure 5-4, nematodes have been excluded from the total count for the discharge station in 1997). Excluding those individuals, abundance has, on average, been highest immediately upcoast of the discharge. However, it was highest near the discharge in both 2008 and 2009. Almost twice as many species were collected in 2009 as in 2008, due in part to the smaller number of stations sampled during the Bight-wide monitoring in 2008. Mean species richness per station was considerably greater than average, and was greater than in all but two years, 2000 and 2007. On average, species richness has been similar among stations along the same isobath, even though sediments have been coarser at the discharge than elsewhere in the study area. Richness has usually been lowest inshore of the discharge, as it was in 2009 (not sampled in 2008). Because of the unusually high abundance in 2009, mean species diversity was below that in both 2008 and the long-term mean. On average, species diversity has been highest farthest downcoast, due to consistently low abundance and near-average species richness. It was highest at that location in 2009 also. The diversity value for the community near the discharge was lower in 2009 than in all previous surveys except 1993, when only four species were collected at that location. The BRI values in 2009 were greater than those in 2008 and also greater than the mean since 2006, the first year that the index was used. The value for the discharge area was the highest found so far, and was the only value to exceed the threshold for Reference Level (undisturbed). The occurrence of high values for abundance, species richness, and BRI in 2009 is similar to the situation seen upcoast offshore of the Mandalay Generating Station, where values in 2009 were also much greater than average. However, this phenomenon was not seen offshore of other generating stations to the south.

Composition of the infaunal community in the study area in 2009 was similar to those in prior surveys. Six of the seven most abundant species have been among the 10 most abundant species occurring in the study area since 1978, and 13 species abundant in 2009 were among the 32 long-term community dominants (Appendix F-5). The Index of Relative Importance and Spearman rank correlation indicate that the communities have been similar among years,



No sampling required in years not shown; * 1998 - only three stations required; ** 2003 and 2008 only four stations required.

Figure 5-4. Comparison of infaunal community parameters 1978 - 2009, summer surveys. Ormond Beach Generating Station NPDES, 2009.

particularly from 2005 to 2009 (Appendix F-6). Greatest similarity was seen between the community in 2002 and that in 2006. The community in 2009 was most similar to that in 2007. The abundant species most consistent in occurrence have been *Apoprionospio pygmaea*, *Diastylopsis tenuis*, *Mediomastus acutus* (one of a group of species recently split from each other), *Tellina modesta*, *Rhepoxynius menziesi*, *Spiophanes bombyx*, and *Carinoma mutabilis*. Conversely, a few species have been quite variable in abundance from survey to survey. In addition to nematodes and *Owenia collaris*, mentioned above, Pacific sand dollar, *Armandia brevis*, *Siliqua lucida*, *Pectinaria californiensis* and another annelid *Magelona sacculata*, *Photis macinerneyi* and other amphipods such as *Aoroides inermis*, *Jassa slatteryi*, and *Ericthonius brasiliensis*, the ostracod *Euphilomedes longiseta*, and the southern moonsnail hermit crab, *Isocheles pilosus,* have occurred only sporadically but occasionally have been very abundant. About one-half of these species were scarce or absent in 2009. Overall, however, the majority of the abundant infauna species seen in 2009 have been part of a core group that has persisted in the study area, resembling communities found in similar shallow-water habitats throughout the Southern California Bight (Barnard 1963, Dexter 1978, Oliver et al. 1980).

CONCLUSION

Abundance, species richness, diversity, and composition of the infauna communities in 2009 were similar among most of the stations near the Ormond Beach Generating Station. The community near the discharge was somewhat different from those elsewhere, with very high abundance due to large numbers of two species, *Armandia brevis* and nematodes, and few *Apoprionospio pygmaea*, the typically dominant species, which was abundant at all of the other stations. The pattern of infaunal values appeared to be only somewhat influenced by sediment characteristics. Abundance was quite high and species richness was highest where sediments were finest, as might be expected, but near the discharge, where abundance was highest, sediments were coarsest, although they were also poorly sorted. The BRI value for the discharge area was the highest seen so far for the study area; it was high enough to suggest some disturbance of the community at that location that resulted in a minor loss of biodiversity. The only obvious difference in habitat from those elsewhere was the coarseness of the sediment and the presence of considerable mussel-shell debris. Values at the other stations indicated the communities were undisturbed, or healthy. The communities were similar to those found in the study area since 1978, and were typical of the shallow, nearshore environment. Other than the localized difference in community dominants, no effects of the generating station discharge were apparent.

CHAPTER 6 — IMPINGEMENT

Once through cooling water systems are commonly used by electric power generating stations sited adjacent to large water bodies (e.g., lake, river, bay, coastal ocean). Such systems may potentially entrap organisms present in the source water entrained into the cooling system. Cooling water is typically screened prior to entering the condensers to remove material that may interfere with the proper operation of the system.

Ormond Beach Generating Station is located approximately 3.7 km southeast of the entrance to Port Hueneme in Ventura County, California. The facility withdraws seawater through a submerged, velocity-capped intake structure located 640 m offshore at a depth of -10 m Mean Low Lower Water (MLLW). Water enters through a riser standing 2 m above the bottom. Seawater was screened by bar racks to remove large debris followed by mesh traveling screens that remove the remaining material. Material, including fish and macroinvertebrates, impinged on the screens was washed off the screens into collection baskets. Impingement sampling was conducted by Proteus Sea Farms International, Inc. (Ojai, California). This report summarizes these observations and subsequent analysis over the monitoring period to determine the interaction between the operation of the cooling water system and the general assemblage and stability of the source water community.

MATERIALS AND METHODS

Proteus Sea Farms International, Inc. conducted all field data collection and transmitted the data sheets to MBC Applied Environmental Sciences for entry and analysis. No heat treatments were monitored during the 2009 monitoring year (1 October 2008 to 30 September 2009). Total impingement at the facility was monitored monthly during normal operation of the cooling water system, usually over 24 hours. During these surveys, the traveling screens and collection baskets were cleared of all accumulated debris at the start of the sampling period. At the end of the survey period all accumulated material was processed. Up to 50 individuals of each fish species were measured to the nearest millimeter (mm) standard length (SL) or other appropriate length (disc width [DW] or total length [TL]), aggregate biomass (kg) was recorded for all measured and unmeasured individuals. Total abundance for species with greater than 50 individuals was estimated by dividing the total weight of the unmeasured individuals by the mean weight of the measured individuals of that species. Macroinvertebrates were also sorted to the lowest possible taxonomic category, counted and an aggregate weight (kg) taken. Individual fish lengths were rounded to the nearest 10 mm, (i.e., 35-44 mm SL = 40 mm SL). Abundance per size class was plotted.

Due to variation in daily operating patterns, all normal operation survey fish and macroinvertebrate data was extrapolated over reported circulated water volumes, in millions (10^6) of gallons, to determine the estimated monthly impingement by the equation: Estimated Impingement = (Abundance/Survey water volume) x Analysis Period water volume. Annual abundances represent the summation of all estimated impingement abundances. Biomass values were analyzed in the same fashion.

RESULTS

Nine normal operation surveys were conducted at the Ormond Beach during the 2009 monitoring year. No heat treatments were conducted during this period. Complete survey data is presented in Appendix G.

Fish

An estimated total of 786 fish weighing 349.28 kg representing 21 species were impinged at Ormond Beach in 2009 (Table 6-1). Bay pipefish (*Syngnathus leptorhynchus*) was the most abundant species with an estimated 135 individuals followed by 133 speckled sanddab (*Citharichthys stigmaeus*), 57 northern anchovy (*Engraulis mordax*), 57 Pacific staghorn sculpin (*Leptocottus armatus*), and 52 unidentified pipefish (*Syngnathus* spp). Combined, these five species accounted for 55% of the total abundance. Each of the remaining 16 species accounted for less than 6% of the total abundance, or 352 fish all together. Biomass was principally influenced by four cartilaginous fishes which, together, contributed 95% to the biomass. Pacific electric ray (*Torpedo californica*) was first with 251.43 kg followed by bat ray (*Myliobatis californica*; 33.15 kg), horn shark (*Heterodontus francisci*; 23.32 kg), and thornback (*Platyrhinoidis triseriata*; 23.30 kg). The remaining 14 species combined accounted for less than 18.08 kg.

Table 6-1. Estimated abundance and biomass (kg) of fish species impinged during normal operation surveys. Ormond Beach Generating Station NPDES, 2009.

	Observed		Estimated		% Total	
Species	Abu.	Biom. (kg)	Abu.	Biom. (kg)	Abu.	Biom. (kg)
bay pipefish	7	0.019	135	0.36	17	<1
speckled sanddab	7	0.023	133	0.44	17	<1
northern anchovy	3	0.052	57	0.99	7	<1
Pacific staghorn sculpin	3	0.116	57	2.21	7	1
pipefish unid	10	0.027	52	0.14	7	<1
thornback	3	1.369	43	23.30	5	7
white seaperch	2	0.163	38	3.11	5	1
horn shark	2	1.299	36	23.32	5	7
Pacific electric ray	2	17.443	26	251.43	3	72
bat ray	1	1.739	19	33.15	2	9
California tonguefish	1	0.037	19	0.71	2	<1
kelp bass	1	0.106	19	2.02	2	1
Pacific sardine	1	0.013	19	0.25	2	<1
pygmy poacher	1	0.002	19	0.04	2	<1
specklefin midshipman	1	0.006	19	0.11	2	<1
white seabass	1	0.021	19	0.40	2	<1
basketweave cusk-eel	1	0.043	17	0.74	2	<1
shiner perch	1	0.005	17	0.09	2	<1
diamond turbot	1	0.270	16	4.23	2	1
queenfish	3	0.101	16	0.52	2	<1
plainfin midshipman	2	0.331	10	1.72	1	<1
Total Abundance	54	23.185	786	349.28		
Number of Species	21		21			

Length Frequency Analysis

Impinged speckled sanddab represented four 10-mm size classes, with one individual in the 50-mm SL size class and two, each, in the 70-, 80-, and 90-mm SL size classes (Figure 6-1a). The impinged bay pipefish represented five size classes, with one individual in each of the 180-,

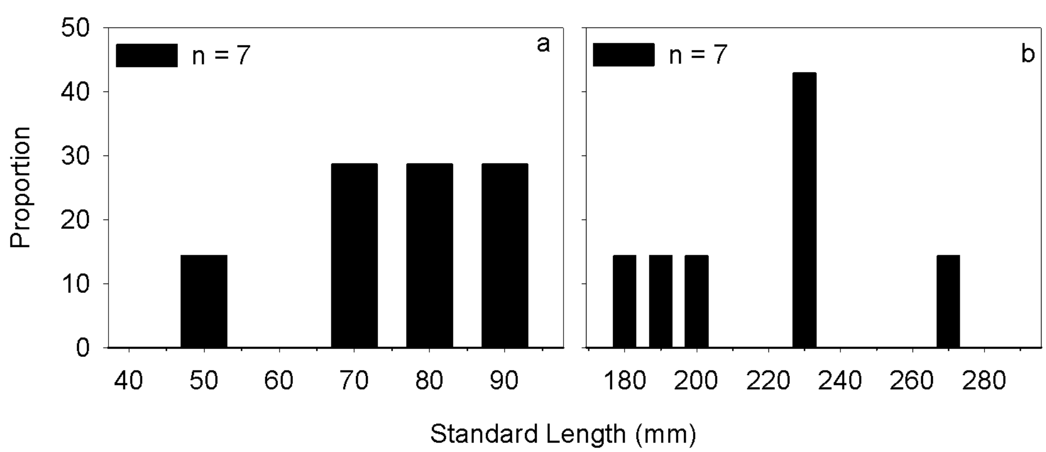


Figure 6-1. Length frequency distribution of a) speckled sanddab and b) bay pipefish impinged during normal operation surveys. Ormond Beach Generating Station NPDES, 2009.

190-, 200-, and 270-mm SL size classes (Figure 6-1b). Three individuals represented the 230-mm SL size class.

Macroinvertebrates

An estimated 5,559 macroinvertebrates weighing 252.34 kg and representing 10 species were impinged in 2009 (Table 6-2). Four species accounted for 88% of the annual abundance. These included: 1,925 blackspotted bay shrimp (*Crangon nigromaculata*), 1,386 yellow crab (*Metacarcinus anthonyi*), 972 Pacific rock crab (*Romaleon antennarius*) , and 587 Xantus swimming crab (*Portunus xantusii*). The remaining six species contributed an additional 689 individuals. Ninety percent of the biomass was comprised of the combination of yellow crab (126.03 kg), Pacific rock crab (81.84 kg), and purple-striped jellyfish (*Chrysaora colorata*; 19.21 kg). The remaining seven species, combined, accounted for 25.26 kg.

Table 6-2. Estimated abundance and biomass (kg) of macroinvertebrate species impinged during normal operation surveys. Ormond Beach Generating Station NPDES, 2009.

	Observed		Estimated		% Total	
Species	Abu.	Biom. (kg)	Abu.	Biom. (kg)	Abu.	Biom. (kg)
blackspotted bay shrimp	122	0.421	1,925	6.71	35	3
yellow crab	94	9.017	1,386	126.03	25	50
Pacific rock crab	68	5.454	972	81.84	17	32
Xantus swimming crab	32	0.157	587	2.73	11	1
red rock shrimp	18	0.055	375	1.15	7	<1
California two-spot octopus	8	0.278	174	6.10	3	2
red rock crab	5	0.517	71	7.08	1	3
California market squid	2	0.071	38	1.35	1	1
purple-striped jellyfish	1	0.903	21	19.21	<1	8
graceful crab	1	0.015	10	0.14	<1	<1
Total Abundance	351	16.888	5,559	252.34		
Number of Species	10		10			

DISCUSSION

Fish impingement in 2009 was among the lowest recorded since 1990, but consistent with the lower abundances recorded over the last two years (Figure 6-2). No heat treatments have been conducted since 2005, which has resulted in substantially lower annual impingement. Cooling water volume has remained similarly low during this time, in comparison to earlier in the decade. Estimated normal operation impingement generally followed cooling water flow volumes due to the inherent correlation between the two, as flow volumes are included in the estimate equation. Queenfish was historically the most abundant species impinged but it has been relatively absent since 2005. While the lack of heat treatments may contribute to this decline in queenfish impingement abundance, queenfish across most of the Southern California Bight has markedly declined since 1980 (Miller et al. 2009). Of those species impinged in 2009, only bay pipefish has recently increased in abundance in relation to its historic numbers, although fewer were impinged in 2009 than in 2008 (MBC 2008a). Bay pipefish were not recorded in annual surveys at Ormond Beach from 1990 through 2001, with the first collection made during the 2002 sampling year. Since then, they have been regularly collected in varying abundances each year, including ranking first in overall abundance in annual totals from 2007 to 2009. All of the fish impinged in 2009 were common to the Southern California Bight (Love et al. 2005, Allen and Pondella 2006).

Three species of pipefish commonly occur throughout the nearshore waters of southern California, including; bay pipefish (*S. leptorhynchus*), kelp pipefish (*Syngnathus californiensis*), and barcheek pipefish (*S. exilis*) (Love et al. 2005). As a group, these three species generally range from at least central Baja California, Mexico to northern California, with varying depth ranges (Love et al. 2005). Eschmeyer et al. (1983) noted that bay pipefish commonly inhabit eelgrass beds within bays,

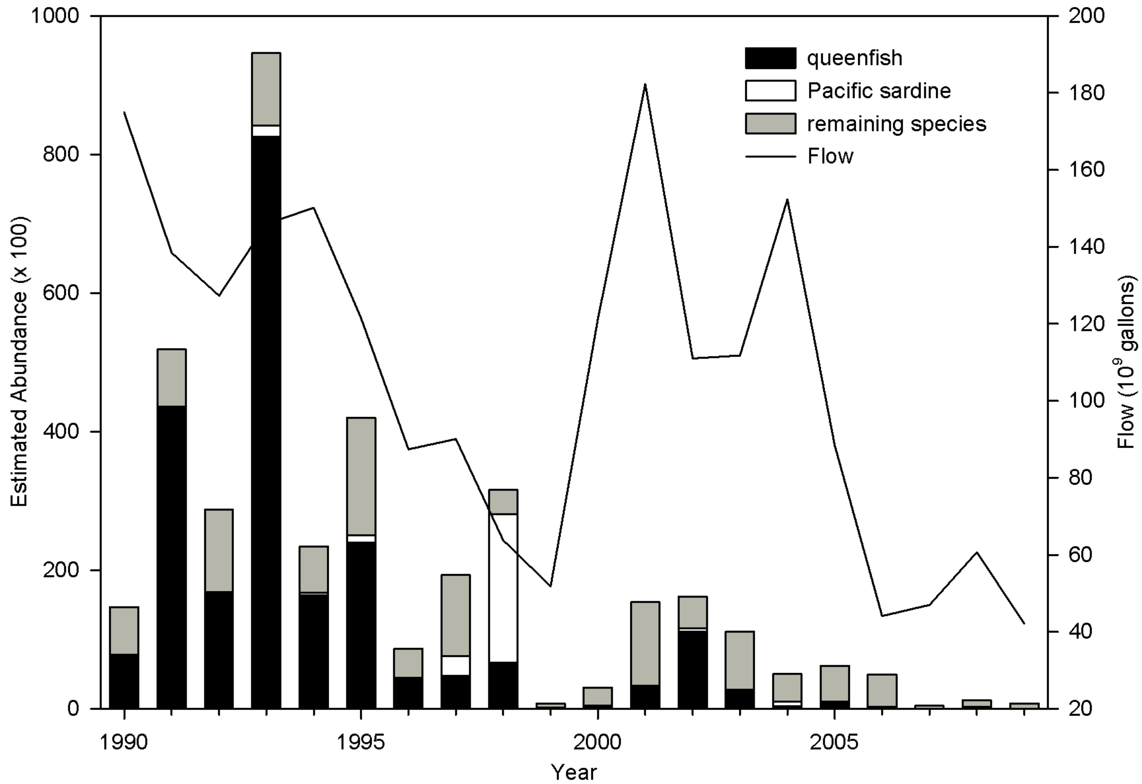


Figure 6-2. Total annual abundance of queenfish, Pacific sardine, and all remaining species impinged during heat treatments and normal operations, 1990-2009. Ormond Beach Generating Station NPDES, 2009.

harbors, and estuaries within southern California. Pipefish, typically kelp or bay, commonly occur during impingement sampling, especially at facilities withdrawing from bays or harbors (MBC 2006b,c). Barcheek pipefish has been uncommon in impingement sampling from Ventura through Northern San Diego County. Bay pipefish life history information is generally scarce, but they frequently live two years to a maximum size of 385 mm TL, indicating that those impinged at Ormond Beach Generating Station were one-year-old, or less.

Speckled sanddab is commonly taken during otter trawl surveys throughout the Southern California Bight, including Ventura County (MBC 2008b-d). During the most recent Bight-wide assessment, speckled sanddab was the second most abundant species of all fishes collected in the 2 - 276-m depth region (Allen et al. 2007). Their abundance was largely limited to the inner shelf (2 - 30 m) where trawls conducted in 96% of the available habitat resulted in a speckled sanddab observation. They are, however, less abundant in impingement sampling where they are commonly observed in low numbers. A non-schooling species, speckled sanddab is associated with soft-bottom habitats throughout the shallow nearshore environment of southern California (Allen 1982, Allen 1985). They feed mainly during the day, hunting primarily by sight on epifaunal invertebrates (Ford 1965, Allen 1982). Because of their small size, they are not an important part of the commercial catch, although they are present in some of the landings, and are frequently sought by recreational anglers (Allen and Leos 2001). Attempts to age individuals are difficult, but at 120 mm SL they may be about two years old, maturing at one year old, with a life span of approximately four years (Fitch and Lavenberg 1975). The majority of individuals taken in 2009 were less than one year old, based on Fitch and Lavenberg (1975).

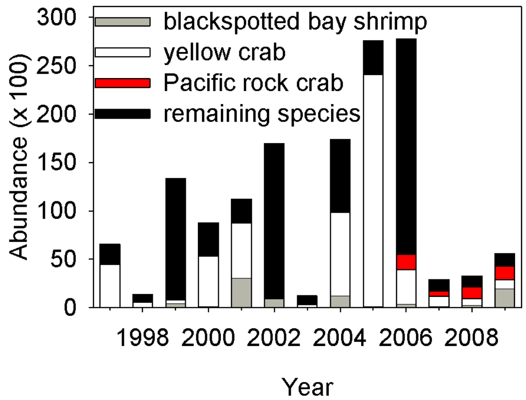


Figure 6-3. Total annual abundance of blackspotted bay shrimp, yellow crab, Pacific rock crab, and all remaining macroinvertebrate species impinged during heat treatments and normal operations, 1997-2009. Ormond Beach Generating Station NPDES, 2009.

Macroinvertebrate abundance in 2009 was slightly higher than that reported in 2007 and 2008, but well below abundances reported in 2004 through 2006 (Figure 6-3). In 2009, the historically core species group, yellow crab and Pacific rock crab, were taken in relatively high abundances, but both occurred in fewer numbers than blackspotted bay shrimp. All three species have occurred previously, although yellow crab has typically been the most abundant of the three. Overall, many of the macroinvertebrate species impinged at the station may live in and on the pipes of the cooling water intake structure, while others, such as jellyfish, are drawn from the water column. Intake flows bring larvae of some species that, once entrained, can settle and grow within the conduits. These fouling communities are typically composed primarily of mollusk and arthropod species common to the area. With an ample food supply brought in with the cooling water, individuals may survive within the cooling water system until the community is removed during a heat treatment (Graham et al. 1977). With regular heat treatments most individuals taken are a similar age and are generally found at a small size, corresponding to growth of newly settled individuals during the time period between heat treatments. When heat treatments are infrequent, however, somewhat larger individuals may occur in impingement sampling, as observed for yellow crab and red rock crab in 2009, when mean biomass of both species exceeded 0.08 kg. The mean size in 2009 exceeded that reported in 2008, also with no heat treatments conducted, and nearly tripled the mean biomass reported in 1998 (0.03 kg) when four heat treatments were conducted. Parker (2001) reports each rock crab species to prefer differing habitats: yellow crab prefer open sand and soft bottom habitat while Pacific rock crabs are more common near rocky reefs. Both species, however, have supported a commercial fishery, collectively landed as “rock crab,” since at least 1926. Their commercial landings began to appreciably increase after 1950, peaking in the mid-1980s.

CONCLUSION

Overall, fish species impinged in 2009 were similar to those collected in recent previous surveys, but were less abundant than recorded in most surveys since 1990. The decline in queenfish, a core member of the impinged assemblage at Ormond Beach Generating Station, mirrored a wider decline throughout the Southern California Bight. Macroinvertebrate composition in 2009 was generally similar to previous years, although abundances were also below average. The similarity of species composed primarily of frequently occurring and long-term dominant species indicates a nearshore assemblage typical of southern California regulated by natural processes.

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APPENDIX A

Receiving water monitoring specifications

V. RECEIVING WATER MONITORING

A. Receiving Water

1. Pursuant to the Code of Federal Regulations [40 CFR § 122.41(j) and §122.48(b)], the monitoring program for a discharger receiving a NPDES permit must determine compliance with NPDES permit 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., nonpoint source runoff, aerial fallout) nor to evaluate the current status of important ecological resources on a regional basis.

B. Regional Database

1. 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.

2. Two pilot regional monitoring programs were conducted; one during the summer of 1994 and another in 1998. The purpose of the pilot programs were to test an alternative sampling design that combines elements of compliance monitoring with a broader regional assessment approach. The pilot program was designed by USEPA, the State Board, and three regional Boards (Los Angeles, Santa Ana, and San Diego) in conjunction with the Southern California Coastal Water Research Project and participating discharger agencies.

   The pilot regional monitoring programs included the following components: microbiology; water quality; sediment chemistry; sediment toxicity testing; benthic infauna; demersal fish; and bioaccumulation.

3. The two pilot regional monitoring programs were funded primarily by resource exchanges with the participating discharger agencies. During the year when the pilot regional monitoring was scheduled, USEPA and this Regional Board eliminated portions of the routine compliance monitoring programs for that year, while retaining certain critical compliance monitoring elements. A certain percentage of the traditional sampling sites were also retained to maintain continuity of the historical record and to allow comparison of different sampling designs. The exchanged resources were redirected to complete sampling within the regional monitoring program design. Thus, the Discharger's overall level of effort for the 1994 and 1998 pilot programs remained approximately the same as the compliance monitoring programs.

4. Given the apparent benefits realized by the first two regional monitoring programs, it is probable that similar comprehensive sampling efforts will be repeated for the California Bight at periodic intervals (perhaps every four or five years). At the present time, it appears likely that the next regional monitoring program will be attempted during the summer of 2002 - 2003.

5. We anticipate that future regional monitoring programs will be funded in a similar manner. Revisions to the routine compliance monitoring program will be made under the direction of the USEPA and this Regional Board as necessary to accomplish this goal; and may include resource exchanges in the number of parameters to be monitored, the frequency of monitoring, or the number, type, and location of samples collected.

6. The compliance monitoring programs for the Mandalay Generating Station, and other major ocean dischargers will serve as the framework for the regional monitoring program. However, substantial changes to these programs may be required to fulfill the goals of regional monitoring, while retaining the compliance monitoring component required to evaluate the potential impacts from NPDES discharges. Revisions to the existing program will be made under the direction of the USEPA and this 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.

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 water which may be impacted by the discharge.

Location of Sampling Stations (see Attached Figure 1):

1. Receiving water stations in the surf zone shall be located as follows:

   a. Station RW1 – 3000 feet upcoast of the discharge terminus, at a depth of 30 feet.

   b. Station RW2 - 1000 feet upcoast of the discharge terminus, at a depth of 30 feet.

   c. Station RW3 - At the point of discharge.

   d. Station RW4 - 1000 feet downcoast of the discharge terminus, at a depth of 30 feet.

   e. Station RW5 - 3000 feet downcoast of the discharge terminus, at a depth of 30 feet.

   f. Station RW6 – along the centerline of the discharge conduit, at a depth of 20 feet.

   g. Station RW7 – along the centerline of the discharge conduit, at a depth of 40 feet.

h. Station RW8 – 7,920 feet downcoast of the discharge terminus, at a depth of 30 feet.

i. Station RW9 – 7,920 feet upcoast of the discharge terminus, at a depth of 30 feet.

2. Benthic stations shall be located as follows:

   Stations B1 through B6 shall be located directly beneath Stations RW1 through RW6, respectively.

D. Type and Frequency of Sampling:

1. Temperature profiles shall be measured semiannually (summer and winter) each year at Stations RW1 through RW9 from surface to bottom at a minimum of one-meter intervals. Dissolved oxygen levels and pH shall be measured semiannually at least at the surface, mid-depth and bottom at each station. All stations shall be sampled during both a flooding tide and an ebbing tide during each semiannual survey.

2. Impingement sampling for fish and commercially important macroinvertebrates shall be conducted at least once every two months at Intake Serial 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 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 collected. When large numbers of given species are collected, length/weight data need only be recorded for 50 individuals and total number and total weight may be estimated based on aliquots samples. Total fish impinged per heat treatment or sampling event shall be reported and data shall be expressed per unit volume water entrained.

3. Native California mussels (Mytilus Californianus) 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.

6. Benthic sampling shall be conducted annually during the summer at Stations B1 through B6.

   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 an 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.

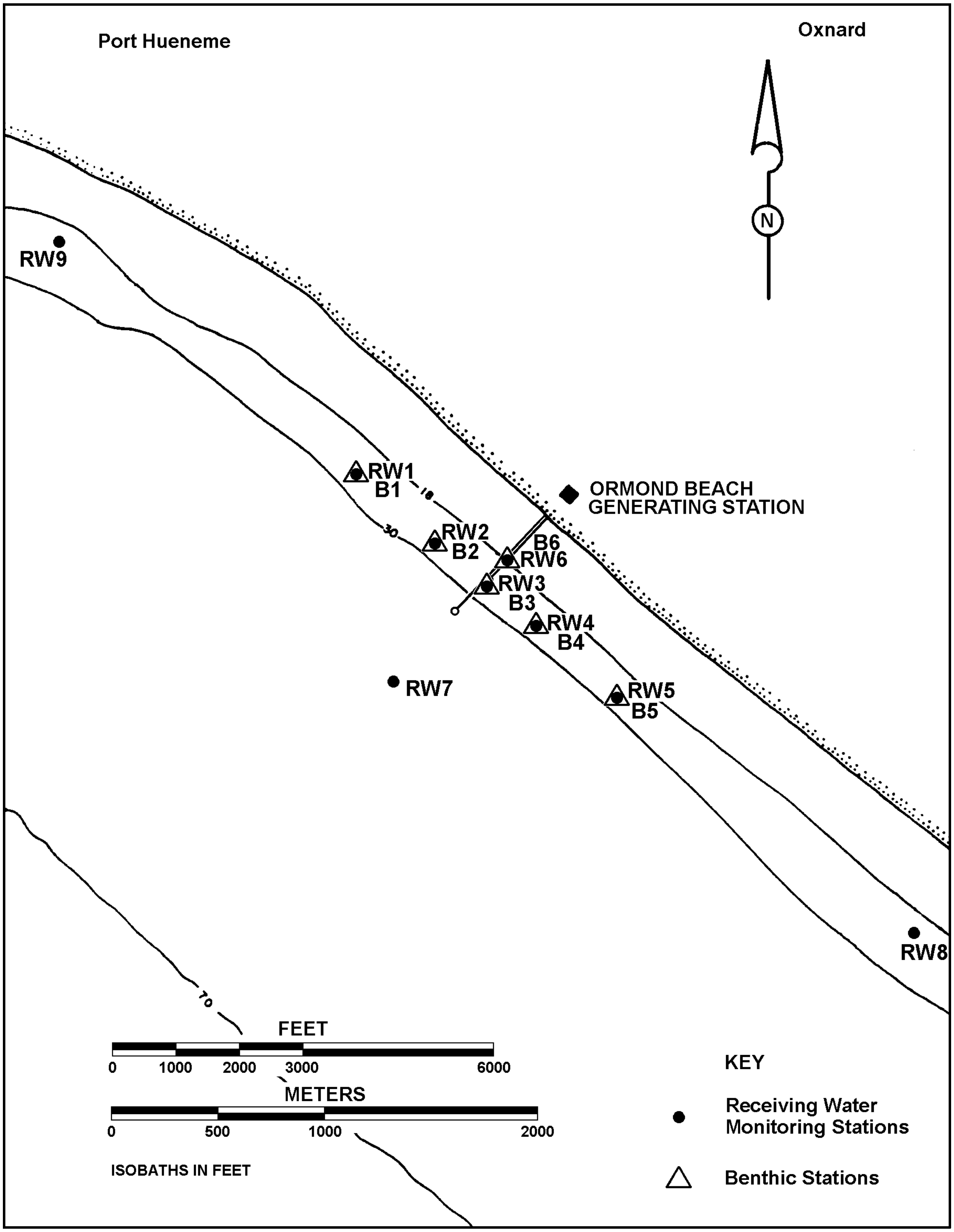
      Biomass shall be determined as the wet weight in grams or milligrams retained on a 0.5 millimeter screen per unit volume (e.g., 1 liter) of sediment. Biomass shall be reported for each major taxonomic group (e.g., polychaetes, crustaceans, mollusks) for each replicate and each station.

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

7. The following general observations or measurement at receiving water, benthic and trawl stations shall be reported:

   a. Tidal stage, time, and date of monitoring.
   b. General water conditions.
   c. Color of the water.
   d. Appearance of oil films or greases, or floatable materials.
   e. Extent of visible turbidity or color patches.
   f. Direction of tidal flow.
   g. Description of odor, if any, of the receiving water.
   h. Depth at each station for each sampling period.

Appendix A. (Cont.).



Locations of the monitoring stations. Ormond Beach Generating Station.

APPENDIX B

Receiving water quality parameters by station

Appendix B-1. Water quality parameters at each receiving water monitoring station during flood and ebb tides. Ormond Beach Generating Station NPDES, winter 2009.

		Temp. (°C)		Oxygen (mg/l)		pH		Salinity (psu)	
	Depth (m)	FLOOD	EBB	FLOOD	EBB	FLOOD	EBB	FLOOD	EBB
RW1	0	12.93	13.54	8.43	10.32	7.96	8.07	33.45	33.44
	1	12.94	13.51	8.43	10.35	7.96	8.07	33.45	33.44
	2	12.95	13.19	8.46	10.37	7.96	8.07	33.45	33.45
	3	12.95	12.98	8.46	10.32	7.96	8.04	33.45	33.46
	4	12.94	12.88	8.47	9.93	7.95	8.00	33.45	33.46
	5	12.94	12.85	8.45	9.31	7.95	7.99	33.45	33.46
	6	12.94	12.84	8.43	9.11	7.95	7.98	33.45	33.46
	7	12.94	12.83	8.43	8.96	7.95	7.97	33.45	33.46
	8	12.94	12.82	8.41	8.90	7.95	7.97	33.45	33.46
	9	12.94	12.75	8.42	8.84	7.95	7.93	33.45	33.46
	10	12.94		8.40		7.94		33.45	
RW2	0	12.93	13.55	8.35	9.92	7.96	8.05	33.45	33.45
	1	12.93	13.54	8.35	9.94	7.96	8.05	33.45	33.45
	2	12.93	13.49	8.36	9.95	7.96	8.05	33.45	33.45
	3	12.93	13.25	8.37	10.00	7.95	8.05	33.45	33.46
	4	12.92	13.10	8.36	9.98	7.95	8.05	33.45	33.46
	5	12.92	13.01	8.35	10.04	7.95	8.04	33.45	33.46
	6	12.92	12.87	8.34	9.89	7.95	8.00	33.45	33.46
	7	12.92	12.78	8.27	9.29	7.94	7.95	33.45	33.46
	8	12.92	12.76	8.21	8.65	7.94	7.94	33.45	33.46
	9	12.89	12.73	8.19	8.41	7.93	7.92	33.45	33.47
RW3	0	12.87	13.56	8.64	9.90	7.97	8.06	33.44	33.45
	1	12.88	13.55	8.62	9.91	7.97	8.06	33.44	33.45
	2	12.88	13.51	8.60	9.93	7.97	8.05	33.44	33.45
	3	12.88	13.28	8.61	9.95	7.96	8.05	33.44	33.46
	4	12.88	13.11	8.49	9.98	7.96	8.05	33.44	33.45
	5	12.88	13.00	8.47	9.98	7.96	8.04	33.44	33.46
	6	12.88	12.92	8.48	9.66	7.95	8.01	33.44	33.46
	7	12.88	12.84	8.46	9.30	7.95	7.99	33.44	33.46
	8	12.88	12.80	8.45	8.93	7.95	7.96	33.45	33.46
	9	12.87	12.75	8.37	8.59	7.94	7.94	33.45	33.47
	10	12.86	12.72	8.27	8.36	7.93	7.91	33.45	33.45
	11	12.86		8.20		7.93		33.45	
RW4	0	12.89	13.68	8.57	10.07	7.98	8.06	33.44	33.45
	1	12.89	13.66	8.56	10.07	7.98	8.06	33.45	33.45
	2	12.89	13.55	8.58	10.12	7.98	8.05	33.45	33.46
	3	12.89	13.35	8.59	10.10	7.98	8.04	33.45	33.46
	4	12.89	13.10	8.59	10.02	7.98	8.04	33.45	33.45
	5	12.88	13.05	8.56	9.88	7.97	8.03	33.45	33.46
	6	12.88	12.95	8.52	9.74	7.97	8.00	33.45	33.46
	7	12.84	12.90	8.48	9.34	7.96	7.98	33.45	33.46
	8	12.78	12.86	8.34	9.04	7.94	7.97	33.45	33.46
	9	12.78	12.83	8.00	8.93	7.92	7.96	33.45	33.46
RW5	0	12.86	13.66	8.76	10.01	7.99	8.07	33.44	33.44
	1	12.86	13.67	8.75	10.00	7.99	8.07	33.44	33.44
	2	12.86	13.54	8.78	10.06	7.99	8.07	33.44	33.45
	3	12.85	13.12	8.75	10.15	7.98	8.07	33.44	33.46
	4	12.84	13.08	8.69	10.17	7.98	8.07	33.44	33.46
	5	12.79	13.02	8.63	10.26	7.96	8.06	33.45	33.46
	6	12.71	12.93	8.31	10.08	7.93	8.03	33.46	33.47
	7	12.67	12.88	7.88	9.76	7.92	8.01	33.47	33.47
	8	12.62	12.81	7.75	9.38	7.91	7.98	33.47	33.47
	9	12.16	12.74	7.59	8.94	7.86	7.95	33.54	33.47

Appendix B-1. (Cont.).

		Temp. (°C)		Oxygen (mg/l)		pH		Salinity (psu)	
	Depth (m)	FLOOD	EBB	FLOOD	EBB	FLOOD	EBB	FLOOD	EBB
RW6	0	12.89	13.55	8.67	9.79	7.98	8.04	33.44	33.44
	1	12.89	13.55	8.68	9.82	7.98	8.04	33.44	33.44
	2	12.88	13.50	8.69	9.81	7.98	8.04	33.44	33.44
	3	12.86	13.41	8.67	9.81	7.97	8.03	33.44	33.44
	4	12.84	13.24	8.57	9.79	7.96	8.02	33.44	33.45
	5	12.82	13.02	8.56	9.54	7.96	7.98	33.43	33.43
	6	12.80		8.55		7.96		33.43	
RW7	0	12.86	13.65	8.55	10.10	7.97	8.06	33.45	33.45
	1	12.87	13.65	8.50	10.10	7.96	8.06	33.45	33.45
	2	12.87	13.50	8.49	10.18	7.96	8.07	33.45	33.46
	3	12.86	13.12	8.48	10.34	7.95	8.06	33.45	33.46
	4	12.86	13.03	8.48	10.31	7.95	8.05	33.45	33.45
	5	12.86	12.95	8.43	9.99	7.95	8.02	33.45	33.45
	6	12.86	12.90	8.42	9.59	7.95	7.99	33.45	33.45
	7	12.86	12.86	8.44	9.20	7.95	7.97	33.45	33.45
	8	12.86	12.81	8.41	8.84	7.95	7.95	33.45	33.45
	9	12.86	12.73	8.36	8.57	7.94	7.93	33.45	33.45
	10	12.86	12.67	8.24	8.22	7.94	7.91	33.45	33.46
	11	12.86	12.55	8.24	7.96	7.94	7.89	33.45	33.49
	12	12.86	12.47	8.23	7.83	7.93	7.86	33.45	33.49
RW8	0	13.03	13.42	8.85	10.43	8.00	8.08	33.44	33.45
	1	13.04	13.44	8.87	10.45	8.00	8.08	33.45	33.45
	2	13.03	13.39	8.88	10.48	8.00	8.08	33.45	33.45
	3	13.02	13.18	8.87	10.51	8.00	8.08	33.44	33.47
	4	13.02	13.01	8.86	10.46	8.00	8.06	33.45	33.46
	5	12.91	12.99	8.87	10.27	7.99	8.06	33.45	33.46
	6	12.69	12.94	8.64	10.11	7.95	8.03	33.48	33.47
	7	12.61	12.83	8.11	9.78	7.93	8.00	33.48	33.47
	8	12.56	12.80	7.94	9.36	7.92	7.99	33.48	33.47
	9	12.53	12.73	7.82	9.20	7.91	7.97	33.49	33.48
RW9	0	12.80	13.35	8.05	9.18	7.93	8.00	33.46	33.45
	1	12.81	13.35	8.06	9.18	7.93	8.00	33.46	33.45
	2	12.80	13.33	8.04	9.21	7.93	8.00	33.46	33.45
	3	12.61	13.10	7.96	9.24	7.91	7.99	33.49	33.46
	4	12.24	12.93	7.58	9.17	7.85	7.97	33.53	33.45
	5	12.22	12.92	6.78	8.79	7.82	7.96	33.53	33.45
	6	12.21	12.92	6.62	8.69	7.82	7.95	33.53	33.45
	7	12.19	12.91	6.59	8.65	7.82	7.95	33.53	33.45
	8	12.15	12.83	6.54	8.55	7.81	7.93	33.53	33.46
	9	12.12	12.68	6.45	8.34	7.80	7.90	33.53	33.47

Appendix B-2. Water quality parameters at each receiving water monitoring station during flood and ebb tides. Ormond Beach Generating Station NPDES, summer 2009.

		Temp. (°C)		Oxygen (mg/l)		pH		Salinity (psu)	
	Depth (m)	FLOOD	EBB	FLOOD	EBB	FLOOD	EBB	FLOOD	EBB
RW1	0	15.32	16.37	7.43	8.27	7.87	7.92	33.49	33.49
	1	15.34	16.32	7.43	8.25	7.87	7.92	33.49	33.49
	2	15.30	16.05	7.44	8.31	7.87	7.93	33.49	33.50
	3	15.03	15.82	7.52	8.40	7.89	7.94	33.49	33.50
	4	14.66	15.65	7.72	8.52	7.89	7.94	33.50	33.50
	5	14.52	15.40	7.65	8.51	7.89	7.94	33.50	33.51
	6	14.28	15.09	7.58	8.51	7.87	7.93	33.50	33.51
	7	14.09	14.88	7.37	8.41	7.86	7.93	33.50	33.51
	8	13.97	14.59	7.23	8.36	7.85	7.92	33.50	33.51
	9	13.92	14.45	7.12	8.17	7.84	7.90	33.50	33.51
	10		14.47		7.99		7.88		33.50
RW2	0	15.55	16.50	7.67	8.50	7.89	7.94	33.49	33.49
	1	15.57	16.47	7.64	8.50	7.89	7.95	33.48	33.49
	2	15.51	16.28	7.66	8.53	7.89	7.94	33.49	33.50
	3	15.16	16.06	7.72	8.46	7.89	7.93	33.49	33.50
	4	14.51	16.03	7.79	8.34	7.89	7.92	33.51	33.50
	5	14.24	15.98	7.59	8.25	7.87	7.91	33.51	33.49
	6	14.08	15.92	7.37	8.13	7.86	7.90	33.50	33.49
	7	14.04	15.58	7.23	8.03	7.85	7.88	33.50	33.49
	8	13.95	15.07	7.20	7.86	7.85	7.87	33.50	33.50
	9	13.88	14.92	7.14	7.85	7.84	7.89	33.50	33.51
RW3	0	15.52	18.26	7.42	7.97	7.88	7.89	33.49	33.48
	1	15.56	18.25	7.39	7.98	7.88	7.89	33.49	33.49
	2	15.50	17.44	7.39	8.08	7.88	7.90	33.49	33.50
	3	15.13	16.95	7.45	8.14	7.89	7.91	33.50	33.50
	4	15.09	17.03	7.55	8.13	7.90	7.90	33.49	33.50
	5	14.92	16.88	7.63	8.13	7.90	7.91	33.50	33.50
	6	14.45	16.37	7.69	8.24	7.90	7.92	33.51	33.51
	7	14.08	16.32	7.59	8.27	7.87	7.91	33.51	33.50
	8	14.04	15.79	7.26	8.24	7.86	7.88	33.51	33.51
	9	14.00	15.40	7.18	7.92	7.86	7.87	33.50	33.51
	10	13.99		7.16		7.86		33.50	
RW4	0	15.01	16.98	7.83	7.75	7.92	7.87	33.49	33.49
	1	15.03	17.00	7.79	7.72	7.92	7.87	33.49	33.49
	2	14.85	16.75	7.82	7.75	7.92	7.87	33.49	33.49
	3	14.28	16.22	7.80	7.79	7.90	7.87	33.51	33.50
	4	14.10	15.89	7.53	7.79	7.88	7.87	33.51	33.50
	5	14.07	15.38	7.27	7.77	7.87	7.87	33.50	33.50
	6	13.98	14.98	7.19	7.79	7.86	7.87	33.50	33.52
	7	13.88	14.77	7.11	7.80	7.85	7.87	33.50	33.51
	8	13.85	14.59	7.03	7.74	7.85	7.87	33.50	33.51
	9	13.83	14.42	7.00	7.56	7.85	7.85	33.50	33.51
	10	13.82		6.99		7.85		33.50	
RW5	0	14.67	16.54	7.69	8.38	7.90	7.93	33.49	33.49
	1	14.70	16.53	7.64	8.35	7.90	7.93	33.49	33.49
	2	14.43	16.36	7.62	8.34	7.89	7.93	33.50	33.50
	3	14.11	16.10	7.37	8.32	7.87	7.92	33.50	33.50
	4	13.92	15.82	7.29	8.27	7.86	7.91	33.51	33.50
	5	13.58	15.69	7.21	8.17	7.83	7.90	33.51	33.50
	6	13.53	15.48	6.91	8.14	7.82	7.90	33.50	33.50
	7	13.52	15.31	6.81	8.01	7.82	7.88	33.50	33.50
	8	13.52	15.17	6.78	7.90	7.82	7.88	33.50	33.50
	9	13.53	14.56	6.75	7.98	7.82	7.90	33.50	33.51
	10		14.45		7.98		7.88		33.52

Appendix B-2. (Cont.).

	Depth (m)	Temp. (℃) FLOOD	EBB	Oxygen (mg/l) FLOOD	EBB	pH FLOOD	EBB	Salinity (psu) FLOOD	EBB
RW6	0	15.10	17.27	7.74	7.66	7.89	7.86	33.48	33.49
	1	15.10	17.22	7.73	7.65	7.89	7.86	33.48	33.49
	2	15.05	17.04	7.75	7.68	7.89	7.86	33.48	33.50
	3	14.69	16.74	7.77	7.66	7.89	7.86	33.50	33.50
	4	14.33	16.60	7.69	7.65	7.88	7.86	33.51	33.50
	5	14.30	16.28	7.44	7.67	7.87	7.86	33.50	33.50
	6	14.28	16.03	7.33	7.64	7.86	7.86	33.50	33.50
RW7	0	15.26	16.45	7.88	8.75	7.92	7.97	33.48	33.49
	1	15.24	16.45	7.85	8.71	7.92	7.97	33.48	33.49
	2	15.08	16.43	7.88	8.72	7.92	7.97	33.49	33.49
	3	14.61	16.07	7.92	8.78	7.92	7.97	33.51	33.51
	4	14.41	15.81	7.79	8.82	7.91	7.97	33.51	33.51
	5	14.14	15.67	7.64	8.90	7.88	7.97	33.51	33.51
	6	13.94	15.50	7.42	8.89	7.87	7.96	33.50	33.51
	7	13.67	15.46	7.28	8.81	7.86	7.96	33.50	33.50
	8	13.44	15.43	7.14	8.78	7.84	7.95	33.50	33.50
	9	13.43	14.94	6.93	8.77	7.83	7.92	33.50	33.52
	10	13.42	14.57	6.87	8.13	7.83	7.88	33.49	33.52
	11	13.43	14.44	6.85	7.83	7.83	7.87	33.49	33.51
	12	13.43	14.19	6.85	7.67	7.83	7.85	33.49	33.52
RW8	0	14.92	16.12	7.72	8.48	7.90	7.95	33.49	33.49
	1	14.93	16.10	7.73	8.48	7.90	7.95	33.49	33.49
	2	14.84	16.09	7.72	8.52	7.90	7.95	33.49	33.49
	3	14.76	16.03	7.71	8.54	7.90	7.95	33.50	33.49
	4	14.66	15.96	7.71	8.61	7.90	7.96	33.50	33.50
	5	14.50	15.87	7.70	8.67	7.90	7.96	33.50	33.50
	6	14.36	15.79	7.62	8.71	7.89	7.96	33.51	33.50
	7	14.16	15.75	7.54	8.70	7.88	7.96	33.51	33.50
	8	13.92	15.54	7.36	8.69	7.86	7.94	33.51	33.50
	9	13.76	15.32	7.15	8.48	7.84	7.92	33.51	33.50
	10		15.28		8.30		7.91		33.50
RW9	0	14.97	15.85	7.63	7.75	7.89	7.88	33.48	33.49
	1	14.96	15.82	7.62	7.74	7.89	7.88	33.48	33.49
	2	14.92	15.77	7.64	7.75	7.89	7.88	33.49	33.49
	3	14.76	15.43	7.68	7.80	7.89	7.89	33.49	33.50
	4	14.50	15.02	7.69	7.87	7.88	7.93	33.49	33.51
	5	14.21	14.70	7.55	8.28	7.87	7.92	33.49	33.52
	6	13.80	14.61	7.35	8.19	7.85	7.91	33.49	33.51
	7	13.62	14.50	7.17	8.02	7.85	7.89	33.49	33.51
	8	13.60	14.47	7.14	7.83	7.85	7.88	33.49	33.51
	9	13.57	14.39	7.14	7.70	7.85	7.87	33.48	33.50

APPENDIX C

Sediment grain size techniques and statistical parameters by station

Appendix C-1. Grain size techniques.

Sediment Grain Size Analysis

Analysis of sediment samples for size distribution characteristics are performed using two techniques. Sediments in the gravel size range (> 2.0 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 sand-silt-clay fraction of sediments [-1 phi through 4 phi (2.0 mm through 0.0625 mm) for sand], [4 phi through 8 phi (0.0625 mm through 0.004 mm) for silt, 8 phi and greater for clay (0.0039 mm and smaller)] is analyzed by laser light diffraction. The sample is suspended in a suspension column and continuously circulated through the laser beam. The laser beam passes through the sample where the suspended particles scatter incident light. Fourier optics collect diffracted light and focus it on to three sets of detectors. A composite, time-averaged diffraction pattern is measured by 126 detectors. Sizes are computed and summed into normal distribution classifications.

Laboratory data from the two methods are mathematically combined and 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. A σ_ϕ value under 0.35ϕ indicates that particles are very well sorted (i.e. sediments are primarily composed of a narrow range of size classes, or a single size class), while a value of over 4.0ϕ indicates that the sediments are extremely poorly sorted, or evenly distributed among size classes.

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

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 (β_ϕ > 1). Those with fatter tails and lower peaks than expected are termed platykurtic (β_ϕ < 1). β_ϕ = 1.00 for a normal curve. Curve category interpretations are based on Folk (1974).

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

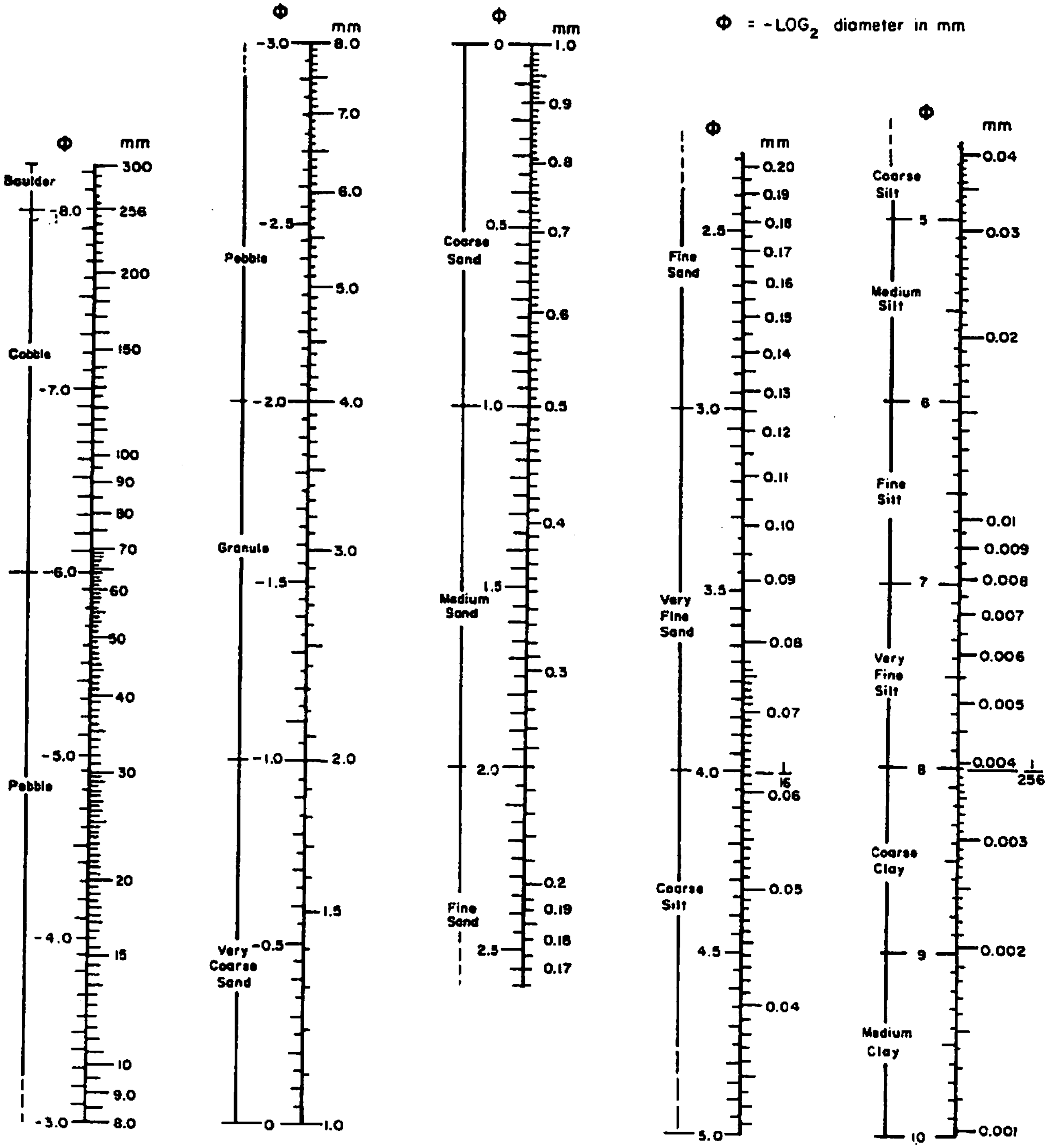
LITERATURE CITED

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.

Appendix C-1. (Cont.).

Phi - Millimeter Conversion Figure



Measurement sorting values for a large number of sediments has suggested the following verbal classification scale for sorting:

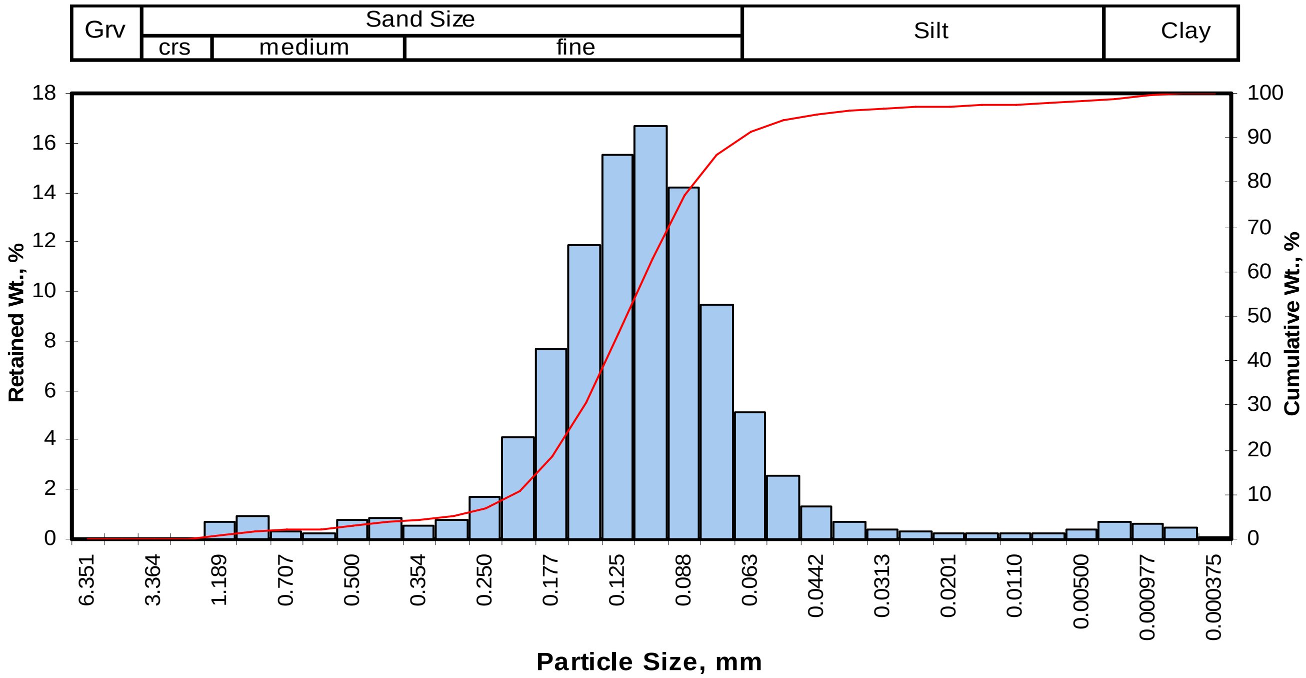
σ_I under	.35 ϕ.	very well sorted
	.35-.50 ϕ.	well sorted
	.50-.71 ϕ.	moderately well sorted
	.71-1.0 ϕ	moderately sorted
	1.0-2.0 ϕ.	poorly sorted
	2.0-4.0 ϕ.	very poorly sorted
	over 4.0 ϕ.	extremely poorly sorted

Appendix C-2. Sediment grain size distribution and statistical parameters by station. Ormond Beach Generating Station NPDES, 2009.

PTS Laboratories, Inc.

Particle Size Analysis - ASTM D4464M

Client:	Calscience	**PTS File No:**	39722
Project:	N/A	**Sample ID:**	OBGS B1
Project No:	09-08-2259	**Depth, ft:**	N/A



Opening (Inches)	Opening (Millimeters)	Phi of Screen	U.S. No.	Sample Weight, grams	Increment Weight, percent	Cumulative Weight, percent
0.2500	6.351	-2.67	1/4	0.00	0.00	0.00
0.1873	4.757	-2.25	4	0.00	0.00	0.00
0.1324	3.364	-1.75	6	0.00	0.00	0.00
0.0787	2.000	-1.00	10	0.00	0.00	0.00
0.0468	1.189	-0.25	16	0.72	0.72	0.72
0.0331	0.841	0.25	20	0.96	0.96	1.68
0.0278	0.707	0.50	25	0.30	0.30	1.98
0.0234	0.595	0.75	30	0.23	0.23	2.21
0.0197	0.500	1.00	35	0.77	0.77	2.98
0.0166	0.420	1.25	40	0.88	0.88	3.86
0.0139	0.354	1.50	45	0.53	0.53	4.39
0.0117	0.297	1.75	50	0.75	0.75	5.14
0.0098	0.250	2.00	60	1.69	1.69	6.83
0.0083	0.210	2.25	70	4.12	4.12	10.96
0.0070	0.177	2.50	80	7.64	7.64	18.60
0.0059	0.149	2.75	100	11.90	11.91	30.51
0.0049	0.125	3.00	120	15.50	15.51	46.02
0.0041	0.105	3.25	140	16.70	16.71	62.73
0.0035	0.088	3.50	170	14.20	14.21	76.94
0.0029	0.074	3.75	200	9.44	9.45	86.39
0.0025	0.063	4.00	230	5.11	5.11	91.50
0.0021	0.053	4.25	270	2.55	2.55	94.05
0.00174	0.0442	4.50	325	1.30	1.30	95.35
0.00146	0.0372	4.75	400	0.70	0.70	96.05
0.00123	0.0313	5.00	450	0.40	0.40	96.45
0.000986	0.0250	5.32	500	0.32	0.32	96.77
0.000790	0.0201	5.64	635	0.24	0.24	97.01
0.000615	0.0156	6.00		0.22	0.22	97.23
0.000435	0.0110	6.50		0.27	0.27	97.50
0.000308	0.00781	7.00		0.27	0.27	97.77
0.000197	0.00500	7.65		0.35	0.35	98.12
0.000077	0.00195	9.00		0.71	0.71	98.83
0.000038	0.000977	10.00		0.61	0.61	99.44
0.000019	0.000488	11.00		0.50	0.50	99.94
0.000015	0.000375	11.38		0.06	0.06	100.00
TOTALS				**99.90**	**100.00**	**100.00**

Cumulative Weight Percent greater than

Weight percent	Phi Value	Particle Size (Inches)	Particle Size (Millimeters)
5	1.70	0.0121	0.307
10	2.19	0.0086	0.219
16	2.41	0.0074	0.188
25	2.63	0.0063	0.161
40	2.90	0.0053	0.134
50	3.06	0.0047	0.120
60	3.21	0.0043	0.108
75	3.47	0.0036	0.091
84	3.69	0.0031	0.078
90	3.93	0.0026	0.066
95	4.43	0.0018	0.046

Measure	Trask	Inman	Folk-Ward
Median, phi	3.06	3.06	3.06
Median, in.	0.0047	0.0047	0.0047
Median, mm	0.120	0.120	0.120
Mean, phi	2.99	3.05	3.05
Mean, in.	0.0050	0.0048	0.0047
Mean, mm	0.126	0.121	0.120
Sorting	1.334	0.636	0.732
Skewness	1.007	-0.014	-0.004
Kurtosis	0.230	1.146	1.346

Grain Size Description (ASTM-USCS Scale)	Fine sand (based on Mean from Trask)

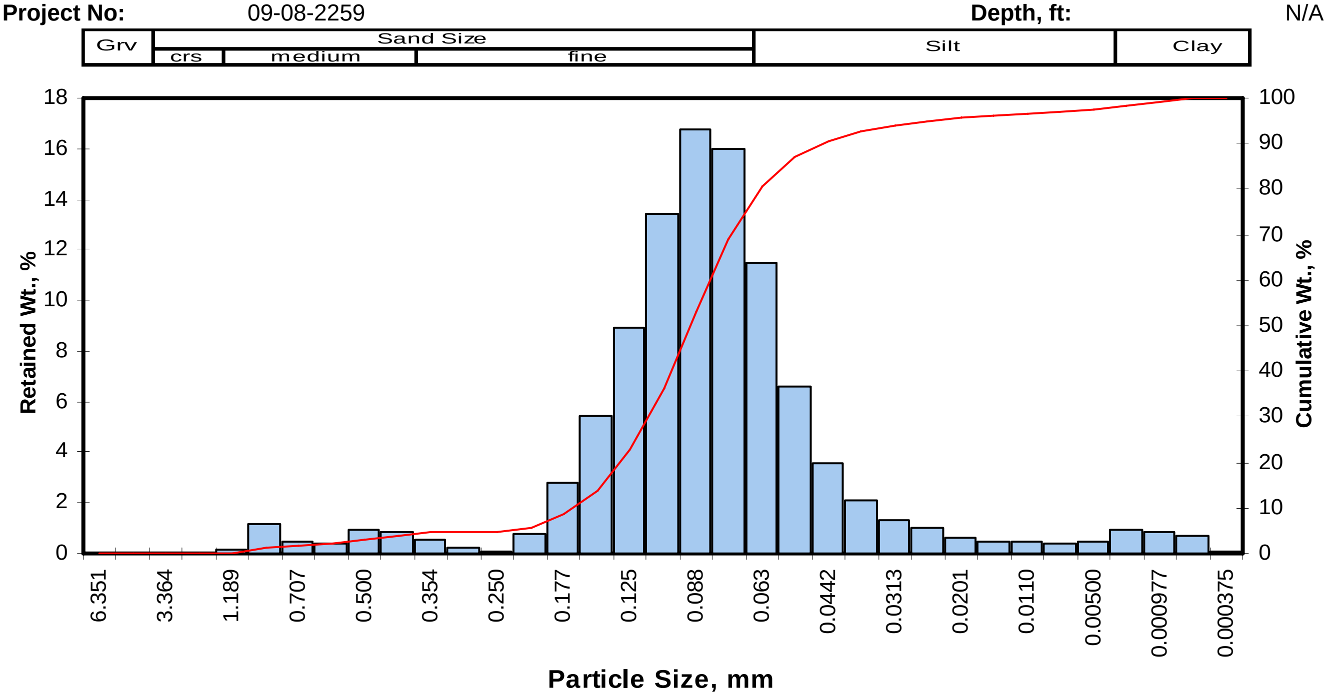
Description	Retained on Sieve #	Weight Percent
Gravel	4	0.00
Coarse Sand	10	0.00
Medium Sand	40	3.86
Fine Sand	200	82.52
Silt	>0.005 mm	11.74
Clay	<0.005 mm	1.88
	Total	**100**

Appendix C-2. (Cont.).

PTS Laboratories, Inc.

Particle Size Analysis - ASTM D4464M

Client:	Calscience	**PTS File No:**	39722
Project:	N/A	**Sample ID:**	OBGS B2
Project No:	09-08-2259	**Depth, ft:**	N/A



Opening Inches	Opening Millimeters	Phi of Screen	U.S. No.	Sample Weight, grams	Increment Weight, percent	Cumulative Weight, percent
0.2500	6.351	-2.67	1/4	0.00	0.00	0.00
0.1873	4.757	-2.25	4	0.00	0.00	0.00
0.1324	3.364	-1.75	6	0.00	0.00	0.00
0.0787	2.000	-1.00	10	0.00	0.00	0.00
0.0468	1.189	-0.25	16	0.14	0.14	0.14
0.0331	0.841	0.25	20	1.20	1.20	1.34
0.0278	0.707	0.50	25	0.47	0.47	1.81
0.0234	0.595	0.75	30	0.41	0.41	2.22
0.0197	0.500	1.00	35	0.93	0.93	3.15
0.0166	0.420	1.25	40	0.88	0.88	4.03
0.0139	0.354	1.50	45	0.52	0.52	4.55
0.0117	0.297	1.75	50	0.26	0.26	4.81
0.0098	0.250	2.00	60	0.05	0.04	4.85
0.0083	0.210	2.25	70	0.78	0.78	5.63
0.0070	0.177	2.50	80	2.79	2.79	8.42
0.0059	0.149	2.75	100	5.40	5.40	13.82
0.0049	0.125	3.00	120	8.89	8.89	22.71
0.0041	0.105	3.25	140	13.40	13.40	36.10
0.0035	0.088	3.50	170	16.80	16.79	52.90
0.0029	0.074	3.75	200	16.00	15.99	68.89
0.0025	0.063	4.00	230	11.50	11.50	80.39
0.0021	0.053	4.25	270	6.60	6.60	86.99
0.00174	0.0442	4.50	325	3.56	3.56	90.55
0.00146	0.0372	4.75	400	2.11	2.11	92.65
0.00123	0.0313	5.00	450	1.32	1.32	93.97
0.000986	0.0250	5.32	500	1.03	1.03	95.00
0.000790	0.0201	5.64	635	0.64	0.64	95.64
0.000615	0.0156	6.00		0.50	0.50	96.14
0.000435	0.0110	6.50		0.48	0.48	96.62
0.000308	0.00781	7.00		0.38	0.38	97.00
0.000197	0.00500	7.65		0.46	0.46	97.46
0.000077	0.00195	9.00		0.94	0.94	98.40
0.000038	0.000977	10.00		0.82	0.82	99.22
0.000019	0.000488	11.00		0.70	0.70	99.92
0.000015	0.000375	11.38		0.08	0.08	100.00
TOTALS				100.00	100.00	100.00

Cumulative Weight Percent greater than			
Weight percent	Phi Value	Particle Size Inches	Particle Size Millimeters
5	2.05	0.0095	0.242
10	2.57	0.0066	0.168
16	2.81	0.0056	0.142
25	3.04	0.0048	0.121
40	3.31	0.0040	0.101
50	3.46	0.0036	0.091
60	3.61	0.0032	0.082
75	3.88	0.0027	0.068
84	4.14	0.0022	0.057
90	4.46	0.0018	0.045
95	5.32	0.0010	0.025

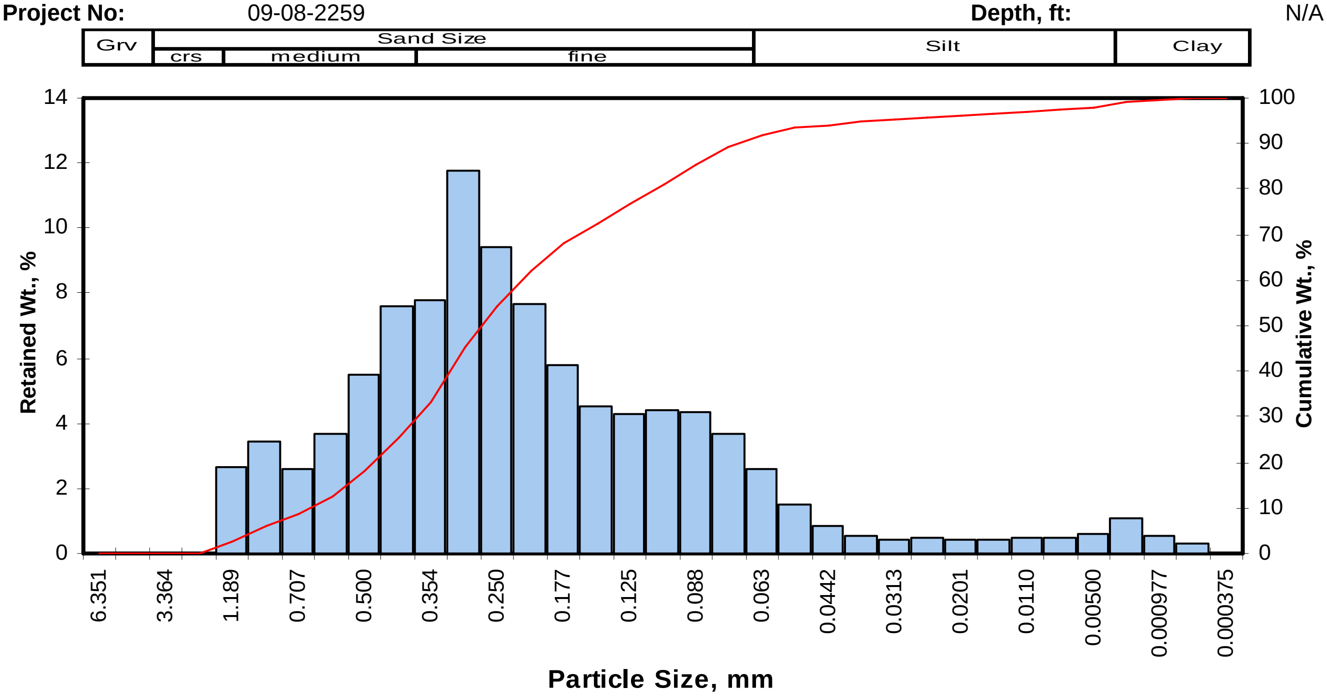
Measure	Trask	Inman	Folk-Ward
Median, phi	3.46	3.46	3.46
Median, in.	0.0036	0.0036	0.0036
Median, mm	0.091	0.091	0.091
Mean, phi	3.40	3.47	3.47
Mean, in.	0.0037	0.0035	0.0036
Mean, mm	0.095	0.090	0.090
Sorting	1.338	0.663	0.827
Skewness	0.996	0.026	0.082
Kurtosis	0.218	1.468	1.596
Grain Size Description (ASTM-USCS Scale)	Fine sand (based on Mean from Trask)		

Description	Retained on Sieve #	Weight Percent
Gravel	4	0.00
Coarse Sand	10	0.00
Medium Sand	40	4.03
Fine Sand	200	64.86
Silt	>0.005 mm	28.57
Clay	<0.005 mm	2.54
	Total	100

PTS Laboratories, Inc.

Particle Size Analysis - ASTM D4464M

Client:	Calscience	**PTS File No:**	39722
Project:	N/A	**Sample ID:**	OBGS B3
Project No:	09-08-2259	**Depth, ft:**	N/A



Opening Inches	Opening Millimeters	Phi of Screen	U.S. No.	Sample Weight, grams	Increment Weight, percent	Cumulative Weight, percent
0.2500	6.351	-2.67	1/4	0.00	0.00	0.00
0.1873	4.757	-2.25	4	0.00	0.00	0.00
0.1324	3.364	-1.75	6	0.00	0.00	0.00
0.0787	2.000	-1.00	10	0.00	0.00	0.00
0.0468	1.189	-0.25	16	2.64	2.64	2.64
0.0331	0.841	0.25	20	3.46	3.46	6.10
0.0278	0.707	0.50	25	2.62	2.62	8.71
0.0234	0.595	0.75	30	3.71	3.71	12.42
0.0197	0.500	1.00	35	5.50	5.50	17.92
0.0166	0.420	1.25	40	7.60	7.59	25.51
0.0139	0.354	1.50	45	7.77	7.76	33.27
0.0117	0.297	1.75	50	11.80	11.79	45.06
0.0098	0.250	2.00	60	9.44	9.43	54.50
0.0083	0.210	2.25	70	7.70	7.69	62.19
0.0070	0.177	2.50	80	5.78	5.78	67.97
0.0059	0.149	2.75	100	4.55	4.55	72.51
0.0049	0.125	3.00	120	4.26	4.26	76.77
0.0041	0.105	3.25	140	4.41	4.41	81.18
0.0035	0.088	3.50	170	4.35	4.35	85.52
0.0029	0.074	3.75	200	3.69	3.69	89.21
0.0025	0.063	4.00	230	2.59	2.59	91.80
0.0021	0.053	4.25	270	1.53	1.53	93.33
0.00174	0.0442	4.50	325	0.85	0.85	94.17
0.00146	0.0372	4.75	400	0.56	0.56	94.73
0.00123	0.0313	5.00	450	0.45	0.45	95.18
0.000986	0.0250	5.32	500	0.49	0.49	95.67
0.000790	0.0201	5.64	635	0.42	0.42	96.09
0.000615	0.0156	6.00		0.40	0.40	96.49
0.000435	0.0110	6.50		0.50	0.50	96.99
0.000308	0.00781	7.00		0.47	0.47	97.46
0.000197	0.00500	7.65		0.58	0.58	98.04
0.000077	0.00195	9.00		1.06	1.06	99.10
0.000038	0.000977	10.00		0.57	0.57	99.67
0.000019	0.000488	11.00		0.30	0.30	99.97
0.000015	0.000375	11.38		0.03	0.03	100.00
TOTALS				**100.10**	**100.00**	**100.00**

Cumulative Weight Percent greater than

Weight percent	Phi Value	Particle Size Inches	Particle Size Millimeters
5	0.09	0.0369	0.938
10	0.59	0.0262	0.666
16	0.91	0.0209	0.531
25	1.23	0.0167	0.425
40	1.64	0.0126	0.320
50	1.88	0.0107	0.272
60	2.18	0.0087	0.221
75	2.90	0.0053	0.134
84	3.41	0.0037	0.094
90	3.83	0.0028	0.070
95	4.90	0.0013	0.034

Measure	Trask	Inman	Folk-Ward
Median, phi	1.88	1.88	1.88
Median, in.	0.0107	0.0107	0.0107
Median, mm	0.272	0.272	0.272
Mean, phi	1.84	2.16	2.07
Mean, in.	0.0110	0.0088	0.0094
Mean, mm	0.280	0.223	0.238
Sorting	1.779	1.250	1.353
Skewness	0.880	0.226	0.240
Kurtosis	0.244	0.923	1.185

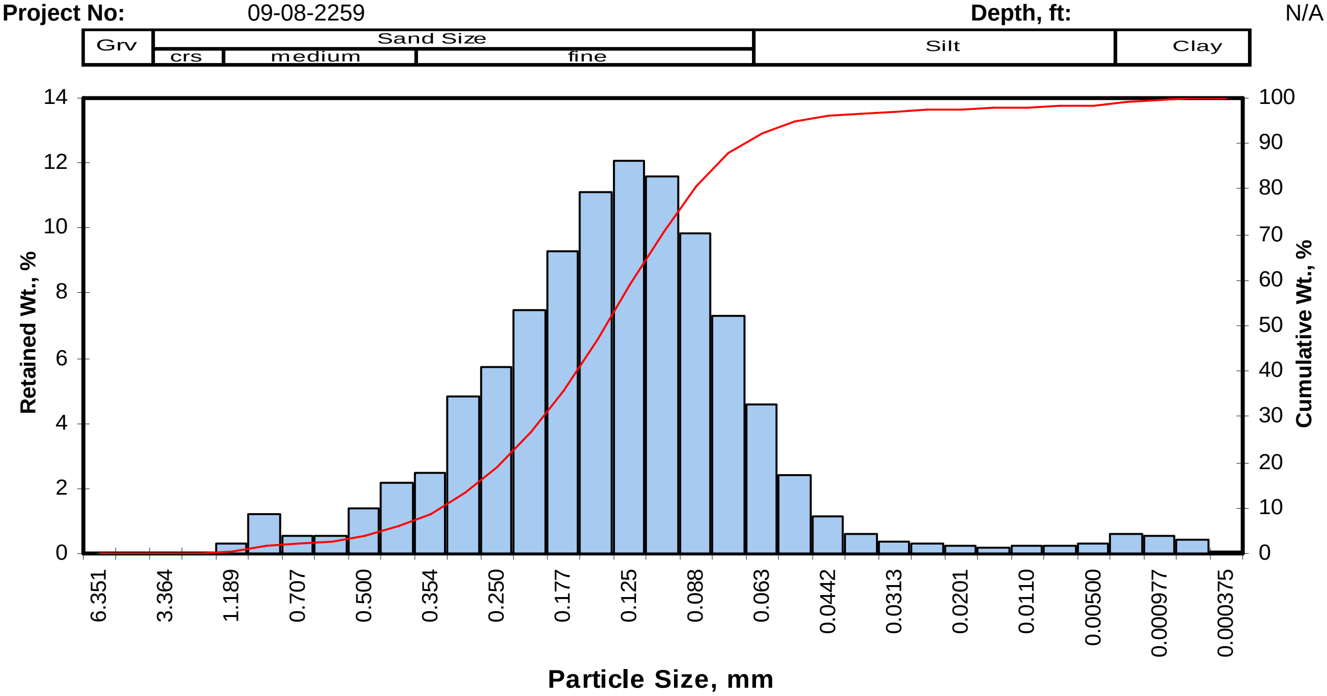
Grain Size Description (ASTM-USCS Scale)	Fine sand (based on Mean from Trask)

Description	Retained on Sieve #	Weight Percent
Gravel	4	0.00
Coarse Sand	10	0.00
Medium Sand	40	25.51
Fine Sand	200	63.70
Silt	>0.005 mm	8.83
Clay	<0.005 mm	1.96
	Total	**100**

PTS Laboratories, Inc.

Particle Size Analysis - ASTM D4464M

Client:	Calscience	**PTS File No:**	39722
Project:	N/A	**Sample ID:**	OBGS B4
Project No:	09-08-2259	**Depth, ft:**	N/A



Opening Inches	Opening Millimeters	Phi of Screen	U.S. No.	Sample Weight, grams	Increment Weight, percent	Cumulative Weight, percent
0.2500	6.351	-2.67	1/4	0.00	0.00	0.00
0.1873	4.757	-2.25	4	0.00	0.00	0.00
0.1324	3.364	-1.75	6	0.00	0.00	0.00
0.0787	2.000	-1.00	10	0.00	0.00	0.00
0.0468	1.189	-0.25	16	0.30	0.30	0.30
0.0331	0.841	0.25	20	1.21	1.21	1.51
0.0278	0.707	0.50	25	0.52	0.52	2.03
0.0234	0.595	0.75	30	0.55	0.55	2.58
0.0197	0.500	1.00	35	1.36	1.36	3.94
0.0166	0.420	1.25	40	2.20	2.20	6.14
0.0139	0.354	1.50	45	2.49	2.49	8.63
0.0117	0.297	1.75	50	4.80	4.80	13.43
0.0098	0.250	2.00	60	5.71	5.71	19.13
0.0083	0.210	2.25	70	7.47	7.47	26.60
0.0070	0.177	2.50	80	9.31	9.31	35.91
0.0059	0.149	2.75	100	11.10	11.10	47.01
0.0049	0.125	3.00	120	12.10	12.10	59.10
0.0041	0.105	3.25	140	11.60	11.60	70.70
0.0035	0.088	3.50	170	9.84	9.84	80.54
0.0029	0.074	3.75	200	7.30	7.30	87.84
0.0025	0.063	4.00	230	4.56	4.56	92.40
0.0021	0.053	4.25	270	2.39	2.39	94.78
0.00174	0.0442	4.50	325	1.16	1.16	95.94
0.00146	0.0372	4.75	400	0.63	0.63	96.57
0.00123	0.0313	5.00	450	0.38	0.38	96.95
0.000986	0.0250	5.32	500	0.31	0.31	97.26
0.000790	0.0201	5.64	635	0.22	0.22	97.48
0.000615	0.0156	6.00		0.19	0.19	97.67
0.000435	0.0110	6.50		0.23	0.23	97.90
0.000308	0.00781	7.00		0.22	0.22	98.12
0.000197	0.00500	7.65		0.29	0.29	98.41
0.000077	0.00195	9.00		0.59	0.59	99.00
0.000038	0.000977	10.00		0.52	0.52	99.52
0.000019	0.000488	11.00		0.43	0.43	99.95
0.000015	0.000375	11.38		0.05	0.05	100.00
TOTALS				**100.00**	**100.00**	**100.00**

Cumulative Weight Percent greater than			
Weight percent	**Phi Value**	**Particle Size Inches**	**Particle Size Millimeters**
5	1.12	0.0181	0.460
10	1.57	0.0132	0.336
16	1.86	0.0108	0.275
25	2.20	0.0086	0.218
40	2.59	0.0065	0.166
50	2.81	0.0056	0.142
60	3.02	0.0049	0.123
75	3.36	0.0038	0.097
84	3.62	0.0032	0.081
90	3.87	0.0027	0.068
95	4.30	0.0020	0.051

Measure	Trask	Inman	Folk-Ward
Median, phi	2.81	2.81	2.81
Median, in.	0.0056	0.0056	0.0056
Median, mm	0.142	0.142	0.142
Mean, phi	2.66	2.74	2.76
Mean, in.	0.0062	0.0059	0.0058
Mean, mm	0.158	0.150	0.147
Sorting	1.496	0.878	0.920
Skewness	1.024	-0.081	-0.073
Kurtosis	0.225	0.809	1.119

Grain Size Description (ASTM-USCS Scale)	Fine sand (based on Mean from Trask)

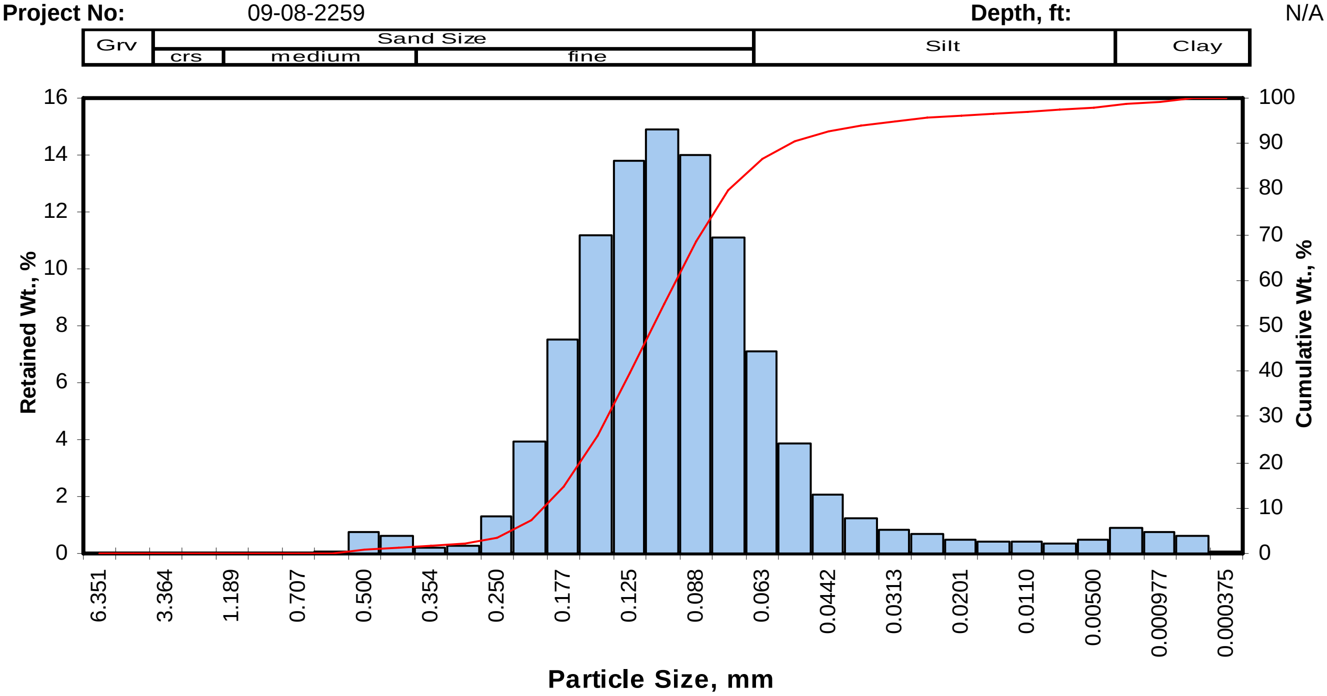
Description	Retained on Sieve #	Weight Percent
Gravel	4	0.00
Coarse Sand	10	0.00
Medium Sand	40	6.14
Fine Sand	200	81.70
Silt	>0.005 mm	10.58
Clay	<0.005 mm	1.59
	Total	**100**

Appendix C-2. (Cont.).

PTS Laboratories, Inc.

Particle Size Analysis - ASTM D4464M

Client:	Calscience	**PTS File No:**	39722
Project:	N/A	**Sample ID:**	OBGS B5
Project No:	09-08-2259	**Depth, ft:**	N/A



Opening Inches	Opening Millimeters	Phi of Screen	U.S. No.	Sample Weight, grams	Increment Weight, percent	Cumulative Weight, percent
0.2500	6.351	-2.67	1/4	0.00	0.00	0.00
0.1873	4.757	-2.25	4	0.00	0.00	0.00
0.1324	3.364	-1.75	6	0.00	0.00	0.00
0.0787	2.000	-1.00	10	0.00	0.00	0.00
0.0468	1.189	-0.25	16	0.00	0.00	0.00
0.0331	0.841	0.25	20	0.00	0.00	0.00
0.0278	0.707	0.50	25	0.00	0.00	0.00
0.0234	0.595	0.75	30	0.10	0.10	0.10
0.0197	0.500	1.00	35	0.73	0.73	0.83
0.0166	0.420	1.25	40	0.63	0.63	1.46
0.0139	0.354	1.50	45	0.21	0.21	1.67
0.0117	0.297	1.75	50	0.29	0.29	1.96
0.0098	0.250	2.00	60	1.32	1.32	3.28
0.0083	0.210	2.25	70	3.93	3.93	7.21
0.0070	0.177	2.50	80	7.53	7.52	14.73
0.0059	0.149	2.75	100	11.20	11.19	25.92
0.0049	0.125	3.00	120	13.80	13.79	39.71
0.0041	0.105	3.25	140	14.90	14.89	54.60
0.0035	0.088	3.50	170	14.00	13.99	68.59
0.0029	0.074	3.75	200	11.10	11.09	79.69
0.0025	0.063	4.00	230	7.10	7.10	86.78
0.0021	0.053	4.25	270	3.87	3.87	90.65
0.00174	0.0442	4.50	325	2.06	2.06	92.71
0.00146	0.0372	4.75	400	1.26	1.26	93.97
0.00123	0.0313	5.00	450	0.84	0.84	94.81
0.000986	0.0250	5.32	500	0.72	0.72	95.53
0.000790	0.0201	5.64	635	0.49	0.49	96.01
0.000615	0.0156	6.00		0.41	0.41	96.42
0.000435	0.0110	6.50		0.43	0.43	96.85
0.000308	0.00781	7.00		0.37	0.37	97.22
0.000197	0.00500	7.65		0.46	0.46	97.68
0.000077	0.00195	9.00		0.90	0.90	98.58
0.000038	0.000977	10.00		0.73	0.73	99.31
0.000019	0.000488	11.00		0.62	0.62	99.93
0.000015	0.000375	11.38		0.07	0.07	100.00
TOTALS				**100.10**	**100.00**	**100.00**

Cumulative Weight Percent greater than

Weight percent	Phi Value	Particle Size Inches	Particle Size Millimeters
5	2.11	0.0091	0.232
10	2.34	0.0078	0.197
16	2.53	0.0068	0.173
25	2.73	0.0059	0.151
40	3.00	0.0049	0.125
50	3.17	0.0044	0.111
60	3.35	0.0039	0.098
75	3.64	0.0031	0.080
84	3.90	0.0026	0.067
90	4.21	0.0021	0.054
95	5.09	0.0012	0.029

Measure	Trask	Inman	Folk-Ward
Median, phi	3.17	3.17	3.17
Median, in.	0.0044	0.0044	0.0044
Median, mm	0.111	0.111	0.111
Mean, phi	3.12	3.22	3.20
Mean, in.	0.0045	0.0042	0.0043
Mean, mm	0.115	0.108	0.109
Sorting	1.373	0.687	0.794
Skewness	0.990	0.062	0.174
Kurtosis	0.248	1.167	1.333

Grain Size Description (ASTM-USCS Scale)	Fine sand (based on Mean from Trask)

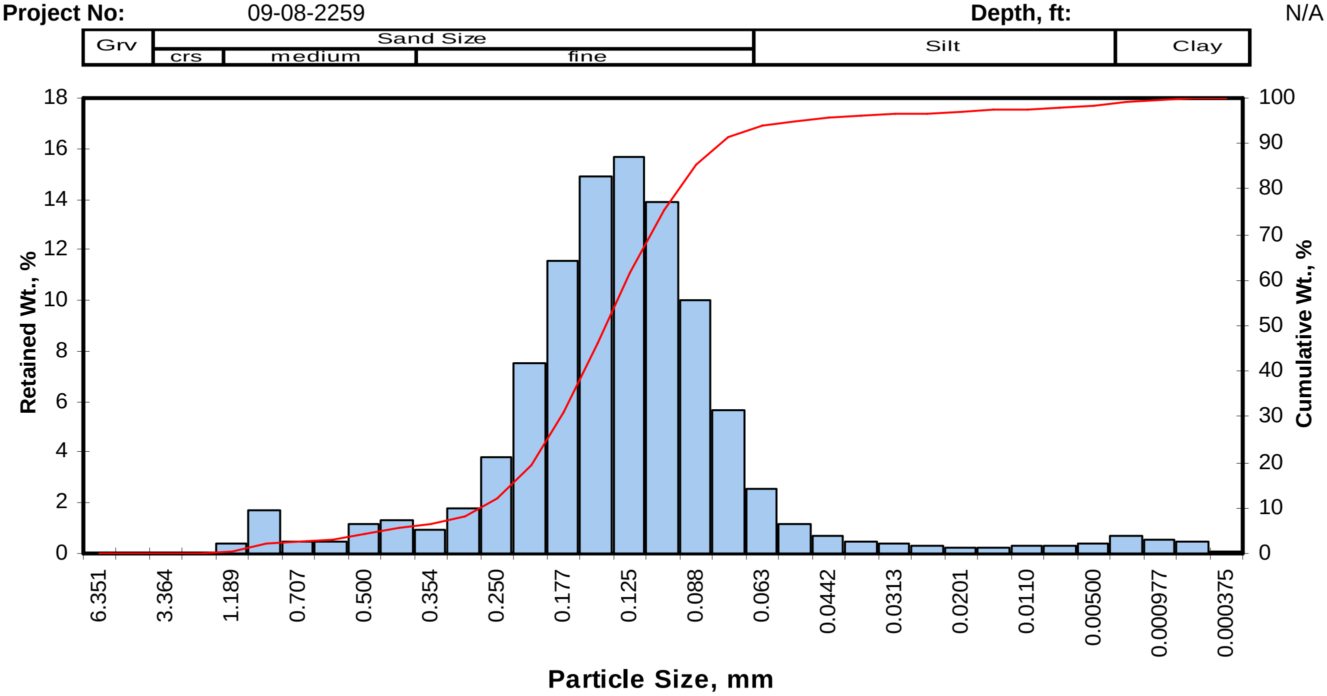
Description	Retained on Sieve #	Weight Percent
Gravel	4	0.00
Coarse Sand	10	0.00
Medium Sand	40	1.46
Fine Sand	200	78.23
Silt	>0.005 mm	18.00
Clay	<0.005 mm	2.32
	Total	**100**

Appendix C-2. (Cont.).

PTS Laboratories, Inc.

Particle Size Analysis - ASTM D4464M

Client:	Calscience	**PTS File No:**	39722
Project:	N/A	**Sample ID:**	OBGS B6
Project No:	09-08-2259	**Depth, ft:**	N/A



Opening		Phi of	U.S.	Sample	Increment	Cumulative
Inches	Millimeters	Screen	No.	Weight, grams	Weight, percent	Weight, percent
0.2500	6.351	-2.67	1/4	0.00	0.00	0.00
0.1873	4.757	-2.25	4	0.00	0.00	0.00
0.1324	3.364	-1.75	6	0.00	0.00	0.00
0.0787	2.000	-1.00	10	0.00	0.00	0.00
0.0468	1.189	-0.25	16	0.38	0.38	0.38
0.0331	0.841	0.25	20	1.70	1.70	2.08
0.0278	0.707	0.50	25	0.48	0.48	2.56
0.0234	0.595	0.75	30	0.45	0.45	3.01
0.0197	0.500	1.00	35	1.19	1.19	4.20
0.0166	0.420	1.25	40	1.30	1.30	5.50
0.0139	0.354	1.50	45	0.90	0.90	6.40
0.0117	0.297	1.75	50	1.81	1.81	8.21
0.0098	0.250	2.00	60	3.78	3.78	11.99
0.0083	0.210	2.25	70	7.49	7.49	19.47
0.0070	0.177	2.50	80	11.60	11.60	31.07
0.0059	0.149	2.75	100	14.90	14.89	45.96
0.0049	0.125	3.00	120	15.70	15.69	61.66
0.0041	0.105	3.25	140	13.90	13.89	75.55
0.0035	0.088	3.50	170	9.98	9.98	85.53
0.0029	0.074	3.75	200	5.67	5.67	91.20
0.0025	0.063	4.00	230	2.58	2.58	93.77
0.0021	0.053	4.25	270	1.14	1.14	94.91
0.00174	0.0442	4.50	325	0.67	0.67	95.58
0.00146	0.0372	4.75	400	0.49	0.49	96.07
0.00123	0.0313	5.00	450	0.35	0.35	96.42
0.000986	0.0250	5.32	500	0.33	0.33	96.75
0.000790	0.0201	5.64	635	0.27	0.27	97.02
0.000615	0.0156	6.00		0.26	0.26	97.28
0.000435	0.0110	6.50		0.31	0.31	97.59
0.000308	0.00781	7.00		0.29	0.29	97.88
0.000197	0.00500	7.65		0.37	0.37	98.25
0.000077	0.00195	9.00		0.71	0.71	98.96
0.000038	0.000977	10.00		0.55	0.55	99.51
0.000019	0.000488	11.00		0.44	0.44	99.95
0.000015	0.000375	11.38		0.05	0.05	100.00
TOTALS				**100.00**	**100.00**	**100.00**

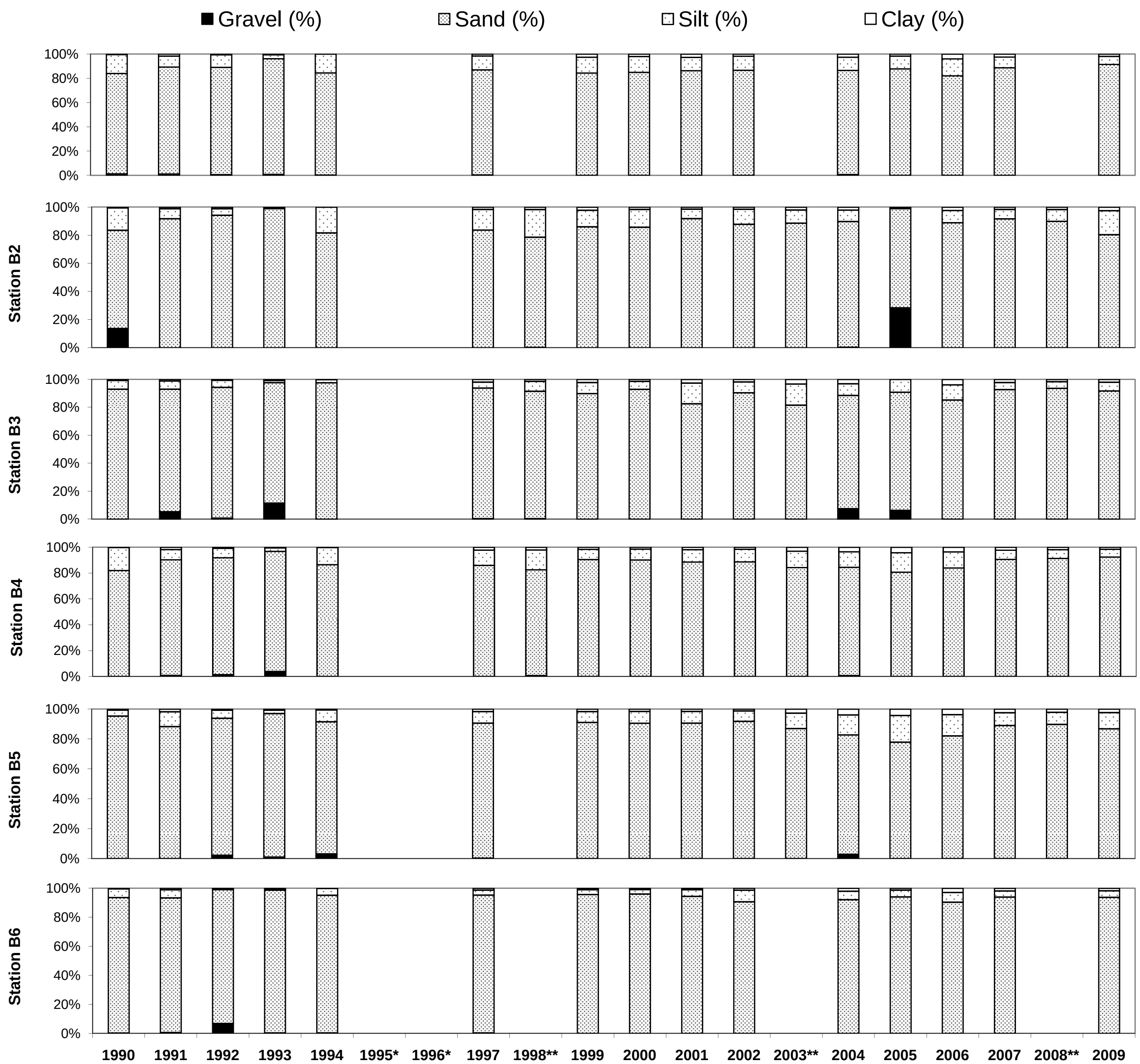
Cumulative Weight Percent greater than			
Weight percent	Phi Value	Particle Size Inches	Particle Size Millimeters
5	1.15	0.0177	0.449
10	1.87	0.0108	0.274
16	2.13	0.0090	0.228
25	2.37	0.0076	0.194
40	2.65	0.0063	0.159
50	2.81	0.0056	0.142
60	2.97	0.0050	0.127
75	3.24	0.0042	0.106
84	3.46	0.0036	0.091
90	3.70	0.0030	0.077
95	4.28	0.0020	0.051

Measure	Trask	Inman	Folk-Ward
Median, phi	2.81	2.81	2.81
Median, in.	0.0056	0.0056	0.0056
Median, mm	0.142	0.142	0.142
Mean, phi	2.74	2.80	2.80
Mean, in.	0.0059	0.0057	0.0056
Mean, mm	0.150	0.144	0.143
Sorting	1.352	0.664	0.806
Skewness	1.007	-0.025	-0.043
Kurtosis	0.223	1.356	1.472

Grain Size Description (ASTM-USCS Scale)	Fine sand (based on Mean from Trask)

Description	Retained on Sieve #	Weight Percent
Gravel	4	0.00
Coarse Sand	10	0.00
Medium Sand	40	5.50
Fine Sand	200	85.70
Silt	>0.005 mm	7.06
Clay	<0.005 mm	1.75
	Total	**100**

Appendix C-3. Long-term sediment composition by size catagory, 1990 - 2009. Ormond Beach Generating Statior NPDES, 2009.



* No sampling required.
** Regional Monitoring Year; 1998 only three stations required; 2003 and 2008 only four stations required

APPENDIX D

Sediment chemistry by station

Calscience Environmental Laboratories, Inc.

Analytical Report

MBC Applied Environmental Sciences
3000 Redhill Avenue
Costa Mesa, CA 92626-4524

Project: OBGS 09206A

Date Received:	07/24/09
Work Order No:	09-07-2038
Preparation:	EPA 3050B
Method:	EPA 6020
Units:	mg/kg
	Page 1 of 2

Client Sample Number	Lab Sample Number	Date /Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
B1-(I, II, III)	**09-07-2038-19-A**	**07/22/09 09:00**	**Solid**	**ICP/MS 03**	**07/28/09**	**07/29/09 12:34**	**090728L01**

Comment(s): -Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	9.39	0.129	1		Nickel	7.11	0.129	1	
Copper	4.22	0.129	1		Zinc	29.1	1.29	1	

Client Sample Number	Lab Sample Number	Date /Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
B2-(I, II, III)	**09-07-2038-20-A**	**07/22/09 08:38**	**Solid**	**ICP/MS 03**	**07/28/09**	**07/29/09 13:10**	**090728L01**

Comment(s): -Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	10.2	0.139	1		Nickel	8.25	0.139	1	
Copper	4.53	0.139	1		Zinc	35.5	1.39	1	

Client Sample Number	Lab Sample Number	Date /Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
B3-(I, II, III)	**09-07-2038-21-A**	**07/22/09 07:55**	**Solid**	**ICP/MS 03**	**07/28/09**	**07/29/09 13:14**	**090728L01**

Comment(s): -Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	6.92	0.124	1		Nickel	5.60	0.124	1	
Copper	5.53	0.124	1		Zinc	25.2	1.24	1	

Client Sample Number	Lab Sample Number	Date /Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
B4-(I, II, III)	**09-07-2038-22-A**	**07/22/09 07:08**	**Solid**	**ICP/MS 03**	**07/28/09**	**07/29/09 13:18**	**090728L01**

Comment(s): -Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	8.25	0.136	1		Nickel	6.76	0.136	1	
Copper	3.60	0.136	1		Zinc	24.3	1.36	1	

Client Sample Number	Lab Sample Number	Date /Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
B5-(I, II, III)	**09-07-2038-23-A**	**07/22/09 06:42**	**Solid**	**ICP/MS 03**	**07/28/09**	**07/29/09 13:22**	**090728L01**

Comment(s): -Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	8.46	0.139	1		Nickel	7.20	0.139	1	
Copper	4.02	0.139	1		Zinc	29.1	1.39	1	

Client Sample Number	Lab Sample Number	Date /Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
B6-(I, II, III)	**09-07-2038-24-A**	**07/22/09 07:29**	**Solid**	**ICP/MS 03**	**07/28/09**	**07/29/09 13:25**	**090728L01**

Comment(s): -Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	9.20	0.139	1		Nickel	8.02	0.139	1	
Copper	4.26	0.139	1		Zinc	26.4	1.39	1	

RL - Reporting Limit , DF - Dilution Factor , Qual - Qualifiers

Calscience Environmental Laboratories, Inc.

Analytical Report

MBC Applied Environmental Sciences	Date Received: 07/24/09
3000 Redhill Avenue	Work Order No: 09-07-2038
Costa Mesa, CA 92626-4524	Preparation: EPA 3050B
	Method: EPA 6020
	Units: mg/kg
Project: OBGS 09206A	Page 2 of 2

Client Sample Number	Lab Sample Number	Date /Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
Method Blank	**096-10-002-1,554**	**N/A**	**Solid**	**ICP/MS 03**	**07/28/09**	**07/28/09 20:14**	**090728L01**

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	ND	0.100	1		Nickel	ND	0.100	1	
Copper	ND	0.100	1		Zinc	ND	1.00	1	

RL - Reporting Limit , DF - Dilution Factor , Qual - Qualifiers

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Calscience Environmental Laboratories, Inc.

Analytical Report

MBC Applied Environmental Sciences
3000 Redhill Avenue
Costa Mesa, CA 92626-4524

Date Received: 07/24/09
Work Order No: 09-07-2038

Project: OBGS 09206A

Client Sample Number	Lab Sample Number	Date Collected	Matrix
B1-(I, II, III)	09-07-2038-19	07/22/09	Solid

Parameter	Result	RL	DF	Qual	Units	Date Prepared	Date Analyzed	Method
Solids, Total	77.6	0.100	1		%	07/30/09	07/30/09	SM 2540 B

Client Sample Number	Lab Sample Number	Date Collected	Matrix
B2-(I, II, III)	09-07-2038-20	07/22/09	Solid

Parameter	Result	RL	DF	Qual	Units	Date Prepared	Date Analyzed	Method
Solids, Total	72.0	0.100	1		%	07/30/09	07/30/09	SM 2540 B

Client Sample Number	Lab Sample Number	Date Collected	Matrix
B3-(I, II, III)	09-07-2038-21	07/22/09	Solid

Parameter	Result	RL	DF	Qual	Units	Date Prepared	Date Analyzed	Method
Solids, Total	80.7	0.100	1		%	07/30/09	07/30/09	SM 2540 B

Client Sample Number	Lab Sample Number	Date Collected	Matrix
B4-(I, II, III)	09-07-2038-22	07/22/09	Solid

Parameter	Result	RL	DF	Qual	Units	Date Prepared	Date Analyzed	Method
Solids, Total	73.7	0.100	1		%	07/30/09	07/30/09	SM 2540 B

Client Sample Number	Lab Sample Number	Date Collected	Matrix
B5-(I, II, III)	09-07-2038-23	07/22/09	Solid

Parameter	Result	RL	DF	Qual	Units	Date Prepared	Date Analyzed	Method
Solids, Total	72.0	0.100	1		%	07/30/09	07/30/09	SM 2540 B

RL - Reporting Limit , DF - Dilution Factor , Qual - Qualifiers

Calscience Environmental Laboratories, Inc.

Analytical Report

MBC Applied Environmental Sciences		Date Received:	07/24/09
3000 Redhill Avenue		Work Order No:	09-07-2038
Costa Mesa, CA 92626-4524			

Project: OBGS 09206A

Client Sample Number	Lab Sample Number	Date Collected	Matrix
B6-(I, II, III)	**09-07-2038-24**	**07/22/09**	**Solid**

Parameter	Result	RL	DF	Qual	Units	Date Prepared	Date Analyzed	Method
Solids, Total	72.1	0.100	1		%	07/30/09	07/30/09	SM 2540 B

Client Sample Number	Lab Sample Number	Date Collected	Matrix
Method Blank		**N/A**	**Solid**

Parameter	Result	RL	DF	Qual	Units	Date Prepared	Date Analyzed	Method
Solids, Total	ND	0.100	1		%	07/30/09	07/30/09	SM 2540 B

RL - Reporting Limit , DF - Dilution Factor , Qual - Qualifiers

Calscience Environmental Laboratories, Inc.

Quality Control - Spike/Spike Duplicate

MBC Applied Environmental Sciences		Date Received:	07/24/09
3000 Redhill Avenue		Work Order No:	09-07-2038
Costa Mesa, CA 92626-4524		Preparation:	EPA 3050B
		Method:	EPA 6020

Project OBGS 09206A

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	MS/MSD Batch Number
09-07-2181-5	**Solid**	**ICP/MS 03**	**07/28/09**	**07/28/09**	**090728S01**

Parameter	MS %REC	MSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Chromium	124	110	20-182	10	0-15	
Copper	118	97	25-157	11	0-22	
Nickel	120	105	46-154	11	0-15	
Zinc	28	28	23-173	0	0-18	

RPD - Relative Percent Difference , CL - Control Limit

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Calscience Environmental Laboratories, Inc.

Quality Control - PDS / PDSD

MBC Applied Environmental Sciences
3000 Redhill Avenue
Costa Mesa, CA 92626-4524

Date Received	07/24/09
Work Order No:	09-07-2038
Preparation:	EPA 3050B
Method:	EPA 6020

Project: OBGS 09206A

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	PDS/PDSD Batch Number
09-07-2181-5	**Solid**	**ICP/MS 03**	**07/28/09**	**07/29/09**	**090728S01**

Parameter	PDS %REC	PDSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Chromium	97	103	75-125	4	0-15	
Copper	102	111	75-125	5	0-22	
Nickel	101	107	75-125	5	0-15	
Zinc	99	120	75-125	6	0-18	

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Quality Control - Duplicate

MBC Applied Environmental Sciences		Date Received:	N/A
3000 Redhill Avenue		Work Order No:	09-07-2038
Costa Mesa, CA 92626-4524			

Project: OBGS 09206A

Matrix: Solid

Parameter	Method	QC Sample ID	Date Analyzed	Sample Conc	DUP Conc	RPD	RPD CL	Qualifiers
Solids, Total	SM 2540 B	09-07-2037-16	07/30/09	77.9	77.6	0	0-25	

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Quality Control - LCS/LCS Duplicate

MBC Applied Environmental Sciences
3000 Redhill Avenue
Costa Mesa, CA 92626-4524

Date Received:	N/A
Work Order No:	09-07-2038
Preparation:	EPA 3050B
Method:	EPA 6020

Project: OBGS 09206A

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	LCS/LCSD Batch Number
096-10-002-1,554	**Solid**	**ICP/MS 03**	**07/28/09**	**07/29/09**	**090728L01**

Parameter	LCS %REC	LCSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Chromium	98	103	80-120	5	0-20	
Copper	104	106	80-120	2	0-20	
Nickel	102	104	80-120	2	0-20	
Zinc	108	112	80-120	3	0-20	

RPD - Relative Percent Difference , CL - Control Limit

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Calscience Environmental Laboratories, Inc.

Glossary of Terms and Qualifiers

Work Order Number: 09-07-2038

Qualifier	Definition
*	See applicable analysis comment.
1	Surrogate compound recovery was out of control due to a required sample dilution, therefore, the sample data was reported without further clarification.
2	Surrogate compound recovery was out of control due to matrix interference. The associated method blank surrogate spike compound was in control and, therefore, the sample data was reported without further clarification.
3	Recovery of the Matrix Spike (MS) or Matrix Spike Duplicate (MSD) compound was out of control due to matrix interference. The associated LCS and/or LCSD was in control and, therefore, the sample data was reported without further clarification.
4	The MS/MSD RPD was out of control due to matrix interference. The LCS/LCSD RPD was in control and, therefore, the sample data was reported without further clarification.
5	The PDS/PDSD associated with this batch of samples was out of control due to a matrix interference effect. The associated batch LCS/LCSD was in control and, hence, the associated sample data was reported with no further corrective action required.
A	Result is the average of all dilutions, as defined by the method.
B	Analyte was present in the associated method blank.
C	Analyte presence was not confirmed on primary column.
E	Concentration exceeds the calibration range.
H	Sample received and/or analyzed past the recommended holding time.
J	Analyte was detected at a concentration below the reporting limit and above the laboratory method detection limit. Reported value is estimated.
ME	LCS Recovery Percentage is within LCS ME Control Limit range.
N	Nontarget Analyte.
ND	Parameter not detected at the indicated reporting limit.
Q	Spike recovery and RPD control limits do not apply resulting from the parameter concentration in the sample exceeding the spike concentration by a factor of four or greater.
U	Undetected at the laboratory method detection limit.
X	% Recovery and/or RPD out-of-range.
Z	Analyte presence was not confirmed by second column or GC/MS analysis.
	Solid - Unless otherwise indicated, solid sample data is reported on a wet weight basis, not corrected for % moisture.

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APPENDIX E

Mussel tissue chemistry by station

Calscience Environmental Laboratories, Inc.

Analytical Report

MBC Applied Environmental Sciences
3000 Redhill Avenue
Costa Mesa, CA 92626-4524

Date Received:	08/04/09
Work Order No:	09-08-0197
Preparation:	EPA 3050B
Method:	EPA 6020
Units:	mg/kg

Project: OBGS 09206A

Page 1 of 1

Client Sample Number	Lab Sample Number	Date /Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
OBGS-I	**09-08-0197-1-A**	**07/22/09 00:00**	**Tissue**	**ICP/MS 03**	**08/10/09**	**08/10/09 20:12**	**090810L01**

Comment(s): -Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	1.51	0.186	0.5		Nickel	0.691	0.0929	0.5	
Copper	2.14	0.279	0.5		Zinc	25.8	1.86	0.5	

Client Sample Number	Lab Sample Number	Date /Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
OBGS-II	**09-08-0197-2-A**	**07/22/09 00:00**	**Tissue**	**ICP/MS 03**	**08/10/09**	**08/10/09 20:16**	**090810L01**

Comment(s): -Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	1.99	0.175	0.5		Nickel	1.01	0.0877	0.5	
Copper	2.17	0.263	0.5		Zinc	29.1	1.75	0.5	

Client Sample Number	Lab Sample Number	Date /Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
OBGS-III	**09-08-0197-3-A**	**07/22/09 00:00**	**Tissue**	**ICP/MS 03**	**08/10/09**	**08/10/09 20:36**	**090810L01**

Comment(s): -Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	1.30	0.181	0.5		Nickel	0.610	0.0904	0.5	
Copper	2.20	0.271	0.5		Zinc	26.5	1.81	0.5	

Client Sample Number	Lab Sample Number	Date /Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
Method Blank	**099-12-411-12**	**N/A**	**Tissue**	**ICP/MS 03**	**08/10/09**	**08/10/09 18:45**	**090810L01**

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	ND	0.100	0.5		Nickel	ND	0.0500	0.5	
Copper	ND	0.150	0.5		Zinc	ND	1.00	0.5	

RL - Reporting Limit , DF - Dilution Factor , Qual - Qualifiers

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Calscience Environmental Laboratories, Inc.

Analytical Report

MBC Applied Environmental Sciences
3000 Redhill Avenue
Costa Mesa, CA 92626-4524

Date Received: 08/04/09
Work Order No: 09-08-0197

Project: OBGS 09206A

Client Sample Number	Lab Sample Number	Date Collected	Matrix
OBGS-I	**09-08-0197-1**	**07/22/09**	**Tissue**

Parameter	Result	RL	DF	Qual	Units	Date Prepared	Date Analyzed	Method
Solids, Total	53.8	0.100	1		%	08/05/09	08/05/09	SM 2540 B

OBGS-II	**09-08-0197-2**	**07/22/09**	**Tissue**

Parameter	Result	RL	DF	Qual	Units	Date Prepared	Date Analyzed	Method
Solids, Total	57.0	0.100	1		%	08/05/09	08/05/09	SM 2540 B

OBGS-III	**09-08-0197-3**	**07/22/09**	**Tissue**

Parameter	Result	RL	DF	Qual	Units	Date Prepared	Date Analyzed	Method
Solids, Total	55.3	0.100	1		%	08/05/09	08/05/09	SM 2540 B

Method Blank		**N/A**	**Solid**

Parameter	Result	RL	DF	Qual	Units	Date Prepared	Date Analyzed	Method
Solids, Total	ND	0.100	1		%	08/05/09	08/05/09	SM 2540 B

RL - Reporting Limit , DF - Dilution Factor , Qual - Qualifiers

Calscience Environmental Laboratories, Inc.

Quality Control - Spike/Spike Duplicate

MBC Applied Environmental Sciences
3000 Redhill Avenue
Costa Mesa, CA 92626-4524

Date Received: 08/04/09
Work Order No: 09-08-0197
Preparation: EPA 3050B
Method: EPA 6020

Project OBGS 09206A

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	MS/MSD Batch Number
09-08-0194-1	**Tissue**	**ICP/MS 03**	**08/10/09**	**08/10/09**	**090810S01**

Parameter	MS %REC	MSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Chromium	98	96	80-120	2	0-20	
Copper	103	101	80-120	2	0-20	
Nickel	98	95	80-120	3	0-20	
Zinc	96	96	80-120	0	0-20	

RPD - Relative Percent Difference , CL - Control Limit

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Calscience Environmental Laboratories, Inc.

Quality Control - PDS / PDSD

MBC Applied Environmental Sciences
3000 Redhill Avenue
Costa Mesa, CA 92626-4524

Date Received	08/04/09
Work Order No:	09-08-0197
Preparation:	EPA 3050B
Method:	EPA 6020

Project: OBGS 09206A

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	PDS/PDSD Batch Number
09-08-0194-1	**Tissue**	**ICP/MS 03**	**08/10/09**	**08/10/09**	**090810S01**

Parameter	PDS %REC	PDSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Chromium	95	97	75-125	2	0-20	
Copper	100	97	75-125	2	0-20	
Nickel	98	97	75-125	1	0-20	
Zinc	74	73	75-125	0	0-20	5

RPD - Relative Percent Difference , CL - Control Limit

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Calscience Environmental Laboratories, Inc.

Quality Control - Duplicate

MBC Applied Environmental Sciences
3000 Redhill Avenue
Costa Mesa, CA 92626-4524

Date Received: N/A
Work Order No: 09-08-0197

Project: OBGS 09206A

Matrix: Tissue

Parameter	Method	QC Sample ID	Date Analyzed	Sample Conc	DUP Conc	RPD	RPD CL	Qualifiers
Solids, Total	SM 2540 B	09-08-0194-1	08/05/09	66.5	66.4	0	0-25	

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Quality Control - LCS/LCS Duplicate

MBC Applied Environmental Sciences		Date Received:	N/A
3000 Redhill Avenue		Work Order No:	09-08-0197
Costa Mesa, CA 92626-4524		Preparation:	EPA 3050B
		Method:	EPA 6020

Project: OBGS 09206A

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	LCS/LCSD Batch Number
099-12-411-12	**Tissue**	**ICP/MS 03**	**08/10/09**	**08/10/09**	**090810L01**

Parameter	LCS %REC	LCSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Chromium	100	98	80-120	2	0-20	
Copper	104	102	80-120	1	0-20	
Nickel	101	100	80-120	0	0-20	
Zinc	105	107	80-120	2	0-20	

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Glossary of Terms and Qualifiers

Work Order Number: 09-08-0197

Qualifier	Definition
*	See applicable analysis comment.
1	Surrogate compound recovery was out of control due to a required sample dilution, therefore, the sample data was reported without further clarification.
2	Surrogate compound recovery was out of control due to matrix interference. The associated method blank surrogate spike compound was in control and, therefore, the sample data was reported without further clarification.
3	Recovery of the Matrix Spike (MS) or Matrix Spike Duplicate (MSD) compound was out of control due to matrix interference. The associated LCS and/or LCSD was in control and, therefore, the sample data was reported without further clarification.
4	The MS/MSD RPD was out of control due to matrix interference. The LCS/LCSD RPD was in control and, therefore, the sample data was reported without further clarification.
5	The PDS/PDSD associated with this batch of samples was out of control due to a matrix interference effect. The associated batch LCS/LCSD was in control and, hence, the associated sample data was reported with no further corrective action required.
A	Result is the average of all dilutions, as defined by the method.
B	Analyte was present in the associated method blank.
C	Analyte presence was not confirmed on primary column.
E	Concentration exceeds the calibration range.
H	Sample received and/or analyzed past the recommended holding time.
J	Analyte was detected at a concentration below the reporting limit and above the laboratory method detection limit. Reported value is estimated.
ME	LCS Recovery Percentage is within LCS ME Control Limit range.
N	Nontarget Analyte.
ND	Parameter not detected at the indicated reporting limit.
Q	Spike recovery and RPD control limits do not apply resulting from the parameter concentration in the sample exceeding the spike concentration by a factor of four or greater.
U	Undetected at the laboratory method detection limit.
X	% Recovery and/or RPD out-of-range.
Z	Analyte presence was not confirmed by second column or GC/MS analysis.
	Solid - Unless otherwise indicated, solid sample data is reported on a wet weight basis, not corrected for % moisture.

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Calscience Environmental Laboratories, Inc.

Analytical Report

MBC Applied Environmental Sciences
3000 Redhill Avenue
Costa Mesa, CA 92626-4524

Date Received:	08/04/09
Work Order No:	09-08-0198
Preparation:	EPA 3050B
Method:	EPA 6020
Units:	mg/kg

Project: MGS 09205A / OBGS 09206A

Client Sample Number	Lab Sample Number	Date /Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
RRI Source-I	**09-08-0198-1-A**	**03/10/09 00:00**	**Tissue**	**ICP/MS 03**	**08/10/09**	**08/10/09 20:40**	**090810L01**

Comment(s): -Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	0.982	0.156	0.5		Nickel	0.462	0.0781	0.5	
Copper	1.17	0.234	0.5		Zinc	27.7	1.56	0.5	

Client Sample Number	Lab Sample Number	Date /Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
RRI Source-II	**09-08-0198-2-A**	**03/10/09 00:00**	**Tissue**	**ICP/MS 03**	**08/10/09**	**08/10/09 20:44**	**090810L01**

Comment(s): -Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	0.885	0.165	0.5		Nickel	0.478	0.0824	0.5	
Copper	1.29	0.247	0.5		Zinc	26.4	1.65	0.5	

Client Sample Number	Lab Sample Number	Date /Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
RRI Source-III	**09-08-0198-3-A**	**03/10/09 00:00**	**Tissue**	**ICP/MS 03**	**08/10/09**	**08/10/09 20:48**	**090810L01**

Comment(s): -Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	0.594	0.145	0.5		Nickel	0.275	0.0725	0.5	
Copper	0.938	0.217	0.5		Zinc	22.6	1.45	0.5	

Client Sample Number	Lab Sample Number	Date /Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
Method Blank	**099-12-411-12**	**N/A**	**Tissue**	**ICP/MS 03**	**08/10/09**	**08/10/09 18:45**	**090810L01**

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	ND	0.100	0.5		Nickel	ND	0.0500	0.5	
Copper	ND	0.150	0.5		Zinc	ND	1.00	0.5	

RL - Reporting Limit , DF - Dilution Factor , Qual - Qualifiers

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Calscience Environmental Laboratories, Inc.

Analytical Report

MBC Applied Environmental Sciences
3000 Redhill Avenue
Costa Mesa, CA 92626-4524

Date Received: 08/04/09
Work Order No: 09-08-0198

Project: MGS 09205A / OBGS 09206A

Client Sample Number	Lab Sample Number	Date Collected	Matrix
RRI Source-I	**09-08-0198-1**	**03/10/09**	**Tissue**

Parameter	Result	RL	DF	Qual	Units	Date Prepared	Date Analyzed	Method
Solids, Total	64.0	0.100	1		%	08/05/09	08/05/09	SM 2540 B

Client Sample Number	Lab Sample Number	Date Collected	Matrix
RRI Source-II	**09-08-0198-2**	**03/10/09**	**Tissue**

Parameter	Result	RL	DF	Qual	Units	Date Prepared	Date Analyzed	Method
Solids, Total	60.7	0.100	1		%	08/05/09	08/05/09	SM 2540 B

Client Sample Number	Lab Sample Number	Date Collected	Matrix
RRI Source-III	**09-08-0198-3**	**03/10/09**	**Tissue**

Parameter	Result	RL	DF	Qual	Units	Date Prepared	Date Analyzed	Method
Solids, Total	69.0	0.100	1		%	08/05/09	08/05/09	SM 2540 B

Client Sample Number	Lab Sample Number	Date Collected	Matrix
Method Blank		**N/A**	**Solid**

Parameter	Result	RL	DF	Qual	Units	Date Prepared	Date Analyzed	Method
Solids, Total	ND	0.100	1		%	08/05/09	08/05/09	SM 2540 B

RL - Reporting Limit , DF - Dilution Factor , Qual - Qualifiers

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Quality Control - Spike/Spike Duplicate

MBC Applied Environmental Sciences		Date Received:	08/04/09
3000 Redhill Avenue		Work Order No:	09-08-0198
Costa Mesa, CA 92626-4524		Preparation:	EPA 3050B
		Method:	EPA 6020

Project MGS 09205A / OBGS 09206A

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	MS/MSD Batch Number
09-08-0194-1	**Tissue**	**ICP/MS 03**	**08/10/09**	**08/10/09**	**090810S01**

Parameter	MS %REC	MSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Chromium	98	96	80-120	2	0-20	
Copper	103	101	80-120	2	0-20	
Nickel	98	95	80-120	3	0-20	
Zinc	96	96	80-120	0	0-20	

RPD - Relative Percent Difference , CL - Control Limit

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Quality Control - PDS / PDSD

MBC Applied Environmental Sciences
3000 Redhill Avenue
Costa Mesa, CA 92626-4524

Date Received: 08/04/09
Work Order No: 09-08-0198
Preparation: EPA 3050B
Method: EPA 6020

Project: MGS 09205A / OBGS 09206A

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	PDS/PDSD Batch Number
09-08-0194-1	**Tissue**	**ICP/MS 03**	**08/10/09**	**08/10/09**	**090810S01**

Parameter	PDS %REC	PDSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Chromium	95	97	75-125	2	0-20	
Copper	100	97	75-125	2	0-20	
Nickel	98	97	75-125	1	0-20	
Zinc	74	73	75-125	0	0-20	5

RPD - Relative Percent Difference , CL - Control Limit

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Quality Control - Duplicate

MBC Applied Environmental Sciences	Date Received:		N/A
3000 Redhill Avenue	Work Order No:		09-08-0198
Costa Mesa, CA 92626-4524			

Project: MGS 09205A / OBGS 09206A

Matrix: Tissue

Parameter	Method	QC Sample ID	Date Analyzed	Sample Conc	DUP Conc	RPD	RPD CL	Qualifiers
Solids, Total	SM 2540 B	09-08-0194-1	08/05/09	66.5	66.4	0	0-25	

RPD - Relative Percent Difference , CL - Control Limit

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Calscience Environmental Laboratories, Inc.

Quality Control - LCS/LCS Duplicate

MBC Applied Environmental Sciences		Date Received:	N/A
3000 Redhill Avenue		Work Order No:	09-08-0198
Costa Mesa, CA 92626-4524		Preparation:	EPA 3050B
		Method:	EPA 6020

Project: MGS 09205A / OBGS 09206A

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	LCS/LCSD Batch Number
099-12-411-12	**Tissue**	**ICP/MS 03**	**08/10/09**	**08/10/09**	**090810L01**

Parameter	LCS %REC	LCSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Chromium	100	98	80-120	2	0-20	
Copper	104	102	80-120	1	0-20	
Nickel	101	100	80-120	0	0-20	
Zinc	105	107	80-120	2	0-20	

RPD - Relative Percent Difference , CL - Control Limit

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Calscience Environmental Laboratories, Inc.

Analytical Report

MBC Applied Environmental Sciences		Date Received:	08/04/09
3000 Redhill Avenue		Work Order No:	09-08-0202
Costa Mesa, CA 92626-4524		Preparation:	EPA 3050B
		Method:	EPA 6020
		Units:	mg/kg
Project: RBGS 09204A			Page 1 of 1

Client Sample Number	Lab Sample Number	Date /Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
RBGS MBP - I	**09-08-0202-1-A**	**07/15/09 00:00**	**Tissue**	**ICP/MS 03**	**08/10/09**	**08/10/09 23:06**	**090810L02**

Comment(s): -Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	1.21	0.157	0.5		Nickel	0.427	0.0787	0.5	
Copper	3.75	0.236	0.5		Zinc	35.6	1.57	0.5	

Client Sample Number	Lab Sample Number	Date /Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
RBGS MBP - II	**09-08-0202-2-A**	**07/15/09 00:00**	**Tissue**	**ICP/MS 03**	**08/10/09**	**08/10/09 23:10**	**090810L02**

Comment(s): -Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	1.12	0.161	0.5		Nickel	0.347	0.0804	0.5	
Copper	3.89	0.241	0.5		Zinc	32.6	1.61	0.5	

Client Sample Number	Lab Sample Number	Date /Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
RBGS MBP - III	**09-08-0202-3-A**	**07/15/09 00:00**	**Tissue**	**ICP/MS 03**	**08/10/09**	**08/10/09 23:14**	**090810L02**

Comment(s): -Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	1.26	0.163	0.5		Nickel	0.570	0.0816	0.5	
Copper	3.63	0.245	0.5		Zinc	38.3	1.63	0.5	

Client Sample Number	Lab Sample Number	Date /Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
Method Blank	**099-12-411-13**	**N/A**	**Tissue**	**ICP/MS 03**	**08/10/09**	**08/10/09 21:04**	**090810L02**

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	ND	0.100	0.5		Nickel	ND	0.0500	0.5	
Copper	ND	0.150	0.5		Zinc	ND	1.00	0.5	

RL - Reporting Limit , DF - Dilution Factor , Qual - Qualifiers

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Analytical Report

MBC Applied Environmental Sciences
3000 Redhill Avenue
Costa Mesa, CA 92626-4524

Date Received: 08/04/09
Work Order No: 09-08-0202

Project: RBGS 09204A

Client Sample Number	Lab Sample Number	Date Collected	Matrix
RBGS MBP - I	**09-08-0202-1**	**07/15/09**	**Tissue**

Parameter	Result	RL	DF	Qual	Units	Date Prepared	Date Analyzed	Method
Solids, Total	63.5	0.100	1		%	08/05/09	08/05/09	SM 2540 B

RBGS MBP - II	**09-08-0202-2**	**07/15/09**	**Tissue**

Parameter	Result	RL	DF	Qual	Units	Date Prepared	Date Analyzed	Method
Solids, Total	62.2	0.100	1		%	08/05/09	08/05/09	SM 2540 B

RBGS MBP- III	**09-08-0202-3**	**07/15/09**	**Tissue**

Parameter	Result	RL	DF	Qual	Units	Date Prepared	Date Analyzed	Method
Solids, Total	61.3	0.100	1		%	08/05/09	08/05/09	SM 2540 B

Method Blank		**N/A**	**Solid**

Parameter	Result	RL	DF	Qual	Units	Date Prepared	Date Analyzed	Method
Solids, Total	ND	0.100	1		%	08/05/09	08/05/09	SM 2540 B

RL - Reporting Limit , DF - Dilution Factor , Qual - Qualifiers

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Calscience Environmental Laboratories, Inc.

Quality Control - Spike/Spike Duplicate

MBC Applied Environmental Sciences
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Costa Mesa, CA 92626-4524

Date Received:	08/04/09
Work Order No:	09-08-0202
Preparation:	EPA 3050B
Method:	EPA 6020

Project RBGS 09204A

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	MS/MSD Batch Number
09-08-0200-1	**Tissue**	**ICP/MS 03**	**08/10/09**	**08/10/09**	**090810S02**

Parameter	MS %REC	MSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Chromium	102	101	80-120	1	0-20	
Copper	60	57	80-120	2	0-20	3
Nickel	103	102	80-120	1	0-20	
Zinc	108	104	80-120	2	0-20	

RPD - Relative Percent Difference , CL - Control Limit

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Quality Control - PDS / PDSD

MBC Applied Environmental Sciences		Date Received	08/04/09
3000 Redhill Avenue		Work Order No:	09-08-0202
Costa Mesa, CA 92626-4524		Preparation:	EPA 3050B
		Method:	EPA 6020

Project: RBGS 09204A

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	PDS/PDSD Batch Number
09-08-0200-1	**Tissue**	**ICP/MS 03**	**08/10/09**	**08/10/09**	**090810S02**

Parameter	PDS %REC	PDSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Chromium	99	99	75-125	1	0-20	
Copper	101	99	75-125	1	0-20	
Nickel	99	98	75-125	1	0-20	
Zinc	94	95	75-125	0	0-20	

RPD - Relative Percent Difference , CL - Control Limit

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Calscience Environmental Laboratories, Inc.

Quality Control - Duplicate

MBC Applied Environmental Sciences
3000 Redhill Avenue
Costa Mesa, CA 92626-4524

Date Received: N/A
Work Order No: 09-08-0202

Project: RBGS 09204A

Matrix: Tissue

Parameter	Method	QC Sample ID	Date Analyzed	Sample Conc	DUP Conc	RPD	RPD CL	Qualifiers
Solids, Total	SM 2540 B	09-08-0199-1	08/05/09	63.4	66.3	4	0-25	

RPD - Relative Percent Difference , CL - Control Limit

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Calscience Environmental Laboratories, Inc.

Quality Control - LCS/LCS Duplicate

MBC Applied Environmental Sciences
3000 Redhill Avenue
Costa Mesa, CA 92626-4524

Date Received:	N/A
Work Order No:	09-08-0202
Preparation:	EPA 3050B
Method:	EPA 6020

Project: RBGS 09204A

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	LCS/LCSD Batch Number
099-12-411-13	Tissue	ICP/MS 03	08/10/09	08/10/09	090810L02

Parameter	LCS %REC	LCSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Chromium	101	101	80-120	0	0-20	
Copper	102	105	80-120	3	0-20	
Nickel	100	102	80-120	3	0-20	
Zinc	104	104	80-120	0	0-20	

RPD - Relative Percent Difference , CL - Control Limit

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APPENDIX F

Infauna data by station

Appendix F-1. Infaunal master species list. Ormond Beach Generating Station NPDES, 2009.

PHYLUM (Phy)
- Subphylum or Class
  - Species

CNIDARIA (CN)
- Anthozoa
  - Actiniaria
  - *Zaolutus actius*

PLATYHELMINTHES (PL)
- Turbellaria
  - *Cryptocelis occidentalis*
  - Platyhelminthes

NEMERTEA (NE)
- Anopla
  - *Carinoma mutabilis*
  - Lineidae
  - *Micrura* sp
  - *Tubulanus polymorphus* [1]
  - *Tubulanus* sp A SCAMIT 2005[2]
- Enopla
  - Hoplonemertea
  - *Paranemertes californica*[3]
  - *Tetrastemma* sp
  - *Zygonemertes virescens*
- Uncertain
  - Nemertea

NEMATODA (NT)
  - Nematoda

MOLLUSCA (MO)
- Gastropoda
  - *Acanthodoris rhodoceras*
  - *Balcis oldroydae*
  - *Caesia perpinguis*[4]
  - *Callianax baetica*[5]
  - *Epitonium sawinae*[6]
  - *Fartulum occidentale*
  - Gastropoda
  - *Odostomia* sp D MBC 1980
  - *Turbonilla almo*
  - *Turbonilla* sp A SCAMIT 1988
- Bivalvia
  - Bivalvia
  - *Cooperella subdiaphana*
  - *Cumingia californica*
  - *Leukoma staminea*[7]
  - *Lyonsia californica*
  - *Macoma* sp
  - Mytilidae
  - *Pandora bilirata*
  - *Periploma discus*
  - *Petricola carditoides*
  - *Rochefortia tumida* [8]
  - *Siliqua lucida*
  - *Simomactra falcata*
  - *Solen sicarius*
  - *Tellina modesta*
- Scaphopoda
  - *Gadila aberrans*[9]

SIPUNCULA (SI)
- Phascolosomatidea
  - *Apionsoma misakianum*[10]
  - *Siphonosoma ingens*

PHYLUM
- Subphylum or Class
  - Species

ANNELIDA (AN)
- Polychaeta
  - *Apoprionospio pygmaea*
  - *Amaeana occidentalis*
  - *Ampharete labrops*
  - *Anotomastus gordiodes*
  - *Aphelochaeta glandaria* Cmplx[11]
  - *Aricidea (Aedicira) pacifica*
  - *Aricidea (Acmira) catherinae* [12]
  - *Armandia brevis*[13]
  - *Chaetozone corona*
  - *Chaetozone setosa* Cmplx [14]
  - *Chone eiffelturris*[15]
  - *Diopatra ornata*
  - *Diopatra splendidissima*
  - *Dipolydora bidentata*
  - Euclymeninae sp A SCAMIT 1987
  - *Exogone lourei*
  - *Glycera macrobranchia* [16]
  - *Glycera nana*
  - *Glycinde armigera*
  - *Goniada littorea*
  - *Goniada maculata*
  - *Hemipodia borealis*
  - *Hesionella mccullochae*
  - *Leitoscoloplos pugettensis* [17]
  - *Lumbrineris japonica*
  - *Magelona berkeleyi*
  - *Magelona sacculata*
  - Maldanidae
  - *Malmgreniella scriptoria*
  - *Mediomastus acutus* [18]
  - *Mediomastus ambiseta* [18]
  - *Mediomastus californiensis*[18]
  - *Monticellina cryptica* [19]
  - *Nephtys caecoides*
  - *Nephtys cornuta*[20]
  - *Notomastus tenuis*[21]
  - Onuphidae
  - *Onuphis* sp A SCAMIT 1992[22]
  - *Owenia collaris*[23]
  - *Pectinaria californiensis*
  - *Phyllodoce hartmanae*
  - *Podarkeopsis glabrus*
  - *Polydora cirrosa*
  - *Rhynchospio arenincola*
  - *Scolelepis (Scolelepis) squamata*
  - *Scoletoma* spp
  - *Scoletoma tetraura* Cmplx [24]
  - *Sigalion spinosus* [25]
  - *Sphaerodoropsis biserialis*
  - *Spiochaetopterus costarum* Cmplx
  - *Spiophanes berkeleyorum*
  - *Spiophanes bombyx*
  - *Spiophanes duplex* [26]
  - *Sthenelais tertiaglabra*
  - Syllidae
  - *Typosyllis farallonensis* [27]
  - *Typosyllis heterochaeta*[28]

Appendix F-1. (Cont.).

PHYLUM Subphylum or Class Species
ARTHROPODA (AR)
Maxillopoda
Harpacticoida
Ostracoda
Asteropella slatteryi
Harbansus bradmyersi
Parasterope hulingsi
Rutiderma rostratum
Zeugophilomedes oblonga[29]
Malacostraca
Americhelidium shoemakeri[30]
Ampelisca agassizi[31]
Anchicolurus occidentalis
Aoroides inermis
Aoroides sp
Campylaspis sp C Myers & Benedict 1974
Caprella californica
Cumella californica[32]
Cyclaspis nubila
Cyclaspis sp C SCAMIT 1986
Diastylopsis tenuis
Edotia sublittoralis[33]
Foxiphalus obtusidens[34]
Gibberosus myersi[35]
Hemilamprops californicus
Incisocalliope newportensis
Ischyrocerus pelagops
Jassa slatteryi[36]
Lamprops carinatus
Lamprops triserrata
Lamprops quadriplicatus
Monocorophium acherusicum
Photis brevipes
Photis californica
Photis macinerneyi
ARTHROPODA (AR)
Malacostraca
Phoxocephalidae
Pinnixa sp
Pontogeneia rostrata
Rhepoxynius abronius
Rhepoxynius menziesi[37]
Rhepoxynius sp
Rhepoxynius sp A SCAMIT 1987
Rhepoxynius variatus
Tiron biocellata
Uromunna ubiquita[38]
KINORHYNCHA (KI)
Kinorhyncha
ECHINODERMATA (EC)
Echinoidea
Dendraster excentricus
Holothuroidea
Leptosynapta sp
Ophiuroidea
Amphiodia digitata
Amphiodia psara[39]
Amphiodia sp
Amphiuridae
PHORONA (PR)
Phoronida
Phoronis sp
BRACHIOPODA (BC)
Inarticulata
Glottidia albida

SCAMIT = Southern California Association of Marine Invertebrate Taxonomists

The following footnotes indicate names used in previous surveys:

1 *Tubulanus pellucidus/polymorphus, T.* sp or *T.* spp
2 *Tubulanus nothus*
3 *Paranemertes* sp A of SCAMIT
4 *Nassarius perpinguis*
5 *Olivella baetica*
6 *Nitidiscala sawinae*
7 *Protothaca staminea*
8 *Mysella tumida, M. cf. aleutica*
9 *Cadulus aberrans*
10 *Golfingia misakiana*
11 *Aphelochaeta* sp C Dorsey
12 *Acmira catherinae*
13 *Armandia bioculata*
14 *Chaetozone "setosa", C.* cf. *setosa*
15 *Chone* sp SD1 Pt. Loma 1997
16 *Glycera convoluta*
17 *Hapolscoloplos elongatus*
18 *Mediomastus* spp (in part)
19 *Monticellina dorsobranchialis, Tharyx* sp A SCAMIT
20 *Nephtys cornuta franciscana*
21 *Notomastus hemipodus*
22 *Onuphis* sp 1 Pt. Loma 1983
23 *Owenia fusiformis*
24 *Lumbrineris "tetraura"* or *L. tetraura*
25 *Thalenessa spinosum*
26 *Spiophanes missionenesis*
27 *Typosyllis farallonensis*
28
29 *Zeugophilomedes oblongatus, Z. oblongata*
30 *Synchelidium shoemakeri*
31 *Ampelisca compressa*
32 *Cumella* sp A Myers & Benedict or *C.* sp A MBC
33 *Edotea sublittoralis*
34 *Paraphoxus obtusidens*
35 *Megaluropus longimerus*
36 *Jassa falcata*
37 *Paraphoxus epistomus, Rhepoxynius epistomus*
38 *Munna ubiquita*
39 *Amphiodia occidentalis*

Appendix F-2. Infauna results by station. Ormond Beach Generating Station NPDES, 2009.

Phylum	Species	B1	B2	B3	B4	B5	B6	Total	Percent Total
AN	*Apoprionospio pygmaea*	412	566	8	157	133	136	1412	30.24
AN	*Armandia brevis*	119	81	491	74	13	88	866	18.55
NT	Nematoda	7	9	441	-	4	1	462	9.90
AN	*Chone eiffelturris*	90	123	6	7	67	7	300	6.43
AN	*Mediomastus acutus*	26	41	2	29	18	16	132	2.83
MO	*Siliqua lucida*	10	22	3	20	6	24	85	1.82
MO	*Tellina modesta*	13	22	1	27	5	16	84	1.80
AN	*Spiophanes bombyx*	15	17	1	7	14	24	78	1.67
AR	*Photis macinerneyi*	9	8	1	11	12	24	65	1.39
AR	*Ampelisca agassizi*	19	4	-	7	29	3	62	1.33
AN	*Pectinaria californiensis*	3	44	-	4	-	10	61	1.31
AR	*Diastylopsis tenuis*	5	6	6	8	7	29	61	1.31
AN	*Notomastus tenuis*	-	-	60	-	-	-	60	1.29
EC	*Dendraster excentricus*	4	2	-	31	7	15	59	1.26
AR	*Zeugophilomedes oblongus*	21	-	-	16	4	-	41	0.88
AR	*Rhepoxynius abronius*	4	2	-	5	4	22	37	0.79
AR	*Rhepoxynius menziesi*	6	2	-	6	2	15	31	0.66
AN	*Typosyllis farallonensis*	6	4	-	2	8	10	30	0.64
AN	*Aricidea (Acmira) catherinae*	6	5	-	7	6	5	29	0.62
AN	*Glycera macrobranchia*	6	10	-	3	9	1	29	0.62
AN	*Spiochaetopterus costarum* Cmplx	5	10	-	3	4	4	26	0.56
AN	*Exogone lourei*	5	2	-	1	16	-	24	0.51
AN	*Polydora cirrosa*	2	5	-	14	3	-	24	0.51
NE	Lineidae	5	7	2	7	3	-	24	0.51
AN	*Rhynchospio arenincola*	-	-	17	5	1	-	23	0.49
AN	Onuphidae	3	4	3	4	4	2	20	0.43
CN	Actiniaria	-	-	15	1	2	2	20	0.43
NE	*Carinoma mutabilis*	8	4	-	1	4	1	18	0.39
AN	*Ampharete labrops*	2	3	6	3	1	2	17	0.36
AN	*Goniada littorea*	4	2	-	1	4	6	17	0.36
AN	*Scoletoma* spp	1	3	12	-	1	-	17	0.36
AR	*Harbansus bradmyersi*	1	3	-	6	7	-	17	0.36
AN	*Chaetozone setosa* Cmplx	2	9	-	1	4	-	16	0.34
AN	*Phyllodoce hartmanae*	4	4	3	3	-	-	14	0.30
MO	*Leukoma staminea*	3	4	1	2	-	4	14	0.30
AR	*Foxiphalus obtusidens*	-	-	5	7	1	-	13	0.28
AN	*Mediomastus californiensis*	-	-	11	-	-	1	12	0.26
AR	*Uromunna ubiquita*	-	7	-	1	1	2	11	0.24
AN	*Onuphis* sp A SCAMIT 1992	2	4	-	-	1	3	10	0.21
AN	*Spiophanes duplex*	1	5	-	-	2	2	10	0.21
MO	*Cooperella subdiaphana*	-	3	-	-	6	1	10	0.21
PR	*Phoronis* sp	2	2	-	1	5	-	10	0.21
AN	*Leitoscoloplos pugettensis*	1	4	4	-	-	-	9	0.19
AN	*Monticellina cryptica*	-	3	-	-	6	-	9	0.19
AR	*Anchicolurus occidentalis*	1	-	6	2	-	-	9	0.19
AR	*Photis brevipes*	-	-	9	-	-	-	9	0.19
MO	*Callianax baetica*	-	-	9	-	-	-	9	0.19
MO	*Rochefortia tumida*	-	2	-	2	3	2	9	0.19
MO	*Macoma* sp	-	4	-	-	-	4	8	0.17
NE	*Tubulanus polymorphus*	2	2	-	1	3	-	8	0.17
AN	*Owenia collaris*	1	1	-	-	-	5	7	0.15
AN	*Scoletoma tetraura* Cmplx	-	3	2	-	-	2	7	0.15
AN	Syllidae	2	2	-	-	3	-	7	0.15
AR	*Americhelidium shoemakeri*	-	1	1	-	2	3	7	0.15
AR	*Jassa slatteryi*	3	4	-	-	-	-	7	0.15
AN	*Glycera nana*	-	-	6	-	-	-	6	0.13
AN	*Nephtys cornuta*	1	3	-	1	1	-	6	0.13
AN	*Typosyllis heterochaeta*	-	1	-	1	1	3	6	0.13
AR	*Rutiderma rostratum*	1	1	-	2	2	-	6	0.13
NE	Nemertea	1	1	-	1	1	2	6	0.13
AN	*Glycinde armigera*	2	-	1	1	1	-	5	0.11
AN	*Magelona berkeleyi*	-	3	-	-	1	1	5	0.11
AR	*Cyclaspis nubila*	-	1	1	2	1	-	5	0.11
EC	Amphiuridae	-	2	1	2	-	-	5	0.11
MO	*Pandora bilirata*	-	5	-	-	-	-	5	0.11

Appendix F-2. (Cont.).

Phylum	Species	B1	B2	B3	B4	B5	B6	Total	Percent Total
MO	*Petricola carditoides*	-	-	5	-	-	-	5	0.11
NE	*Paranemertes californica*	-	-	-	1	2	2	5	0.11
AN	*Diopatra ornata*	-	-	2	2	-	-	4	0.09
AN	Euclymeninae sp A SCAMIT 1987	-	1	1	-	1	1	4	0.09
AN	*Hesionella mccullochae*	-	-	4	-	-	-	4	0.09
AN	*Mediomastus ambiseta*	2	1	1	-	-	-	4	0.09
AN	*Sphaerodoropsis biserialis*	-	1	-	2	1	-	4	0.09
AR	*Asteropella slatteryi*	1	-	-	-	2	1	4	0.09
AR	*Gibberosus myersi*	-	-	1	2	-	1	4	0.09
AR	*Rhepoxynius* sp A SCAMIT 1987	-	-	-	-	-	4	4	0.09
MO	*Fartulum occidentale*	-	-	4	-	-	-	4	0.09
MO	Mytilidae	-	-	2	-	1	1	4	0.09
AN	*Dipolydora bidentata*	-	-	-	-	3	-	3	0.06
AN	*Nephtys caecoides*	1	1	-	-	1	-	3	0.06
AN	*Sthenelais tertiaglabra*	2	-	1	-	-	-	3	0.06
AR	*Edotia sublittoralis*	-	1	2	-	-	-	3	0.06
AR	Harpacticoida	1	-	-	1	1	-	3	0.06
CN	*Zaolutus actius*	2	1	-	-	-	-	3	0.06
EC	*Amphiodia digitata*	-	-	-	-	-	3	3	0.06
MO	Bivalvia	-	-	2	1	-	-	3	0.06
NE	*Zygonemertes virescens*	-	-	3	-	-	-	3	0.06
AN	*Anotomastus gordiodes*	-	-	2	-	-	-	2	0.04
AN	*Aphelochaeta glandaria* Cmplx	1	-	-	1	-	-	2	0.04
AN	Maldanidae	-	-	-	1	1	-	2	0.04
AR	*Aoroides inermis*	-	2	-	-	-	-	2	0.04
AR	*Campylaspis* sp C Myers&Benedict 1974	-	-	-	1	1	-	2	0.04
AR	*Caprella californica*	-	2	-	-	-	-	2	0.04
AR	*Cumella californica*	-	-	-	-	2	-	2	0.04
AR	*Cyclaspis* sp C SCAMIT 1986	-	-	2	-	-	-	2	0.04
AR	*Hemilamprops californicus*	-	-	-	2	-	-	2	0.04
AR	*Lamprops triserrata*	-	1	-	1	-	-	2	0.04
EC	*Leptosynapta* sp	-	-	-	-	2	-	2	0.04
MO	*Balcis oldroydae*	-	-	-	-	-	2	2	0.04
MO	*Cumingia californica*	-	-	2	-	-	-	2	0.04
MO	Gastropoda	-	-	2	-	-	-	2	0.04
NE	*Micrura* sp	-	1	1	-	-	-	2	0.04
NE	*Tubulanus* sp A SCAMIT 2005	-	2	-	-	-	-	2	0.04
SI	*Apionsoma misakianum*	-	1	-	-	1	-	2	0.04
AN	*Amaeana occidentalis*	-	1	-	-	-	-	1	0.02
AN	*Aricidea (Aedicira) pacifica*	-	1	-	-	-	-	1	0.02
AN	*Chaetozone corona*	-	-	-	-	1	-	1	0.02
AN	*Diopatra splendidissima*	-	-	1	-	-	-	1	0.02
AN	*Goniada maculata*	-	-	-	-	1	-	1	0.02
AN	*Hemipodia borealis*	-	-	1	-	-	-	1	0.02
AN	*Lumbrineris japonica*	-	-	-	1	-	-	1	0.02
AN	*Magelona sacculata*	-	-	-	1	-	-	1	0.02
AN	*Malmgreniella scriptoria*	-	-	-	-	1	-	1	0.02
AN	*Podarkeopsis glabrus*	-	1	-	-	-	-	1	0.02
AN	*Scolelepis (Scolelepis) squamata*	-	-	-	1	-	-	1	0.02
AN	*Sigalion spinosus*	1	-	-	-	-	-	1	0.02
AN	*Spiophanes berkeleyorum*	1	-	-	-	-	-	1	0.02
AR	*Aoroides* sp	1	-	-	-	-	-	1	0.02
AR	*Incisocalliope newportensis*	1	-	-	-	-	-	1	0.02
AR	*Ischyrocerus pelagops*	1	-	-	-	-	-	1	0.02
AR	*Lamprops carinatus*	-	1	-	-	-	-	1	0.02
AR	*Lamprops quadriplicatus*	-	-	-	1	-	-	1	0.02
AR	*Monocorophium acherusicum*	-	-	1	-	-	-	1	0.02
AR	*Parasterope hulingsi*	-	-	-	-	1	-	1	0.02
AR	*Photis californica*	1	-	-	-	-	-	1	0.02
AR	Phoxocephalidae	-	-	-	-	1	-	1	0.02
AR	*Pinnixa* sp	-	-	-	-	1	-	1	0.02
AR	*Pontogeneia rostrata*	-	-	1	-	-	-	1	0.02
AR	*Rhepoxynius* sp	1	-	-	-	-	-	1	0.02
AR	*Rhepoxynius variatus*	-	-	-	-	1	-	1	0.02
AR	*Tiron biocellata*	-	1	-	-	-	-	1	0.02

Appendix F-2. (Cont.).

Phylum	Species	Station B1	B2	B3	B4	B5	B6	Total	Percent Total
BC	*Glottidia albida*	-	-	-	1	-	-	1	0.02
EC	*Amphiodia psara*	-	-	-	1	-	-	1	0.02
EC	*Amphiodia* sp	-	-	-	-	1	-	1	0.02
KI	Kinorhyncha	-	1	-	-	-	-	1	0.02
MO	*Acanthodoris rhodoceras*	-	1	-	-	-	-	1	0.02
MO	*Caesia perpinguis*	-	-	1	-	-	-	1	0.02
MO	*Epitonium sawinae*	-	1	-	-	-	-	1	0.02
MO	*Gadila aberrans*	-	-	-	-	1	-	1	0.02
MO	*Lyonsia californica*	-	-	-	1	-	-	1	0.02
MO	*Odostomia* sp D MBC 1980	-	-	-	-	1	-	1	0.02
MO	*Periploma discus*	-	1	-	-	-	-	1	0.02
MO	*Simomactra falcata*	-	-	1	-	-	-	1	0.02
MO	*Solen sicarius*	-	1	-	-	-	-	1	0.02
MO	*Turbonilla almo*	-	-	1	-	-	-	1	0.02
MO	*Turbonilla* sp A SCAMIT 1988	-	1	-	-	-	-	1	0.02
NE	Hoplonemertea	-	-	-	-	1	-	1	0.02
NE	*Tetrastemma* sp	-	-	1	-	-	-	1	0.02
PL	*Cryptocelis occidentalis*	-	-	-	1	-	-	1	0.02
PL	Platyhelminthes	-	-	-	-	1	-	1	0.02
SI	*Siphonosoma ingens*	-	-	-	1	-	-	1	0.02
	Number of individuals	863	1118	1180	521	474	513	4669	
	Number of species	59	77	56	65	74	46	150	
	Diversity (H')	2.20	2.27	1.74	2.90	3.12	2.80	2.86	

Appendix F-3. Infauna data by station and replicate. Ormond Beach Generating Station NPDES. 2009.

Station B1

Phylum	Species	Replicate B1-I	B1-II	B1-III	B1-IV	Total	Percent Composition	Density No./m²
AN	*Apoprionospio pygmaea*	134	129	35	114	412	47.74	10300.0
AN	*Armandia brevis*	17	38	23	41	119	13.79	2975.0
AN	*Chone eiffelturris*	16	46	15	13	90	10.43	2250.0
AN	*Mediomastus acutus*	4	10	5	7	26	3.01	650.0
AR	*Zeugophilomedes oblongus*	9	6	6	-	21	2.43	525.0
AR	*Ampelisca agassizi*	1	3	2	13	19	2.20	475.0
AN	*Spiophanes bombyx*	2	3	4	6	15	1.74	375.0
MO	*Tellina modesta*	6	5	2	-	13	1.51	325.0
MO	*Siliqua lucida*	3	6	1	-	10	1.16	250.0
AR	*Photis macinerneyi*	3	2	1	3	9	1.04	225.0
NE	*Carinoma mutabilis*	3	2	2	1	8	0.93	200.0
NT	Nematoda	1	1	3	2	7	0.81	175.0
AN	*Aricidea (Acmira) catherinae*	1	1	3	1	6	0.70	150.0
AN	*Glycera macrobranchia*	1	1	3	1	6	0.70	150.0
AN	*Typosyllis farallonensis*	1	4	-	1	6	0.70	150.0
AR	*Rhepoxynius menziesi*	-	4	1	1	6	0.70	150.0
AN	*Exogone lourei*	-	2	2	1	5	0.58	125.0
AN	*Spiochaetopterus costarum* Cmplx	2	3	-	-	5	0.58	125.0
AR	*Diastylopsis tenuis*	1	3	1	-	5	0.58	125.0
NE	Lineidae	2	2	1	-	5	0.58	125.0
AN	*Goniada littorea*	1	2	-	1	4	0.46	100.0
AN	*Phyllodoce hartmanae*	2	2	-	-	4	0.46	100.0
AR	*Rhepoxynius abronius*	3	1	-	-	4	0.46	100.0
EC	*Dendraster excentricus*	1	2	1	-	4	0.46	100.0
AN	Onuphidae	-	3	-	-	3	0.35	75.0
AN	*Pectinaria californiensis*	2	-	1	-	3	0.35	75.0
AR	*Jassa slatteryi*	1	1	-	1	3	0.35	75.0
MO	*Leukoma staminea*	2	1	-	-	3	0.35	75.0
AN	*Ampharete labrops*	-	1	1	-	2	0.23	50.0
AN	*Chaetozone setosa* Cmplx	-	1	1	-	2	0.23	50.0
AN	*Glycinde armigera*	-	2	-	-	2	0.23	50.0
AN	*Mediomastus ambiseta*	1	-	1	-	2	0.23	50.0
AN	*Onuphis* sp A SCAMIT 1992	1	-	1	-	2	0.23	50.0
AN	*Polydora cirrosa*	-	2	-	-	2	0.23	50.0
AN	*Sthenelais tertiaglabra*	-	1	1	-	2	0.23	50.0
AN	Syllidae	-	1	-	1	2	0.23	50.0
CN	*Zaolutus actius*	1	-	-	1	2	0.23	50.0
NE	*Tubulanus polymorphus*	-	1	1	-	2	0.23	50.0
PR	*Phoronis* sp	2	-	-	-	2	0.23	50.0
AN	*Aphelochaeta glandaria* Cmplx	-	-	-	1	1	0.12	25.0
AN	*Leitoscoloplos pugettensis*	-	1	-	-	1	0.12	25.0
AN	*Nephtys caecoides*	-	-	1	-	1	0.12	25.0
AN	*Nephtys cornuta*	-	1	-	-	1	0.12	25.0
AN	*Owenia collaris*	-	1	-	-	1	0.12	25.0
AN	*Scoletoma* sp	1	-	-	-	1	0.12	25.0
AN	*Sigalion spinosus*	1	-	-	-	1	0.12	25.0
AN	*Spiophanes berkeleyorum*	-	-	1	-	1	0.12	25.0
AN	*Spiophanes duplex*	-	-	-	1	1	0.12	25.0
AR	*Anchicolurus occidentalis*	-	1	-	-	1	0.12	25.0
AR	*Aoroides* sp	-	-	1	-	1	0.12	25.0
AR	*Asteropella slatteryi*	-	-	1	-	1	0.12	25.0
AR	*Harbansus bradmyersi*	-	1	-	-	1	0.12	25.0
AR	Harpacticoida	-	1	-	-	1	0.12	25.0
AR	*Incisocalliope newportensis*	-	-	-	1	1	0.12	25.0
AR	*Ischyrocerus pelagops*	-	1	-	-	1	0.12	25.0
AR	*Photis californica*	-	-	-	1	1	0.12	25.0
AR	*Rhepoxynius* sp	-	-	-	1	1	0.12	25.0
AR	*Rutiderma rostratum*	-	1	-	-	1	0.12	25.0
NE	Nemertea	-	-	1	-	1	0.12	25.0

Summary

Parameter	Replicate B1-I	B1-II	B1-III	B1-IV	Station Total	Overall Mean	S.D.
Number of individuals	226	300	123	214	863	215.8	72.6
Number of species	31	42	31	23	59	31.8	7.8
Diversity (H')	1.85	2.26	2.56	1.68	2.20	2.09	0.40

Appendix F-3. (Cont.).

Station B2

Phylum	Species	Replicate B2-I	B2-II	B2-III	B2-IV	Total	Percent Composition	Density No./m²
AN	*Apoprionospio pygmaea*	118	206	142	100	566	50.63	14150.0
AN	*Chone eiffelturris*	43	37	29	14	123	11.00	3075.0
AN	*Armandia brevis*	34	32	12	3	81	7.25	2025.0
AN	*Pectinaria californiensis*	23	-	1	20	44	3.94	1100.0
AN	*Mediomastus acutus*	16	8	5	12	41	3.67	1025.0
MO	*Siliqua lucida*	5	6	2	9	22	1.97	550.0
MO	*Tellina modesta*	13	2	1	6	22	1.97	550.0
AN	*Spiophanes bombyx*	5	5	5	2	17	1.52	425.0
AN	*Glycera macrobranchia*	1	2	4	3	10	0.89	250.0
AN	*Spiochaetopterus costarum* Cmplx	5	2	2	1	10	0.89	250.0
AN	*Chaetozone setosa* Cmplx	1	4	2	2	9	0.81	225.0
NT	Nematoda	2	2	4	1	9	0.81	225.0
AR	*Photis macinerneyi*	1	4	3	-	8	0.72	200.0
AR	*Uromunna ubiquita*	1	2	1	3	7	0.63	175.0
NE	Lineidae	2	1	2	2	7	0.63	175.0
AR	*Diastylopsis tenuis*	1	2	1	2	6	0.54	150.0
AN	*Aricidea (Acmira) catherinae*	1	3	-	1	5	0.45	125.0
AN	*Polydora cirrosa*	3	1	1	-	5	0.45	125.0
AN	*Spiophanes duplex*	-	3	2	-	5	0.45	125.0
MO	*Pandora bilirata*	2	-	1	2	5	0.45	125.0
AN	*Leitoscoloplos pugettensis*	-	2	1	1	4	0.36	100.0
AN	Onuphidae	2	-	-	2	4	0.36	100.0
AN	*Onuphis* sp A SCAMIT 1992	1	2	1	-	4	0.36	100.0
AN	*Phyllodoce hartmanae*	-	1	-	3	4	0.36	100.0
AN	*Typosyllis farallonensis*	2	-	1	1	4	0.36	100.0
AR	*Ampelisca agassizi*	-	1	2	1	4	0.36	100.0
AR	*Jassa slatteryi*	1	-	-	3	4	0.36	100.0
MO	*Leukoma staminea*	3	1	-	-	4	0.36	100.0
MO	*Macoma* sp	2	1	-	1	4	0.36	100.0
NE	*Carinoma mutabilis*	-	2	2	-	4	0.36	100.0
AN	*Ampharete labrops*	3	-	-	-	3	0.27	75.0
AN	*Magelona berkeleyi*	-	-	2	1	3	0.27	75.0
AN	*Monticellina cryptica*	-	-	2	1	3	0.27	75.0
AN	*Nephtys cornuta*	1	2	-	-	3	0.27	75.0
AN	*Scoletoma* sp	1	1	1	-	3	0.27	75.0
AN	*Scoletoma tetraura* Cmplx	-	-	2	1	3	0.27	75.0
AR	*Harbansus bradmyersi*	3	-	-	-	3	0.27	75.0
MO	*Cooperella subdiaphana*	3	-	-	-	3	0.27	75.0
AN	*Exogone lourei*	2	-	-	-	2	0.18	50.0
AN	*Goniada littorea*	-	-	2	-	2	0.18	50.0
AN	Syllidae	1	-	1	-	2	0.18	50.0
AR	*Aoroides inermis*	-	-	-	2	2	0.18	50.0
AR	*Caprella californica*	-	1	-	1	2	0.18	50.0
AR	*Rhepoxynius abronius*	1	1	-	-	2	0.18	50.0
AR	*Rhepoxynius menziesi*	-	2	-	-	2	0.18	50.0
EC	Amphiuridae	1	-	1	-	2	0.18	50.0
EC	*Dendraster excentricus*	2	-	-	-	2	0.18	50.0
MO	*Rochefortia tumida*	2	-	-	-	2	0.18	50.0
NE	*Tubulanus polymorphus*	1	-	-	1	2	0.18	50.0
NE	*Tubulanus* sp A SCAMIT 2005	-	1	-	1	2	0.18	50.0
PR	*Phoronis* sp	1	-	1	-	2	0.18	50.0
AN	*Amaeana occidentalis*	-	1	-	-	1	0.09	25.0
AN	*Aricidea (Aedicira) pacifica*	1	-	-	-	1	0.09	25.0
AN	Euclymeninae sp A SCAMIT 1987	-	-	1	-	1	0.09	25.0
AN	*Mediomastus ambiseta*	-	1	-	-	1	0.09	25.0
AN	*Nephtys caecoides*	-	-	-	1	1	0.09	25.0
AN	*Owenia collaris*	1	-	-	-	1	0.09	25.0
AN	*Podarkeopsis glabrus*	-	-	1	-	1	0.09	25.0
AN	*Sphaerodoropsis biserialis*	-	-	1	-	1	0.09	25.0
AN	*Typosyllis heterochaeta*	-	-	-	1	1	0.09	25.0
AR	*Americhelidium shoemakeri*	-	1	-	-	1	0.09	25.0
AR	*Cyclaspis nubila*	-	-	-	1	1	0.09	25.0
AR	*Edotia sublittoralis*	1	-	-	-	1	0.09	25.0
AR	*Lamprops carinatus*	-	-	-	1	1	0.09	25.0
AR	*Lamprops triserrata*	-	-	-	1	1	0.09	25.0

Appendix F-3. (Cont.).

Station B2

Phylum	Species	Replicate B2-I	B2-II	B2-III	B2-IV	Total	Percent Composition	Density No./m²
AR	*Rutiderma rostratum*	1	-	-	-	1	0.09	25.0
AR	*Tiron biocellata*	-	-	1	-	1	0.09	25.0
CN	*Zaolutus actius*	1	-	-	-	1	0.09	25.0
KI	Kinorhyncha	-	-	1	-	1	0.09	25.0
MO	*Acanthodoris rhodoceras*	-	-	1	-	1	0.09	25.0
MO	*Epitonium sawinae*	1	-	-	-	1	0.09	25.0
MO	*Periploma discus*	1	-	-	-	1	0.09	25.0
MO	*Solen sicarius*	-	-	-	1	1	0.09	25.0
MO	*Turbonilla* sp A SCAMIT 1988	1	-	-	-	1	0.09	25.0
NE	*Micrura* sp	-	1	-	-	1	0.09	25.0
NE	Nemertea	1	-	-	-	1	0.09	25.0
SI	*Apionsoma misakianum*	-	-	1	-	1	0.09	25.0

Summary

Parameter	Replicate B2-I	B2-II	B2-III	B2-IV	Station Total	Overall Mean	S.D.
Number of individuals	319	344	246	209	1118	279.5	62.8
Number of species	47	35	39	37	77	39.5	5.3
Diversity (H')	2.48	1.74	1.94	2.26	2.27	2.11	0.33

Appendix F-3. (Cont.).

Station B3

Phylum	Species	Replicate B3-I	B3-II	B3-III	B3-IV	Total	Percent Composition	Density No./m²
AN	*Armandia brevis*	36	127	221	107	491	41.61	12275.0
NT	Nematoda	13	326	8	94	441	37.37	11025.0
AN	*Notomastus tenuis*	-	36	24	-	60	5.08	1500.0
AN	*Rhynchospio arenincola*	1	9	2	5	17	1.44	425.0
CN	Actiniaria	2	2	9	2	15	1.27	375.0
AN	*Scoletoma* spp	1	7	3	1	12	1.02	300.0
AN	*Mediomastus californiensis*	-	3	6	2	11	0.93	275.0
AR	*Photis brevipes*	-	9	-	-	9	0.76	225.0
MO	*Callianax baetica*	1	-	8	-	9	0.76	225.0
AN	*Apoprionospio pygmaea*	3	1	2	2	8	0.68	200.0
AN	*Ampharete labrops*	-	1	5	-	6	0.51	150.0
AN	*Chone eiffelturris*	2	1	2	1	6	0.51	150.0
AN	*Glycera nana*	2	-	3	1	6	0.51	150.0
AR	*Anchicolurus occidentalis*	2	2	2	-	6	0.51	150.0
AR	*Diastylopsis tenuis*	4	1	1	-	6	0.51	150.0
AR	*Foxiphalus obtusidens*	1	-	3	1	5	0.42	125.0
MO	*Petricola carditoides*	2	2	1	-	5	0.42	125.0
AN	*Hesionella mccullochae*	1	1	2	-	4	0.34	100.0
AN	*Leitoscoloplos pugettensis*	-	2	1	1	4	0.34	100.0
MO	*Fartulum occidentale*	2	-	1	1	4	0.34	100.0
AN	Onuphidae	1	1	-	1	3	0.25	75.0
AN	*Phyllodoce hartmanae*	-	1	2	-	3	0.25	75.0
MO	*Siliqua lucida*	2	-	-	1	3	0.25	75.0
NE	*Zygonemertes virescens*	-	3	-	-	3	0.25	75.0
AN	*Anotomastus gordiodes*	2	-	-	-	2	0.17	50.0
AN	*Diopatra ornata*	-	1	1	-	2	0.17	50.0
AN	*Mediomastus acutus*	-	-	1	1	2	0.17	50.0
AN	*Scoletoma tetraura* Cmplx	-	1	1	-	2	0.17	50.0
AR	*Cyclaspis* sp C SCAMIT 1986	-	-	1	1	2	0.17	50.0
AR	*Edotia sublittoralis*	-	1	-	1	2	0.17	50.0
MO	Bivalvia	-	-	1	1	2	0.17	50.0
MO	*Cumingia californica*	-	2	-	-	2	0.17	50.0
MO	Gastropoda	-	1	1	-	2	0.17	50.0
MO	Mytilidae	1	-	1	-	2	0.17	50.0
NE	Lineidae	-	1	-	1	2	0.17	50.0
AN	*Diopatra splendidissima*	1	-	-	-	1	0.08	25.0
AN	Euclymeninae sp A SCAMIT 1987	-	-	1	-	1	0.08	25.0
AN	*Glycinde armigera*	-	1	-	-	1	0.08	25.0
AN	*Hemipodia borealis*	-	1	-	-	1	0.08	25.0
AN	*Mediomastus ambiseta*	1	-	-	-	1	0.08	25.0
AN	*Spiophanes bombyx*	1	-	-	-	1	0.08	25.0
AN	*Sthenelais tertiaglabra*	1	-	-	-	1	0.08	25.0
AR	*Americhelidium shoemakeri*	1	-	-	-	1	0.08	25.0
AR	*Cyclaspis nubila*	-	-	-	1	1	0.08	25.0
AR	*Gibberosus myersi*	1	-	-	-	1	0.08	25.0
AR	*Monocorophium acherusicum*	-	1	-	-	1	0.08	25.0
AR	*Photis macinerneyi*	-	-	1	-	1	0.08	25.0
AR	*Pontogeneia rostrata*	1	-	-	-	1	0.08	25.0
EC	Amphiuridae	-	-	-	1	1	0.08	25.0
MO	*Caesia perpinguis*	-	-	-	1	1	0.08	25.0
MO	*Leukoma staminea*	-	-	1	-	1	0.08	25.0
MO	*Simomactra falcata*	-	1	-	-	1	0.08	25.0
MO	*Tellina modesta*	-	1	-	-	1	0.08	25.0
MO	*Turbonilla almo*	-	-	-	1	1	0.08	25.0
NE	*Micrura* sp	-	-	1	-	1	0.08	25.0
NE	*Tetrastemma* sp	-	-	1	-	1	0.08	25.0

Summary

Parameter	Replicate B3-I	B3-II	B3-III	B3-IV	Station Total	Overall Mean	S.D.
Number of individuals	86	547	318	229	1180	295.0	193.3
Number of species	26	30	32	23	56	27.8	4.0
Diversity (H')	2.33	1.37	1.49	1.33	1.74	1.63	0.47

Appendix F-3. (Cont.).

Station B4

Phylum	Species	Replicate B4-I	B4-II	B4-III	B4-IV	Total	Percent Composition	Density No./m²
AN	*Apoprionospio pygmaea*	49	40	58	10	157	30.13	3925.0
AN	*Armandia brevis*	12	28	26	8	74	14.20	1850.0
EC	*Dendraster excentricus*	18	4	6	3	31	5.95	775.0
AN	*Mediomastus acutus*	13	5	9	2	29	5.57	725.0
MO	*Tellina modesta*	15	6	6	-	27	5.18	675.0
MO	*Siliqua lucida*	10	8	2	-	20	3.84	500.0
AR	*Zeugophilomedes oblongus*	10	2	4	-	16	3.07	400.0
AN	*Polydora cirrosa*	-	-	14	-	14	2.69	350.0
AR	*Photis macinerneyi*	3	2	4	2	11	2.11	275.0
AR	*Diastylopsis tenuis*	4	3	-	1	8	1.54	200.0
AN	*Aricidea (Acmira) catherinae*	1	3	2	1	7	1.34	175.0
AN	*Chone eiffelturris*	1	1	4	1	7	1.34	175.0
AN	*Spiophanes bombyx*	3	-	3	1	7	1.34	175.0
AR	*Ampelisca agassizi*	-	5	2	-	7	1.34	175.0
AR	*Foxiphalus obtusidens*	6	-	1	-	7	1.34	175.0
NE	Lineidae	2	1	1	3	7	1.34	175.0
AR	*Harbansus bradmyersi*	1	2	3	-	6	1.15	150.0
AR	*Rhepoxynius menziesi*	5	-	1	-	6	1.15	150.0
AN	*Rhynchospio arenincola*	4	-	1	-	5	0.96	125.0
AR	*Rhepoxynius abronius*	2	2	1	-	5	0.96	125.0
AN	Onuphidae	-	2	2	-	4	0.77	100.0
AN	*Pectinaria californiensis*	2	-	2	-	4	0.77	100.0
AN	*Ampharete labrops*	3	-	-	-	3	0.58	75.0
AN	*Glycera macrobranchia*	-	2	-	1	3	0.58	75.0
AN	*Phyllodoce hartmanae*	3	-	-	-	3	0.58	75.0
AN	*Spiochaetopterus costarum* Cmplx	1	1	-	1	3	0.58	75.0
AN	*Diopatra ornata*	1	-	1	-	2	0.38	50.0
AN	*Sphaerodoropsis biserialis*	-	-	2	-	2	0.38	50.0
AN	*Typosyllis farallonensis*	-	2	-	-	2	0.38	50.0
AR	*Anchicolurus occidentalis*	-	1	-	1	2	0.38	50.0
AR	*Cyclaspis nubila*	-	1	1	-	2	0.38	50.0
AR	*Gibberosus myersi*	-	1	-	1	2	0.38	50.0
AR	*Hemilamprops californicus*	1	1	-	-	2	0.38	50.0
AR	*Rutiderma rostratum*	1	1	-	-	2	0.38	50.0
EC	Amphiuridae	1	1	-	-	2	0.38	50.0
MO	*Leukoma staminea*	-	1	1	-	2	0.38	50.0
MO	*Rochefortia tumida*	-	-	1	1	2	0.38	50.0
AN	*Aphelochaeta glandaria* Cmplx	-	1	-	-	1	0.19	25.0
AN	*Chaetozone setosa* Cmplx	1	-	-	-	1	0.19	25.0
AN	*Exogone lourei*	1	-	-	-	1	0.19	25.0
AN	*Glycinde armigera*	1	-	-	-	1	0.19	25.0
AN	*Goniada littorea*	1	-	-	-	1	0.19	25.0
AN	*Lumbrineris japonica*	-	-	1	-	1	0.19	25.0
AN	*Magelona sacculata*	-	1	-	-	1	0.19	25.0
AN	Maldanidae	1	-	-	-	1	0.19	25.0
AN	*Nephtys cornuta*	-	-	-	1	1	0.19	25.0
AN	*Scolelepis (Scolelepis) squamata*	-	-	-	1	1	0.19	25.0
AN	*Typosyllis heterochaeta*	-	-	1	-	1	0.19	25.0
AR	*Campylaspis* sp C Myers&Benedict 1974	-	1	-	-	1	0.19	25.0
AR	Harpacticoida	-	1	-	-	1	0.19	25.0
AR	*Lamprops quadriplicatus*	-	1	-	-	1	0.19	25.0
AR	*Lamprops triserrata*	-	1	-	-	1	0.19	25.0
AR	*Uromunna ubiquita*	-	-	1	-	1	0.19	25.0
BC	*Glottidia albida*	-	1	-	-	1	0.19	25.0
CN	Actiniaria	1	-	-	-	1	0.19	25.0
EC	*Amphiodia psara*	-	-	-	1	1	0.19	25.0
MO	Bivalvia	-	1	-	-	1	0.19	25.0
MO	*Lyonsia californica*	1	-	-	-	1	0.19	25.0
NE	*Carinoma mutabilis*	1	-	-	-	1	0.19	25.0
NE	Nemertea	-	1	-	-	1	0.19	25.0
NE	*Paranemertes californica*	-	-	1	-	1	0.19	25.0
NE	*Tubulanus polymorphus*	-	1	-	-	1	0.19	25.0
PL	*Cryptocelis occidentalis*	-	-	1	-	1	0.19	25.0
PR	*Phoronis* sp	1	-	-	-	1	0.19	25.0
SI	*Siphonosoma ingens*	-	-	1	-	1	0.19	25.0

Summary

Parameter	Replicate B4-I	B4-II	B4-III	B4-IV	Station Total	Overall Mean	S.D.
Number of individuals	181	136	164	40	521	130.3	63.0
Number of species	35	36	32	18	65	30.3	8.3
Diversity (H')	2.77	2.66	2.48	2.46	2.90	2.59	0.15

Appendix F-3. (Cont.).

Station B5

Phylum	Species	Replicate B5-I	B5-II	B5-III	B5-IV	Total	Percent Composition	Density No./m²
AN	*Apoprionospio pygmaea*	32	10	56	35	133	28.06	3325.0
AN	*Chone eiffelturris*	36	16	10	5	67	14.14	1675.0
AR	*Ampelisca agassizi*	13	3	10	3	29	6.12	725.0
AN	*Mediomastus acutus*	2	1	5	10	18	3.80	450.0
AN	*Exogone lourei*	8	-	6	2	16	3.38	400.0
AN	*Spiophanes bombyx*	8	2	1	3	14	2.95	350.0
AN	*Armandia brevis*	5	4	3	1	13	2.74	325.0
AR	*Photis macinerneyi*	3	2	4	3	12	2.53	300.0
AN	*Glycera macrobranchia*	3	3	3	-	9	1.90	225.0
AN	*Typosyllis farallonensis*	2	2	2	2	8	1.69	200.0
AR	*Diastylopsis tenuis*	5	-	1	1	7	1.48	175.0
AR	*Harbansus bradmyersi*	4	-	2	1	7	1.48	175.0
EC	*Dendraster excentricus*	3	-	2	2	7	1.48	175.0
AN	*Aricidea (Acmira) catherinae*	3	1	2	-	6	1.27	150.0
AN	*Monticellina cryptica*	-	2	2	2	6	1.27	150.0
MO	*Cooperella subdiaphana*	1	1	3	1	6	1.27	150.0
MO	*Siliqua lucida*	4	1	-	1	6	1.27	150.0
MO	*Tellina modesta*	5	-	-	-	5	1.05	125.0
PR	*Phoronis* sp	1	3	1	-	5	1.05	125.0
AN	*Chaetozone setosa* Cmplx	1	-	1	2	4	0.84	100.0
AN	*Goniada littorea*	1	1	2	-	4	0.84	100.0
AN	Onuphidae	2	2	-	-	4	0.84	100.0
AN	*Spiochaetopterus costarum* Cmplx	1	-	1	2	4	0.84	100.0
AR	*Rhepoxynius abronius*	2	1	1	-	4	0.84	100.0
AR	*Zeugophilomedes oblongus*	1	-	3	-	4	0.84	100.0
NE	*Carinoma mutabilis*	3	1	-	-	4	0.84	100.0
NT	Nematoda	1	-	1	2	4	0.84	100.0
AN	*Dipolydora bidentata*	3	-	-	-	3	0.63	75.0
AN	*Polydora cirrosa*	1	-	2	-	3	0.63	75.0
AN	Syllidae	-	2	1	-	3	0.63	75.0
MO	*Rochefortia tumida*	-	1	1	1	3	0.63	75.0
NE	Lineidae	2	1	-	-	3	0.63	75.0
NE	*Tubulanus polymorphus*	-	2	1	-	3	0.63	75.0
AN	*Spiophanes duplex*	1	-	1	-	2	0.42	50.0
AR	*Americhelidium shoemakeri*	2	-	-	-	2	0.42	50.0
AR	*Asteropella slatteryi*	1	-	-	1	2	0.42	50.0
AR	*Cumella californica*	-	1	-	1	2	0.42	50.0
AR	*Rhepoxynius menziesi*	1	-	1	-	2	0.42	50.0
AR	*Rutiderma rostratum*	2	-	-	-	2	0.42	50.0
CN	Actiniaria	-	-	1	1	2	0.42	50.0
EC	*Leptosynapta* sp	-	1	-	1	2	0.42	50.0
NE	*Paranemertes californica*	2	-	-	-	2	0.42	50.0
AN	*Ampharete labrops*	1	-	-	-	1	0.21	25.0
AN	*Chaetozone corona*	-	-	1	-	1	0.21	25.0
AN	Euclymeninae sp A SCAMIT 1987	1	-	-	-	1	0.21	25.0
AN	*Glycinde armigera*	-	-	1	-	1	0.21	25.0
AN	*Goniada maculata*	-	-	1	-	1	0.21	25.0
AN	*Magelona berkeleyi*	-	-	-	1	1	0.21	25.0
AN	Maldanidae	-	1	-	-	1	0.21	25.0
AN	*Malmgreniella scriptoria*	-	-	-	1	1	0.21	25.0
AN	*Nephtys caecoides*	-	1	-	-	1	0.21	25.0
AN	*Nephtys cornuta*	-	-	-	1	1	0.21	25.0
AN	*Onuphis* sp A SCAMIT 1992	-	-	-	1	1	0.21	25.0
AN	*Rhynchospio arenincola*	-	-	1	-	1	0.21	25.0
AN	*Scoletoma* sp	-	1	-	-	1	0.21	25.0
AN	*Sphaerodoropsis biserialis*	1	-	-	-	1	0.21	25.0
AN	*Typosyllis heterochaeta*	-	-	1	-	1	0.21	25.0
AR	*Campylaspis* sp C Myers&Benedict 1974	1	-	-	-	1	0.21	25.0
AR	*Cyclaspis nubila*	1	-	-	-	1	0.21	25.0
AR	*Foxiphalus obtusidens*	1	-	-	-	1	0.21	25.0
AR	Harpacticoida	-	1	-	-	1	0.21	25.0
AR	*Parasterope hulingsi*	-	-	1	-	1	0.21	25.0
AR	Phoxocephalidae	1	-	-	-	1	0.21	25.0
AR	*Pinnixa* sp	-	-	-	1	1	0.21	25.0
AR	*Rhepoxynius variatus*	-	-	-	1	1	0.21	25.0

Appendix F-3. (Cont.).

Station B5

Phylum	Species	Replicate B5-I	B5-II	B5-III	B5-IV	Total	Percent Composition	Density No./m²
AR	*Uromunna ubiquita*	1	-	-	-	1	0.21	25.0
EC	*Amphiodia* sp	1	-	-	-	1	0.21	25.0
MO	*Gadila aberrans*	1	-	-	-	1	0.21	25.0
MO	Mytilidae	-	-	-	1	1	0.21	25.0
MO	*Odostomia* sp D MBC 1980	-	-	1	-	1	0.21	25.0
NE	Hoplonemertea	1	-	-	-	1	0.21	25.0
NE	Nemertea	-	-	1	-	1	0.21	25.0
PL	Platyhelminthes	-	-	-	1	1	0.21	25.0
SI	*Apionsoma misakianum*	1	-	-	-	1	0.21	25.0

Summary

Parameter	Replicate B5-I	B5-II	B5-III	B5-IV	Station Total	Overall Mean	S.D.
Number of individuals	177	68	138	91	474	118.5	48.7
Number of species	47	28	38	31	74	36.0	8.4
Diversity (H')	3.07	2.86	2.62	2.59	3.12	2.78	0.23

Appendix F-3. (Cont.).

Station B6

Phylum	Species	Replicate B6-I	B6-II	B6-III	B6-IV	Total	Percent Composition	Density No./m²
AN	*Apoprionospio pygmaea*	48	20	49	19	136	26.51	3400.0
AN	*Armandia brevis*	38	8	27	15	88	17.15	2200.0
AR	*Diastylopsis tenuis*	10	7	9	3	29	5.65	725.0
AN	*Spiophanes bombyx*	10	8	3	3	24	4.68	600.0
AR	*Photis macinerneyi*	4	6	5	9	24	4.68	600.0
MO	*Siliqua lucida*	7	4	9	4	24	4.68	600.0
AR	*Rhepoxynius abronius*	12	4	3	3	22	4.29	550.0
AN	*Mediomastus acutus*	5	2	6	3	16	3.12	400.0
MO	*Tellina modesta*	8	2	2	4	16	3.12	400.0
AR	*Rhepoxynius menziesi*	9	2	3	1	15	2.92	375.0
EC	*Dendraster excentricus*	9	3	2	1	15	2.92	375.0
AN	*Pectinaria californiensis*	4	2	-	4	10	1.95	250.0
AN	*Typosyllis farallonensis*	2	3	3	2	10	1.95	250.0
AN	*Chone eiffelturris*	4	-	2	1	7	1.36	175.0
AN	*Goniada littorea*	2	1	3	-	6	1.17	150.0
AN	*Aricidea (Acmira) catherinae*	-	1	2	2	5	0.97	125.0
AN	*Owenia collaris*	2	1	-	2	5	0.97	125.0
AN	*Spiochaetopterus costarum* Cmplx	2	-	2	-	4	0.78	100.0
AR	*Rhepoxynius* sp A SCAMIT 1987	2	1	1	-	4	0.78	100.0
MO	*Leukoma staminea*	3	1	-	-	4	0.78	100.0
MO	*Macoma* sp	1	-	-	3	4	0.78	100.0
AN	*Onuphis* sp A SCAMIT 1992	2	-	-	1	3	0.58	75.0
AN	*Typosyllis heterochaeta*	-	-	3	-	3	0.58	75.0
AR	*Americhelidium shoemakeri*	-	-	1	2	3	0.58	75.0
AR	*Ampelisca agassizi*	1	2	-	-	3	0.58	75.0
EC	*Amphiodia digitata*	1	-	-	2	3	0.58	75.0
AN	*Ampharete labrops*	1	1	-	-	2	0.39	50.0
AN	Onuphidae	-	-	1	1	2	0.39	50.0
AN	*Scoletoma tetraura* Cmplx	1	-	-	1	2	0.39	50.0
AN	*Spiophanes duplex*	2	-	-	-	2	0.39	50.0
AR	*Uromunna ubiquita*	-	1	1	-	2	0.39	50.0
CN	Actiniaria	-	-	-	2	2	0.39	50.0
MO	*Balcis oldroydae*	1	-	-	1	2	0.39	50.0
MO	*Rochefortia tumida*	-	1	-	1	2	0.39	50.0
NE	Nemertea	-	-	1	1	2	0.39	50.0
NE	*Paranemertes californica*	1	1	-	-	2	0.39	50.0
AN	Euclymeninae sp A SCAMIT 1987	-	-	-	1	1	0.19	25.0
AN	*Glycera macrobranchia*	-	-	-	1	1	0.19	25.0
AN	*Magelona berkeleyi*	-	-	1	-	1	0.19	25.0
AN	*Mediomastus californiensis*	-	-	-	1	1	0.19	25.0
AR	*Asteropella slatteryi*	-	-	-	1	1	0.19	25.0
AR	*Gibberosus myersi*	1	-	-	-	1	0.19	25.0
MO	*Cooperella subdiaphana*	-	-	1	-	1	0.19	25.0
MO	Mytilidae	-	-	-	1	1	0.19	25.0
NE	*Carinoma mutabilis*	-	-	1	-	1	0.19	25.0
NT	Nematoda	-	1	-	-	1	0.19	25.0

Summary

Parameter	Replicate B6-I	B6-II	B6-III	B6-IV	Station Total	Overall Mean	S.D.
Number of individuals	193	83	141	96	513	128.3	49.8
Number of species	29	24	25	31	46	27.3	3.3
Diversity (H')	2.63	2.71	2.36	2.92	2.80	2.66	0.23

Appendix F-4. Infaunal wet weight biomass data (g). Ormond Beach Generating Station NPDES, 2009.

Sta-Rep	Annelida	Arthropoda	Mollusca	Echinodermata	Misc.	Total
B1-I	0.1087	0.0030	<0.0001	<0.0001	0.1681	0.2798
B1-II	0.0864	0.0537	0.0220	<0.0001	0.0397	0.2018
B1-III	0.0593	0.0115	0.0142	<0.0001	0.0391	0.1241
B1-IV	0.0906	0.0050	-	-	<0.0001	0.0956
Total	0.3450	0.0732	0.0362	<0.0001	0.2469	0.7013
B2-I	0.1555	<0.0001	0.0924	0.0048	0.0171	0.2698
B2-II	0.1463	<0.0001	<0.0001	-	0.2456	0.3919
B2-III	0.1391	<0.0001	0.0510	<0.0001	0.0420	0.2321
B2-IV	0.1029	<0.0001	0.5769	-	<0.0001	0.6798
Total	0.5438	<0.0001	0.7203	0.0048	0.3047	1.5736
B3-I	0.1670	0.0063	0.0788	-	<0.0001	0.2521
B3-II	0.5415	0.1017	0.1110	-	<0.0001	0.7542
B3-III	0.4776	0.0263	0.0807	-	0.0403	0.6249
B3-IV	0.0105	0.0386	0.0689	0.0314	<0.0001	0.1494
Total	1.1966	0.1729	0.3394	0.0314	0.0403	1.7806
B4-I	0.0532	0.0048	0.0349	0.0398	<0.0001	0.1327
B4-II	0.2123	<0.0001	0.0181	<0.0001	<0.0001	0.2304
B4-III	0.2679	<0.0001	0.0479	<0.0001	0.0132	0.3290
B4-IV	0.0399	0.0081	0.0472	1.3897	<0.0001	1.4849
Total	0.5733	0.0129	0.1481	1.4295	0.0132	2.1770
B5-I	0.1555	0.0108	<0.0001	0.1057	0.0286	0.3006
B5-II	0.0799	<0.0001	0.0053	0.1844	0.1590	0.4286
B5-III	0.3547	<0.0001	<0.0001	<0.0001	<0.0001	0.3547
B5-IV	0.1175	0.0234	<0.0001	0.3108	<0.0001	0.4517
Total	0.7076	0.0342	0.0053	0.6009	0.1876	1.5356
B6-I	0.1433	0.0250	0.0671	0.0557	<0.0001	0.2911
B6-II	0.0177	0.0646	0.0293	<0.0001	<0.0001	0.1116
B6-III	0.0825	0.0171	0.0630	<0.0001	<0.0001	0.1626
B6-IV	0.4890	<0.0001	0.0239	0.0373	0.0086	0.5588
Total	0.7325	0.1067	0.1833	0.0930	0.0086	1.1241
Grand Total	4.0988	0.3999	1.4326	2.1596	0.8013	8.8922

Note: - = no animals

Appendix F-5. Top 40 species yearly infaunal abundance. Ormond Beach Generating Station NPDES, 2009.

		Year																							%	Cum.	
Phy	Species	1978	1980	1986	1988	1990	1991	1992	1993	1994	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Total	Total	%	FO
NT	Nematoda	7	5	-	2	6	2	-	-	5	8375	-	5	24	6	15	61	17	10	8	25	6	462	9041	19.17	19.17	18
AN	*Apoprionospio pygmaea*	29	108	9	464	42	509	17	12	156	43	41	94	53	948	73	44	256	128	120	601	30	1412	5189	11.00	30.17	22
AN	*Owenia collaris*	3	2	-	6	4	82	-	-	2	5	10	59	3275	111	2	1	1	1	2	18	-	7	3591	7.61	37.78	18
AR	*Diastylopsis tenuis*	306	110	28	80	59	23	1	19	62	67	1	391	728	136	108	10	54	32	209	48	30	61	2563	5.43	43.21	22
EC	*Dendraster excentricus*	8	11	7	9	9	-	4	5	33	1075	31	32	118	360	62	333	88	42	51	94	4	59	2435	5.16	48.37	21
AN	*Armandia brevis*	1	2	-	1	-	3	-	-	3	-	1	23	3	324	9	61	18	26	5	37	-	866	1383	2.93	51.30	16
AN	*Mediomastus acutus*	28	30	-	-	-	-	-	2	27	66	282	86	124	94	43	44	72	81	106	129	14	132	1360	2.88	54.19	17
MO	*Tellina modesta*	8	48	23	13	29	5	3	1	32	22	13	105	316	106	37	9	87	6	39	95	37	84	1118	2.37	56.56	22
AR	*Rhepoxynius menziesi*	32	57	27	45	44	26	14	11	50	16	24	137	256	48	31	4	31	21	50	49	24	31	1028	2.18	58.74	22
MO	*Siliqua lucida*	1	17	17	10	-	7	-	22	29	31	15	473	11	14	12	2	3	8	7	106	-	85	870	1.84	60.58	19
AN	*Pectinaria californiensis*	3	-	1	123	2	-	-	1	-	15	1	465	46	19	4	1	-	2	-	22	-	61	766	1.62	62.21	15
AN	*Spiophanes bombyx*	9	39	22	53	22	17	28	24	33	19	13	32	63	33	33	16	40	19	10	30	7	78	640	1.36	63.56	22
NE	*Carinoma mutabilis*	-	4	9	12	13	13	32	10	20	43	22	16	19	54	43	25	58	29	69	22	6	18	537	1.14	64.70	21
AR	*Photis macinerneyi*	-	-	4	66	12	1	-	-	5	43	2	72	166	29	14	2	10	4	15	23	-	65	533	1.13	65.83	17
AN	*Magelona sacculata*	7	100	37	127	27	66	12	3	-	-	-	-	5	8	8	-	-	2	-	2	3	1	408	0.86	66.69	15
AN	*Chone eiffelturris*	-	-	-	-	-	-	-	-	-	-	3	1	6	3	17	2	6	2	41	21	2	300	404	0.86	67.55	12
AR	*Rhepoxynius abronius*	9	24	1	8	8	28	8	-	5	6	5	14	108	65	16	-	3	7	19	26	4	37	401	0.85	68.40	20
AR	*Gibberosus myersi*	7	3	4	9	5	18	-	-	11	11	2	31	140	37	30	3	39	6	19	2	4	4	385	0.82	69.22	20
AR	*Anchicolurus occidentalis*	5	6	7	15	10	12	3	1	15	17	1	98	123	13	13	2	2	14	4	5	4	9	379	0.80	70.02	22
AN	*Aricidea (Acmira) catherinae*	26	70	6	18	10	12	21	5	12	8	2	11	9	39	19	5	20	33	15	1	7	29	378	0.80	70.82	22
AN	*Exogone lourei*	3	1	-	-	24	2	1	-	6	52	6	18	21	8	5	57	38	9	37	28	3	24	343	0.73	71.55	19
AR	*Aoroides inermis*	-	-	-	-	-	-	-	-	-	-	-	188	43	60	22	3	-	5	-	6	-	2	329	0.70	72.25	8
AR	*Photis brevipes*	6	-	-	-	3	2	-	-	5	1	15	106	122	14	11	15	-	-	3	6	5	9	323	0.68	72.93	15
AN	*Onuphis* sp A SCAMIT 1992	-	-	-	-	-	-	-	-	-	35	13	7	17	24	10	8	11	35	49	97	5	10	321	0.68	73.61	13
AN	*Goniada littorea*	42	18	9	10	24	20	4	6	15	14	12	27	17	10	15	3	6	2	15	23	4	17	313	0.66	74.28	22
AN	*Chaetozone setosa* Cmplx	10	14	2	6	55	16	13	2	5	8	12	-	-	5	22	8	33	6	11	12	4	16	260	0.55	74.83	20
MO	*Cooperella subdiaphana*	-	-	2	7	3	-	-	-	-	5	4	18	90	10	9	6	1	-	5	89	1	10	260	0.55	75.38	15
AN	*Scoloplos armiger* Cmplx	7	6	21	25	28	43	19	5	18	43	11	5	1	3	8	-	11	1	-	3	-	-	258	0.55	75.92	18
AR	*Euphilomedes longiseta*	-	10	-	-	1	-	-	-	-	-	-	63	163	-	5	-	3	2	1	3	-	-	251	0.53	76.46	9
AR	*Jassa slatteryi*	-	-	-	-	9	-	-	-	-	-	-	93	86	4	-	-	5	6	-	36	2	7	248	0.53	76.98	9
NE	Lineidae	-	-	-	4	-	-	-	-	5	9	1	3	10	12	6	8	44	12	20	82	7	24	247	0.52	77.51	15
AR	*Ampelisca agassizi*	-	1	1	16	64	10	2	-	4	3	-	1	5	4	45	1	7	3	2	8	4	62	243	0.52	78.02	19
AN	*Capitella capitata* Cmplx	-	1	191	-	-	14	-	-	-	-	-	-	1	4	-	-	-	-	-	-	-	-	211	0.45	78.47	5
AN	*Typosyllis farallonensis*	-	-	1	-	-	-	-	-	14	14	5	3	-	2	7	10	44	22	28	23	1	30	204	0.43	78.90	14
AR	*Isocheles pilosus*	1	4	3	9	3	-	-	-	-	-	-	1	176	-	-	-	-	-	-	-	-	-	197	0.42	79.32	7
AR	*Ericthonius brasiliensis*	-	-	-	-	-	-	-	-	-	-	-	130	3	6	2	1	-	-	-	54	-	-	196	0.42	79.73	6
AN	*Mediomastus* spp	2	20	-	37	34	6	3	-	-	13	46	12	6	-	-	-	-	-	-	-	-	-	179	0.38	80.11	10
AR	*Americhelidium shoemakeri*	25	-	2	5	-	-	-	-	1	-	-	11	77	13	5	2	1	4	6	8	7	7	174	0.37	80.48	15
MO	*Rochefortia tumida*	4	6	2	1	1	-	-	-	1	1	-	4	45	45	20	5	3	2	3	9	1	9	162	0.34	80.83	18
AN	*Glycera macrobranchia*	3	4	1	5	4	4	5	3	6	12	4	2	5	10	6	3	8	6	18	13	7	29	158	0.33	81.16	22
Number of individuals		988	1267	576	1717	878	1238	312	244	933	10393	781	3373	7829	3311	1187	1095	1381	963	1289	2388	361	4669	47173			
Number of species		108	144	92	140	129	100	60	60	149	124	91	162	206	174	152	114	119	133	107	165	78	151	592			
Diversity (H')		3.35	3.92	3.17	3.41	4.00	2.91	3.49	3.52	3.97	0.99	3.11	3.45	2.94	3.28	4.19	3.28	3.60	3.98	3.54	3.62	3.73	2.87	3.84			
Number of stations/reps		7/4	7/4	7/4*	7/4	6/4	6/4	6/4	6/4	6/4	6/4	3/4	6/4	6/4	6/4	6/4	4/2	6/4	6/4	6/4	6/4	4/2					
Total biomass		NR	NR	28.0	1.43	75.3	2.71	21.4	16.1	12.7	7.96	6.02	78.9	437	16.6	28.9	6.3	6.2	6.8	7.3	9.5	3.2					

NR = Not Reported
F.O. = Frequency of Occurrence
Note: 0.00 = <0.005
* = Samples screened on 1.0 mm screen, all other years on 0.5 mm screen.

Appendix F-6. Index of Relative Importance for the top 25 infaunal organisms observed during infaunal sampling and contigency table of Spearman rank correlation coefficients by year, 1990 - 2009. Ormond Beach Generating Station NPDES, 2009.

Species	1990	1994	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Apoprionospio pygmaea	**1**	**1**	7	**2**	3	11	**1**	**2**	5	**1**	**1**	**1**	**1**	3	**1**
Mediomastus acutus	-	8	4	**1**	7	7	8	5	**2**	3	**2**	**2**	**2**	5	4
Diastylopsis tenuis	3	**2**	**2**	18	**1**	**2**	3	**1**	9	6	4	3	6	**1**	9
Dendraster excentricus	13	4	**1**	4	14	5	**2**	4	**1**	5	4	7	4	11	11
Tellina modesta	4	9	9	7	5	4	10	6	10	**2**	16	7	3	**2**	10
Rhepoxynius menziesi	**1**	5	15	5	**2**	**2**	8	7	13	9	9	6	7	3	15
Spiophanes bombyx	5	3	8	6	12	9	11	8	8	7	8	16	9	6	5
Carinoma mutabilis	9	6	5	3	16	16	7	3	7	4	6	3	14	7	16
Onuphis sp A SCAMIT 1992	-	-	-	-	-	-	-	-	-	-	-	5	-	10	19
Nematoda	13	14	**2**	-	22	15	23	17	**2**	12	11	17	13	8	5
Siliqua lucida	-	6	10	8	5	20	17	17	17	17	15	18	5	-	7
Armandia brevis	-	18	-	18	20	24	6	19	**2**	12	7	19	7	-	**2**
Rhepoxynius abronius	12	17	18	12	17	12	5	13	-	17	13	10	10	13	13
Goniada littorea	5	11	12	10	14	17	18	12	14	16	19	11	10	12	16
Aricidea (Acmira) catherinae	10	12	17	15	21	21	12	8	11	11	3	14	24	9	11
Photis macinerneyi	-	15	11	15	10	8	14	15	17	14	18	15	15	-	7
Exogone lourei	8	15	6	12	19	18	21	23	5	10	12	13	12	16	18
Gibberosus myersi	15	13	16	15	17	6	13	10	14	8	14	11	22	13	23
Anchicolurus occidentalis	10	10	14	18	8	10	18	15	17	19	10	20	20	13	20
Pectinaria californiensis	18	-	12	18	3	13	16	22	21	-	19	-	17	-	13
Chone eiffelturris	-	-	-	14	23	22	24	10	20	14	19	9	15	19	3
Owenia collaris	16	20	19	11	9	**1**	4	24	21	20	23	22	18	-	21
Aoroides inermis	-	-	-	-	10	18	14	13	14	-	17	-	21	-	24
Photis brevipes	17	18	20	9	12	13	20	21	11	-	-	21	19	17	21
Magelona sacculata	7	-	-	-	-	23	21	20	-	-	19	-	22	18	25
1990	-	**0.74**	0.37	0.38	0.37	0.11	0.27	**0.62**	0.33	**0.52**	0.38	**0.68**	**0.59**	**0.64**	0.40
1994	-	-	**0.60**	**0.50**	**0.56**	0.27	0.37	**0.83**	0.26	**0.65**	**0.56**	**0.65**	**0.59**	**0.78**	0.38
1997	-	-	-	0.39	0.06	0.03	0.18	**0.49**	**0.76**	**0.61**	**0.49**	**0.50**	**0.61**	0.45	**0.60**
1998	-	-	-	-	0.20	0.22	0.31	**0.47**	**0.46**	**0.55**	0.33	**0.49**	**0.58**	0.38	0.16
1999	-	-	-	-	-	**0.58**	0.36	0.24	-0.22	0.28	0.07	0.28	0.39	**0.69**	-0.01
2000	-	-	-	-	-	-	**0.54**	0.37	0.00	0.28	0.14	0.25	0.32	**0.68**	-0.03
2001	-	-	-	-	-	-	-	**0.55**	0.37	0.42	**0.54**	**0.44**	**0.50**	**0.68**	0.24
2002	-	-	-	-	-	-	-	-	0.42	**0.80**	**0.66**	**0.87**	**0.49**	**0.78**	0.37
2003	-	-	-	-	-	-	-	-	-	**0.66**	**0.76**	0.38	**0.55**	0.38	0.38
2004	-	-	-	-	-	-	-	-	-	-	**0.64**	**0.77**	**0.56**	**0.70**	0.30
2005	-	-	-	-	-	-	-	-	-	-	-	**0.47**	**0.47**	**0.60**	**0.44**
2006	-	-	-	-	-	-	-	-	-	-	-	-	**0.56**	**0.59**	0.25
2007	-	-	-	-	-	-	-	-	-	-	-	-	-	**0.70**	**0.66**
2008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**0.54**

Bold = correlation is significant at the 0.05 level (2-tailed)

APPENDIX G

Fish and macroinvertebrate heat treatment and normal operation data

Appendix G-1. Species list of impinged fish and macroinvertebrate species. Ormond Beach Generating Station NPDES, 2009.

Phylum	Class	Family	Species	Common name
Arthropoda				
	Malacostraca			
		Cancridae		
			Romaleon antennarius	Pacific rock crab
			Metacarcinus gracilis	graceful crab
			Metacarcinus anthonyi	yellow crab
			Cancer productus	red rock crab
		Crangonidae		
			Crangon nigromaculata	blackspotted bay shrimp
		Hippolytidae		
			Lysmata californica	red rock shrimp
		Portunidae		
			Portunus xantusii	Xantus swimming crab
Cnidaria				
	Scyphozoa			
		Pelagiidae		
			Chrysaora colorata	purple-striped jellyfish
Mollusca				
	Cephalopoda			
		Loliginidae		
			Doryteuthis opalescens	California market squid
		Octopodidae		
			Octopus bimaculatus/bimaculoides	California two-spot octopus

Phylum	Class	Family	Species	Common name
Chordata				
	Chondrichthyes			
		Heterodontidae		
			Heterodontus francisci	horn shark
		Myliobatidae		
			Myliobatis californica	bat ray
		Platyrhinidae		
			Platyrhinoidis triseriata	thornback
		Torpedinidae		
			Torpedo californica	Pacific electric ray
	Actinopterygii			
		Agonidae		
			Odontopyxis trispinosa	pygmy poacher
		Batrachoididae		
			Porichthys myriaster	specklefin midshipman
			Porichthys notatus	plainfin midshipman
		Clupeidae		
			Sardinops sagax	Pacific sardine
		Cottidae		
			Leptocottus armatus	Pacific staghorn sculpin
		Cynoglossidae		
			Symphurus atricaudus	California tonguefish
		Embiotocidae		
			Cymatogaster aggregata	shiner perch
			Phanerodon furcatus	white seaperch
		Engraulidae		
			Engraulis mordax	northern anchovy
		Ophididae		
			Ophidion scrippsae	basketweave cusk-eel
		Paralichthyidae		
			Citharichthys stigmaeus	speckled sanddab
		Pleuronectidae		
			Pleuronichthys guttulatus	diamond turbot
		Sciaenidae		
			Atractoscion nobilis	white seabass
			Seriphus politus	queenfish
		Serranidae		
			Paralabrax clathratus	kelp bass
		Syngnathidae		
			Syngnathus leptorhynchus	bay pipefish
			Syngnathus sp	pipefish unid

Appendix G-2. Abundance of fish impinged during normal operations by survey date. Ormond Beach Generating Station NPDES, 2009.

Species	10/3/2008	11/14/2008	12/13/2008	2/11/2009	4/21/2009	5/18/2009	7/25/2009	8/21/2009	9/11/2009	Total Abundance
Syngnathus sp	-	-	-	-	10	-	-	-	-	10
Citharichthys stigmaeus	-	-	-	7	-	-	-	-	-	7
Syngnathus leptorhynchus	-	3	-	2	-	-	2	-	-	7
Engraulis mordax	-	-	-	3	-	-	-	-	-	3
Leptocottus armatus	-	-	-	3	-	-	-	-	-	3
Platyrhinoidis triseriata	-	-	-	2	1	-	-	-	-	3
Seriphus politus	-	-	-	-	3	-	-	-	-	3
Heterodontus francisci	-	-	1	1	-	-	-	-	-	2
Phanerodon furcatus	-	-	-	2	-	-	-	-	-	2
Porichthys notatus	-	-	-	-	2	-	-	-	-	2
Torpedo californica	1	1	-	-	-	-	-	-	-	2
Atractoscion nobilis	-	-	-	1	-	-	-	-	-	1
Cymatogaster aggregata	-	-	1	-	-	-	-	-	-	1
Myliobatis californica	-	-	-	1	-	-	-	-	-	1
Odontopyxis trispinosa	-	-	-	1	-	-	-	-	-	1
Ophidion scrippsae	-	-	1	-	-	-	-	-	-	1
Paralabrax clathratus	-	-	-	1	-	-	-	-	-	1
Pleuronichthys guttulatus	-	1	-	-	-	-	-	-	-	1
Porichthys myriaster	-	-	-	1	-	-	-	-	-	1
Sardinops sagax	-	-	-	1	-	-	-	-	-	1
Symphurus atricaudus	-	-	-	1	-	-	-	-	-	1
Total Abundance	1	5	3	27	16	-	2	-	-	54
Number of Taxa	1	3	3	14	4	-	1	-	-	21

Appendix G-3. Biomass (kg) of fish impinged during normal operations by survey date. Ormond Beach Generating Station NPDES, 2009.

Species	10/3/2008	11/14/2008	12/13/2008	2/11/2009	4/21/2009	5/18/2009	7/25/2009	8/21/2009	9/11/2009	Total Biomass (kg)
Torpedo californica	3.643	13.800	-	-	-	-	-	-	-	17.443
Myliobatis californica	-	-	-	1.739	-	-	-	-	-	1.739
Platyrhinoidis triseriata	-	-	-	1.167	0.202	-	-	-	-	1.369
Heterodontus francisci	-	-	0.808	0.491	-	-	-	-	-	1.299
Porichthys notatus	-	-	-	-	0.331	-	-	-	-	0.331
Pleuronichthys guttulatus	-	0.270	-	-	-	-	-	-	-	0.270
Phanerodon furcatus	-	-	-	0.163	-	-	-	-	-	0.163
Leptocottus armatus	-	-	-	0.116	-	-	-	-	-	0.116
Paralabrax clathratus	-	-	-	0.106	-	-	-	-	-	0.106
Seriphus politus	-	-	-	-	0.101	-	-	-	-	0.101
Engraulis mordax	-	-	-	0.052	-	-	-	-	-	0.052
Ophidion scrippsae	-	-	0.043	-	-	-	-	-	-	0.043
Symphurus atricaudus	-	-	-	0.037	-	-	-	-	-	0.037
Syngnathus sp	-	-	-	-	0.027	-	-	-	-	0.027
Citharichthys stigmaeus	-	-	-	0.023	-	-	-	-	-	0.023
Atractoscion nobilis	-	-	-	0.021	-	-	-	-	-	0.021
Syngnathus leptorhynchus	-	0.012	-	0.002	-	-	0.005	-	-	0.019
Sardinops sagax	-	-	-	0.013	-	-	-	-	-	0.013
Porichthys myriaster	-	-	-	0.006	-	-	-	-	-	0.006
Cymatogaster aggregata	-	-	0.005	-	-	-	-	-	-	0.005
Odontopyxis trispinosa	-	-	-	0.002	-	-	-	-	-	0.002
Total Biomass (kg)	3.643	14.082	0.856	3.938	0.661	-	0.005	-	-	23.185

Appendix G-4. Estimated monthly abundance of fish impinged during normal operations. Ormond Beach Generating Station NPDES, 2009.

	2008		2008/2009	2009						Total
Species	Oct	Nov	Dec/Jan	Feb/Mar	May/Jun	Apr	Jul	Aug	Sep	Abundance
Syngnathus leptorhynchus	-	47	-	38	-	-	50	-	-	135
Citharichthys stigmaeus	-	-	-	133	-	-	-	-	-	133
Engraulis mordax	-	-	-	57	-	-	-	-	-	57
Leptocottus armatus	-	-	-	57	-	-	-	-	-	57
Syngnathus sp	-	-	-	-	52	-	-	-	-	52
Platyrhinoidis triseriata	-	-	-	38	5	-	-	-	-	43
Phanerodon furcatus	-	-	-	38	-	-	-	-	-	38
Heterodontus francisci	-	-	17	19	-	-	-	-	-	36
Torpedo californica	10	16	-	-	-	-	-	-	-	26
Atractoscion nobilis	-	-	-	19	-	-	-	-	-	19
Myliobatis californica	-	-	-	19	-	-	-	-	-	19
Odontopyxis trispinosa	-	-	-	19	-	-	-	-	-	19
Paralabrax clathratus	-	-	-	19	-	-	-	-	-	19
Porichthys myriaster	-	-	-	19	-	-	-	-	-	19
Sardinops sagax	-	-	-	19	-	-	-	-	-	19
Symphurus atricaudus	-	-	-	19	-	-	-	-	-	19
Cymatogaster aggregata	-	-	17	-	-	-	-	-	-	17
Ophidion scrippsae	-	-	17	-	-	-	-	-	-	17
Pleuronichthys guttulatus	-	16	-	-	-	-	-	-	-	16
Seriphus politus	-	-	-	-	16	-	-	-	-	16
Porichthys notatus	-	-	-	-	10	-	-	-	-	10
Total Abundance	10	79	51	513	83	-	50	-	-	786
Number of Species	1	3	3	14	4	-	1	-	-	21
Analysis Flow (mg)	4762	4911.1	4615	6467.8	3494.6	1757.6	4731.8	1957.5	9448.3	

Appendix G-5. Estimated monthly biomass (kg) of fish impinged during normal operations. Ormond Beach Generating Station NPDES, 2009.

	2008		2008/2009	2009						Total
Species	Oct	Nov	Dec/Jan	Feb/Mar	May/Jun	Apr	Jul	Aug	Sep	Biomass (kg)
Torpedo californica	35.040	216.390	-	-	-	-	-	-	-	251.430
Myliobatis californica	-	-	-	33.150	-	-	-	-	-	33.150
Heterodontus francisci	-	-	13.960	9.360	-	-	-	-	-	23.320
Platyrhinoidis triseriata	-	-	-	22.250	1.050	-	-	-	-	23.300
Pleuronichthys guttulatus	-	4.230	-	-	-	-	-	-	-	4.230
Phanerodon furcatus	-	-	-	3.110	-	-	-	-	-	3.110
Leptocottus armatus	-	-	-	2.210	-	-	-	-	-	2.210
Paralabrax clathratus	-	-	-	2.020	-	-	-	-	-	2.020
Porichthys notatus	-	-	-	-	1.720	-	-	-	-	1.720
Engraulis mordax	-	-	-	0.990	-	-	-	-	-	0.990
Ophidion scrippsae	-	-	0.740	-	-	-	-	-	-	0.740
Symphurus atricaudus	-	-	-	0.710	-	-	-	-	-	0.710
Seriphus politus	-	-	-	-	0.520	-	-	-	-	0.520
Citharichthys stigmaeus	-	-	-	0.440	-	-	-	-	-	0.440
Atractoscion nobilis	-	-	-	0.400	-	-	-	-	-	0.400
Syngnathus leptorhynchus	-	0.190	-	0.040	-	-	0.130	-	-	0.360
Sardinops sagax	-	-	-	0.250	-	-	-	-	-	0.250
Syngnathus sp	-	-	-	-	0.140	-	-	-	-	0.140
Porichthys myriaster	-	-	-	0.110	-	-	-	-	-	0.110
Cymatogaster aggregata	-	-	0.090	-	-	-	-	-	-	0.090
Odontopyxis trispinosa	-	-	-	0.040	-	-	-	-	-	0.040
Total Biomass (kg)	35.040	220.810	14.790	75.080	3.430	-	0.130	-	-	349.280

Appendix G-6. Length frequency of impinged fish measured during normal operation surveys. Ormond Beach Generating Station NPDES, 2009.

	Size Class (cm)																												Total
Species	5	6	7	8	9	10	11	12	13	14	16	17	18	19	20	21	22	23	25	27	31	39	40	45	47	48	61	94	Measured
Atractoscion nobilis	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Citharichthys stigmaeus	1	-	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7
Cymatogaster aggregata	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Engraulis mordax	-	-	-	-	-	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
*Heterodontus francisci**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	2
Leptocottus armatus	-	-	-	-	-	1	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
*Myliobatis californica***	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
Odontopyxis trispinosa	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Ophidion scrippsae	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Paralabrax clathratus	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Phanerodon furcatus	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
*Platyrhinoidis triseriata**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	1	-	-	-	3
Pleuronichthys guttulatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1
Porichthys myriaster	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Porichthys notatus	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	2
Sardinops sagax	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Seriphus politus	-	-	-	-	-	-	-	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Symphurus atricaudus	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Syngnathus leptorhynchus	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	3	-	1	-	-	-	-	-	-	-	-	7
Syngnathus sp	-	-	-	-	-	-	-	-	-	-	-	1	-	1	3	2	1	1	1	-	-	-	-	-	-	-	-	-	10
*Torpedo californica**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	2

Note: * = Total Length, ** = Disc Width

Appendix G-7. Abundance of macroinvertebrates impinged during normal operations by survey date. Ormond Beach Generating Station NPDES, 2009.

Species	10/3/2008	11/14/2008	12/13/2008	2/11/2009	4/21/2009	5/18/2009	7/25/2009	8/21/2009	9/11/2009	Total Abundance
Crangon nigromaculata	-	1	-	65	36	1	19	-	-	122
Metacarcinus anthonyi	-	10	2	54	27	-	1	-	-	94
Romaleon antennarius	18	4	6	24	9	2	3	2	-	68
Portunus xantusii	1	-	-	30	-	1	-	-	-	32
Lysmata californica	-	-	-	4	-	1	3	9	1	18
Octopus bimaculatus/bimaculoides	-	-	-	-	-	-	1	7	-	8
Cancer productus	1	-	2	-	1	-	-	1	-	5
Doryteuthis opalescens	-	-	-	2	-	-	-	-	-	2
Chrysaora colorata	-	-	-	-	-	-	-	1	-	1
Metacarcinus gracilis	1	-	-	-	-	-	-	-	-	1
Total Abundance	21	15	10	179	73	5	27	20	1	351
Number of Species	4	3	3	6	4	4	5	5	1	10

Appendix G-8. Biomass (kg) of macroinvertebrates impinged during normal operations by survey date. Ormond Beach Generating Station NPDES, 2009.

Species	10/3/2008	11/14/2008	12/13/2008	2/11/2009	4/21/2009	5/18/2009	7/25/2009	8/21/2009	9/11/2009	Total Biomass (kg)
Metacarcinus anthonyi	-	0.643	0.210	4.871	3.175	-	0.118	-	-	9.017
Romaleon antennarius	1.135	0.371	0.306	2.210	0.628	0.249	0.343	0.212	-	5.454
Chrysaora colorata	-	-	-	-	-	-	-	0.903	-	0.903
Cancer productus	0.073	-	0.229	-	0.134	-	-	0.081	-	0.517
Crangon nigromaculata	-	0.002	-	0.244	0.117	0.002	0.056	-	-	0.421
Octopus bimaculatus/bimaculoides	-	-	-	-	-	-	0.049	0.229	-	0.278
Portunus xantusii	0.015	-	-	0.134	-	0.008	-	-	-	0.157
Doryteuthis opalescens	-	-	-	0.071	-	-	-	-	-	0.071
Lysmata californica	-	-	-	0.012	-	0.004	0.010	0.024	0.005	0.055
Metacarcinus gracilis	0.015	-	-	-	-	-	-	-	-	0.015
Total Biomass (kg)	1.238	1.016	0.745	7.542	4.054	0.263	0.576	1.449	0.005	16.888

Appendix G-9. Estimated monthly abundance of macroinvertebrates impinged during normal operations. Ormond Beach Generating Station NPDES, 2009.

	2008		2008/2009			2009				Total
Species	Oct	Nov	Dec/Jan	Feb/Mar	May/Jun	Apr	Jul	Aug	Sep	Abundance
Crangon nigromaculata	-	16	-	1,239	187	5	478	-	-	1,925
Metacarcinus anthonyi	-	157	35	1,029	140	-	25	-	-	1,386
Romaleon antennarius	173	63	104	457	47	10	75	43	-	972
Portunus xantusii	10	-	-	572	-	5	-	-	-	587
Lysmata californica	-	-	-	76	-	5	75	191	28	375
Octopus bimaculatus/bimaculoides	-	-	-	-	-	-	25	149	-	174
Cancer productus	10	-	35	-	5	-	-	21	-	71
Doryteuthis opalescens	-	-	-	38	-	-	-	-	-	38
Chrysaora colorata	-	-	-	-	-	-	-	21	-	21
Metacarcinus gracilis	10	-	-	-	-	-	-	-	-	10
Total Abundance	203	236	174	3,411	379	25	678	425	28	5,559
Number of species	4	3	3	6	4	4	5	5	1	10

Appendix G-10. Estimated monthly biomass (kg) of macroinvertebrates impinged during normal operations. Ormond Beach Generating Station NPDES, 2009.

	2008		2008/2009			2009				Total
Species	Oct	Nov	Dec/Jan	Feb/Mar	May/Jun	Apr	Jul	Aug	Sep	Biomass (kg)
Metacarcinus anthonyi	-	10.08	3.63	92.85	16.50	-	2.97	-	-	126.03
Romaleon antennarius	10.92	5.82	5.29	42.13	3.26	1.28	8.63	4.51	-	81.84
Chrysaora colorata	-	-	-	-	-	-	-	19.21	-	19.21
Cancer productus	0.70	-	3.96	-	0.70	-	-	1.72	-	7.08
Crangon nigromaculata	-	0.03	-	4.65	0.61	0.01	1.41	-	-	6.71
Octopus bimaculatus/bimaculoides	-	-	-	-	-	-	1.23	4.87	-	6.10
Portunus xantusii	0.14	-	-	2.55	-	0.04	-	-	-	2.73
Doryteuthis opalescens	-	-	-	1.35	-	-	-	-	-	1.35
Lysmata californica	-	-	-	0.23	-	0.02	0.25	0.51	0.14	1.15
Metacarcinus gracilis	0.14	-	-	-	-	-	-	-	-	0.14
Total Biomass (kg)	11.90	15.93	12.88	143.76	21.07	1.35	14.49	30.82	0.14	252.34

Appendix G-11. Total abundance of the top 20 fish impinged during heat treatments and extrapolated normal operations, 1990 - 2009. Ormond Beach Generating Station NPDES, 2009.

	Year																					Percent	
Species	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Total	Total	Mean
Seriphus politus	7460	43501	16697	82521	16382	24008	4218	4725	6632	161	361	3057	11089	2684	375	882	202	-	287	16	225258	59.29	11262.9
Sardinops sagax	322	86	110	1643	362	1056	197	2921	21434	24	89	295	483	107	632	156	28	2	25	19	29991	7.89	1499.5
Cymatogaster aggregata	278	270	997	1333	1023	8830	503	2423	891	8	366	542	532	1397	1113	2716	725	34	18	17	24016	6.32	1200.8
Engraulis mordax	301	365	891	631	2022	1600	2169	4329	73	177	564	1144	2095	4076	1395	426	578	-	18	57	22911	6.03	1145.5
Hyperprosopon argenteum	1506	1521	3942	550	126	616	10	1353	431	-	2	611	432	266	11	143	80	-	-	-	11600	3.05	580.0
Phanerodon furcatus	1606	987	1054	1019	1169	2454	395	926	158	-	35	36	75	86	55	229	204	78	-	38	10604	2.79	530.2
Porichthys notatus	1844	1484	999	490	336	432	11	-	-	46	58	1	172	2	-	-	257	26	36	10	6204	1.63	310.2
Peprilus simillimus	1	157	72	738	22	16	4	1	1	-	5	3350	186	280	8	30	124	-	-	-	4995	1.31	249.8
Citharichthys stigmaeus	-	390	230	504	60	240	-	-	-	-	461	1330	102	454	40	19	921	-	14	133	4898	1.29	244.9
Genyonemus lineatus	14	707	149	2506	58	679	50	4	433	-	-	101	65	5	-	-	-	-	-	-	4771	1.26	238.6
Atherinops affinis	9	105	30	49	-	44	310	1620	204	-	-	974	37	-	-	-	228	-	-	-	3610	0.95	180.5
Scomber japonicus	10	11	1848	400	451	262	5	1	54	-	-	4	1	-	-	3	45	4	-	-	3099	0.82	155.0
Platyrhinoidis triseriata	46	322	33	200	76	60	2	50	72	-	29	565	21	205	61	37	127	-	18	43	1967	0.52	98.3
Syngnathus leptorhynchus	-	-	-	-	-	-	-	-	-	-	-	-	13	22	416	299	301	111	632	135	1929	0.51	96.5
Paralabrax nebulifer	159	154	435	142	102	164	47	63	9	13	159	244	59	70	35	22	-	-	-	-	1877	0.49	93.9
Pleuronichthys verticalis	64	118	126	268	104	99	-	99	70	-	202	219	-	74	61	13	101	-	-	-	1618	0.43	80.9
Leuresthes tenuis	1	593	364	83	11	-	-	-	-	-	-	127	2	347	-	-	-	-	-	-	1528	0.40	76.4
Leptocottus armatus	73	16	27	85	23	1	7	30	98	92	175	463	16	67	121	68	98	-	-	57	1517	0.40	75.9
Trachurus symmetricus	194	15	8	266	275	499	-	2	11	-	-	1	-	1	64	60	-	-	55	-	1451	0.38	72.5
Myliobatis californica	-	53	78	154	85	2	1	8	15	2	-	740	14	66	-	24	103	-	4	19	1368	0.36	68.4
Number of individuals	14680	51860	28796	94602	23403	41996	8664	19266	31545	761	3078	15382	16209	11132	4987	6216	4910	416	1206	786	379895		18994.7
Number of species	54	65	54	60	59	48	41	38	47	28	42	49	54	53	41	47	41	11	16	21	121		43.5

Appendix G-12. Total abundance of the top 20 macroinvertebrates impinged during heat treatments and estimated normal operations, 1994 - 2009. Ormond Beach Generating Station NPDES, 2009.

	YEAR																Percent	Cum.
Species	1994	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Total	Mean	Total	Percent
Romaleon antennarius	138	4434	571	377	5184	5687	79	255	8590	23931	3566	1,074	688	972	55546	3967.6	33.56	33.6
Thetys vagina	14	-	-	11488	145	387	9599	29	40	-	3621	-	58	-	25381	1812.9	15.33	48.9
Metacarcinus anthonyi	15636	55	-	-	-	-	-	29	-	-	1591	535	1,204	1,386	20436	1459.7	12.35	61.2
Cancer productus	42	-	-	-	11	-	4559	28	4767	1662	4364	234	145	71	15883	1134.5	9.60	70.8
Lysmata californica	353	510	90	22	64	4	371	14	17	457	7265	368	14	375	9924	708.9	6.00	76.8
Crangon nigromaculata	35	-	-	417	144	3060	916	58	1236	129	348	92	260	1,925	8620	615.7	5.21	82.0
Metacarcinus gracilis	708	-	-	-	-	1201	1	14	1587	487	2258	62	13	10	6341	452.9	3.83	85.9
Portunus xantusii	2352	99	560	730	235	194	355	43	20	12	127	47	4	587	5365	383.2	3.24	89.1
Chrysaora colorata	304	77	24	2	1823	-	489	202	-	12	5	140	12	21	3112	222.3	1.88	91.0
Farfantepenaeus californiensis	7	-	1	-	29	39	-	-	-	-	2220	-	-	-	2296	164.0	1.39	92.4
Pachygrapsus crassipes	1447	-	88	9	5	5	6	2	351	47	221	-	-	-	2181	155.8	1.32	93.7
Pisaster giganteus	1	1233	-	-	9	-	-	-	-	-	20	75	25	-	1363	97.4	0.82	94.5
Loligo opalescens	80	26	-	23	203	232	59	101	44	23	445	-	6	-	1242	88.7	0.75	95.3
Polyorchis penicillata	35	-	-	23	-	1	-	29	433	254	83	18	-	-	876	62.6	0.53	95.8
Octopus bimaculatus/bimaculoides	14	39	7	73	27	27	28	209	55	57	118	4	37	174	869	62.1	0.53	96.3
Romaleon jordani	-	-	-	75	316	-	-	-	2	195	112	-	98	-	798	57.0	0.48	96.8
Anthopleura xanthogrammica	-	-	-	-	-	-	-	-	-	-	691	-	-	-	691	49.4	0.42	97.2
Pisaster sp	35	-	3	15	-	15	391	45	49	111	-	26	-	-	690	49.3	0.42	97.6
Pyromaia tuberculata	483	-	12	1	-	-	1	-	-	-	171	-	-	-	668	47.7	0.40	98.0
Aurelia labiata	-	-	-	-	-	-	-	-	-	-	-	-	657	-	657	46.9	0.40	98.4
Number of individuals	21785	6524	1368	13312	8764	11225	16958	1196	17368	27570	27746	2877	3259	5559	165511	13057.8		
Number of species	26	12	12	16	19	19	19	20	19	19	27	16	16	10	45	18.7		

Note: 0.00 = <0.005